

Student Perceptions of Mathematics Learning and Achievement in the Global East, Middle, and West: A Comparative Study from TIMSS 2023

Shashidhar Belbase^{*1}, Kenneth J. Roblee¹, Nicholas Alan Newman¹, Bed Raj Acharya², Mukunda Prakash Kshetree², Bishnu Khanal², Ram Krishna Panthi², Yagya Prasad Gnawali²

¹ *Department of Mathematics, College of Science and Engineering, Troy University, Troy, Alabama, USA*

² *Faculty of Education, Tribhuvan University, Kathmandu, Nepal*

Abstract

This study examines the intricate relationship between eighth-grade students' perceptions of mathematics learning and their academic achievement, positing that student perceptions significantly influence engagement with mathematical tasks, activities, and problem-solving. Utilizing open data from the 2023 Trends in International Mathematics and Science Study (TIMSS), this research analyzes and compares these perceptions against average mathematics achievement across a selection of countries from the Global East, Middle, and West. Findings reveal a counterintuitive trend in the Global East, where students exhibit negative perceptions of mathematics learning despite consistently achieving high scores on international assessments. Conversely, students in the Global Middle report positive perceptions of mathematics, yet their average achievement falls below the international average. Students in the Global West present a more varied outcome, demonstrating mixed levels of perceptions and achievement. Collectively, these results suggest that a direct, positive correlation between students' perceptions of mathematics learning and their average achievement is not universally evident, challenging conventional assumptions about this relationship.

Keywords: student perceptions; perceptions of mathematics learning; mathematics achievement.

MSC Classification: 51F30, 51F99

*Corresponding Author.

Email addresses: sbelbase@troy.edu, kroblee@troy.edu, newman@troy.edu, bedraj@cded.tu.edu.np, mpkshetree@yahoo.com, Bishnu.khanal@mrc.tu.edu.np, panthirk2031@mrc.tu.edu.np, yagya@mrc.tu.edu.np

1. Introduction

Mathematics is an indispensable discipline that plays a pivotal role across various academic and professional fields, making it both challenging and rewarding for students (Etuk et al., 2013). Despite its undeniable significance in daily life and several professional fields, many students struggle to grasp the underlying concepts, procedures, and application skills in mathematics (Hagan et al., 2020). In this context, there is a general consensus that students' perceptions of mathematics and their learning experiences significantly impact their achievement (Alemany-Arrebola et al., 2025; Wakhata et al., 2022). Students' experiences with mathematics are diverse: while some find joy and intrinsic motivation in mathematics learning due to its logical structure and problem-solving aspects, others experience fear or frustration, often stemming from past negative encounters or low self-confidence (Grootenboer et al., 2016).

How students perceive mathematics learning may influence their performance in either positive or negative ways, leading to mixed results in the research literature. On one hand, studies reported a negative association, suggesting that low achievement is related to high degree of negative anxiety, low self-esteem, and low confidence in mathematics. For example, Hagan et al. (2020) reported a negative association between student perceptions and their mathematics performance, while Kanafiah and Jumadi (2013) emphasize the common fear and nervousness when confronted with mathematical tasks. Unfortunately, some students develop negative perceptions students harbor when confronted with mathematics. Such negative perceptions can lead to anxiety and aversion toward math during classroom learning, leading them to avoid math-related tasks and forego careers in the field, hindering their financial prospects and overall life satisfaction (Kanafiah & Jumadi, 2013). Conversely, a positive relationship between students' perceptions of mathematics learning and their achievement has been reported by Byiringiro (2024) and Matney et al. (2022). Ampadu (2012) highlights that those students who genuinely enjoy learning mathematics tend to exhibit higher motivation levels and a willingness to invest additional effort, translating into improved performance and a deeper conceptual understanding.

The underlying varied perceptions of mathematics are complex and multifaced, stemming from different personal, institutional, social, cultural, and political factors. Some theories suggest that students' emotional responses about learning, achievement, and feeling of mathematics transform into perceptions and later consolidate as beliefs (Furinghetti & Pehkonen, 2002; Garofalo, 1989; Kasmin et al., 2019;), which significantly impact their performance (Ferreira & Santoso, 2008; Kunwar, 2021). Mata et al. (2012) further underscore the impact of prior negative experiences, stressful exams, and societal views that mathematics is inherently difficult, which exacerbate negative feelings. However, these perceptions are influenced by various factors: school environment, teacher attitudes and beliefs, teaching methods, and parental perspectives all contribute to students' overall outlook on mathematics learning (Asante, 2012). Recognizing and addressing these perceptual, attitudinal, and contextual aspects in mathematics teaching and learning is crucial for enhancing students' mathematical competence and achievement.

Despite the recognized effects of students' perceptions of mathematics learning on their achievement, Vionita and Purboningsih (2017) reveal that there is room for improvement in understanding this relationship fully. It is particularly interesting for the mathematics education community to understand students' perceptions of mathematics learning and

compare these perceptions with their average achievement across diverse social and cultural contexts in regions such as the Global East, Middle, and the West. This study, therefore, seeks to answer the following questions: How do eighth-grade students perceive mathematics learning in the Global East, Middle, and West? How do eighth-grade students perceptions of mathematics learning compare to their average achievement scores in the Global East, Middle, and West?

The TIMSS 2023 Grade 8 participating countries are classified into three analytical regions in this study: Global East, Global Middle, and Global West. This division is not strictly geographical but rather culturally contextual, established to group countries with similar dominant cultural influences:

Global East: Defined by a shared Asian cultural context.

Global Middle: Characterized by shared Middle Eastern, Arab, and African cultural contexts.

Global West: Defined by common cultural contexts influenced by European and American (North and South) traditions.

The participating countries in TIMSS 2023 grade eight and our division of them in the Global East, Middle, and West is shown in Figure 1.



Figure 1. Countries that participated in the TIMSS 2023 grade 8 and their achievement in mathematics in the Global East, Middle, and West (Map Source: https://www.reddit.com/r/MapPorn/comments/1h6sb1s/summary_of_timss_2023_results_in_mathematics_at/#lightbox)

2. Perceptions of Mathematics Learning in the Global East

In the Global East, mathematics is valued highly within the education system, often seen not just as an academic discipline, but as a sign of intelligence and a strong predictor of success in school education, resulting in its compulsory status up to the secondary level in most countries. Unfortunately, this high cultural value of mathematics often translates into a strong emphasis on academic achievement in tests through procedural fluency (Yang, 2013). Such environment places most students under pressure from high-stakes testing and teacher-centered instructional strategies (OECD, 2023). In this sense, the perspectives of students towards mathematics learning are largely influenced by pedagogical approaches and evaluation processes.

In most schools in the Eastern region, the instructional approach is found to be very structured, focusing on teacher-centered practices, memorizing facts, and repeatedly practicing the same problems. This rigorous approach has a dual impact: on one hand, it helps students build strong foundational skills, which often contributes to perform better on paper-and-pencil tests (Wang et al., 2023). On the other hand, it leads students to feel that mathematics is a rigid, abstract, and less interesting subject (Li, 2012b), frequently resulting in feelings of fear and anxiety (Liu & Wang, 2021). Despite moderate recent shifts toward more student-focused interactive models emphasizing problem-solving skills and real-life problems, which have led to slight increase in positive sentiment toward mathematics (Boaler, 2016; Hwang & Son, 2021). None the less, the low performance of some students in mathematics has been attributed to their negative perceptions and beliefs stemming from inadequate support and a lack of effective classroom participation (Hwang & Son, 2021).

It is critical to note that the Global East exhibits significant internal differences regarding student attitudes. Studies suggest that students in East Asian countries like Singapore (Eric, 2011; Wong & Chen, 2012), China (Zhang & Zhang, 2020), Japan (Leung et al., 2015), and Vietnam (OECD, 2015) generally show positive attitudes toward mathematics. In stark contrast, most countries from the Indian subcontinent like India (Roshni, 2021 July 13; Sasidharan & Kareem, 2023) and Nepal (Marasini et al., 2025) exhibit negative perceptions and attitudes towards school mathematics.

3. Perceptions of Mathematics Learning in the Global Middle

Mathematical knowledge and skills are widely recognized for their pivotal role in framing students cognitive and analytical strategies, including problem-solving abilities. Nevertheless, in the Global Middle, students' attitudes, experiences, and beliefs about mathematics are subject to significant variation due to diverse cultural practices, socioeconomic conditions, societal expectations, pedagogical strategies (Alemany-Arrebola et al., 2025). The regional context creates a blend of positive recognition for mathematics alongside substantial pressures and anxieties. In this context, in some regions, the emphasis on a rigorous curriculum and rote learning creates distinct challenges. For instance, Avila-Mangarin and Montefolka (2023) report that Jordanian eighth-grade students perceive mathematics as a challenging subject, albeit with a positive attitude, frequently expressing anxiety and stress related to mathematics, stemming from high-stakes examinations and societal expectations. This pressure can lead to a feeling that mathematics is a challenging subject rather than an enjoyable one (Avila-Mangarin & Montefolka, 2023). Despite these feelings, most students still recognize the importance of mathematics learning for academic and future career pursuits, with boys often expressing more confidence than girls (Anokye & Ampadu, 2020). Generally, while a small portion of students may lack enthusiasm about the subject, the majority in those contexts do not view mathematics as an outright negative experience (Barroso et al., 2021; Berger et al., 2020; Galende et al., 2020).

Conversely, other nations in the Global Middle, particularly those that have prioritized curriculum and policy reforms, demonstrate distinctly positive perceptions of mathematics learning. For example, UAE students often exhibit a positive perception of mathematics learning, largely because the curriculum emphasizes critical thinking, problem-solving, and real-world applications through a practical engagement, competitions, and STEM-related activities (Jiang et al., 2024). Many students in the region recognize the relevance of mathematics in various aspects of life, including finance, engineering, and technology, which enhances their motivation to engage with the subject (Dowker et al., 2019; Ing & Nylund-Gibson, 2017). Similarly, in Uzbekistan, recent educational reform with modernizing curriculum by introducing practical and applied mathematics has also had a positive influence on students perceptions and attitudes (Alemany-Arrebola et al., 2025). Students

strongly agree that they enjoy mathematics, with a robust positive sentiment toward the subject, perceiving it as an enjoyable subject (Geary et al., 2023; Libradilla et al., 2023).

Overall, eighth-grade students across most of the Global Middle generally hold a positive perceptions and attitudes toward mathematics learning (Suherman & Vidákovich, 2024), with a few notable exceptions, such as Pakistan (Bashir et al., 2023), where negative perceptions and attitudes prevail. It shows that mathematics is considered one of their preferred subjects, though not necessarily the absolute favorite, as claimed by Suherman and Vidákovich (2024). This general positive sentiment is often directly linked to achievement, as studies show a strong positive correlation between students' perceptions and their average mathematics performance (Mutodi & Ngirande, 2014).

4. Perceptions of Mathematics Learning in the Global West

Research on student perceptions of mathematics learning in the Global West reveals a diverse landscape where affective and cognitive factors play a major role in achievement. Empirical studies consistently demonstrate that psychological variables such as value, confidence, and self-concept have a moderate relation with enjoyment (Luo et al., 2016; Peixoto et al., 2017), and the relation between enjoyment and achievement indicate a moderate to strong positive interrelation (Van der Beek et al., 2017). Consequently, a multidimensional definition of mathematics learning perceptions is adopted, combining specific mathematical cognitions (value, gender roles/beliefs, confidence, self-concept), affects (enjoyment, anxiety) and behavioral intentions (i.e., willingness and tendency to spend more time learning mathematics subjects) (Wen & Dubé, 2022).

Student perceptions of mathematics learning and the factors influencing them vary significantly across Western nations. In Australia, primary students generally view mathematics as an important discipline and feel confident in their ability to learn it. However, internal cultural and gender dynamics influence these perceptions significantly. Han (2019) reported that boys rated their math competence higher and outperformed girls on math tests, although gender stereotypes did not affect the self-concept of math. Conversely, culture played a key role, with indigenous students reporting less enjoyment in learning mathematics compared to their non-Indigenous peers. A 2024 report from the Australian Council for Educational Research (ACER), based on OECD PISA data, highlighted that higher mathematics performance was associated with a positive classroom environment, strong teacher-student relationships, and a sense of belonging. Conversely, the report found that bullying and lower stress resilience negatively impacted students enjoyment and achievement in the subject (De Bortoli et al., 2024).

The pattern of emphasizing positive affective experiences is echoed in other Western contexts. Research in Finland, for example, stresses the cultural influences on students' emotional responses to mathematics, showing how individual and inter-individual factors shape learning attitudes (Tuohilampi et al., 2015, 2016). In another study, comparing Ghanaian and Australian primary school students, Davis et al. (2024) found that a majority of students in both countries reported a positive valuation of mathematics learning. Similarly, in the United States, studies consistently highlight the negative impacts of anxiety and negative perceptions on student performance, underscoring the importance of fostering positive attitudes to improve achievement (Matney et al., 2022). Furthermore, Matney et al. (2022) concluded that there was a significant difference between perceptions of doing mathematics between the 8th grade of US and Fiji data, with the US 8 data group having significantly better perceptions of doing mathematics than their counterparts in Fiji. In the US, high school students mathematics beliefs are shaped by various factors, including gender, ethnicity, academic performance, teacher expectations, and cultural context (Roesdiana, 2023).

The importance of self-confidence and self-perception about mathematics learning is strongly evident in Latin and South American nations, considered in the Global West in this study. In Brazil, self-efficacy and attitudes toward mathematics learning play a crucial role in students' performance, underscoring the importance of motivation and confidence in mathematical learning (Iaochite et al., 2025). Similarly, earlier research using TIMSS 1999 data suggested that Chilean students like and value mathematics and mathematics learning, but demonstrated an inflated self-perception of their mathematic competence (Ramírez, 2005). More recent findings from Saadati et al. (2023) confirmed that students perceived difficulty, expectations for further education, and beliefs about the causes of their mathematics outcomes were significant predictors of achievement in Chile.

As per the literature, students perceptions of mathematics learning demonstrate divergent regional emphases across the Global East, Middle, and West, influenced primarily by cultural value and pedagogical practice. In the Global East, mathematics is highly valued as a sign of success, but this cultural pressure often leads to structured, teacher centered instruction focused on procedural fluency and high-stakes testing, resulting in a mixed outcome of high test performance (Wang et al., 2023) alongside frequent reports of fear and anxiety (Liu & Wang, 2021). The Global Middle presents a blended picture, balancing a general recognition of mathematics importance with significant variation: while nations with curriculum modernization (like the UAE and Uzbekistan) show strong positive sentiment and enjoyment (Jiang et al., 2024; Alemany Arrebola et al., 2025), others experience anxiety due to rigorous curricula and rote learning (Avila-Mangarin & Montefolka, 2023). Conversely, the Global West primarily frames perception through a multidimensional affective and cognitive lens (Wen & Dubé, 2022), where factors like self-concept, confidence, and positive classroom environments (De Bortoli et al., 2024) are recognized as major predictors of achievement, highlighting the critical role of psychological and relational factors in fostering positive attitudes and reducing anxiety (Matney et al., 2022).

5. Theoretical Framework

The Cultural-Historical Activity Theory (CHAT) (Roth & Radford, 2011; Vygotsky, 1978) provides a robust theoretical framework for understanding differences in students' perceptions of mathematics across the Global East, Middle, and West. Students' views of mathematics learning and their academic achievement do not develop in isolation; rather, they are deeply rooted in historical, social, and cultural contexts. CHAT hypothesizes that all human actions—including students' engagement in mathematics learning—are mediated by social and cultural artifacts and shaped by the broader historical environment in which they occur (Roth & Radford, 2011). Consequently, the differences observed in students' mathematical perceptions and perceptions of learning and performance across world regions (as reflected in assessments such as TIMSS) can be interpreted through their distinguishing cultural and educational contexts. CHAT offers a methodical way to examine these regional variances by focusing on the interplay among the key components of the activity system within mathematics classrooms:

Subjects (Persons): Students and teachers who participate in the learning process.

Actions (Processes): The methods and practices through which mathematics is taught and learned.

Mediating Artifacts: The socio-cultural and historical factors that shape activity, such as national education policies, curricular reforms, and standardized assessments, including classroom resources and language of interactions.

Outcomes (Products): Students' mathematics learning experiences, which influence their perceptions, beliefs, attitudes, and ultimately, achievement.

The historical and cultural trajectories of the three regions have shaped their mathematics classroom activities in distinct ways, influencing how students perceive and experience mathematics:

Global East: The educational culture places a strong emphasis on mathematics as a gateway to higher education and career success, often mediated by high-stakes testing. This system prioritizes procedural fluency and measurable achievement, resulting in high performance levels but frequently accompanied by heightened anxiety and performance pressure among students.

Global Middle: This region reflects an ongoing shift toward modernization and curriculum reform. National initiatives aim to move from rote memorization toward fostering critical thinking and real-world problem solving. Consequently, students' perceptions of mathematics are in transition—showing diverse, often positive attitudes but not always aligning consistently with achievement outcomes.

Global West: The educational tradition emphasizes conceptual understanding, inclusiveness, and the psychological well-being of learners. Instruction focuses on enjoyment, confidence, and self-efficacy, fostering a strong link between positive affective factors (such as attitudes and perceptions) and mathematical achievement.

Hence, CHAT serves as an appropriate theoretical lens for analyzing how students' mathematical perceptions and attitudes are shaped by and interact with their cultural-historical contexts. It enables researchers to trace how affective experiences in mathematics evolve and influence achievement, highlighting the central role of the socio-cultural and historical contexts in mediating students' learning (Roth & Radford, 2011).

6. Method of Study

We utilized secondary data for eighth-grade students' perceptions of mathematics and their average achievement for two countries in the Global East, four countries in the Global Middle, and five countries in the Global West from the Trends in International Mathematics and Science Study (TIMSS) 2023 data. The data were retrieved from the publicly available data bank of the TIMSS 2023 International Database (<https://timss2023.org/data/>) (Fishbein et al., 2025). We cleaned the dataset and integrated them into a single data file to ensure data quality by including only the relevant variables. Our primary research question focused on understanding eighth-grade students' perceptions of mathematics learning and how these perceptions compare to their average achievement in TIMSS 2023 in the Global East (Singapore and Japan), Global Middle (Jordan, United Arab Emirates, Uzbekistan, and South Africa), and Global West (Australia, Finland, United States of America, Brazil, and Chile). We selected only two countries (Singapore and Japan) from the Global East because these countries share similar cultural and social contexts. We selected more countries from the Global Middle and the Global West due to wide variations in social and cultural contexts in those regions. The selection of these countries from the TIMSS 2023 database was a random selection from the participating countries to include representative samples from each region. The steps taken in this process are outlined below:

First, we retrieved items of student perceptions of mathematics learning from the TIMSS 2023 context questionnaires for eighth grade (<https://timss2023.org/results/context-questionnaires/>). The nine items were related to the question "How much do you agree with these statements about learning mathematics?" and scaled with using a four-point Likert-type response of "agree a lot, agree a little, disagree a little, and disagree a lot." These nine items were:

- BSBM19A) I enjoy learning mathematics.
- BSBM19B) I wish I did not have to study mathematics.
- BSBM19C) Mathematics is boring.

- BSBM19D) I learn many interesting things in mathematics.
 BSBM19E) I like mathematics.
 BSBM19F) I like any schoolwork that involves numbers.
 BSBM19G) I like to solve mathematics problems.
 BSBM19H) I look forward to mathematics class.
 BSBM19I) Mathematics is one of my favorite subjects.

(TIMSS & PIRLS International Study Center, 2025).

Additionally, we obtained eighth-grade students' average mathematics achievement scores for each of the selected countries. Missing data points from students' perceptions were handled by deleting the missing values within the SPSS data file for each of the selected countries. The default coding for the student responses in the TIMSS data were – agree a lot = 1, agree a little = 2, disagree a little = 3, and disagree a lot = 4. The data values were reverse-coded to align higher values with agreement and lower values with disagreement for each study variable. For example, "agree a lot" was coded 1, and "disagree a lot" was coded 4, which were then reverse-coded as 4 and 1, respectively.

Second, we performed a one-sample T-test for each item for the selected country to assess the degree of agreement or disagreement among students for each item. The test value was 2.5 (the average of 1, 2, 3, and 4) as cut-off points for determining the average agreement and disagreement levels for each item. The average values below 2.5 were considered students' disagreement with the statement, and the average values above 2.5 were considered students' agreement with the statement. The significance of the degree of agreement/disagreement as the level of students' perceptions in each statement was assessed at 0.05 level of significance. The output data results in the SPSS together with country average achievement for eighth grade students in mathematics were retrieved in Excel Spreadsheet for construction of charts for visualization of average perceptions for each selected countries and regions and their average achievement scores in mathematics in TIMSS 2023.

Third, we constructed column charts to demonstrate and compare the average perceptions of students in each item (along the y-axis). The average achievement in mathematics for each country was presented with the country name (along the x-axis). Then, students' perceptions of mathematics learning were assessed based on the cut-off value of 2.5, for which average perceptions below 2.5 were considered negative perceptions in that item for the country, and an average value above 2.5 was considered positive perceptions and significant at 0.05 level.

7. Results

The results of the study are presented separately for each of the nine perceptual items related to students' perceptions of mathematics learning in TIMSS 2023 eighth-grade students. Each item presented a unique perception of mathematics learning, and hence, it was deemed suitable to present them separately instead of computing a single grouped or composite perception value.

Enjoy Learning Mathematics

The analysis of student perceptions of mathematics learning, based on one-sample t-tests against the test value of 2.5 (mid-value), provides meaningful insights into their perceptions of learning the subject in the Global East, Middle, and West. The results for the first item, "I enjoy learning mathematics," are presented in Table 1 and Figure 2.

Table 1. Student perception of mathematics with reference to the item "I enjoy learning mathematics."

Table 1. Student perception of mathematics with reference to the item "I enjoy learning mathematics."

Test Value = 2.5												
Global Region	Country	N	Mean	STD V	t	df	Significance		Mean Difference	95% C.I. of the Difference		Effect Size
							One-Sided p	Two-Sided p		Lower	Upper	
Global East	Japan (595)	3730	2.68	0.9	12.062	3729	<.001	<.001	0.178	0.15	0.21	0.197
	Singapore (605)	4728	2.93	1.012	28.94	4727	<.001	<.001	0.426	0.4	0.45	0.421
Global Middle	Jordan (388)	6451	3.09	1.05	44.989	6450	<.001	<.001	0.588	0.56	0.61	0.56
	UAE (489)	30235	2.94	1.048	73.502	30234	<.001	<.001	0.443	0.43	0.45	0.423
	Uzbekistan (421)	4207	3.5	0.76	85.024	4206	<.001	<.001	0.996	0.97	1.02	1.311
	South Africa (397)	10487	3.35	0.85	102.49	10486	<.001	<.001	0.851	0.83	0.87	1.001
Global West	Australia (509)	4539	2.29	0.99	-	4538	<.001	<.001	-0.208	-0.24	-0.18	-0.211
	Finland (504)	5594	2.35	0.964	-	5593	<.001	<.001	-0.148	-0.17	-0.12	-0.153
	USA (488)	7682	2.62	1.041	10.15	7681	<.001	<.001	0.121	0.1	0.14	0.116
	Brazil (378)	21092	2.91	1.032	57.004	21091	<.001	<.001	0.405	0.39	0.42	0.393
	Chile (416)	4298	2.85	0.957	24.072	4297	<.001	<.001	0.351	0.32	0.38	0.367

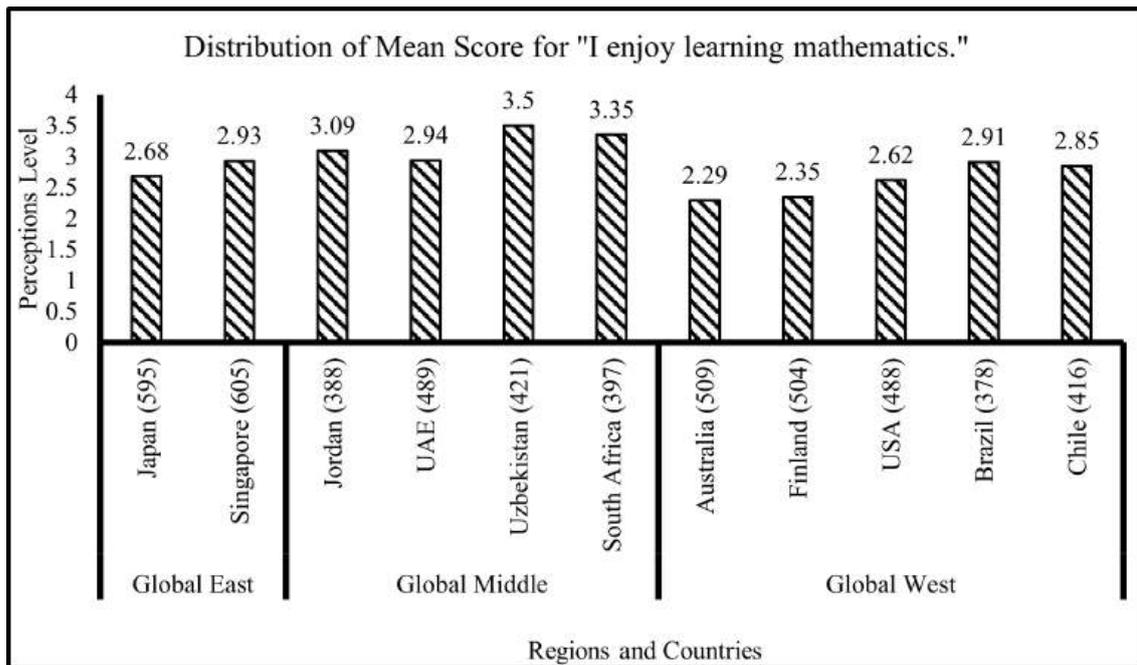


Figure 2. Distribution of average student perceptions related to enjoyment in mathematics learning

We examined responses to the statement, "I enjoy learning mathematics," and compared these to their average mathematics achievement scores from TIMSS 2023, with the international average set at 500. Students in the Global East exhibit a strong connection between enjoying math and performing well. In Japan, students generally tend to enjoy math (Mean = 2.68, SD = 0.90; $t = 12.062$, $p < .001$, Cohen's $d = .197$). This slight positive inclination aligns with their impressive mean mathematics achievement of 595, which is significantly above the international average of 500. Even stronger positive feelings were found in Singapore, where students expressed a clear enjoyment of learning mathematics (Mean = 2.93, SD = 1.012; $t = 28.940$, $p < .001$, Cohen's $d = .421$). Their mean achievement score

in TIMSS 2023 was 605, signifying that their enjoyment of learning mathematics is indeed corroborated by high achievement.

The Global Middle presents an intriguing contrast, where high enjoyment of mathematics does not always translate into high achievement. Students in Jordan agreed that they enjoy learning mathematics (Mean = 3.09, SD = 1.05; $t = 44.989$, $p < .001$, Cohen's $d = 0.560$). Yet, their average achievement score in TIMSS 2023 was 388, which is significantly below the international average of 500, suggesting a negative correlation between enjoyment and average achievement. Similarly, for UAE students, agreement with enjoying mathematics learning was strong (Mean = 2.94, SD = 1.048; $t = 73.502$, $p < .001$, Cohen's $d = 0.423$). Nevertheless, their country average of 489, slightly below the international average, suggests a negative relationship between enjoyment and achievement in mathematics. In Uzbekistan, students strongly agreed with enjoying mathematics learning (Mean = 3.50, SD = 0.76; $t = 85.024$, $p < .001$, Cohen's $d = 1.311$), indicating very strong agreement. Despite this, their mean achievement score was 421, significantly below the international average of 500. Finally, South African students also showed a strong positive response to enjoying mathematics learning (Mean = 3.35; $t = 102.499$, $p < 0.001$, Cohen's $d = 1.001$). But, their average achievement of 397 in TIMSS 2023 mathematics was below the international average, reflecting a negative direction between enjoyment and average achievement.

The relationship between enjoyment in mathematics learning and achievement in the Global West is quite varied. Interestingly, Australian students generally disagreed with the statement "I enjoy learning mathematics" (Mean = 2.29, SD = 0.990; $t = -14.182$, $p < .001$, Cohen's $d = -0.211$). Despite this, their average mathematics achievement in TIMSS 2023 was 509, slightly above the international average of 500. Similarly, Finnish students also disagreed with enjoying mathematics learning (Mean = 2.35, SD = 0.964; $t = -11.457$, $p < .001$, Cohen's $d = -0.153$). Their average achievement in TIMSS 2023 was 504, also slightly above the international average, suggesting that a lack of explicit enjoyment does not necessarily hinder their performance.

In contrast, American students agreed that they enjoyed mathematics (Mean = 2.62, SD = 1.041; $t = 10.150$, $p < .001$, Cohen's $d = 0.116$). On the other hand, their average achievement score in TIMSS 2023 mathematics was 488, slightly below the international average. Students in Brazil also generally agreed that they enjoyed learning mathematics (Mean = 2.91, SD = 1.032; $t = 57.004$, $p < .001$, Cohen's $d = 0.393$). Despite this moderate agreement, their average achievement in TIMSS 2023 mathematics was 378, significantly below the international average of 500. Lastly, Chilean students agreed that they enjoyed mathematics learning (Mean = 2.85, SD = 0.957; $t = 24.072$, $p < .001$, Cohen's $d = 0.367$). Nevertheless, their average achievement score of 416 in TIMSS 2023 was below the international average, suggesting that students enjoyment did not align with their achievement scores.

In summary, while the Global East generally shows a positive alignment between enjoyment and high achievement in mathematics, the Global Middle consistently demonstrates a disconnect where high enjoyment does not translate into above-average achievement. The Global West presents a more varied picture, with some countries achieving above-average performance despite lower enjoyment and others showing positive enjoyment without reaching the international average.

Wish not to Study Mathematics

This analysis examines 8th-grade students responses to the statement, "I wish I did not have to study mathematics," and explores how their desire to avoid math correlates with their average achievement scores from TIMSS 2023 (international average = 500). A mean score above 2.5 indicates agreement with the negative statement (wishing to avoid math), while a score below 2.5 indicates disagreement. The details of these results are presented in Table 2 and Figure 3.

Students in the Global East generally show a lower desire to avoid mathematics, aligning with their high achievement. In Japan, students disagreed with the statement "I wish I did not have to study mathematics" (Mean = 2.26, SD = 0.901; $t = -15.999$, $p < .001$, Cohen's $d = -0.262$). This indicates they do not wish to avoid studying mathematics. Their mean achievement in mathematics is 595, significantly above the international average of 500, suggesting a positive relationship between not wanting to avoid math and high performance. For Singaporean students, the results for "I wish I did not have to study mathematics" (Mean = 2.48, SD = 1.093; $t = -1.553$, $p = .120$, Cohen's $d = -0.023$) were not statistically significant. This suggests that students neither strongly agree nor disagree with the idea of avoiding math. Despite this neutrality, their mean achievement score in TIMSS 2023 was 605, signifying high achievement.

In the Global Middle, there is a nuanced picture regarding the desire to avoid mathematics, which often does not align with their lower achievement scores. Jordanian students showed some disagreement with the statement "I wish I did not have to study mathematics" (Mean = 2.47, SD = 1.219; $t = -2.238$, $p = .013$, Cohen's $d = -0.028$). While statistically significant, the very small effect size suggests that the overall sentiment is not overwhelmingly negative. Yet, their average achievement score in TIMSS 2023 is 388, which is far below the international average of 500, indicating a potential disconnect where a slight disinclination to avoid math does not translate into higher scores. UAE students slightly agreed with "I wish I did not have to study mathematics" (Mean = 2.54, SD = 1.166; $t = 5.483$, $p < .001$, Cohen's $d = 0.032$), suggesting some reluctance but not a strong dislike. Their country's average achievement is 489, slightly below the international average of 500, suggesting a negative relationship between this slight reluctance and achievement. For Uzbekistan, students disagreed with the statement "I wish I did not have to study mathematics" (Mean = 2.29, SD = 1.195; $t = -11.343$, $p < .001$, Cohen's $d = -0.179$). This statistically significant disagreement indicates they do not wish to avoid studying mathematics. Despite this, their mean achievement score was 421, significantly below the international average of 500. South African students strongly indicated that they do not wish to avoid studying mathematics (Mean = 2.06; $t = -40.345$, $p < 0.001$, Cohen's $d = -0.395$). The average achievement of grade eight students in South Africa in TIMSS 2023 was 397, which was below the international average of 500, reflecting a negative direction between not wishing to avoid math and lower achievement.

Table 2. Student perception of mathematics learning concerning the second item, "I wish I did not have to study mathematics."

Global Region	Country	Test Value = 2.5										
		N	Mean	STDV	t	df	Significance		Mean Difference	95% C.I. of the Difference		Effect Size
							One-Sided p	Two-Sided p		Lower	Upper	
Global East	Japan (595)	3723	2.26	0.901	-15.999	3722	<.001	<.001	-0.236	-0.27	-0.21	-0.262
	Singapore (605)	4709	2.48	1.093	-1.553	4708	0.06	0.12	-0.025	-0.06	0.01	-0.023
Global Middle	Jordan (388)	6268	2.47	1.219	-2.238	6267	0.013	0.025	-0.034	-0.06	0	-0.028
	UAE (489)	29889	2.54	1.166	5.483	29888	<.001	<.001	0.037	0.02	0.05	0.032
	Uzbekistan (421)	3994	2.29	1.195	-11.343	3993	<.001	<.001	-0.215	-0.25	-0.18	-0.179
	South Africa (397)	10416	2.06	1.109	-40.345	10415	<.001	<.001	-0.438	-0.46	-0.42	-0.395
Global West	Australia (509)	4519	2.9	1.069	24.917	4518	<.001	<.001	0.396	0.37	0.43	0.371
	Finland (504)	5568	2.7	1.027	14.592	5567	<.001	<.001	0.201	0.17	0.23	0.196
	USA (488)	7628	2.75	1.043	20.958	7627	<.001	<.001	0.25	0.23	0.27	0.24
	Brazil (378)	20295	2.46	1.147	-5.051	20294	<.001	<.001	-0.041	-0.06	-0.02	-0.035
	Chile (416)	4262	2.39	1.057	-7.045	4261	<.001	<.001	-0.114	-0.15	-0.08	-0.108

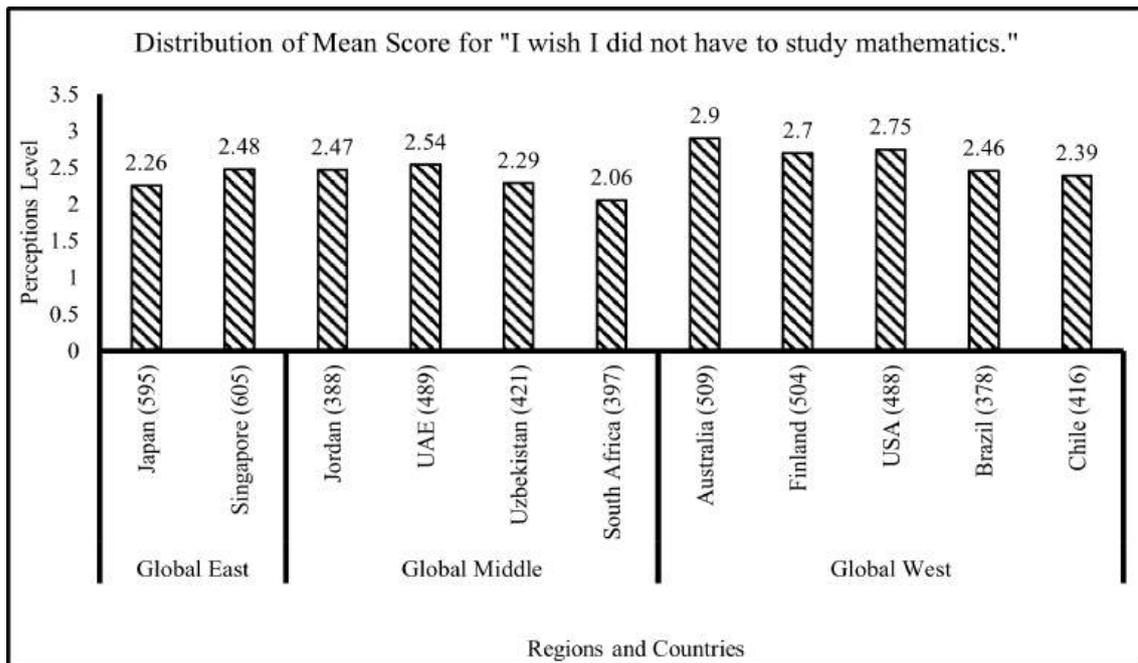


Figure 3. Distribution of average student perceptions related to wish not to study mathematics

The Global West shows a tendency for students to wish they did not have to study mathematics, yet their achievement can vary. Australian students agreed with the statement "I wish I did not have to study mathematics" (Mean = 2.90, SD = 1.069; $t = 24.917$, $p < .001$, Cohen's $d = 0.371$), suggesting that a significant portion would prefer to avoid math. But, their average achievement in mathematics in TIMSS 2023 was 509, slightly above the international average of 500. Similarly, Finnish students agreed with "I wish I did not have to study mathematics" (Mean = 2.70, SD = 1.027; $t = 14.592$, $p < .001$, Cohen's $d = 0.196$), suggesting that many would prefer to avoid it. Despite this, their average achievement in mathematics in TIMSS 2023 was 504, slightly above the international

average. This indicates that for Australia and Finland, a desire to avoid math does not necessarily hinder above-average performance.

For US students, the mean was 2.75 (SD = 1.043; $t = 20.958$, $p < .001$, Cohen's $d = 0.240$) for "I wish I did not have to study mathematics," indicating that they generally wish they did not have to study mathematics. The average achievement score in TIMSS 2023 mathematics for US eighth graders was 488, slightly below the international average. Regarding Brazilian students, the mean score was 2.46 (SD = 1.147; $t = -5.051$, $p < .001$, Cohen's $d = -0.035$) for "I wish I did not have to study mathematics," indicating they tend to disagree with this statement, reflecting a slight but statistically significant tendency towards not wishing to avoid math. Still, their average achievement in TIMSS 2023 mathematics was 378, way below the international average of 500. For Chilean students, the mean score was 2.39 (SD = 1.057; $t = -7.045$, $p < .001$, Cohen's $d = -0.108$), indicating disagreement with the wish to avoid studying mathematics. Despite this, their average achievement score of 416 in TIMSS 2023 was below the international average of 500.

In conclusion, the Global East generally exhibits a positive alignment, where students do not wish to avoid math and achieve high results. The Global Middle often exhibits a significant desire to avoid math, yet their achievement scores remain below the international average. The Global West presents a more mixed picture, with some countries achieving above-average results despite a reported desire to avoid math. In contrast, others exhibit varied relationships between their desire to avoid math and their actual achievement.

Mathematics is Boring

This analysis examines how 8th-grade students perceive mathematics learning in terms of its perceived "boringness," as indicated by their responses to the statement "Mathematics is boring." A mean score above 2.5 indicates agreement with the statement that math is boring, while a score below 2.5 indicates disagreement (meaning they do not find it boring). We have also considered their average mathematics achievement scores from TIMSS 2023, with the international average at 500. The detailed results are presented in Table 3 and Figure 4.

Students in the Global East generally do not find mathematics boring, a perception that aligns with their strong achievements. In Japan, students disagreed with the statement "Mathematics is boring" (Mean = 2.25, SD = 0.835; $t = -17.896$, $p < .001$, Cohen's $d = -0.294$). This suggests they do not find the subject completely unappealing or boring. Their mean achievement in mathematics is 595, significantly above the international average. Singaporean students also strongly disagreed that "Mathematics is boring" (Mean = 2.44, SD = 1.005; $t = -3.816$, $p < .001$, Cohen's $d = -0.056$). This reinforces their generally positive perception of math, indicating they do not find the subject uninteresting. Their mean achievement score in TIMSS 2023 was 605, signifying high achievement that corresponds with a lack of boredom.

Table 3. Student perception of mathematics concerning the item "Mathematics is boring."

Global Region	Country	Test Value = 2.5										
					t	df	Significance		Mean Difference	95% C.I. of the Difference		Effect Size
		N	Mean	STDV			One-Sided p	Two-Sided p		Lower	Upper	Cohen's d
Global East	Japan (595)	3709	2.25	0.835	-17.896	3708	<.001	<.001	-0.245	-0.27	-0.22	-0.294
	Singapore (605)	4702	2.44	1.005	-3.816	4701	<.001	<.001	-0.056	-0.08	-0.03	-0.056
Global Middle	Jordan (388)	6232	2.49	1.178	-0.817	6231	0.207	0.414	-0.012	-0.04	0.02	-0.01
	UAE (489)	29814	2.54	1.115	6.599	29813	<.001	<.001	0.043	0.03	0.06	0.038
	Uzbekistan (421)	3992	1.97	1.122	-29.957	3991	<.001	<.001	-0.532	-0.57	-0.5	-0.474
	South Africa (397)	10252	1.87	1.002	63.475	10251	<.001	<.001	-0.628	-0.65	-0.61	-0.627
Global West	Australia (509)	4526	2.61	0.978	7.341	4525	<.001	<.001	0.107	0.08	0.14	0.109
	Finland (504)	5572	2.89	0.945	31.026	5571	<.001	<.001	0.393	0.37	0.42	0.416
	USA (488)	7590	2.8	0.981	26.54	7589	<.001	<.001	0.299	0.28	0.32	0.305
	Brazil (378)	20045	2.67	1.087	22.127	20044	<.001	<.001	0.17	0.15	0.18	0.156
	Chile (416)	4206	2.46	0.992	-2.317	4205	0.01	0.021	-0.035	-0.07	-0.01	-0.036

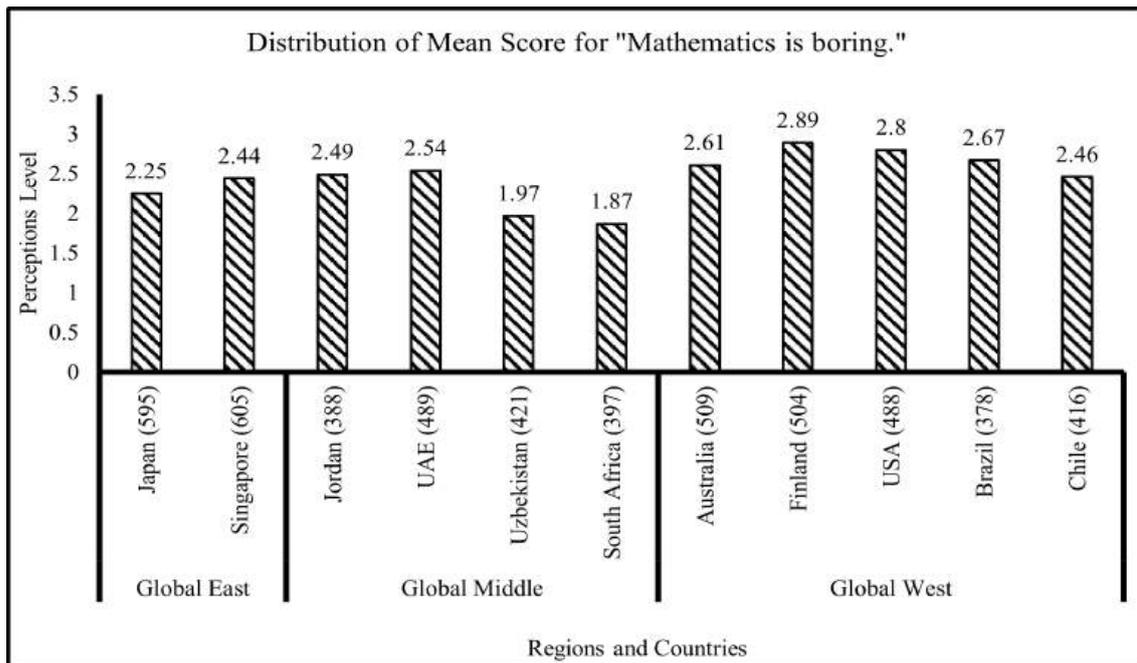


Figure 4. Distribution of average student perceptions related to boring mathematics

The Global Middle presents an interesting scenario where students generally, do not find mathematics boring, but this positive perception often does not translate into higher achievement. Jordanian students slightly disagreed with the statement "Mathematics is boring" (Mean = 2.49, SD = 1.178; $t = -0.817$, $p = .207$, Cohen's $d = -0.010$). This indicates that mathematics is not widely considered boring by students. Nevertheless, their average achievement score in TIMSS 2023 is 388, far below the international average. Similarly, UAE students slightly agreed that "Mathematics is boring" (Mean = 2.54, SD = 1.115; $t = 6.599$, $p < .001$, Cohen's $d = 0.038$), suggesting that some elements might be considered dull, but it is not strongly perceived as boring. Their country's average achievement is 489, slightly below the international average.

For Uzbekistan, students strongly disagreed with the statement "Mathematics is boring" (Mean = 1.97, SD = 1.122; $t = -29.957$, $p < .001$, Cohen's $d = -0.474$). This statistically significant and strong disagreement indicates that, on average, students do not find mathematics boring. Despite this, their mean achievement score was 421, significantly below the international average.

South African students also strongly indicated that they do not find mathematics boring (Mean = 1.87; $t = -63.475$, $p < 0.001$, Cohen's $d = 0.627$). This reflects a strong tendency towards seeing mathematics as not boring. In contrary, their average achievement in TIMSS 2023 was 397, which was below the international average.

The Global West shows a more varied picture, with some countries finding math boring while others do not, and achievement levels also differing. Australian students showed a slight tendency to agree that "Mathematics is boring" (Mean = 2.61, SD = 0.978; $t = 7.341$, $p < .001$, Cohen's $d = 0.109$), suggesting that many do not find it engaging. Despite this, their average achievement in mathematics in TIMSS 2023 was 509, slightly above the international average. Additionally, students in Finland agreed that "Mathematics is boring" (Mean = 2.89, SD = 0.945; $t = 31.026$, $p < .001$, Cohen's $d = 0.416$), reinforcing the perception that the subject is not engaging. Their average achievement in mathematics in TIMSS 2023 was 504, also slightly above the international average, suggesting that finding math boring does not necessarily prevent above-average performance in these countries.

American students agreed that "Mathematics is boring" (Mean = 2.80, SD = 0.981; $t = 26.540$, $p < .001$, Cohen's $d = 0.305$), indicating a general perception that mathematics is perceived as boring. The average achievement score in TIMSS 2023 mathematics for US eighth graders was 488, slightly below the international average.

For Brazilian students, the mean score was 2.67 (SD = 1.087; $t = 22.127$, $p < .001$, Cohen's $d = 0.156$), indicating that they agree mathematics is boring. In the same vein, their average achievement in TIMSS 2023 mathematics was 378, way below the international average.

Conversely, Chilean students slightly disagreed that "Mathematics is boring" (Mean = 2.46, SD = 0.992; $t = -2.317$, $p = .010$, Cohen's $d = -0.036$), indicating that they do not find mathematics boring. Despite this, their average achievement score of 416 in TIMSS 2023 was below the international average.

In summary, the Global East consistently shows that students do not find mathematics boring, which correlates with their high achievement. The Global Middle generally shares this perception that math is not boring, but their achievement scores remain below the international average, highlighting a disconnect. In the Global West, there is a split. Some countries find math boring but still achieve above average, while others who perceive it as boring (or not boring) show varied achievement levels relative to the international standard.

Learning Interesting Things in Mathematics

This analysis explores how 8th-grade students perceive the content of mathematics, specifically whether they "learn many interesting things in mathematics." A mean score above 2.5 indicates agreement with learning interesting things, while a score below 2.5 indicates disagreement. We have also cross-referenced these perceptions with their average mathematics achievement scores from TIMSS 2023, where the international average is 500. The results are presented in Table 4 and Figure 5.

Students in the Global East generally agree that they learn many interesting things in mathematics, a perception that aligns with their strong achievement. In Japan, students agreed that they learn many interesting things in mathematics (Mean = 2.53, SD = 0.839; $t = 2.455$, $p = .007$, Cohen's $d = 0.40$). Although the effect size is small, indicating weak agreement, this positive view of the content is evident. Their mean achievement in mathematics is 595, significantly above the international average with some alignment with their perception of learning interesting things in math.

Table 4. Student perception of mathematics concerning the item "I learn many interesting things in mathematics."

Global Region	Country	Test Value = 2.5										
		N	Mean	STDV	t	df	Significance	Mean Difference	95% C.I. of the Difference		Effect Size	
								One-Sided P	Two-Sided P	Lower	Upper	Cohen's d
Global East	Japan (595)	3713	2.53	0.839	2.455	3712	0.007	0.014	0.034	0.01	0.06	0.04
	Singapore (605)	4710	2.93	0.906	32.643	4709	<.001	<.001	0.431	0.41	0.46	0.476
Global Middle	Jordan (388)	6232	3.09	1.048	44.565	6231	<.001	<.001	0.591	0.57	0.62	0.565
	UAE (489)	29880	3	1.024	84.756	29879	<.001	<.001	0.502	0.49	0.51	0.49
	Uzbekistan (421)	4014	3.5	0.812	77.886	4013	<.001	<.001	0.998	0.97	1.02	1.229
	South Africa (397)	10376	3.34	0.864	98.526	10375	<.001	<.001	0.836	0.82	0.85	0.967
Global West	Australia (509)	4521	2.36	0.944	-9.951	4520	<.001	<.001	-0.14	-0.17	-0.11	-0.148
	Finland (504)	5549	2.38	0.914	-9.953	5548	<.001	<.001	-0.122	-0.15	-0.1	-0.134
	USA (488)	7626	2.73	0.971	20.688	7625	<.001	<.001	0.23	0.21	0.25	0.237
	Brazil (378)	20167	3.06	0.988	80.007	20166	<.001	<.001	0.537	0.54	0.57	0.563
	Chile (416)	4260	2.97	0.876	34.686	4259	<.001	<.001	0.466	0.44	0.49	0.531

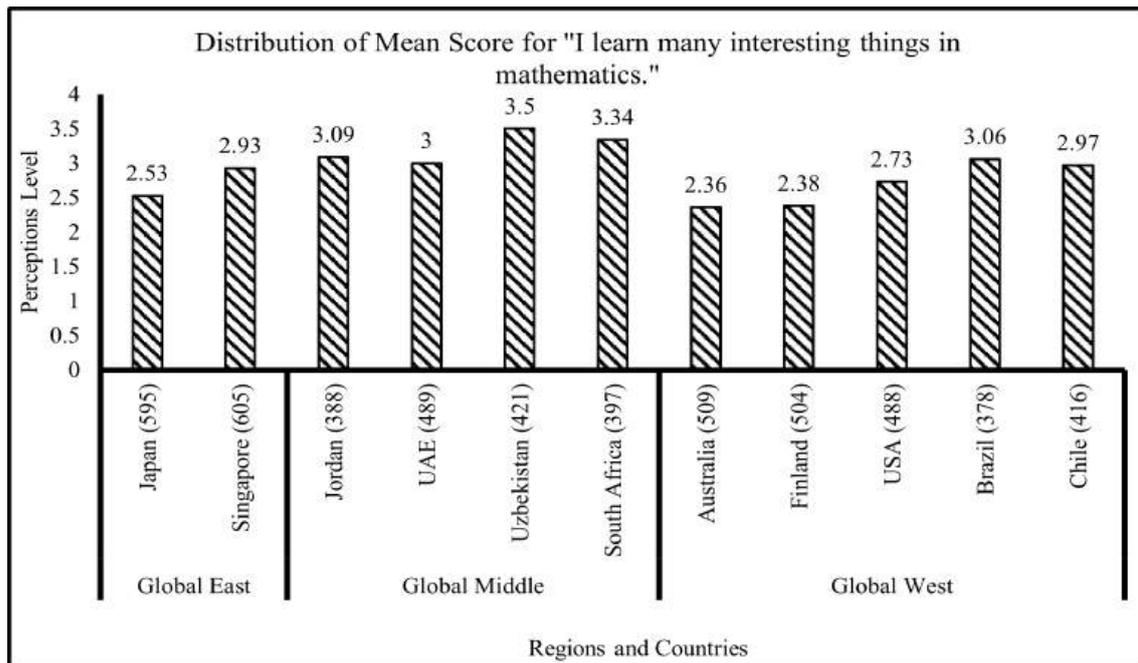


Figure 5. Distribution of average student perceptions related to interesting things in mathematics

Singaporean students strongly agreed that they "learn many interesting things in mathematics" (Mean = 2.93, SD = 0.906; $t = 32.643$, $p < .001$, Cohen's $d = .476$). This reinforces the perception that mathematics is an engaging subject for them. Their mean achievement score in TIMSS 2023 was 605, signifying high achievement that correlates with finding the content interesting.

The Global Middle shows a consistent pattern where students strongly believe they learn many interesting things in mathematics, but this perception often does not translate into higher achievement. Jordanian students agreed that they "learn many interesting things in mathematics" (Mean = 3.09, SD = 1.048; $t(44) = 44.565$, $p < .001$, Cohen's $d = 0.565$). This reflects that they find mathematics content engaging. Conversely, their

average achievement score in TIMSS 2023 is 388, far below the international average of 500, despite their positive perceptions of mathematics content learning. Similarly, UAE students agreed that they learned many interesting things in mathematics (Mean = 3.00, SD = 1.024; $t = 84.756$, $p < .001$, Cohen's $d = 0.490$), indicating that they found the mathematics content engaging and interesting. But, their country's average achievement is 489, slightly below the international average, which is against their perception of learning interesting things.

For Uzbekistan, students strongly agreed with "I learn many interesting things in mathematics" (Mean = 3.50, SD = 0.812; $t = 77.886$, $p < .001$, Cohen's $d = 1.229$), indicating a very strong belief that they learn many interesting things. Despite this strong agreement, their mean achievement score was 421, significantly below the international average. Likewise, South African students also strongly believe that they learn many interesting things in mathematics (Mean = 3.34; $t = 98.526$, $p < 0.001$, Cohen's $d = 0.967$). This highlights a strong positive response to the content-related engagement. Nonetheless, their average achievement in TIMSS 2023 was 397, which was below the international average.

The Global West shows a mixed bag of perceptions regarding interesting math content, with varying correlations to achievement. Australian students disagreed with "I learn many interesting things in mathematics" (Mean = 2.36, SD = 0.944; $t = -9.951$, $p < .001$, Cohen's $d = -0.148$), suggesting that they do not find mathematics particularly engaging. Despite this, their average achievement in mathematics in TIMSS 2023 was 509, slightly above the international average.

Likewise, students in Finland also disagreed with "I learn many interesting things in mathematics" (Mean = 2.38, SD = 0.914; $t = -9.953$, $p < .001$, Cohen's $d = -0.134$), suggesting that they do not perceive mathematics as engaging or exciting. Similar to Australia, their average achievement in mathematics in TIMSS 2023 was 504, also slightly above the international average.

The students in the US agreed that they "learn many interesting things in mathematics" (Mean = 2.73, SD = 0.971; $t = 20.688$, $p < .001$, Cohen's $d = 0.237$), perceiving mathematics as a subject with interesting content. Yet, their average achievement score in TIMSS 2023 mathematics was 488, slightly below the international average.

For Brazilian students, the mean of 3.06 (SD = 0.988; $t = 80.007$, $p < .001$, Cohen's $d = 0.563$) indicated a strong agreement that they learn many interesting things in mathematics. Despite this strong belief, their average achievement in TIMSS 2023 mathematics was 378, way below the international average.

Finally, Chilean students agreed with "I learn many interesting things in mathematics" (Mean = 2.97, SD = 0.876; $t = 34.686$, $p < .001$, Cohen's $d = 0.531$), indicating a strong belief that they learn many interesting things in mathematics. But, their average achievement score of 416 in TIMSS 2023 was below the international average.

In conclusion, the Global East consistently shows students finding mathematics content interesting, which aligns with their high achievement. In the Global Middle, students strongly perceive mathematics as interesting, but this positive outlook does not translate into above-average achievement. The Global West presents a mixed scenario, with some countries achieving above-average results despite a reported lack of interest in the content. In contrast, others show strong interest but do not reach the international average in performance.

Like/Dislike Mathematics

This analysis examines the general sentiment of 8th-grade students towards mathematics, specifically their agreement with the statement "I like mathematics." A mean score above 2.5 indicates agreement with liking mathematics, while a score below 2.5 indicates disagreement. We have also compared these perceptions with their average mathematics achievement

scores from TIMSS 2023, where the international average is 500. These results are presented in the following Table 5 and Figure 6.

The Global East presents an interesting dynamic where students reported "liking" for mathematics is somewhat varied despite consistently high achievement. In Japan, students do not strongly identify with liking mathematics (Mean = 2.39, SD = 0.959; $t = -6.771$, $p < .001$, Cohen's $d = -0.111$). This indicates a slight disagreement with liking the subject. Despite this, their mean achievement in mathematics is 595, significantly above the international average of 500. This suggests that a strong personal "liking" is not a prerequisite for high performance in Japan. Conversely, Singaporean students agree with "I like mathematics" (Mean = 2.79, SD = 1.036; $t = 19.479$, $p < .001$, Cohen's $d = .284$). This positive sentiment aligns with their outstanding mean achievement score of 605 in TIMSS 2023, signifying that both enjoyment and high performance coexist.

In the Global Middle, there is a clear pattern of students strongly agreeing that they like mathematics, yet this positive sentiment generally does not correlate with above-average achievement. Jordanian students agree with "I like mathematics" (Mean = 2.94, SD = 1.127; $t = 31.166$, $p < .001$, Cohen's $d = 0.394$), suggesting they generally like mathematics. Nevertheless, their average achievement score in TIMSS 2023 is 388, far below the international average. Similarly, UAE students agree with "I like mathematics" (Mean = 2.85, SD = 1.097; $t = 55.146$, $p < .001$, Cohen's $d = 0.319$), indicating a general liking for the subject. Their country's average achievement is 489, slightly below the international average. Likewise, for Uzbekistan, students strongly agree with "I like mathematics" (Mean = 3.48, SD = 0.819; $t = 75.567$, $p < .001$, Cohen's $d = 1.192$), indicating a very strong level of agreement. This means that, on average, students like mathematics. Despite this strong affinity, their mean achievement score was 421, which is significantly below the international average.

The mean score for South African students on "I like mathematics" is 3.21, significantly above 2.5 ($t = 74.743$, $p < 0.001$, Cohen's $d = 0.735$), indicating a strong positive sentiment towards the subject. However, their average achievement in TIMSS 2023 was 397, which was below the international average, suggesting that a liking for math does not necessarily lead to high achievement.

Table 5. Student perception of mathematics concerning the item "I like mathematics."

Global Region	Country	Test Value = 2.5										
					t	df	Significance	Mean Difference	95% C.I. of the Difference		Effect Size	
		N	Mean	STDV			One-Sided p	Two-Sided p	Lower	Upper	Cohen's d	
Global East	Japan (595)	3720	2.39	0.959	-6.771	3719	<.001	<.001	-0.106	-0.14	-0.08	-0.111
	Singapore (605)	4710	2.79	1.036	19.479	4709	<.001	<.001	0.294	0.26	0.32	0.284
Global Middle	Jordan (388)	6263	2.94	1.127	31.166	6262	<.001	<.001	0.444	0.42	0.47	0.394
	UAE (489)	29916	2.85	1.097	55.146	29915	<.001	<.001	0.35	0.34	0.36	0.319
	Uzbekistan (421)	4019	3.48	0.819	75.567	4018	<.001	<.001	0.976	0.95	1	1.192
	South Africa (397)	10329	3.21	0.97	74.743	10328	<.001	<.001	0.713	0.69	0.73	0.735
Global West	Australia (509)	4525	2.35	1.026	-9.512	4524	<.001	<.001	-0.145	-0.17	-0.12	-0.141
	Finland (504)	5566	2.24	0.992	-19.521	5565	<.001	<.001	-0.26	-0.29	-0.23	-0.262
	USA (488)	7633	2.52	1.059	1.562	7632	0.059	0.118	0.019	0	0.04	0.018
	Brazil (378)	20345	2.63	1.122	16.843	20344	<.001	<.001	0.133	0.12	0.15	0.118
	Chile (416)	4259	2.67	1.039	10.744	4258	<.001	<.001	0.171	0.14	0.2	0.165

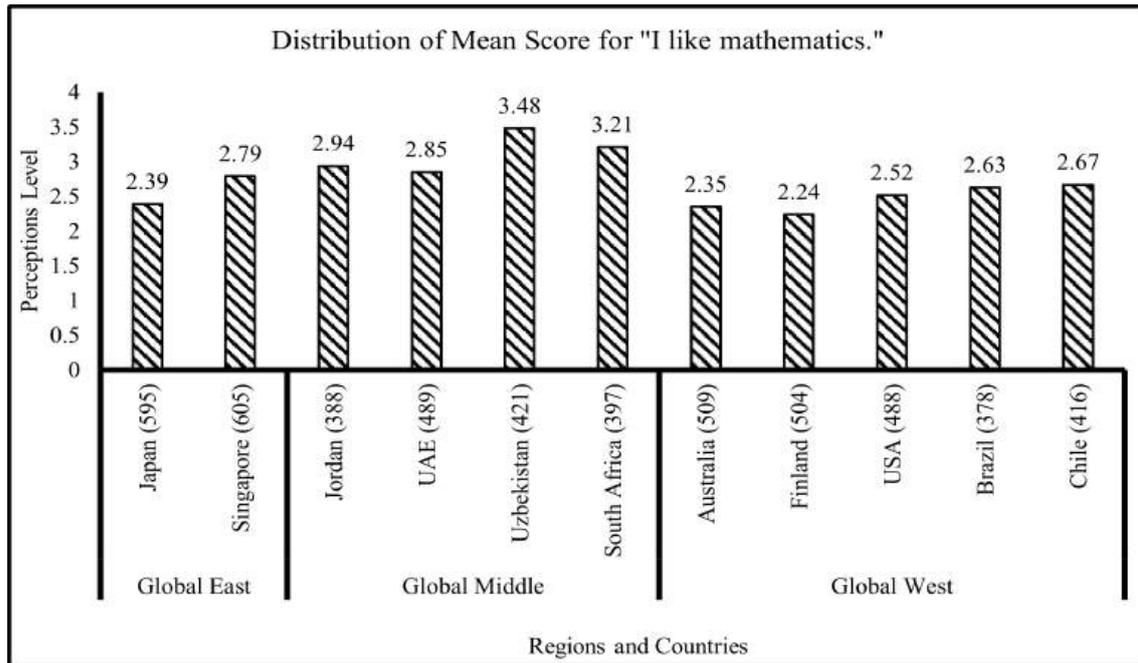


Figure 6. Distribution of average student perceptions related to like/dislike mathematics

The Global West presents a varied landscape concerning students liking for mathematics, with corresponding mixed achievement outcomes. Australian students disagreed with "I like mathematics" (Mean = 2.35, SD = 1.026; $t = -9.512$, $p < .001$, Cohen's $d = -0.141$), indicating an overall lack of enthusiasm for the subject. Despite this, their average achievement in mathematics in TIMSS 2023 was 509, slightly above the international average of 500. Furthermore, Finnish students also disagreed with "I like mathematics" (Mean = 2.24, SD = 0.992; $t = 19.521$, $p < .001$, Cohen's $d = -0.262$), reinforcing a less favorable attitude. On the other hand, their average achievement in mathematics in TIMSS 2023 was 504, which is slightly above the international average, suggesting that a dislike for math does not necessarily prevent strong academic performance.

American students showed a neutral stance on "I like mathematics" (Mean = 2.52, SD = 1.059; $t = 1.562$, $p = .118$). This indicates no significant agreement or disagreement, reflecting a neutral feeling. Their average achievement score in TIMSS 2023 mathematics was 488, slightly below the international average. Whereas, for Brazilian students, the mean of 2.63 (SD = 1.122; $t = 16.843$, $p < .001$, Cohen's $d = 0.118$) showed a slight agreement with liking mathematics, though not overwhelmingly strong. Their average achievement in TIMSS 2023 mathematics was 378, way below the international average. Finally, Chilean students agreed with "I like mathematics" (Mean = 2.67, SD = 1.039; $t = 10.744$, $p < .001$, Cohen's $d = 0.165$), indicating a small but statistically significant level of agreement. Despite this, their average achievement score of 416 in TIMSS 2023 was below the international average.

In conclusion, the relationship between "liking" mathematics and achievement varies significantly across regions. In the Global East, both high liking and high achievement can coexist (Singapore), or high achievement can be present despite a less pronounced liking (Japan). The Global Middle consistently shows a strong reported liking for mathematics, but this does not translate into above-average achievement. The Global West presents a complex picture where a lack of strong liking for mathematics can still coincide with above-average achievement (Australia, Finland). At the same time, other countries show varying degrees of liking that do not necessarily guarantee higher scores.

Like Schoolwork that Involves Numbers

This analysis investigates 8th-grade students preferences for schoolwork that involves numbers based on their agreement with the statement, "I like any schoolwork that involves

numbers." A mean score above 2.5 indicates agreement (they like numerical tasks), while a score below 2.5 indicates disagreement (they do not particularly like numerical tasks). We have also examined their average mathematics achievement scores from TIMSS 2023, where the international average is 500, about their perceptions of working with numbers. These results are presented in Table 6 and Figure 7.

The Global East presents a curious case where students generally do not strongly like schoolwork that involves numbers, yet they achieve exceptionally high in mathematics. Japanese students show a significant disagreement with "liking any schoolwork that involves numbers" (Mean = 2.08, SD = 0.802; $t = -31.876$, $p < .001$, Cohen's $d = -0.523$). This indicates a notable lack of preference for numerical tasks. Despite this, their mean achievement in mathematics is 595, significantly above the international average of 500, suggesting that a strong liking for numerical tasks is not necessary for high performance. Similarly, Singaporean students disagreed with the statement "I like any schoolwork that involves numbers" (Mean = 2.46, SD = 0.999; $t = -2.739$, $p = .003$, Cohen's $d = -0.040$). While not a strong rejection, it suggests they do not strongly prefer numerical work. Their mean achievement score in TIMSS 2023 was 605, signifying high achievement despite this less enthusiastic view of numerical tasks.

Table 6. Student perception of mathematics concerning the item "I like schoolwork that involves numbers."

Global Region	Country	Test Value = 2.5										
					t	df	Significance		Mean Difference	95% C.I. of the Difference		Effect Size
		N	Mean	STDV			One-Sided p	Two-Sided p		Lower	Upper	Cohen's d
Global East	Japan (595)	3717	2.08	0.802	-31.876	3716	<.001	<.001	-0.419	-0.45	-0.39	-0.523
	Singapore (605)	4718	2.46	0.999	-2.739	4717	0.003	0.006	-0.04	-0.07	-0.01	-0.04
Global Middle	Jordan (388)	6254	2.91	1.099	29.734	6253	<.001	<.001	0.413	0.39	0.44	0.376
	UAE (489)	29874	2.66	1.101	25.515	29873	<.001	<.001	0.162	0.15	0.17	0.148
	Uzbekistan (421)	3990	3.33	0.849	61.636	3989	<.001	<.001	0.829	0.8	0.85	0.976
	South Africa (397)	10432	3.04	0.95	57.768	10431	<.001	<.001	0.538	0.52	0.56	0.566
Global West	Australia (509)	4523	2.43	1.034	-4.608	4522	<.001	<.001	-0.071	-0.1	-0.04	-0.069
	Finland (504)	5550	1.92	0.856	-50.886	5549	<.001	<.001	-0.585	-0.61	-0.56	-0.683
	USA (488)	7622	2.21	0.983	-25.997	7621	<.001	<.001	-0.293	-0.31	-0.27	-0.298
	Brazil (378)	20107	2.36	1.068	-17.917	20106	<.001	<.001	-0.135	-0.15	-0.12	-0.126
	Chile (416)	4256	2.35	0.984	-10.261	4255	<.001	<.001	-0.155	-0.18	-0.13	-0.157

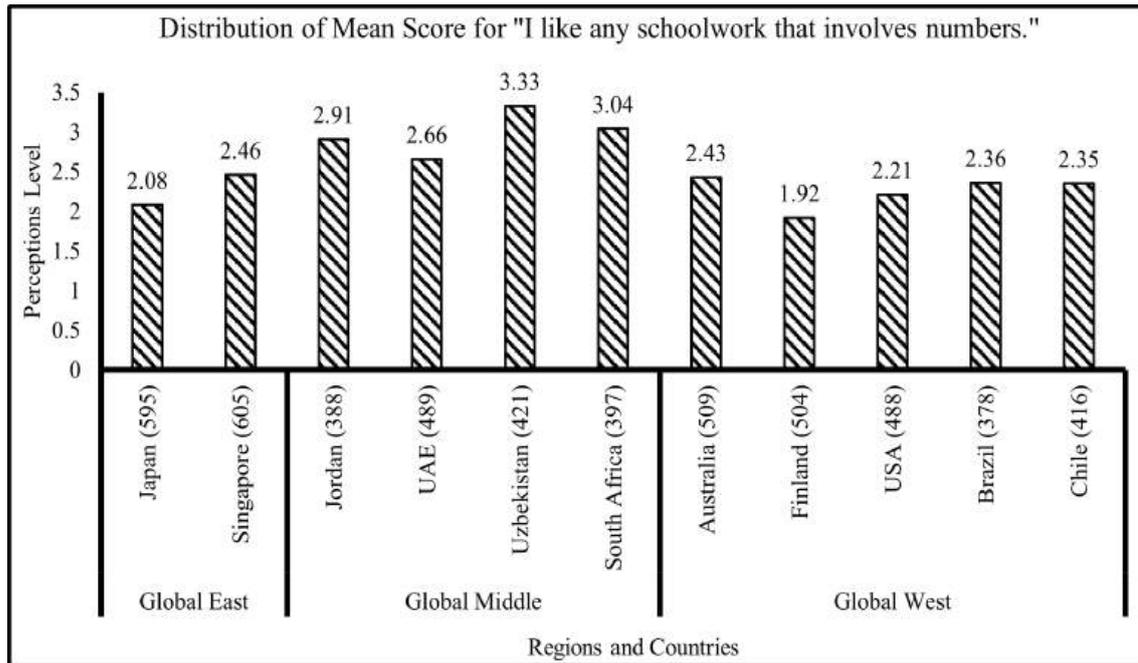


Figure 7. Distribution of average student perceptions related to school works with numbers

In the Global Middle, there is a consistent pattern of students agreeing that they enjoy schoolwork that involves numbers; in the contrary, this positive sentiment generally does not correlate with above-average achievement. Students in Jordan agree with the statement "I like any schoolwork that involves numbers" (Mean = 2.91, SD = 1.099; $t = 29.734$, $p < .001$, Cohen's $d = 0.376$), indicating their enjoyment of numerical tasks. But, their average achievement score in TIMSS 2023 is 388, far below the international average.

The UAE students also agree with "I like any schoolwork that involves numbers" (Mean = 2.66, SD = 1.101; $t = 25.515$, $p < .001$, Cohen's $d = 0.148$), indicating a general enjoyment of numerical tasks in schoolwork. Their country's average achievement is 489, slightly below the international average.

For Uzbekistan, students agree with "I like any schoolwork that involves numbers" (Mean = 3.33, SD = 0.849; $t = 61.636$, $p < .001$, Cohen's $d = 0.976$), indicating a large and statistically significant level of agreement. This means that, on average, students like schoolwork that involves numbers. Despite their strong preference for numerical tasks, their mean achievement score was 421, which is significantly below the international average.

South African students also indicate a strong preference for schoolwork involving numbers (Mean = 3.04; $t = 57.768$, $p < 0.001$, Cohen's $d = 0.566$). This shows a moderate to strong positive sentiment towards numerical tasks. Nevertheless, their average achievement in TIMSS 2023 was 397, which was below the international average.

The Global West generally shows students disagreeing with liking schoolwork that involves numbers, with varied implications for their achievement. Australian students show a slight tendency to disagree with the statement "I like any schoolwork that involves numbers" (Mean = 2.43, SD = 1.034; $t = -4.608$, $p < .001$, Cohen's $d = -0.069$). Despite this, their average achievement in mathematics in TIMSS 2023 was 509, slightly above the international average of 500.

Finnish students express clear disagreement with "I like any schoolwork that involves numbers" (Mean = 1.92, SD = 0.856; $t = -50.886$, $p < .001$, Cohen's $d = -0.683$), suggesting a strong aversion to numerical tasks. Nevertheless, their average achievement in mathematics in TIMSS 2023 was 504, also slightly above the international average, suggesting that disliking numerical tasks does not necessarily hinder strong performance.

American students disagreed with the statement "I like any schoolwork that involves numbers" (Mean = 2.21, SD = 0.983; $t = -25.997$, $p < .001$, Cohen's $d = -0.298$), indicating that they do not particularly enjoy such schoolwork. Their average achievement score in TIMSS 2023 mathematics was 488, slightly below the international average.

Regarding Brazilian students, the mean score was 2.36 (SD = 1.068; $t = -17.917$, $p < .001$, Cohen's $d = -0.126$), indicating a tendency to disagree, which suggests that they do not particularly enjoy schoolwork involving numbers. Their average achievement in TIMSS 2023 mathematics was 378, way below the international average.

Finally, Chilean students disagreed with the statement "I like any schoolwork that involves numbers" (Mean = 2.35, SD = 0.984; $t = -10.261$, $p < .001$, Cohen's $d = -0.157$), suggesting that they do not particularly enjoy schoolwork involving numbers. Their average achievement score of 416 in TIMSS 2023 was below the international average.

In conclusion, the Global East demonstrates that high achievement in mathematics can occur even when students do not strongly prefer schoolwork involving numbers. The Global Middle, in contrast, consistently shows students expressing a strong liking for numerical tasks, but this positive sentiment generally does not translate into above-average achievement. In the Global West, there is a widespread tendency to dislike numerical schoolwork. However, some countries still achieve above-average results, highlighting a complex relationship between a preference for numerical tasks and actual performance.

Like to Solve Mathematics Problems

This analysis examines the attitudes of 8th-grade students toward a core aspect of mathematics: problem-solving. We look at their agreement with the statement, "I like to solve mathematics problems." A mean score above 2.5 indicates agreement (they like solving problems), while a score below 2.5 indicates disagreement (they do not particularly like solving problems). These perceptions are then considered alongside their average mathematics achievement scores from TIMSS 2023, where the international average is 500. These results are presented in Table 7 and Figure 8.

The Global East presents a nuanced picture regarding the enjoyment of solving mathematics problems, with students in some countries showing less enthusiasm despite consistently high achievement. Japanese students generally, exhibit a lack of enthusiasm for mathematics-related tasks, as indicated by their disagreement with "liking to solve mathematics problems" (Mean = 2.41, SD = 0.929; $t = -5.822$, $p < .001$, Cohen's $d = -0.096$). Despite this, their mean achievement in mathematics is 595, significantly above the international average of 500. This suggests that a strong personal enjoyment of problem-solving does not solely drive high performance in Japan.

Conversely, students in Singapore generally hold a favorable attitude toward problem-solving activities, agreeing that they "like to solve mathematics problems" (Mean = 2.65, SD = 1.059; $t = 9.733$, $p < .001$, Cohen's $d = .142$). This aligns with their outstanding mean achievement score of 605 in TIMSS 2023, suggesting a positive correlation between enjoyment of problem-solving and high performance.

In the Global Middle, there is a consistent pattern of students agreeing that they enjoy solving mathematics problems, but this positive sentiment generally does not correlate with above-average achievement. Students in Jordan agree with "I like to solve mathematics problems" (Mean = 2.96, SD = 1.104; $t = 32.773$, $p < .001$, Cohen's $d = 0.416$), indicating an enjoyment of problem-solving activities. In contrary, their average achievement score in TIMSS 2023 is 388, far below the international average.

UAE students also agree with "I like to solve mathematics problems" (Mean = 2.76, SD = 1.107; $t = 40.636$, $p < .001$, Cohen's $d = 0.235$), indicating an enjoyment of problem-solving activities in mathematics. Their country's average achievement is 489, slightly below the international average.

For Uzbekistan, students strongly agree with "I like to solve mathematics problems" (Mean = 3.36, SD = 0.857; $t = 63.346$, $p < .001$, Cohen's $d = 1.000$), indicating a statistically

significant and large level of agreement. This means that, on average, students enjoy solving mathematics problems. Despite this strong enjoyment, their mean achievement score was 421, significantly below the international average. South African students also exhibit a moderate to strong positive attitude towards solving mathematical problems (Mean = 3.04; $t = 57.484$, $p < 0.001$, Cohen's $d = 0.563$), indicating that they enjoy these tasks. However, their average achievement in TIMSS 2023 was 397, which was below the international average despite the strong positive perceptions of mathematics problem-solving.

Table 7. Student perception of mathematics concerning the item "I like to solve mathematics problems."

Global Region	Country	Test Value = 2.5										
		N	Mean	STDV	t	df	Significance	Mean Difference	95% C.I. of the Difference		Effect Size	
								One-Sided p	Two-Sided p	Lower	Upper	Cohen's d
Global East	Japan (595)	3711	2.41	0.929	-5.822	3710	<.001	<.001	-0.089	-0.12	-0.06	-0.096
	Singapore (605)	4702	2.65	1.059	9.733	4701	<.001	<.001	0.15	0.12	0.18	0.142
Global Middle	Jordan (388)	6219	2.96	1.104	32.773	6218	<.001	<.001	0.459	0.43	0.49	0.416
	USA (489)	29831	2.76	1.107	40.636	29830	<.001	<.001	0.26	0.25	0.27	0.235
	Uzbekistan (421)	4010	3.36	0.857	63.346	4009	<.001	<.001	0.857	0.83	0.88	1
	South Africa (397)	10431	3.04	0.968	57.484	10430	<.001	<.001	0.545	0.53	0.56	0.563
Global West	Australia (509)	4516	2.27	1.01	-15.051	4515	<.001	<.001	-0.226	-0.26	-0.2	-0.224
	Finland (504)	5569	2.16	1	-25.01	5568	<.001	<.001	-0.335	-0.36	-0.31	-0.335
	USA (488)	7611	2.36	1.041	-11.872	7610	<.001	<.001	-0.142	-0.17	-0.12	-0.136
	Brazil (378)	20077	2.42	1.109	-10.026	20076	<.001	<.001	-0.078	-0.09	-0.06	-0.071
	Chile (416)	4269	2.47	1.023	-1.848	4268	0.032	0.065	-0.029	-0.06	0	-0.028

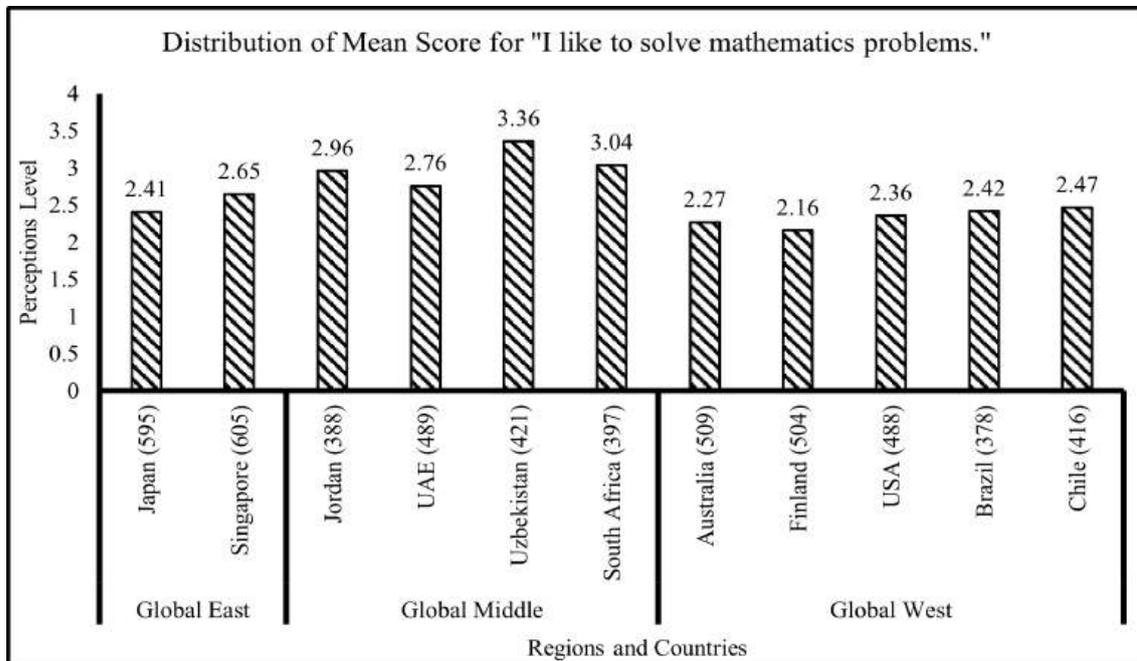


Figure 8. Distribution of average student perceptions related to liking to solve mathematics problems

The Global West generally shows students disagreeing with liking to solve mathematics problems, with varied implications for their achievement. Students in Australia disagree with the statement "I like to solve mathematics problems" (Mean = 2.27, SD = 1.010;

$t = -15.051$, $p < .001$, Cohen's $d = -0.224$). These results suggest that students do not particularly enjoy problem-solving tasks. Despite this, their average achievement in mathematics in TIMSS 2023 was 509, slightly above the international average of 500. In a similar vein, Finnish students express clear disagreement with the statement "I like to solve mathematics problems" (Mean = 2.16, SD = 1.00; $t = -25.01$, $p < .001$, Cohen's $d = -0.335$), indicating that problem-solving is not an enjoyable aspect of their learning experience. Nevertheless, their average achievement in mathematics in TIMSS 2023 was 504, also slightly above the international average, suggesting that disliking problem-solving does not necessarily hinder strong performance.

US students disagreed with "I like to solve mathematics problems" (Mean = 2.36, SD = 1.041; $t = -11.872$, $p < .001$, Cohen's $d = -0.136$), suggesting they do not have a strong liking for solving math problems. Their average achievement score in TIMSS 2023 mathematics was 488, slightly below the international average.

For Brazilian students, the mean score of 2.42 (SD = 1.109; $t = -10.026$, $p < .001$, Cohen's $d = -0.071$) suggests a moderate disagreement with enjoying solving math problems. Their average achievement in TIMSS 2023 mathematics was 378, way below the international average. Finally, Chilean students disagreed with "I like to solve mathematics problems" (Mean = 2.47, SD = 1.023; $t = -1.848$, $p = .032$, Cohen's $d = -0.028$), indicating that they do not strongly enjoy solving mathematics problems. Their average achievement score of 416 in TIMSS 2023 was below the international average, which corroborates their perception of mathematics problems and their achievement.

In conclusion, the Global East shows a varied connection between liking problem-solving and achievement, with some high-achieving countries not strongly enjoying it (Japan) and others demonstrating a favorable attitude (Singapore). The Global Middle consistently indicates a strong enjoyment of solving mathematics problems, yet this positive sentiment does not lead to above-average achievement. In the Global West, there is a general trend among students to dislike solving mathematics problems, but this does not always translate to lower achievement, as seen in Australia and Finland. Other countries in the West show a similar disliking that aligns with below-average performance.

Looking Forward to Mathematics Class

This analysis examines 8th-grade students' anticipation of their mathematics class, based on their agreement with the statement "I look forward to mathematics class." A mean score above 2.5 indicates agreement (they look forward to class), while a score below 2.5 indicates disagreement (they do not look forward to class). These perceptions are then considered alongside their average mathematics achievement scores from TIMSS 2023, where the international average is 500. These results are presented in Table 8 and Figure 9.

Table 8. Student perception of mathematics concerning the item "I look forward to mathematics class."

Global Region	Country	Test Value = 2.5										
					t	df	Significance		Mean Difference	95% C.I. of the Difference		Effect Size
		N	Mean	STDV			One-Sided p	Two-Sided p		Lower	Upper	Cohen's d
Global East	Japan (595)	3706	2.24	0.886	-18.011	3705	<.001	<.001	-0.262	-0.29	-0.23	-0.296
	Singapore (605)	4712	2.53	1.035	2.28	4711	0.011	0.023	0.034	0	0.06	0.033
Global Middle	Jordan (388)	6152	2.78	1.156	18.845	6151	<.001	<.001	0.278	0.25	0.31	0.24
	UAE (489)	29768	2.7	1.116	30.357	29767	<.001	<.001	0.196	0.18	0.21	0.176
	Uzbekistan (421)	4011	3.18	0.914	46.972	4010	<.001	<.001	0.678	0.65	0.71	0.742
	South Africa (397)	10430	3.06	0.979	57.974	10429	<.001	<.001	0.556	0.54	0.57	0.568
Global West	Australia (509)	4512	2	0.94	-35.77	4511	<.001	<.001	-0.5	-0.53	-0.47	-0.533
	Finland (504)	5553	1.79	0.861	-61.314	5552	<.001	<.001	-0.709	-0.73	-0.69	-0.823
	USA (488)	7610	2.29	1.044	-17.265	7609	<.001	<.001	-0.207	-0.23	-0.18	-0.198
	Brazil (378)	19967	2.06	1.078	-57.95	19966	<.001	<.001	-0.442	-0.46	-0.43	-0.41
	Chile (416)	4259	2.18	0.994	-21.135	4258	<.001	<.001	-0.322	-0.35	-0.29	-0.324

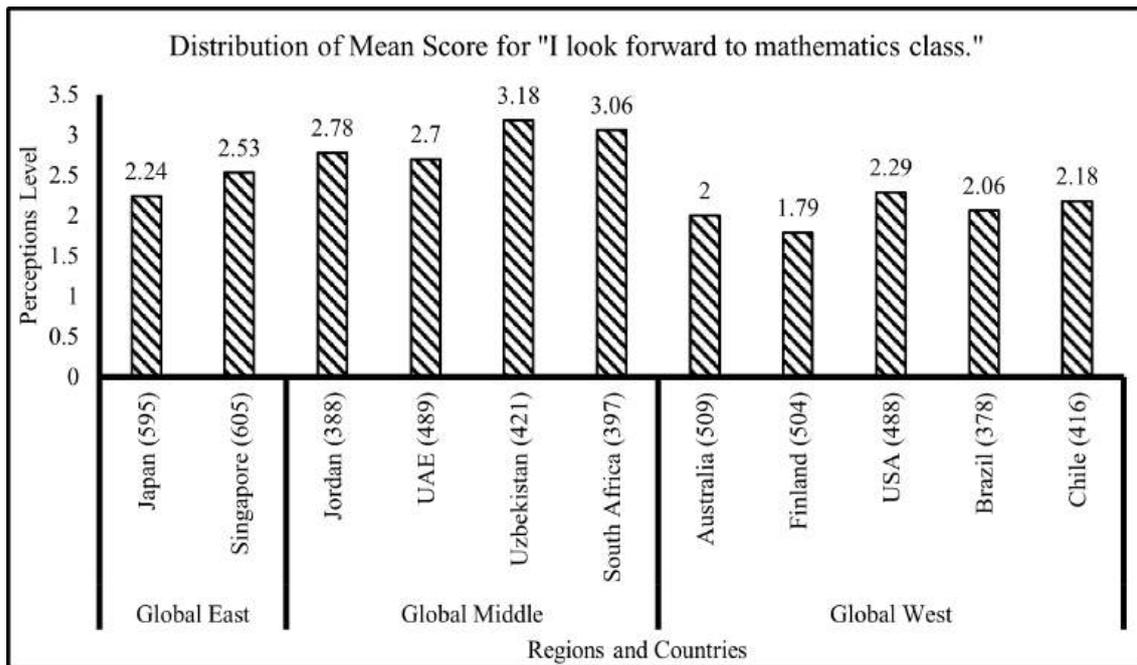


Figure 9. Distribution of average student perceptions related to looking forward to mathematics class

The Global East presents a mixed picture regarding students eagerness for mathematics class despite their consistently high achievement. Japanese students generally disagree with looking forward to mathematics class (Mean = 2.24, SD = 0.886; $t = -18.011$, $p < .001$, Cohen's $d = -0.296$). This indicates a general lack of enthusiasm for mathematics-related tasks. Despite this, their mean achievement in mathematics is 595, significantly above the international average of 500, suggesting that looking forward to class is not a prerequisite for high performance in Japan. Nonetheless, Singaporean students, while achieving highly, show only a slight tendency to look forward to mathematics class (Mean = 2.53, SD = 1.035; $t = 2.280$, $p = .011$, Cohen's $d = .033$). This very weak agreement suggests a neutral

to mildly positive anticipation. Their mean achievement score in TIMSS 2023 was 605, signifying high achievement despite this less pronounced eagerness for mathematics class.

In the Global Middle, there is a consistent pattern of students agreeing that they look forward to mathematics class. However, this positive anticipation generally does not correlate with above-average achievement. Jordanian students agree that they look forward to mathematics lessons with moderate enthusiasm (Mean = 2.78, SD = 1.156; $t = 18.845$, $p < .001$, Cohen's $d = 0.240$). Nevertheless, their average achievement score in TIMSS 2023 is 388, far below the international average.

Students from the UAE also agree that they look forward to mathematics lessons with moderate enthusiasm (Mean = 2.70, SD = 1.116; $t = 30.357$, $p < .001$, Cohen's $d = 0.176$). Their country's average achievement is 489, slightly below the international average. For Uzbekistan, students agree with "I look forward to mathematics class" (Mean = 3.18, SD = 0.914; $t = 46.972$, $p < .001$, Cohen's $d = 0.742$), indicating statistically significant and moderate agreement. This means that, on average, students look forward to mathematics class. Despite this positive anticipation, their mean achievement score was 421, significantly below the international average. South African students generally look forward to their mathematics classes (Mean = 3.06; $t = 57.974$, $p < 0.001$, Cohen's $d = 0.568$), indicating a strong positive sentiment towards attending. However, their average achievement in TIMSS 2023 was 397, which was below the international average.

The Global West generally shows students disagreeing with looking forward to mathematics class, with varied implications for their achievement. Notably, Australian students strongly disagree with the statement "I look forward to mathematics class" (Mean = 2.00, SD = 0.940; $t = -35.770$, $p < .001$, Cohen's $d = -0.533$). Despite this strong negative sentiment, their average achievement in mathematics in TIMSS 2023 was 509, slightly above the international average of 500.

Students in Finland exhibit a strong aversion to mathematics class, as they strongly disagree with the statement "I look forward to mathematics class" (Mean = 1.79, SD = 0.861; $t = -61.314$, $p < .001$, Cohen's $d = -0.823$). This highlights that a significant portion of students do not anticipate mathematics lessons with enthusiasm. Nevertheless, their average achievement in mathematics in TIMSS 2023 was 504, also slightly above the international average, suggesting that disliking class anticipation does not necessarily hinder strong performance. US students disagreed with "I look forward to mathematics class" (Mean = 2.29, SD = 1.044; $t = -17.265$, $p < .001$, Cohen's $d = -0.198$), suggesting that they generally, do not look forward to mathematics class. Their average achievement score in TIMSS 2023 mathematics was 488, slightly below the international average.

Brazilian students showed a clear disagreement with looking forward to mathematics class (Mean = 2.06, SD = 1.078; $t = -57.950$, $p < .001$, Cohen's $d = -0.410$), indicating that they are not enthusiastic about attending math class. Their average achievement in TIMSS 2023 mathematics was 378, way below the international average. Finally, Chilean students disagreed with "I look forward to mathematics class" (Mean = 2.18, SD = 0.994; $t = -21.135$, $p < .001$, Cohen's $d = -0.324$), indicating that, on average, students do not look forward to mathematics class. Their average achievement score of 416 in TIMSS 2023 was below the international average.

In conclusion, the Global East demonstrates a mixed picture regarding anticipation for math class, with high achievement observed even when students do not strongly look forward to it (Japan) or show only slight eagerness (Singapore). The Global Middle consistently indicates a strong positive anticipation for mathematics class, yet this enthusiasm does not translate into above-average achievement. In the Global West, there is a general trend among students to not look forward to mathematics class; but this does not always lead to lower achievement, as seen in Australia and Finland. Other countries in the West exhibit a similar lack of anticipation, which aligns with their below-average performance.

Mathematics as a Favorite Subject

This analysis examines 8th-grade students general preference for mathematics based on their agreement with the statement, "Mathematics is one of my favorite subjects." A mean score above 2.5 indicates agreement (it is a favorite subject), while a score below 2.5 indicates disagreement (it is not a favorite subject). These perceptions are then considered alongside their average mathematics achievement scores from TIMSS 2023, where the international average is 500. These results are presented in the following Table 9 and Figure 10.

Table 9. Student perception of mathematics concerning the item "Mathematics is one of my favorite subjects."

Global Region	Country	N	Mean	STDV	Test Value = 2.5		Significance	Mean Difference	95% C.I. of the Difference		Effect Size	
					t	df			Lower	Upper		Cohen's d
Global East	Japan (595)	3721	2.24	0.989	-16.086	3720	<.001	<.001	-0.261	-0.29	-0.23	-0.264
	Singapore (605)	4717	2.55	1.166	2.854	4716	0.002	0.004	0.048	0.02	0.08	0.042
Global Middle	Jordan (388)	6204	2.8	1.206	19.434	6203	<.001	<.001	0.298	0.27	0.33	0.247
	UAE (489)	29848	2.64	1.196	19.791	29847	<.001	<.001	0.137	0.12	0.15	0.115
	Uzbekistan (421)	4039	3.28	0.948	52.228	4038	<.001	<.001	0.779	0.75	0.81	0.822
	South Africa (397)	10465	2.87	1.116	34.117	10464	<.001	<.001	0.372	0.35	0.39	0.334
Global West	Australia (509)	4525	1.94	1.056	-35.84	4524	<.001	<.001	-0.563	-0.59	-0.53	-0.533
	Finland (504)	5569	1.84	1.013	-48.312	5568	<.001	<.001	-0.656	-0.68	-0.63	-0.647
	USA (488)	7636	2.28	1.141	-17.095	7635	<.001	<.001	-0.223	-0.25	-0.2	-0.196
	Brazil (378)	20083	2.2	1.193	-36.116	20082	<.001	<.001	-0.304	-0.32	-0.29	-0.255
	Chile (416)	4270	2.3	1.115	-11.518	4269	<.001	<.001	-0.196	-0.23	-0.16	-0.176

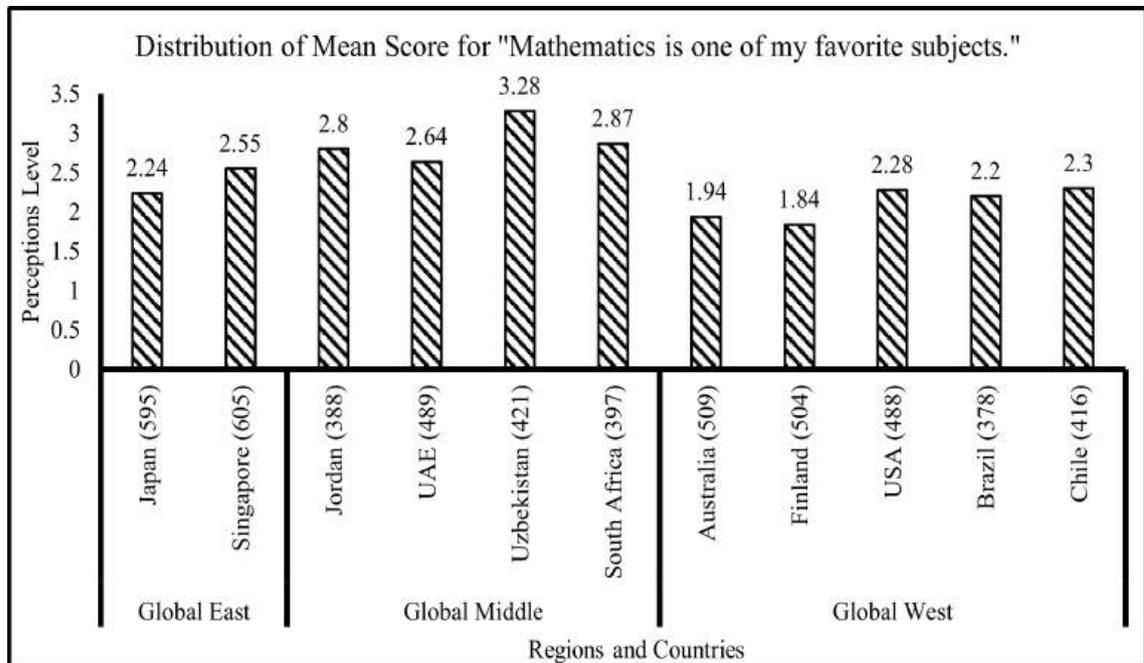


Figure 10. Distribution of average student perceptions related to mathematics as a favorite subject

The Global East presents a mixed picture regarding whether mathematics is considered a favorite subject despite consistently high achievement. Japanese students generally disagree with "considering mathematics one of their favorite subjects" (Mean = 2.24, SD = 0.989;

$t = -16.086, p < .001$, Cohen's $d = -.264$). This suggests that while they do not have an overtly negative view, they do not perceive it as particularly enjoyable or engaging enough to be a favorite. Despite this, their mean achievement in mathematics is 595, significantly above the international average of 500. This indicates that high performance in Japan is not necessarily tied to viewing mathematics as a favorite subject. Singaporean students show a weak agreement that "mathematics is one of their favorite subjects" (Mean = 2.55, SD = 1.166; $t = 2.854, p = .002$, Cohen's $d = .042$). While statistically significant, the small effect size suggests only a slight inclination. Their mean achievement score in TIMSS 2023 was 605, indicating high achievement, even though mathematics is not overwhelmingly their top favorite.

In the Global Middle, there is a consistent pattern of students agreeing that mathematics is one of their favorite subjects. However, this positive sentiment generally does not correlate with above-average achievement. Jordanian students agree that "Mathematics is one of my favorite subjects" (Mean = 2.80, SD = 1.206; $t = 19.434, p < .001$, Cohen's $d = 0.247$), suggesting it is one of their preferred subjects, although not their favorite. Nevertheless, their average achievement score in TIMSS 2023 is 388, far below the international average.

For UAE students, the mean of 2.64 (SD = 1.196; $t = 19.791, p < .001$, Cohen's $d = 0.115$) indicates that mathematics is one of their preferred subjects, although not necessarily their absolute favorite. Their country's average achievement is 489, slightly below the international average. For Uzbekistan, students strongly agree with the statement "Mathematics is one of my favorite subjects" (Mean = 3.28, SD = 0.948; $t = 52.228, p < .001$, Cohen's $d = 0.822$), indicating a statistically significant and large level of agreement. This means that, on average, mathematics is one of the students favorite subjects. Despite this strong positive perception, their mean achievement score was 421, significantly below the international average. Lastly, for South African students, the mean score of 2.87 ($t = 34.117, p < 0.001$, Cohen's $d = 0.334$) indicates that mathematics is one of their favorite subjects, suggesting a moderate positive sentiment. However, their average achievement in TIMSS 2023 was 397, which was below the international average.

The Global West generally shows students disagreeing with mathematics being one of their favorite subjects, with varied implications for their achievement. Notably, Australian students strongly disagree with the statement "Mathematics is one of my favorite subjects" (Mean = 1.94, SD = 1.056; $t = -35.840, p < .001$, Cohen's $d = -0.533$). This indicates a markedly negative perception of mathematics as a favored subject. Despite this, their average achievement in mathematics in TIMSS 2023 was 509, slightly above the international average of 500. Finnish students also showed strong disagreement with the statement "Mathematics is one of my favorite subjects" (Mean = 1.84, SD = 1.013; $t = -48.312, p < .001$, Cohen's $d = -0.647$), indicating that very few students consider mathematics a favored subject. Nevertheless, their average achievement in mathematics in TIMSS 2023 was 504, also slightly above the international average, suggesting that not considering math a favorite subject does not necessarily hinder strong performance.

US students disagreed with "Mathematics is one of my favorite subjects" (Mean = 2.28, SD = 1.141; $t = -17.095, p < .001$, Cohen's $d = -0.196$), indicating that they do not consider it a favorite, with a moderate level of disagreement. Their average achievement score in TIMSS 2023 mathematics was 488, slightly below the international average. For Brazilian students, the mean of 2.20 (SD = 1.193; $t = -36.116, p < .001$, Cohen's $d = -0.255$) suggests a significant disagreement that mathematics is a favorite subject. Their average achievement in TIMSS 2023 mathematics was 378, way below the international average. Chilean students disagreed with the statement "Mathematics is one of my favorite subjects" (Mean = 2.30, SD = 1.115; $t = -11.518, p < .001$, Cohen's $d = -0.176$), indicating that, on average, mathematics is not one of their favorite subjects. Their average achievement score of 416 in TIMSS 2023 was below the international average.

In conclusion, the Global East presents a scenario where high mathematics achievement is observed, whether mathematics is a favorite subject (as in Singapore) or not strongly perceived as one (as in Japan). The Global Middle consistently shows students considering mathematics a favorite subject, but this positive sentiment does not lead to above-average achievement. In the Global West, there is a general trend among students of not considering mathematics a favorite subject, with some countries still achieving above-average results despite this perception (Australia, Finland). In contrast, others align this lower favorability with below-average performance.

8. Discussion

The Trends in International Mathematics and Science Study (TIMSS) 2023 offers a fascinating lens into the complex relationship between student perceptions of mathematics and their actual achievement across various global regions. With an international average mathematics achievement score of 500, the data reveal distinct patterns in the Global East, Middle, and West. While some regions demonstrate a clear alignment between positive perceptions of mathematics learning and high performance, others highlight a puzzling disconnect, suggesting that a multifaceted interplay of cultural, pedagogical, and individual factors influences success in mathematics.

In the Global East, represented by Japan and Singapore, we observe consistently high mathematics achievement, with both countries significantly surpassing the international average (Japan: 595, Singapore: 605). However, student perceptions of mathematics are surprisingly nuanced and even contradictory. Japanese students, for instance, generally do not consider mathematics one of their favorite subjects (Mean = 2.24), express a lack of enthusiasm for problem-solving (Mean = 2.41) or numerical schoolwork (Mean = 2.08), and do not look forward to math class (Mean = 2.24). This indicates that their high performance is not driven by an overt "liking" or strong anticipation for the subject itself or its component tasks. Instead, their success may stem from other factors such as rigorous curricula, strong instructional practices, cultural emphasis on effort, or a different motivational framework that prioritizes mastery and societal expectations over personal enjoyment.

Singapore, while also a high-achieving nation, presents a slightly more positive picture than Japan. Singaporean students show a slight tendency to agree that they learn many interesting things in mathematics (Mean = 2.93), as well as in mathematics in general (Mean = 2.79), and perceive that they enjoy solving mathematics problems (Mean = 2.65). They also show a slight tendency to look forward to mathematics class (Mean = 2.53) and consider mathematics one of their favorite subjects (Mean = 2.55), albeit with small effect sizes indicating weak agreement. This suggests a mild positive sentiment that might contribute to, or at least not detract from, their exceptional academic outcomes. The high achievement in both countries, despite varying degrees of overt enthusiasm, challenges the simplistic notion that "liking" a subject is a potential determinant of success.

These results are consistent with the findings of the past studies in East Asia. For example, Tabao and Faiz (2020) conducted a study in the Philippines. They found that students perceived mathematics learning as rule-bound, primarily involving number domains, and that mathematics learning develops thinking abilities. They also disagreed that mathematics is a cold subject. Other studies, such as those by Ho (2009), Li (2004), and Wong (2004), have reported that students in East Asian cultures typically perform well despite experiencing high anxiety and negative perceptions of mathematics learning. These results are also supported by Matney et al. (2022), who found that Chinese students have relatively higher levels of negative perceptions of mathematics compared to their American counterparts, yet they performed better on the tests.

Therefore, students' perceptions of mathematics learning in the Asian context are more aligned with the cultural aspects of direct instruction, memorization, repeated practice, and obedience to authorities (e.g., teachers) (Chiu, 2016; Leung & Revina, 2023). These perceptions tend to be more negative in South Korea as students advance to higher grade levels (Kim et al., 2024). Japanese mathematics teachers participate in lesson studies that focus on student-centered activities in teaching and learning to promote mathematical thinking (Okazaki et al., 2019). However, the current study found that students in Japan have a negative perception of mathematics learning despite the teachers' efforts to promote student-centered teaching with the concept of fostering positive perceptions and performance. Despite achieving high scores in international tests, such as TIMSS, only 63

The Global Middle, encompassing countries such as Jordan, the UAE, Uzbekistan, and South Africa, presents a striking contrast. Students in these regions consistently express positive perceptions across nearly all categories of mathematical engagement and enjoyment. They generally agree that they learn many interesting things in mathematics (Jordan: 3.09, UAE: 3.00, Uzbekistan: 3.50, South Africa: 3.34), like mathematics (Jordan: 2.94, UAE: 2.85, Uzbekistan: 3.48, South Africa: 3.21), enjoy schoolwork involving numbers (Jordan: 2.91, UAE: 2.66, Uzbekistan: 3.33, South Africa: 3.04), like to solve mathematics problems (Jordan: 2.96, UAE: 2.76, Uzbekistan: 3.36, South Africa: 3.04), and look forward to math class (Jordan: 2.78, UAE: 2.70, Uzbekistan: 3.18, South Africa: 3.06). Many even consider mathematics one of their favorite subjects (Jordan: 2.80, UAE: 2.64, Uzbekistan: 3.28, South Africa: 2.87).

Nevertheless, this widespread positive perception does not translate into commensurately high achievement. All countries in this region score below the international average in mathematics (Jordan: 388, UAE: 489, Uzbekistan: 421, South Africa: 397). This significant disconnect suggests that while students may genuinely feel positive about mathematics and its content, other factors may be at play, such as instructional quality, curriculum alignment, resource availability, or broader systemic issues that impede the conversion of positive attitudes into higher academic outcomes.

These results are consistent with the findings of past studies; for example, Edo et al. (2023) reported that students' perceptions of mathematics learning did not predict achievement scores. The findings from a study by Edo et al. (2023) showed that a majority of students in Ghana disagreed that math makes them nervous (59%), disagreed that they dislike mathematics (54%), and did not agree that math is boring (53%). However, students' positive perceptions of mathematics learning had a negative relation with their performance in the Kumasi region of Ghana (Hagan et al., 2020). In another study in the same region, Salifu and Bakari (2022) and Shone et al. (2023) reported a positive relation between student perceptions and mathematics achievement. Likewise, students in the UAE have a positive perception of mathematics learning, and it increases with the progress in students' mathematics course levels, especially in higher education (Moussa & Saali, 2022). Results from a study in Ethiopia also showed that students' perceptions of mathematics learning were positively related to their mathematics performance, with a high degree of correlation (Shone et al., 2023). This way, there is not a general agreement on student perceptions of mathematics learning and their achievement in the Global Middle.

The Global West, represented by Australia, Finland, the US, Brazil, and Chile, exhibits a prevalent tendency towards disagreement or neutrality regarding various aspects of liking mathematics. Students in Australia, Finland, the US, Brazil, and Chile generally do not find mathematics particularly engaging or interesting (Australia: 2.36, Finland: 2.38, US: 2.73 - mild agreement, Brazil: 2.36, Chile: 2.97 - agreement, but note the US, Brazil, and Chile show a less consistent pattern than the Global Middle). More notably, students in this region largely disagree with statements about "liking mathematics" (Australia: 2.35, Finland: 2.24, US: 2.52 - neutral, Brazil: 2.63 - slight agreement, Chile: 2.67 - slight agreement), "liking any schoolwork that involves numbers" (Australia: 2.43, Finland: 1.92,

US: 2.21, Brazil: 2.36, Chile: 2.35), "liking to solve mathematics problems" (Australia: 2.27, Finland: 2.16, US: 2.36, Brazil: 2.42, Chile: 2.47), and "looking forward to mathematics class" (Australia: 2.00, Finland: 1.79, US: 2.29, Brazil: 2.06, Chile: 2.18). Furthermore, many students in this region do not consider mathematics one of their favorite subjects (Australia: 1.94, Finland: 1.84, US: 2.28, Brazil: 2.20, Chile: 2.30). These mixed results of students' perceptions of mathematics learning are consistent with the findings of some past studies. Matney et al. (2022) reported that students from the US generally have a positive perception of mathematics learning and doing mathematics. They reported that student perceptions of mathematics tend to decrease as grade levels increase, which also affects their achievement in higher grade levels.

Despite this widespread reported disinterest, achievement levels vary. Australia (509) and Finland (504) score slightly above the international average, exhibiting a phenomenon similar to Japan, where high performance can coexist with a lack of enthusiasm for the subject. This might be attributed to the quality of the education system, pedagogical approaches that ensure a foundational understanding regardless of affective states, or effective problem-solving strategies. Conversely, the US (488), Brazil (378), and Chile (416) generally perform below the international average, with their lower perceptions aligning more directly with their lower academic outcomes. This suggests that for these countries, a lack of engagement and positive perception may contribute to weaker performance.

The global landscape of student perceptions in mathematics reveals that the relationship between attitude and achievement is far from straightforward. While positive perceptions might be a desirable outcome in themselves, they do not guarantee high achievement, particularly evident in the Global Middle. Conversely, high achievement can be attained even with a notable lack of enthusiasm, as demonstrated by several countries in the Global East and West. This complex interplay underscores the importance of considering multiple factors beyond just student perceptions when striving to improve mathematics education. Effective pedagogical strategies, robust curriculum design, and the broader educational ecosystem likely play crucial roles in shaping both student attitudes and their ultimate academic success in mathematics.

9. Conclusion and Limitation

This study utilizes data from the Trends in International Mathematics and Science Study (TIMSS) 2023 to investigate the intricate relationship between students' perceptions of mathematics learning and their academic achievement across various global regions. Our analysis reveals that student perceptions are not consistently predictive of achievement. In the Global East, high-performing nations like Japan and Singapore demonstrate strong mathematical prowess despite moderate to low student enthusiasm, suggesting that factors such as cultural values, instructional rigor, and robust systemic support may be more influential than personal enjoyment. Conversely, the Global Middle presents a striking contrast. Here, students express overwhelmingly positive attitudes toward mathematics learning, yet their achievement consistently falls below the international average. This highlights that favorable perceptions alone are insufficient without accompanying high-quality teaching and effective educational systems. The Global West exhibits a mixed landscape, where achievement varies despite generally neutral or negative student perceptions of mathematics learning, further underscoring that affective factors are not the sole determinants of outcomes.

Collectively, these findings emphasize the multifaceted nature of mathematics achievement and caution against simplistic assumptions about the direct link between liking mathematics and excelling in it. While the study utilizes open data from TIMSS 2023, its generalizability is subject to the participating countries and their diverse sociocultural contexts. Future research should delve deeper into sociocultural differences to better

interpret student perceptions within specific regional contexts. Ultimately, for meaningful advancements in mathematics education, policymakers and educators must prioritize systemic support for deep learning, skill development, and long-term academic growth, alongside efforts to foster positive attitudes toward mathematics learning among students.

References

- [1] Alemany-Arrebola, I., Ortiz-Gómez, M. d. M., Lizarte-Simón, E. J., & Mingorance-Estrada, A. C. (2025). The attitudes towards mathematics: Analysis in a multicultural context. *Humanities & Social Science Communications*, 12, 254. <https://doi.org/10.1057/s41599-025-04548-x>
- [2] Ampadu, E. (2012). Students' perceptions of their teachers' teaching of mathematics: The case of Ghana. *International Online Journal of Educational Sciences*, 4(2), 351–358. <https://www.ajindex.com/dosyalar/makale/acarindex-1423904313.pdf>
- [3] Anokye, E., & Ampadu, A. (2020). Fenemma-Sherman Mathematics Attitude Scales: Instruments designed to measure attitudes towards the learning of mathematics by females and males. *Journal for Research in Mathematics Education*, 7(5), 324–326. <https://doi.org/10.5296/ije.v12i3.17136>
- [4] Asante, K. O. (2012). Secondary students' attitudes towards mathematics. *IFE Psychologia: An International Journal*, 20(1), 121–133.
- [5] Avila-Mangarin, R., & Montefolka, R. (2023). The influence of social-emotional intelligence on attitude towards mathematics instruction. *International Journal of Research and Innovation in Social Sciences*, 7(4), 801–815. <https://doi.org/10.47772/IJRISS.2023.7466>
- [6] Barroso, C., Ganley, C. M., McGraw, A. L., Geer, E. A., Hart, S. A., & Daucourt, M. C. (2021). A meta-analysis of the relation between math anxiety and math achievement. *Psychological Bulletin*, 147(2), 134–168. <https://doi.org/10.1037/bul0000307>
- [7] Bashir, N., Akram, K., & Bashir, R. (2023). Gender difference in students' attitude towards mathematics and their academic achievements at secondary level. *Pakistan Journal of Social Research*, 5(2), 77–84. <https://doi.org/10.52567/pjsr.v5i02.1169>
- [8] Berger, N., Mackenzie, E., & Holmes, K. (2020). Positive attitudes towards mathematics and science are mutually beneficial for student achievement: A latent profile analysis of TIMSS 2015. *The Australian Educational Researcher*, 47(3), 409–444. <https://doi.org/10.1007/s13384-020-00379-8>
- [9] Boaler, J. (2016). *Mathematical Mindsets: Unleashing Students' Potential through Creative Math, Inspiring Messages and Innovative Teaching*. Jossey-Bass.
- [10] Byiringiro, E. (2024). The effect of student Perception on teaching and learning mathematics in secondary schools in El'arish in North Sinai Governorate in Egypt. *International Journal of Modern Statistics*, 4(1), 1–13.
- [11] Chiu, M. M. (2016). Chinese teaching and learning of mathematics. In C. Chou & J. Spangler (Eds.), *Chinese education models in a global age. Education in the Asia-Pacific Region: Issues, concerns and prospects (Vol. 31)* (pp. 293–304). Springer, Singapore. https://doi.org/10.1007/978-981-10-0330-1_21
- [12] Davis, E. K., Kalogeropoulos, P., & Russo, J. A. (2024). Comparative study of primary school students' values in mathematics learning in Ghana and Australia. In *Values and valuing in mathematics education* (pp. 169–190). Springer, Singapore. <https://doi.org/10.1007/978-981-99-9454-09>
- [13] De Bortoli, L., Underwood, C., Friedman, T., & Gebhardt, E. (2024). *PISA 2022. Reporting Australia's results. Volume II: Student and school characteristics*. In OECD Programme for International Student Assessment (PISA) Australia. Australian Council for Educational Research. <https://doi.org/10.37517/978-1-74286-726-7>

- [14] Dowker, A., Cheriton, O., Horton, R., & Winifred, M. (2019). Relationships between attitudes and performance in young children's mathematics. *Educational Studies in Mathematics*, *100*, 211–230. <https://doi.org/10.1007/s10649-019-9880-5>
- [15] Edo, H., Vivian, M., Hashimu, M., Golbert, A., & Amoah, E. (2023). Students' perceptions of learning mathematics: The impact on achievement in the Ga East Municipality. *International Journal of Novel Research in Education and Learning*, *10*(5), 17–28. <https://doi.org/10.5281/zenodo.8328401>
- [16] Eric, C. C. M. (2011). Primary 6 students' attitudes towards mathematical problem-solving in a problem-based learning setting. *The Mathematics Educator*, *13*(1), 15–31. https://math.nie.edu.sg/ame/matheduc/tme/tmeV13_1/2.pdf
- [17] Etuk, E. N., Afangideh, M. E., & Uya, A. O. (2013). Students' perception of teachers' characteristics and their attitude towards mathematics in Oron Education Zone, Nigeria. *International Education Studies*, *6*(2), 197–204. <http://dx.doi.org/10.5539/ies.v6n2p197>
- [18] Ferreira, A., & Santoso, A. (2008). Do students' perceptions matter? A study of the effect of students' perceptions on academic performance. *Accounting & Finance*, *48*(2), 209–231. <https://doi.org/10.1111/j.1467-629X.2007.00239.x>
- [19] Fishbein, B., Taneva, M., & Kowolik, K. (2025). *TIMSS 2023 user guide for international database*. Boston College, TIMSS & PIRLS International Study Center. <https://timss2023.org/data>
- [20] Furinghetti, F., & Pehkonen, E. (2002). Rethinking characterizations of beliefs. In G. C. Leder, E. Pehkonen, & G. Törner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 39–58). Kluwer. https://doi.org/10.1007/0-306-47958-3_3
- [21] Galende, N., Arrivillaga, R., & Madariaga, M. (2020). Attitudes towards mathematics in secondary school students. Personal and family factors. *Culture and Education*, *32*(3), 529–555. <https://doi.org/10.1080/11356405.2020.1785156>
- [22] Garofalo, J. (1989). Beliefs and their influence on mathematical performance. *The Mathematics Teacher*, *82*(10), 502–505. <https://doi.org/10.5951/mt.82.7.0502>
- [23] Geary, C., Hoard, K., Nugent, L., Ünal, E., & Greene, R. (2023). Sex differences and similarities in relations between mathematics achievement, attitudes, and anxiety: A seventh-to-ninth grade longitudinal study. *Journal of Educational Psychology*, *115*(5), 767–782. <https://doi.org/10.1037/edu0000793.supp>
- [24] Grootenboer, P., Marshman, M., Grootenboer, P., & Marshman, M. (2016). The affective domain, mathematics, and mathematics education. In *Mathematics, affect and learning: Middle school students' beliefs and attitudes about mathematics education* (pp. 13–33). https://doi.org/10.1007/978-981-287-679-9_2
- [25] Hagan, J. E., Amoaddai, S., Lawer, V. T., & Atteh, E. (2020). Students' perception towards mathematics and its effects on academic performance. *Asian Journal of Education and Social Studies*, *8*(1), 8–14. <https://doi.org/10.9734/AJESS/2020/v8i130210>
- [26] Han, F. (2019). Self-concept and achievement in math among Australian primary students: Gender and culture issues. *Frontiers in Psychology*, *10*, Article 603. <https://doi.org/10.3389/fpsyg.2019.00603>
- [27] Ho, F. S. (2009). Characteristics of East Asian learners: What we learned from PISA. *Educational Research Journal*, *24*(2), 327–348. <https://neqmap.bangkok.unesco.org/wp-content/uploads/2019/08/Characteristics-of-East-Asian-Learners-What-We-Learned-from-PISA.pdf>
- [28] Hwang, S., & Son, T. (2021). Students' attitude towards mathematics and its relationship with mathematics achievement. *Journal of Education and E-Learning Research*, *8*(3), 272–280. <https://doi.org/10.20448/JOURNAL.509.2021.83.272.280>
- [29] Iaochite, R. T., da Matos, M. M., da Costa Filho, R. A., Azzi, R. G., & Maciel, A. C. de M. (2025). Mathematics Self-Efficacy of Brazilian High School Students: A

- Mixed-Methods Approach Study. *International Journal of Psychology*, 60(2), e70019. <https://doi.org/10.1002/ijop.70019>
- [30] Ing, M., & Nylund-Gibson, K. (2017). The importance of early attitudes toward mathematics and science. *Teachers College Records: The Voice of Scholarship in Education*, 119(5), 1–32. <https://doi.org/10.1177/016146811711900507>
- [31] Jiang, H., Zhang, L., & Zhang, W. (2024). Influence of career awareness on STEM career interests: Examining the roles of self-efficacy, outcome expectations, and gender. *International Journal of STEM Education*, 11, Article 22. <https://doi.org/10.1186/s40594-024-00482-7>
- [32] Kanafiah, S. F. H. M., & Jumadi, A. (2013). Students' perception towards mathematics: Attitudes, interests and lecturers' teaching. In *International Symposium on Mathematical Sciences and Computing Research* (pp. 6–7).
- [33] Kasmin, F., Othman, Z., & Ahmad, S. S. S. (2019). Improving students' perception towards learning mathematics: Impact of teaching application of mathematics. *EDUCATUM Journal of Science, Mathematics and Technology*, 6(1), 29–34. <https://doi.org/10.37134/ejsmt.vol6.1.4.2019>
- [34] Kim, S., Suh, B., Ko, H. K., & Huh, N. (2024). A study of students' perceptions of mathematics learning situations. *Journal of the Korean Society of Mathematical Education Series A*, 63(3), 4110436. <https://doi.org/10.7468/mathedu.2024.63.3.411>
- [35] Kunwar, R. (2021). A Study on low performing students' perception towards mathematics: A case of secondary level community school students of Nepal. *Researcher: A Research Journal of Culture and Society*, 5(1), 125–137. <https://doi.org/10.3126/researcher.v5i1.41384>
- [36] Leung, F. K. S., Park, K., Shimizu, Y., & Xu, B. (2015). Mathematics education in East Asia. In S. J. Cho (Ed.), *The proceedings of the 12th international conference on mathematical education: Intellectual and attitudinal challenges* (pp. 123–144). Springer.
- [37] Leung, F. K. S., & Revina, S. (2023). The influence of culture on students' mathematics achievement in East Asia. In W. O. Lee, P. Brown, A. L. Goodwin, & A. Green (Eds.), *International handbook on education development in the Asia-Pacific* (pp. 1463–1479). Springer, Singapore. https://doi.org/10.1007/978-981-19-6887-7_48
- [38] Li, J. (2004). A Chinese culture model of learning. In L. Fan, N. Y. Wong, J. Cai, & S. Li (Eds.), *How Chinese learn mathematics: Perspectives from insiders* (pp. 124–156). World Scientific, Singapore.
- [39] Li, Y. (2012b). What does it mean to learn to teach mathematics in East Asia? *ZDM Mathematics Education*, 44(3), 265–277. <https://doi.org/10.1007/s11858-012-0415-0>
- [40] Lianghuo, F., Seng, Q. K., Yan, Z., Mei, Y. S., Pereira-Mendoza, L., & Yee, L. P. (n.d.). *Assessing Singapore students' attitudes toward mathematics and mathematics learning: Findings from a survey of lower secondary students*. Paper presented at the ICMI regional conference: The 3rd East Asia Regional Conference on Mathematics Education, Shanghai, China. NIE Repository. <https://repository.nie.edu.sg/server/api/core/bitstreams/495a995b-67d0-494a-a493-5274372fc9bc/content>
- [41] Libradilla, A., Morales, R., Piamonte-Baatan, J., & Misoles, A. (2023). Examining the association between attitude towards mathematics and student achievement. *International Journal of Research Publication and Reviews*, 4(7), 1040–1046. <https://ijrpr.com/uploads/V4ISSUE7/IJRPR15348.pdf>
- [42] Liu, F., & Wang, C. (2021). Math anxiety and its relationship with math performance among Chinese primary school students: The mediating role of working memory. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2021.647473>

- [43] Luo, W., Ng, P. T., Lee, K., & Aye, K. M. (2016). Self-efficacy, value, and achievement emotions as mediators between parenting practice and homework behavior: A control-value theory perspective. *Learning and Individual Differences*, 50, 275–282. <https://doi.org/10.1016/j.lindif.2016.07.01750>
- [44] Marasini, M., Panthi, D., Parajuli, K. K., & Upadhyay, H. P. (2025). Student perceptions of difficulty in high school mathematics: A qualitative study. *International Journal of Literacy and Education*, 5(1), 417–422. <https://doi.org/10.22271/27891607.2025.v5.i1f.298>
- [45] Mata, M. D. L., Monteiro, V., & Peixoto, F. (2012). Attitudes towards mathematics: Effects of individual, motivational, and social support factors. *Child Development Research*, 2012(1), 876028. <https://doi.org/10.1155/2012/876028>
- [46] Matney, G. T., Fischer, C., & Jackson II, J. L. (2022). Understanding students' perceptions of doing mathematics: A cultural comparison. *Southeast Asian Mathematics Education Journal*, 12(2), 105–124. <https://doi.org/10.46517/seamej.v12i2.185>
- [47] Moussa, N. M., & Saali, T. (2022). Factors affecting attitude toward learning mathematics: A case of higher education institutions in the Gulf Region. *SAGE Open*, 12(3), 1–13. <https://doi.org/10.1177/21582440221123023>
- [48] Mutodi, P., & Ngirande, H. (2014). The influence of students' perceptions on mathematics performance: A case of a selected high school in South Africa. *Mediterranean Journal of Social Sciences*, 5(3), 431–445. <https://doi.org/10.5901/mjss.2014.v5n3p431>
- [49] OECD. (2015). *PISA 2015 Results (Volume I): Excellence and Equity in Education*. OECD Publishing. <https://www.oecd.org>
- [50] OECD. (2023). *PISA 2022 Results (Volume II): Learning During and Beyond COVID-19*. Organization for Economic Co-operation and Development. <https://www.oecd.org/education/pisa-2022-results-volume-ii-4f5bffb4-en.ht>
- [51] Okazaki, M., Okamoto, K., & Morozumi, T. (2019). Characterizing the quality of mathematics lessons in Japan from the narrative structure of the classroom: “Mathematics lessons incorporating students' questions as a main axis” as a leading case. *Hiroshima Journal of Mathematics Education*, 12, 49–70. <https://doi.org/10.24529/hjme.1204>
- [52] Peixoto, F., Sanches, C., Mata, L., & Monteiro, V. (2017). “How do you feel about math?”: Relationships between competence and value appraisals, achievement emotions and academic achievement. *European Journal of Psychology of Education*, 32(3), 385–405. <https://doi.org/10.1007/s10212-016-0299-4>
- [53] Ramírez, M. J. (2005). Attitudes toward mathematics and academic performance among Chilean 8th graders. *Estudios Pedagógicos (Valdivia)*, 31(1), 97–112. <https://doi.org/10.4067/s0718-07052005000100006>
- [54] Roesdiana, L. (2023). Mathematics beliefs of secondary school students: A systematic reviews. *Journal of Research in Science and Mathematics Education (J-RSME)*, 2(1), 13–18. <https://doi.org/10.56855/jrsme.v2i1.245>
- [55] Roshni. (2021, July 13). 82% students of classes 7 to 10 are fearful of math: Survey. India Today. <https://www.indiatoday.in/education-today/latest-studies/story/82-students-classes-7-to-10-are-fearful-of-math-survey-1827619-2021-07-13>
- [56] Roth, W. M., & Bradford, L. (2011). *A cultural historical perspective on mathematics teaching and learning*. Sense Publishers.
- [57] Saadati, F., Martínez, M. V., & Espinoza, C. G. (2023). Upper primary student attitudes toward mathematics problem solving; an exploratory study in Chile. *Research in Mathematics Education*, 27(1), 44–65. <https://doi.org/10.1080/14794802.2023.2221659>

- [58] Salifu, A. S., & Bakari, A. (2022). Exploring the relationship between students' perception, interest and mathematics achievement. *Mediterranean Journal of Social & Behavioral Research*, 6(1), 13–20. <https://doi.org/10.30935/mjosbr/11491>
- [59] Sasidharan, S., & Kareem, J. (2023). Student perceptions and experiences in mathematics classrooms: A thematic analysis. *International Journal of Innovation in Science and Mathematics Education*, 31(2), 47–59. <https://doi.org/10.30722/IJISME.31.02.004>
- [60] Shone, E. T., Weldemeskel, F. M., & Worku, B. N. (2024). The role of students' mathematics perception and self-efficacy toward their mathematics achievement. *Psychology in the Schools*, 61, 103–122. <https://doi.org/10.1002/pits.23033>
- [61] Suherman, S., & Vidákovich, T. (2024). Mathematical creative thinking-ethnomathematics based test: Role of attitude toward mathematics, creative style, ethnic identity, and parents' educational level. *Revista de Educacion a Distancia (RED)*, 24(77), 1–22. <https://doi.org/10.6018/red.58122>
- [62] Tabao, S. A., & Faiz, A. D. H. (2020). Students' perceptions and attitude towards mathematics learning. *International Journal of Trends in Scientific Research and Development (IJTSRD)*, 4(6), 811–814. <https://www.ijtsrd.com/humanities-and-the-arts/education/33479/students%E2%80%99-perceptions-and-attitude-towards-mathematics-learning/shamseda-azis-tabao>
- [63] Tuohilampi, L., Hannula, M. S., Varas, L., Giacconi, V., Laine, A., Näveri, L., & i Nevado, L. S. (2015). Challenging the western approach to cultural comparisons: Young pupils' affective structures regarding mathematics in Finland and Chile. *International Journal of Science and Mathematics Education*, 13(6), 1625–1648. <https://doi.org/10.1007/s10763-014-9562-9>
- [64] Tuohilampi, L., Laine, A., Hannula, M. S., & Varas, L. (2016). A comparative study of Finland and Chile: The culture-dependent significance of the individual and interindividual levels of the mathematics-related affect. *International Journal of Science and Mathematics Education*, 14(6), 1093–1111. <https://doi.org/10.1007/s10763-015-9639-0>
- [65] Van der Beek, J. P. J., Van der Ven, S. H. G., Kroesbergen, E. H., & Leseman, P. P. M. (2017). Self-concept mediates the relation between achievement and emotions in mathematics. *British Journal of Educational Psychology*, 87(3), 478–495. <https://doi.org/10.1111/bjep.12160>
- [66] Vionita, A., & Purboningsih, D. (2017, August). Improving attitudes toward mathematics learning with problem posing in class VIII. *AIP Conference Proceedings*, 1868(1), 050007. AIP Publishing. <https://doi.org/10.1063/1.4995134>
- [67] Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- [68] Wakhata, R., Mutarutinya, V., & Balimuttajjo, S. (2022). Secondary students' attitude towards mathematics word problems. *Humanities and Social Sciences Communications*, 9, Article No. 444. <https://doi.org/10.1057/s41599-022-01449-1>
- [69] Wang, F., King, R. B., & Leung, S. O. (2023). Why do East Asian students do so well in mathematics? A machine learning study. *International Journal of Science and Mathematics Education*, 21(3), 691–711. <https://doi.org/10.1007/s10763-022-10262-w>
- [70] Wen, R., & Dubé, A. K. (2022). A systematic review of secondary students' attitudes towards mathematics and its relations with mathematics achievement. *Journal of Numerical Cognition*, 8(2), 295–325. <https://doi.org/10.5964/jnc.7937>
- [71] Wong, K. Y., & Chen, Q. (2012). Nature of an attitude toward learning mathematics questionnaire. In J. Dindyal, L. P. Cheng, & S. F. Ng (Eds.), *Mathematics education: Expanding horizons* (Proceedings of the 35th annual conference of the Mathematics Education Research Group of Australasia). Singapore: MERGA.

- [72] Wong, N. Y. (2004). The CHC learner's phenomenon: Its implications on mathematics education. In L. Fan, N. Y. Wong, J. Cai, & S. Li (Eds.), *How Chinese learn mathematics: Perspectives from insiders* (pp. 503–534). World Scientific, Singapore.
- [73] Yang, X. (2013). Senior secondary students' perceptions of mathematics classroom learning environments in China and their attitudes towards mathematics. *The Mathematics Educator*, 15(1), 66–80. https://math.nie.edu.sg/ame/matheduc/journal/v15_1/v15_4.aspx
- [74] Zhang, Q., & Zhang, D. (2020). Students' mathematical learning values in China: A cross-grade survey. *Journal of Research in Science, Mathematics and Technology Education*, 3(2), 121–136. <https://doi.org/10.1177/2096531120930240>