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The Turkish Education System's Outlook Through the Lens of TIMSS 2023 Results: Academic Performance and Equality of Opportunities

Hayri Eren Suna[1] **Mahmut Özer**[2]

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Abstract

As one of the premier large-scale assessment studies worldwide, the TIMSS study has provided substantial feedback to participating countries with its latest results for 2023. As a long-term participant in TIMSS, Türkiye participated in the 2023 cycle at a time when the effects of the COVID-19 pandemic and the earthquakes that occurred on February 6, 2023, continued. In particular, the recent and substantial impact of the earthquakes on February 6, 2023, forced Türkiye to partially limit its area of sampling. However, despite the partial limitations of the implementation, the results of the TIMSS 2023 cycle provide valuable insight into the performance of the Turkish education system in the wake of these two major challenges. The purpose of this study is to evaluate the results of the 2023 cycle from a comparative perspective within the framework of TIMSS indicators related to academic achievement and educational equity in Türkiye. Based on the findings, Türkiye's overall performance within TIMSS has continued to improve under the implementation conditions of the 2023 cycle. It should be noted, however, that the percentage of students who do not possess basic skills remains higher than in other countries that have similar overall performance levels. Moreover, the study indicates that the relationship between socioeconomic disparities and student performance is relatively stronger in Türkiye, emphasising the necessity for measures to enhance educational equity in the country. We discuss recent initiatives, as well as supporting examples, aligned with the findings of the study, which are aimed at strengthening equity in the Turkish education system.

Keywords: TIMSS, academic achievement, equal opportunities in education, socioeconomic status

[1] Corresponding Author, herensuna@gmail.com, General Consulate of Türkiye in Paris, France
[2] Author, mahmutozer2002@yahoo.com, Turkish Grand National Assembly Commission of National Education, Culture, Youth and Sports, Ankara, Türkiye.

Introduction

International large-scale assessments (ILSAs) play a critical role in interpreting education policies as well as determining the readiness of students in different countries for today's conditions (Creswell et al., 2015; UNESCO, 2018). The purpose of ILSAs is to collect data from representative samples in order to reflect the diversity of educational systems across countries and provide valid and reliable information about students' skills. A key feature of ILSAs is their ability to provide comparable evidence across structurally different education systems by utilizing common criteria.

Since the late 1950s, ILSAs have been implemented with the aim of establishing data-driven policies in education and systematically monitoring education indicators (IEA, 2020; Rutkowski et al., 2020). Through reports and the availability of their data to researchers, the findings of these studies have increased public awareness of education policies, as well as enabling independent researchers to examine different components of education systems based on data (Hernández-Torrano and Courtney, 2021; IEA, 2020; Özer, 2020). Since education is among the most important public investment areas and the contributions of the investments made at the societal level (European Commission, 2023; Özer, 2021; Psacharopoulos, 2006), mechanisms for monitoring education systems have become increasingly important. Therefore, since the 1990s, there has been a marked increase in the diversity of ILSAs as well as an increased interest in ILSAs (IEA, 2020).

Furthermore, a number of factors play an important role in the spread of ILSAs and their expansion into new areas. Even though efforts to massify education since the 1970s have substantially solved the issue of access to education, educational inequality tends to increase due to significant rise in societal inequality, and the importance of indicators regarding educational inequality has increased. (European Commission, 2024; Haelermans et al., 2022; Langtaher and Malik, 2023). The second aspect is the value attached to the results of ILSAs in order to evaluate how compatible they are with global expectations of changing education policies following the technological revolution. The increased interest has led to ILSAs providing more "contextual data" regarding different components of education systems in the process of developing these skills, as well as evaluating student performance (Creswell et al., 2015). This has resulted in ILSAs providing more information about the different characteristics of education systems and allowing them to be compared with other education systems from a variety of indicators.

Education systems are currently experiencing an extremely large-scale and rapid transformation within the framework of the concepts of quality and equality of opportunity that are the basis of the design of the ILSAs (Qayyum, 2023; Özer, 2024). Our era is indeed one in which education access has largely been resolved, however, as a result of increasing social inequalities, disparities and inequalities in education present unique challenges (European Commission, 2024; Haelermans et al., 2022; Langtaher and Malik, 2023). In the current era of digital advancements, particularly the use of digitalization and AI algorithms, society has been impacted significantly which has resulted in a widening of economic, psychological, and social gaps (European Parliament, 2024; Tian and Xiang, 2024). The impact of this transformation can be seen even in the daily lives of individuals, including the way in which communication is conducted, the way in which consumers consume goods, and the way in which people understand one another. It is therefore imperative that education systems which are responsible for providing individuals with the necessary skills are expected to assume new responsibilities in light of these new circumstances (European Commission, 2020; Oliveira and de Souza, 2021).

Based on their responsibility in responding the skill needs of individuals and leading the improving the human labor in changing global perspective, education systems are facing with comprehensive reforms (Boeskens and Meyer, 2025). The transformation experienced in the labor market is rapidly changing the skills expected from students, and educational systems are also subject to constant change in order to provide students with the required skill sets (Fasih, 2008; Hogarth , 2019; Özer and Perc , 2020; Özer and Suna, 2023). Particularly, digitalization is the most emerging topic in the recent reforms in educational reforms due to increased expectation of digital skills from labor market and Covid-19 experience (Boeskens and Meyer, 2025; Mukul & Büyüközkan, 2023). It is well-known that digitalization leads to diverse advantages for supporting educational systems with personalized learning and assessment mehods, instant feedback and improved accessibility (Major, Francis and Tsapali, 2021; Schmid et al., 2022). Still, recent evidences show that the impact of educational digitalization on

students is not limited with beneficial attributes. As education systems become increasingly affected by digitalization, they also deal with a growing number of psychological and social problems related to this transformation (Özer and Suna, 2020; Sing Yun, 2023). Therefore, education systems are facing an era of transformation which leads both advantages and bootlenecks for educational stakeholders, and educational policy makers need valid, reliable, relevant and comparable data to enlight their way of policies. As expected, ILSAs are key agents for gathering qualified and comprehensive data in a comparable perspective within the period of transformation.

Since the implementation of the ILSAs as a reference point for data-based policies, discussions regarding their interpretation have also increased (Hamilton, 2017; Rutkowski et al., 2020; Torney-Purta & Amadeo, 2013). In the first discussion, it is pointed out that only general performance indicators are taken into account in the interpretation of the results, and that contextual data and findings related to this performance are under-represented (Fischman et al., 2017). In addition, causal inferences are drawn regarding education policies by analyzing changes in general performance over time (Rutkowski et al., 2020). As a result of ILSAs, cross-sectional designs are often insufficient for making causal inferences; however, they provide the potential to evaluate results from a correlational perspective (Rutkowski & Delandshere, 2016). Hence, it is critical to review the ILSA findings using a correlational perspective while taking into account possible external factors and past trends in examining their relationship to education policy. As one of the most well-established and well-respected studies within the scope of the ILSA, the Trends in International Mathematics and Science Survey (TIMSS) is conducted by the International Agency for the Evaluation of Educational Achievement (IEA). TIMSS, which has been in use since 1995, evaluates the academic achievement of 4th and 8th grade students in mathematics and science and determines contextual variables related to them (IEA, 1996). Throughout the duration of the cycles, which have been implemented for approximately 30 years, participating countries and economies have had the opportunity to monitor performance patterns. It is also important to preserve contextual data collected from students, teachers, and administrators throughout the cycles, so that inferences can be drawn regarding the change in factors that contribute to student achievement in the future (von Davier et al., 2022).

As a long-term participant in the TIMSS study, Türkiye receives significant coverage from both the academy and the national media following the announcement of results after each cycle. In the current cycle of the TIMSS 2023, Türkiye has been subjected to cycle-specific limitations due to the negative impacts of multiple factors during the period when the TIMSS was administered. A first factor is the effects of the Covid-19 global pandemic, and Türkiye was a country that remained closed to face-to-face education for several years during the pandemic (ERG and TÜSİAD, 2021; Özer et al., 2022). The second and main factor is the impact of the earthquake that occurred on February 6, 2023, one of the largest earthquake in the Republic's history. The disaster, which deeply affected educational activities due to the geographical area and the size of the human population it affected (more than 13 million people living in 11 provinces) (OECD, 2024; Özer et al., 2023) has also created inevitable obligations in terms of Türkiye's participation in TIMSS. The application standards were maintained by excluding nine provinces in the earthquake zone in Türkiye from the sample as a result of the difficulties mentioned above. In spite of the fact that the impact of disasters concentrated in particular areas and cities, all stakeholders and dimensions of the Turkish education system-wide are affected psychologically. In this manner, TIMSS 2023 results have a unique importance in revealing the response of Turkish education system to the consecutive disasters. Within this perspective, the purpose of this study is to assess the performance of the Türkish education system in terms of academic achievement and equality indicators in education within the context of TIMSS 2023. In line with this purpose, we examined the performance changes of countries/economies at different levels since the 2011 cycle and the changes in the relationships between the factors related to equality of opportunity and student performance. Several opinions and suggestions were offered regarding the possible relationship between the results and Turkish education policies in recent years.

Method

This study uses a systematic review (SR) design with a comparative perspective. SRs are classified as secondary research based on primary evidence and allows researchers to focus on phenomen(s) in a detailed way via a comprehensive literature review (Tranfield, 2003). The present study uses the findings

of secondary data which was already analyzed and published by IEA. As authors, we selected particular findings regarding the indicators of academic achievement and educational inequality to examine the change in Türkiye's performance. Rationale behind our decisions on selected countires and TIMSS cycles were as follows:

-We considered the last four TIMSS cycles (2011, 2015, 2019, 2023) in academic achievement indicators and educational inequality indicators based on the fact that Türkiye has participated to begin the consecutive TIMSS cycles with students in both 4th grades and 8th grades. Exceptionally, we just used average scores of Türkiye in 1999 and 2007 for reviewing and tracking the academic performance of 8th graders before the period of focus.

-Türkiye has participated the 2011 and 2015 TIMSS cycles for 4th grade with sampling of 4th graders, and decided to participate the same level with 5th graders in the 2019 and 2023 cycles due to higher coherence between TIMSS Mathematics and Science Frameworks and national curriculum. All sampling procedures about Türkiye and other participating countries are available in Technical Reports by TIMSS & PIRLS Study Center.

-For easier interpretation, we selected a group of countries to review the changes in both academic performance and educational inequalities in the 4th graders and 8th graders. In this perspective, we selected the countries to based on their performance level in the 2011 TIMSS cycle. Since the average performance of countries differ between 4th and 8th grade levels, we used six-step and four-step models, respectively. Thus we had opportunity to review the changes of performances of countries from different levels since 2011 TIMSS cycle. Table 1 showed our classification in diverse grade and performance levels.

Table 1.
Selected Participant Countries and Their Groups Based on TIMSS 2011 Findings

Group	4th Grade		Group	8th Grade	
	Maths	Science		Maths	Science
Dramatically Higher Than Midpoint (AS≥540)	Belgium USA	Japan	Dramatically Higher Than Midpoint (AS≥530)	Japan	Finland England
Higher than Midpoint (530≤AS<540)	Portugal	Czech Republic	Higher Than Midpoint (500-529)	Israel USA England	Hungary Sweden Italy Kazakhstan
Slightly Higher than Midpoint (501≤AS<530)	Hungary Sweden	England Portugal Spain			
Slightly Lower Than Midpoint (470≤AS<500)	Poland	Kazakhstan Chile Thailand	Lower Than Midpoint (451-499)	Italy Sweden UAE	Iran Thailand
Lower than Midpoint (450≤AS<470)	Chili	Iran	Dramatically Lower than Midpoint (AS≤450)	Lebanon Malaysia Chile	Oman
Dramatically Lower than Midpoint (AS<450)	Georgia	UAE Oman			

All the findings which presented and interpreted in the present study were provided by IEA, thus, these findigs are open for all researchers and my be reached via TIMSS & PIRLS Study Center. At the time of conducting this review, the official data of TIMSS 2023 were still not available for researchers for potential further analyses by authors. Particularly, we selected the relevant indicators about academic performance and educational inequality and review the changes in these indicators across TIMSS cycles and selected countries.

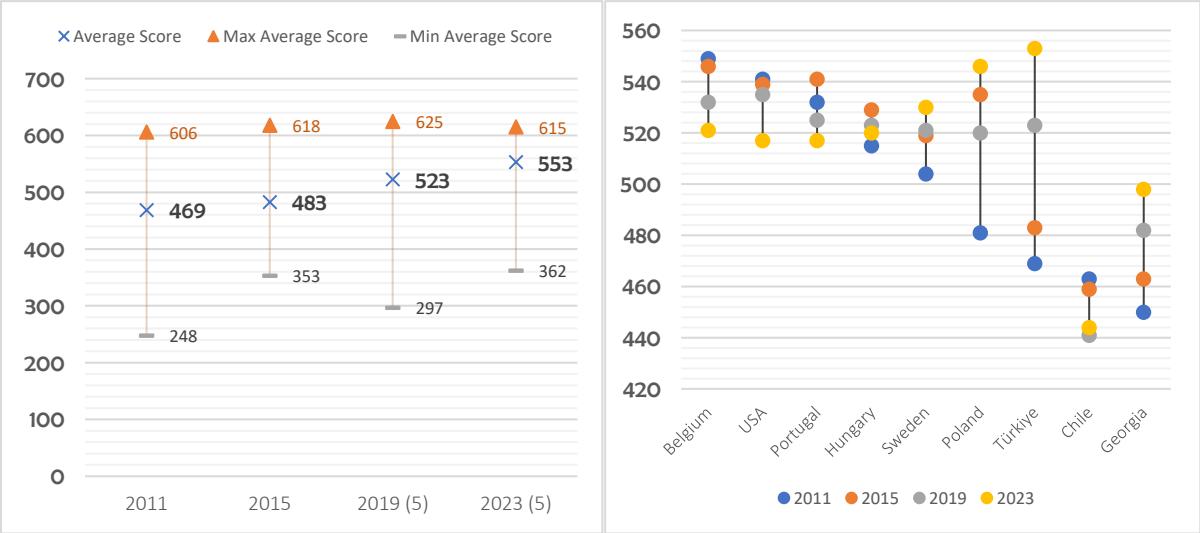
Findings

Türkiye's Academic Achievement According to TIMSS 2023 Indicators

Similar to many ILSAs, TIMSS assesses students' academic achievement through a variety of indicators. Indicators commonly used are changes in average scores of countries and economies and changes in the proportion of students who have achieved different levels of proficiency. From one TIMSS cycle to another, changes in average scores reflect the academic achievement scores in science and mathematics of students selected through statistical methods to represent students studying in countries/economies (von Davier et al., 2024). It provides important and comparable information about how the academic achievement of students in mathematics and science has changed in each country/economy compared to the previous cycle. Furthermore, since the average score of each participating country/economy may change during each cycle, the "scale midpoint" has been defined by TIMSS as a comparable standard of achievement across all cycles. We analysed the change in the distribution of Türkiye's average scores over time and the proficiency levels of students in the last four cycles, as well as the changes in the performance of countries with different performance levels in the 2011 cycle.

Mathematical Achievement

In TIMSS, mathematics achievement is assessed using the "TIMSS Mathematics Framework", which was developed with the participation of participating countries (Mullis et al., 2021). As a result of this framework, we are able to identify the mathematics skills expected from fourth graders and eighth graders in participating countries with widely varying curricula and education programs, and use it to prepare questions to develop these skills. Additionally, this framework is updated before each implementation with the assistance of participating countries. Countries/economies evaluate the compatibility of the updated framework with their own curricula and education programs. As an example, Türkiye, Norway, and South Africa compared the fourth-grade mathematics framework developed for the 2019-2023 cycle to local curricula and education programs, and found that the appropriate skills were primarily imparted at the fifth-grade level in their local education systems, and took part in the implementation at the fifth-grade level as well. In Figure 1, Türkiye is shown alongside countries at different levels of performance with their average TIMSS scores.



a. Türkiye's Average Scores in the Last Four Cycles *b. Selected Countries' Score Changes in the Last Four Cycles*

Figure 1. Changes in Türkiye's Average Scores with Selected Countries Throughout the Cycles – 4th Grade Mathematics Achievement *,**

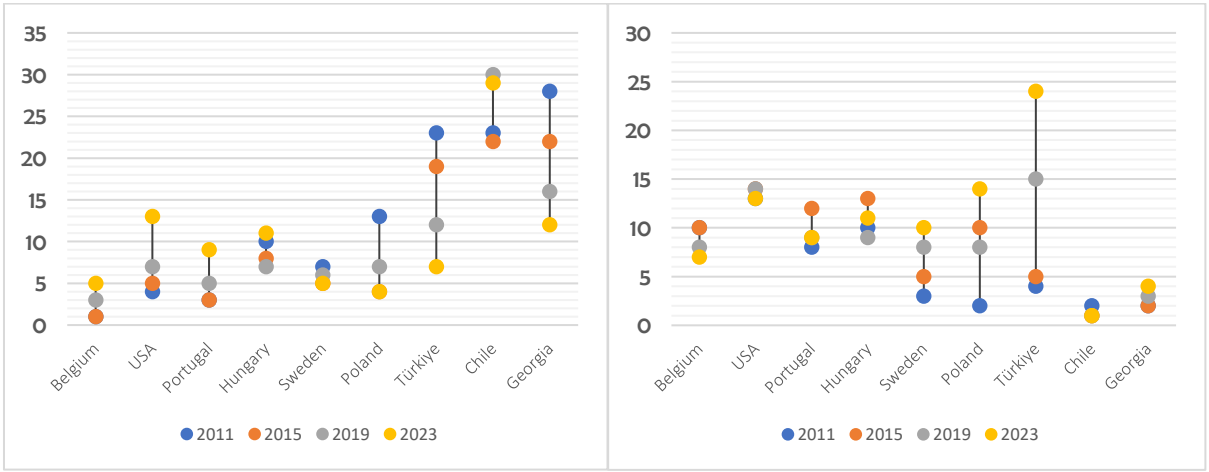
** Türkiye participated in the 2019 and 2023 cycles at the 5th grade level.*
***In the 2023 cycle, the 9 provinces affected by the February 6, 2023 earthquakes were not included in the Türkiye sample.*

As shown in Figure 1a, the average mathematics achievement scores have increased consistently from the 2011 cycle, when Türkiye began participating in TIMSS at the 4th grade level, to the 2019 cycle. In particular, the upward trend has intensified since Türkiye decided to participate with the 5th grade in the 2019 TIMSS mathematics assessment framework, due to its assessment that it is fully compatible with

the Turkish curriculum for the 5th grade level. Due to the partial sample limitations, Türkiye's average score reached the highest level in the 2023 cycle. For the first time in the 2019 and 2023 cycles, when the grade level change took place, Türkiye exceeded 500 points, which represented the midpoint of the scale. The result of this change was also a narrowing of the score gap between Türkiye and the highest-performing countries (137 points in 2011, 135 points in 2015, 102 points in 2019, and 62 points in 2023).

The change in Türkiye's average score at the 4th-grade level is examined together with other countries for which it has participated in TIMSS cycles since 2011. As shown in Figure 1, it exhibits similar trends to Georgia and Poland but also differs significantly from other countries. There is an important finding to be noted there: Belgium, the USA, Portugal and Hungary, all of which showed relatively high mathematics achievement in the 2011 cycle, have shown a downward trend in the last three cycles. In contrast, Sweden, Poland, Türkiye and Georgia, which showed relatively low performance during the 2011 cycle, have shown a tendency to improve in the following cycles and have been classified into groups based on opposing trends. According to Figure 1b, the change in Türkiye's average score between the 2019 and 2023 cycles was relatively high, especially when compared to the change in other countries.

One of the most commonly used criteria when evaluating the performance of countries and economies under the TIMSS is the percentage of students reaching different levels of international proficiency. The proficiency levels developed using the TIMSS assessment framework provide a concrete link between the TIMSS scores obtained and the skills students can acquire in the relevant field (von Davier et al., 2024). A low proficiency level is defined as the level at which students are capable of demonstrating basic skills in the relevant field, solving simple problems and applying application skills in simple situations. It refers to the minimum level of proficiency required for students to demonstrate basic mathematics and science skills. Therefore, reaching a proficiency level where all students are capable of demonstrating at least basic skills is one of the primary objectives of all countries and economies.In contrast, the advanced proficiency level is at the opposite end of the ability scale and refers to students who are capable of solving complex problems, synthesizing different types of information correctly, and successfully implementing their learning in real situations (von Davier et al., 2024). Based on the TIMSS assessment framework, students who are at the advanced proficiency level demonstrate the ability to solve complex problems that require simultaneous use of multiple skills in math or science. As a consequence, these students are considered to have acquired the skills expected of them at the highest level among their peers and to have effectively implemented those skills to real situations. Since the TIMSS 2011 cycle, Figure 2 shows the percentage of students who were not able to reach the low proficiency level and who reached the advanced proficiency level in selected countries with different performance levels, including Türkiye.



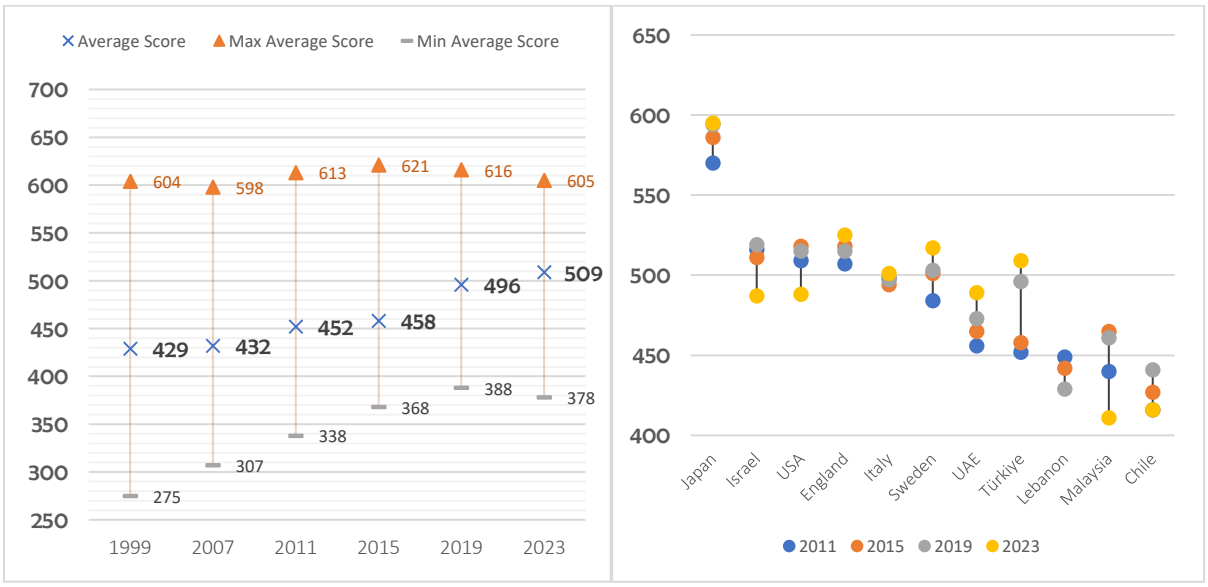
a. Percentage of students who did not reach the Low PL *b. Percentage of students who reached the High PL*

Figure 2. Percentage of Students at Both Ends of the Mathematics Proficiency Level in Different TIMSS Cycles – 4th Grade Mathematics Achievement*,**

** Türkiye participated in the 2019 and 2023 cycles at the 5th grade level.*
***In the 2023 cycle, the 9 provinces affected by the February 6, 2023 earthquakes were not included in the Türkiye sample.*

According to Figure 2a, there is a significant difference between the overall mean scores and the percentages of students at different proficiency levels across countries. Some countries with relatively higher overall average performance have a higher proportion of students lacking basic mathematical skills than countries with relatively lower performance. As shown in Figure 1b, Hungary had a higher overall average score at the 4th grade level (515) than Sweden (504) in the 2011 cycle, yet Figure 2a indicates that Hungary has a greater percentage of students who lack basic mathematical skills. The percentage of Turkish students who are not yet proficient in basic mathematics remains significantly higher than in countries such as Poland, where overall average scores are relatively similar. Based on the results obtained in the 2011 cycle, it appears that approximately one in five students did not possess basic mathematical skills at the 4th grade level in 2011, which was the first year that Türkiye participated in TIMSS. Although Türkiye has made significant progress in reducing the percentage of students who have not acquired basic mathematics skills since the 2015 cycle, this trend has been accelerating as of 2019. Even at the highest performance level reached in the 2023 cycle, the percentage of students who lack basic mathematics skills in Türkiye remains higher than those in countries with lower overall performance. According to this situation, increased overall performance is not uniformly distributed across the representative student population.

A second finding that should be noted is the percentage of students who have reached advanced proficiency level in mathematics, as shown in Figure 2b. A continuous rise in the rate has been observed between the 2011 and 2019 cycles, but it increased by approximately 10% in 2019 and became one of the main determinants of Türkiye's improved overall performance. According to Figure 2b, the special conditions in the 2023 cycle have enabled Türkiye to achieve a much higher level of performance than the countries with comparable performance levels in previous cycles. While Sweden and Poland have also seen gradual increases in the rate of students with advanced mathematics proficiency, Türkiye's large and unprecedented increase in the last two cycles requires a closer examination than the general trend. The discussion and conclusion sections examine the participation in the 5th grade in 2019 and the possible impacts of the partial limitation of the sample in 2023, as well as the possible contributions of the education policies implemented during this period. In Figure 3, Türkiye's performance as compared with selected countries at different levels of mathematics skills is shown for students in 8th grade, the second target group of the TIMSS.



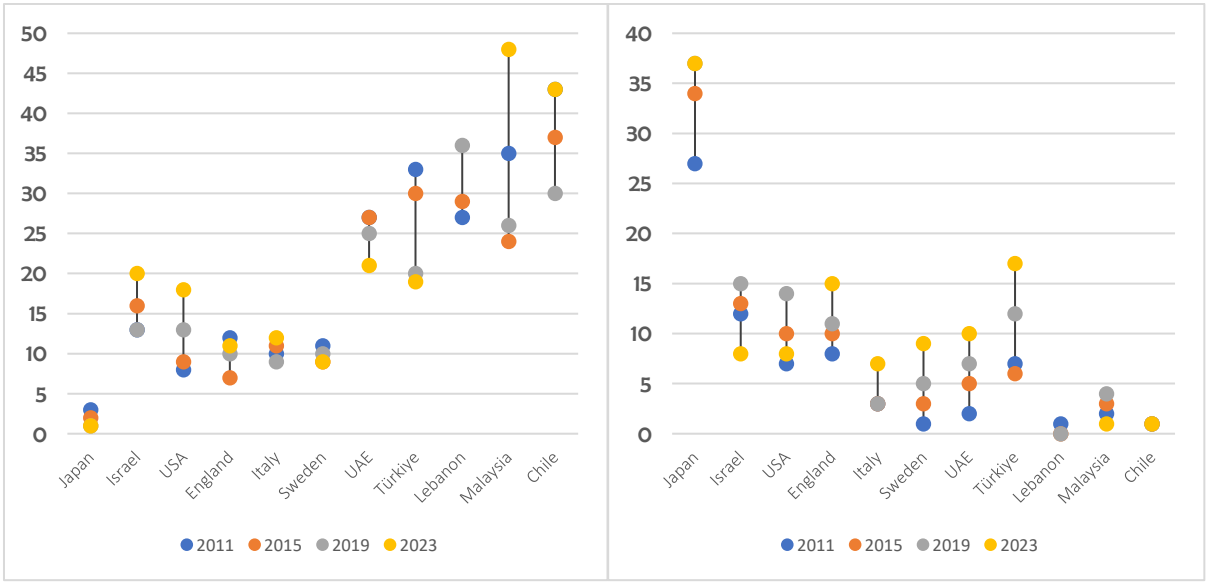
a. Türkiye's Average Scores in the Last Six Cycles *b. Selected Countries' Score Changes in the Last Four Cycles*

Figure 3. Changes in Türkiye's Average Scores with Selected Countries Across Cycles – 8th Grade Mathematics Achievement**

***In the 2023 cycle, 9 provinces affected by the earthquake were not included in the Türkiye sample.*

As shown in Figure 3a, Türkiye's performance at the 8th grade level has also significantly increased over the years, with the trend developing in the 2019 cycle and exceeding the scale midpoint in the 2023

cycle. With the partial limitations of the 2023 cycle, Türkiye exceeded the scale midpoint for the first time, and also decreased the difference between Singapore, the country with the highest performance, to below 100 points. In an assessment of the performance changes of the countries at different performance levels in the 2011 cycle, it is apparent that the performance changes are in different directions. In Figure 3b, we see that the average score of Japan, which was among the countries representing the highest performance level at the end of the 2011 cycle, continued to increase gradually until the end of the 2023 cycle, and the same trend was also observed for BEA and Italy. In contrast, the average scores of Israel, the USA, and Malaysia, which are situated at different levels of the performance scale, have gradually decreased over time since the 2011 cycle. Figure 3b illustrates that Türkiye has maintained its steady upward trend in the last four TIMSS cycles, similar to the UK, Japan, Italy, Sweden and BEA. As shown in Figure 4, these countries have experienced a change in the percentage of students not reaching the lower proficiency level and reaching the higher proficiency level.



a. Percentage of students who did not reach the Low PL *b. Percentage of students who reached the Advanced PL*

Figure 4. Percentages of Students at Both Ends of the Mathematics Proficiency Scale in Different TIMSS Cycles – 8th Grade Level Mathematics Achievement**

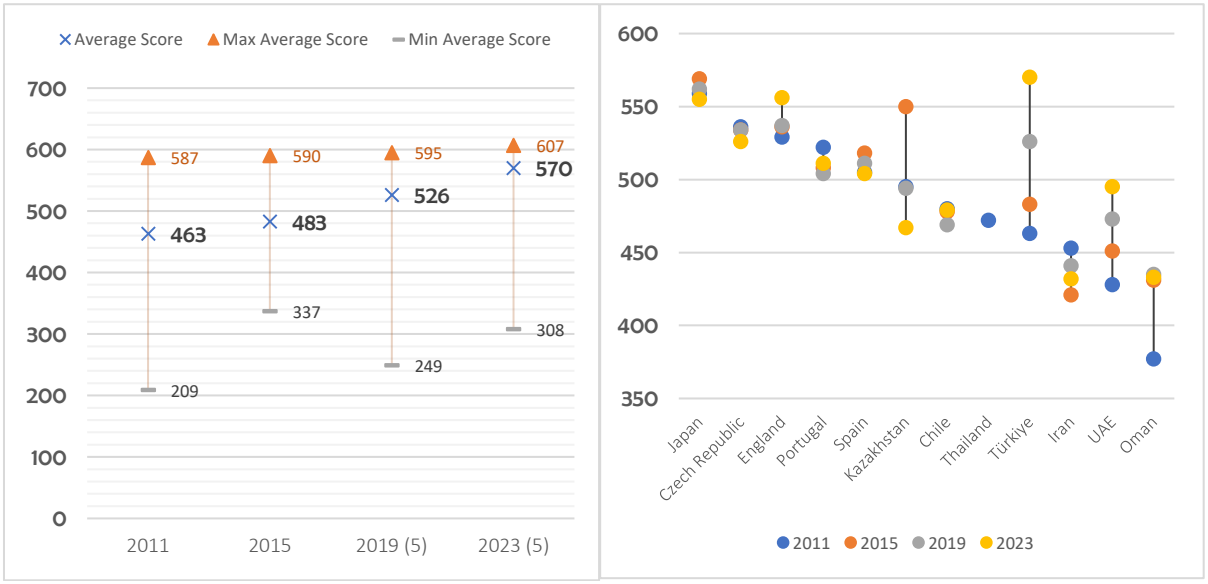
The percentages shown in Figures 4a and 4b provide valuable insights into the distribution of countries' general mathematics performance among representative student groups. As an illustration, in Israel, the USA and the UK, two countries with similar mean scores in the TIMSS 2011 cycle, there is a significant difference in the percentage of students who lack basic mathematics skills in the 8th grade between cycles. The proportion of UK students who lack basic mathematics skills over four cycles is at most 12%, whereas it reaches 18% in the USA and 20% in Israel. Conversely, in Sweden and Italy, where the overall average scores are lower, the highest proportions of students lacking basic mathematics skills remain at 11% and 12%, respectively. In the Turkish sample, the proportion of students who do not have basic mathematics skills has been higher than in countries with similar overall performance between 2011 and 2019. According to the 2011 cycle, Türkiye had slightly higher average scores than Lebanon, but the percentage of students who lacked basic mathematics skills was significantly greater (Türkiye 33%, Lebanon 27%). It can be seen in Figure 4a that even in 2023, when Türkiye's average score was at its highest, the percentage of students lacking basic mathematical skills had dropped to 19%. These percentages were calculated to be 12% in Lithuania and 11% in the UK, which have similar overall average scores.

It is evident from Figure 6b that there has been a significant increase in the percentage of students at the higher end of the proficiency scale over the last two cycles, and that this country has significantly distinguished itself from countries with similar general performance levels during the 2011 cycle. While the increases were more limited than those seen at the fourth grade level, they have been identified as being a significant improvement between the 2011 and 2019 cycles and have doubled since then. This increasing trend in addition to the partial limitations in the 2023 cycle appeared to have placed Türkiye

significantly ahead of countries with similar performance in previous cycles. Based on the 2023 cycle, Türkiye ranked higher than Lithuania (11%) and England (15%) in terms of a proportion of students who were proficient in advanced mathematics.

Science Achievement

As part of TIMSS, the "TIMSS Science Framework" is used to assess student performance in the science area (Mullis et al , 2021). In a similar manner to mathematics, the Science Framework is also updated each cycle, and based on a comparison of the current framework with the local curriculum and education programs, participants decide which grade level they wish to participate in the cycle. During the 2019 cycle, Türkiye participated in the fourth grade TIMSS application with the fifth grade level, continuing its decision in 2023. Figure 5 shows the change in Türkiye's average science score for the 4th grade compared to selected countries and previous cycles.



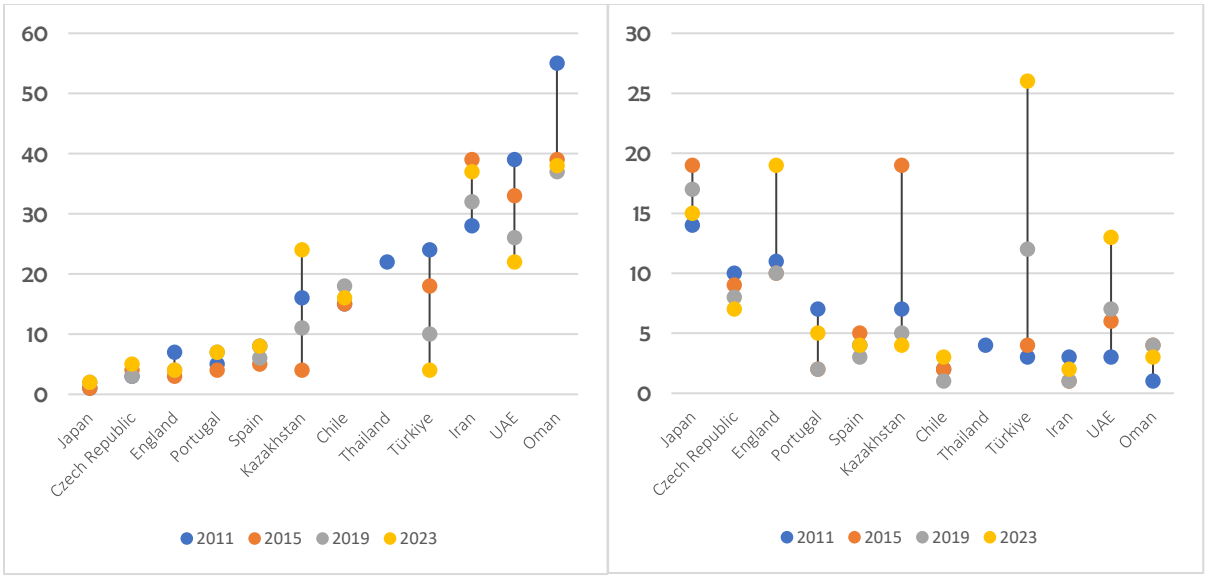
a. Türkiye's Average Scores in the Last Four Cycles *b. Selected Countries' Score Changes in the Last Four Cycles*

Figure 5. Changes in Türkiye's Average Scores with Selected Countries Across Cycles – 4th Grade Science Achievement**

According to Figure 5a, Türkiye's average science score at the 4th grade level is very close to Singapore and South Korea, which represent the highest achievement level in the 2023 cycle. For the first time in the 2019 cycle, Türkiye has exceeded the scale midpoint at this point, and with the assistance of cycle-specific conditions, it has accelerated its upward trend in the 2023 cycle, bringing it to its highest point and reducing the difference to less than 40 points with the country with the highest average score. Figure 5b illustrates the direction of change in performance for the selected countries since the 2011 cycle. Iran, Kazakhstan, Portugal, and the Czech Republic were among the countries whose average scores decreased toward the 2023 cycle, but the UK, UAE, Oman, and Türkiye had higher average scores than the previous cycle. In this context, Japan, the Czech Republic and the United Kingdom are among the countries that have maintained their high performance to a large extent since the 2011 cycle, and Türkiye and the United Arab Emirates have increased their average scores gradually and relatively significantly since then. Figure 6 illustrates the change in the distribution of proficiency levels over time.

As shown in Figures 6a and 6b, the percentages of students with different proficiency levels also provides information regarding science success in different countries. A number of European countries, including the Czech Republic, England, Portugal, and Spain, which are among those selected, have shown relatively small changes over the last four TIMSS cycles, ranging between 3% and 8% in terms of students who do not have basic science skills. In this context, despite varying performances in the science field across cycles, these countries have been able to provide basic science proficiency to more than 90% of their students in all TIMSS cycles. In contrast, Türkiye, the UAE, and Oman reduced the proportion of students who lacked basic science skills across cycles, along with an increase in their overall performance. Among Turkish students in particular, although 24% did not possess the basic

skills needed to succeed in science in the 2011 cycle, this proportion significantly decreased in the past two cycles. Additionally, even in the 2023 cycle, the percentage of Turkish students not capable of reaching basic science skills is still high compared to other countries with similar overall average scores. As a result of these findings in conjunction with Figure 6b, which depicts the rates of students with advanced science proficiency, it is likely that the distribution of students based on proficiency levels is more heterogeneous in comparison to countries with similar performance levels. Under special conditions in the 2023 cycle, Türkiye has the highest rates of advanced science proficiency among compared countries.

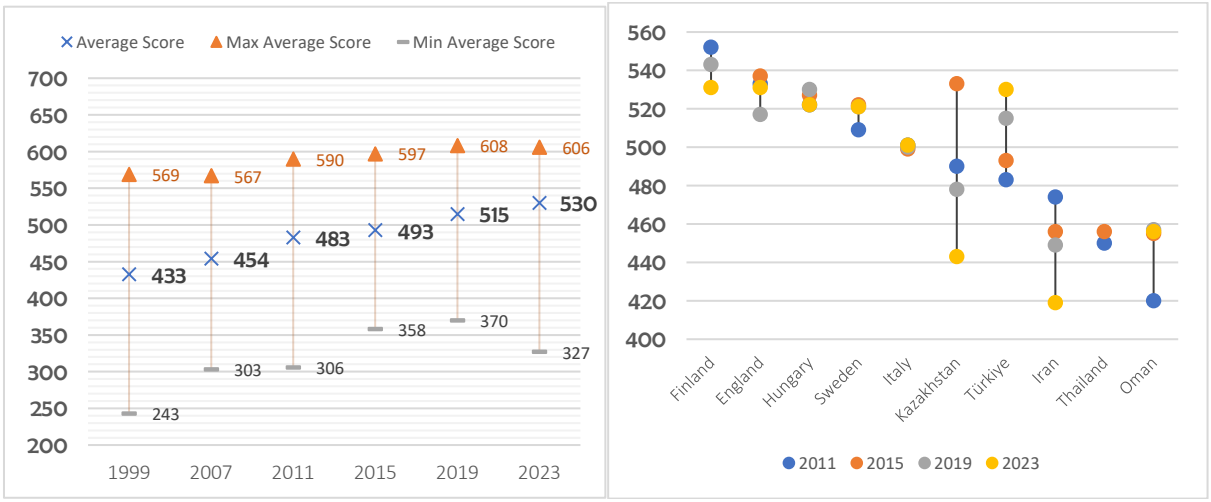


a. Percentage of students who did not reach the Low PL *b. Percentage of students who reached the High YD*

Figure 6. Percentage of Students at Both Ends of the Science Proficiency Scale in Different TIMSS Cycles – 4th Grade Level*,**

** Türkiye participated in the 2019 and 2023 cycles at the 5th grade level. **In the 2023 cycle, the 9 provinces affected by the February 6, 2023 earthquakes were not included in the Türkiye sample.*

The performance of 8th grade students in selected countries within the scope of science achievement is shown in Figure 7.



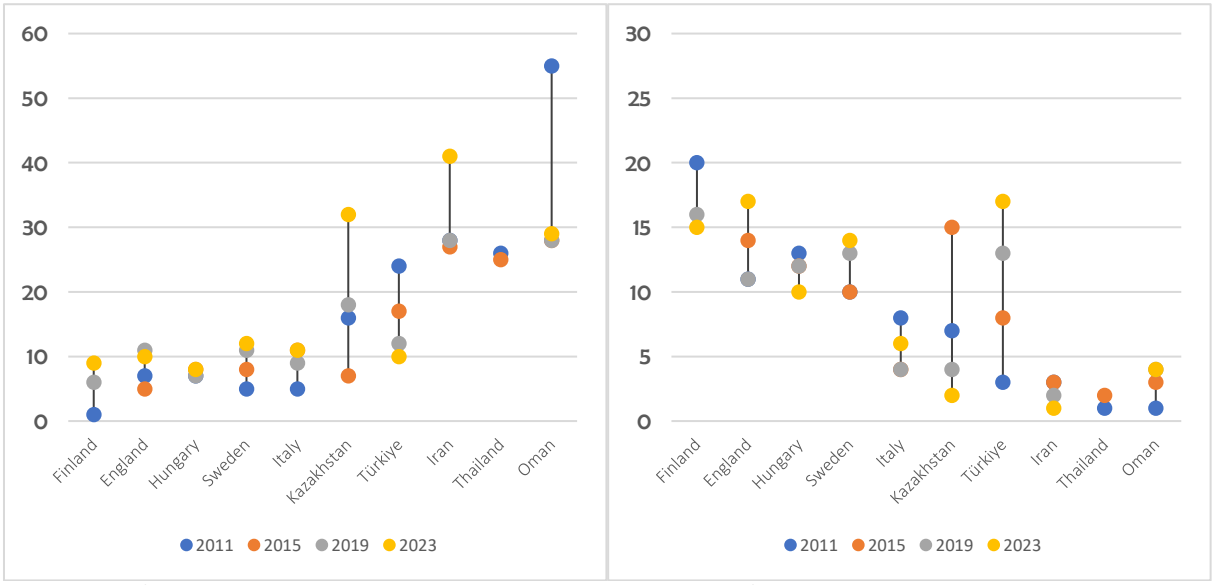
a. Türkiye's Average Scores in the Last Four Cycles *b. Selected Countries' Score Changes in the Last Four Cycles*

Figure 7. Comparison of Türkiye's TIMSS 2023 Average Score with Other Selected Countries and with Average Score in Previous Cycles – 8th Grade Science Achievement**

***In the 2023 cycle, the 9 provinces affected by the February 6, 2023 earthquakes were not included in the Türkiye sample.*

According to Figure 7a and Figure 7b, Türkiye, Kazakhstan, and Iran stand out among the selected countries in terms of the scale of their score changes between 2011 and 2023. The Turkish average score

has significantly increased over all TIMSS cycles since 1999, and this upward trend is becoming more pronounced as of the 2019 cycle. Based on Figure 7b, Finland, which was at its highest performance level according to the 2011 cycle, as well as England, Hungary, and Italy, which are above the scale midpoint, have experienced relatively little change over the past three cycles. In this context, the difference between Türkiye's average score and the average score of the top-scoring countries has also decreased to its lowest level since 2023. Additionally, Figure 8 provides valuable insight into the performance of students between the 2011 and 2023 cycles in terms of proficiency levels.



a. Percentage of students who did not reach the Low PL *b. Percentage of students who reached the Advanced PL*

Figure 8. Percentage of Students at Both Ends of the Science Proficiency Level in Different TIMSS Cycles – 8th Grade Level**

It is evident from Figure 8 that even in countries with similar overall performance, the percentage of students who do not possess basic science proficiency at the 8th grade level can vary significantly. When England and Hungary, which had similar overall average scores in the 2011 cycle, are compared, it is apparent that England has a greater proportion of students who are not proficient in basic science skills in both the 2011 and 2023 cycles. The average score in Sweden increased from the 2011 cycle to the 2023 cycle, and this increase in performance was accompanied by an increase in the percentage of students who did not have basic science skills. In contrast, Kazakhstan and Iran have seen significant increases in the percentage of students lacking basic science skills due to significant decreases in test score levels. Türkiye's overall performance in the 2023 cycle is characterized by a significant decrease in the number of students lacking basic skills as well as an increase in the number of students who have reached advanced proficiency levels, and these indicators show a similarity with those in England.

Türkiye's Performance on Equal Opportunities in Education According to TIMSS 2023 Indicator

A major reason why ILSAs are regarded as important by education authorities today is their emphasis on the factors that are likely to contribute to academic achievement and student skills. The psychological characteristic of academic success is quite complex in nature, and it is affected by many factors including home environment and school environment (Ker et al., 2023; Özer and Suna, 2022; Schwerter et al., 2024; Suna et al., 2021). Information on factors associated with academic achievement in ILSAs, which is referred to as context data, is used to explain the relationship between various factors discussed in the education literature and students' cognitive, social, and motor characteristics (Creswell et al., 2015). Educators can make data-based inferences about areas for improvement and the potential outcomes of improvements and investments based on the relationships between students' skills and academic achievement. Since the education ecosystem is a multi-stakeholder, extremely large-scale system that is susceptible to external influences, it is evident that determining the physical and psychological characteristics associated with desired student outcomes will be extremely important to the development of accurate educational policies. As a result, TIMSS provides important findings about students' home

resources, schools' socioeconomic status, students' competencies at school entry, and schools' emphasis on academic achievement.

Home Resources for Learning

Providing children with the opportunities they need for learning at home is an important variable in order to provide a learning environment that can facilitate children's learning and meet their learning needs. Several empirical studies have demonstrated a direct relationship between the opportunities students have at home and their academic success (Ker et al., 2023; Schwerter et al., 2022). As well, since home resources are an indication of a family's interest and investment in education, it is known that families who enhance these opportunities at home are more likely to invest in their children's education (Strämme and Helland, 2020). Consequently, the opportunities that students have at home are an out-of-school factor that is associated with academic achievement and is considered to be an indicator of socioeconomic status.

Home resources are the subject of a number of academic studies, and the indicators used in the studies may differ from one another. Home facilities are evaluated within the scope of TIMSS, which include the physical facilities that the student can access through his/her family, as well as the educational status of the parents. TIMSS takes into account the number of books available at a student's home, whether the student has a separate room at home, whether there is an internet connection at home, and the level of education of their parents in order to assess students' home resources within this context. Using these indicators, students are categorized into three categories based on the amount of resources they have at their disposal, such as "many resources", "some resources", and "few resources". Figure 9 illustrates the change in the average score of the students in these three groups over the last four TIMSS cycles.

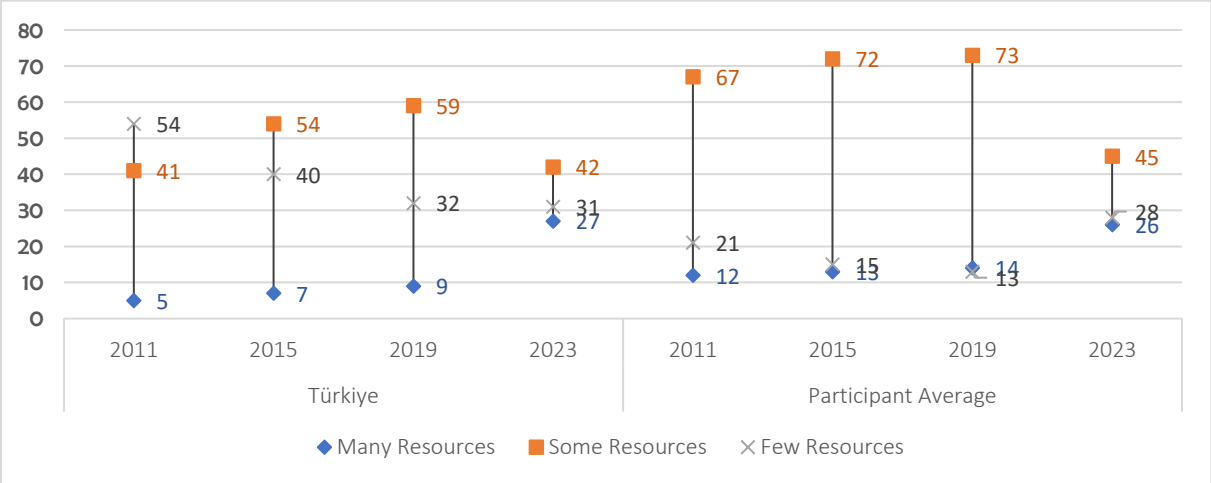


Figure 9a. Student Percentages at Different Levels of Home Resources – Türkiye and Participant Average

According to Figure 9, there is a significant difference between Türkiye and the participant averages in terms of the opportunities students have at home between 2011 and 2019. In Türkiye, between the 2011 and 2019 cycles, the proportion of students with "few resources" gradually decreased from 54% to 32%, while the participant average decreased from 21% to 13%. During this period, the proportion of students with few resources decreased and the proportion of students with some resources increased, from 41% to 59%. Particularly during this period, the proportion of Turkish students lacking resources is significantly higher than the average of the participating countries. Even though the socioeconomic status of the Turkish students has improved between 2011 and 2019, they still remain significantly disadvantaged in comparison to the average of the countries participating in TIMSS. During the 2023 cycle, in addition to the socioeconomic improvements that continued from previous cycles, a significant change was observed in the distribution of home opportunities due to the partial limitation of sample size. In the 2023 cycle, the socioeconomic distribution of the Turkish sample reached an average level very close to that of the participants, as shown in Figure 9a.

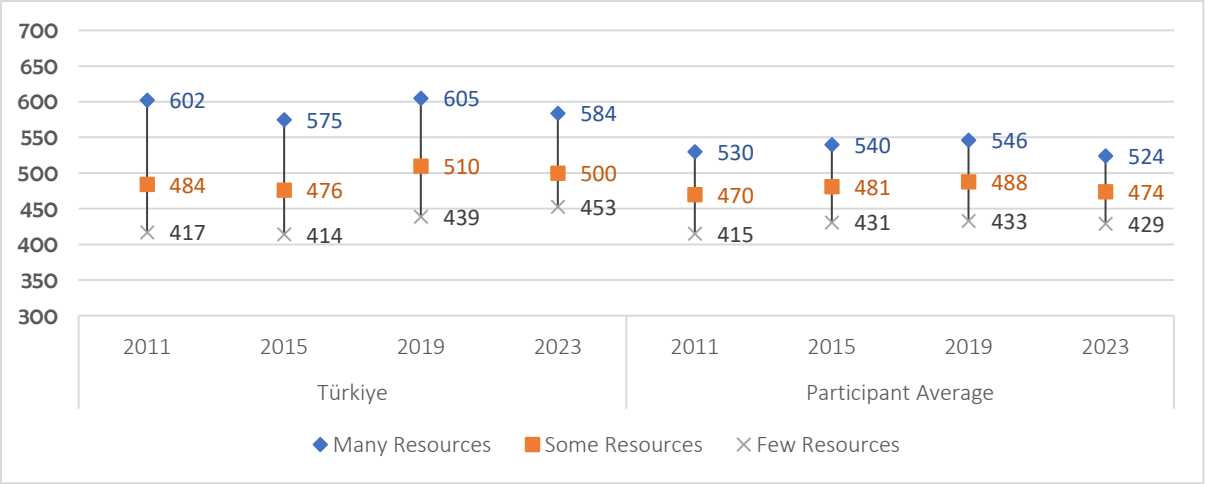


Figure 9b. Average Scores of Students at Different Levels of Home Resources – 8th Grade Mathematic Achievement

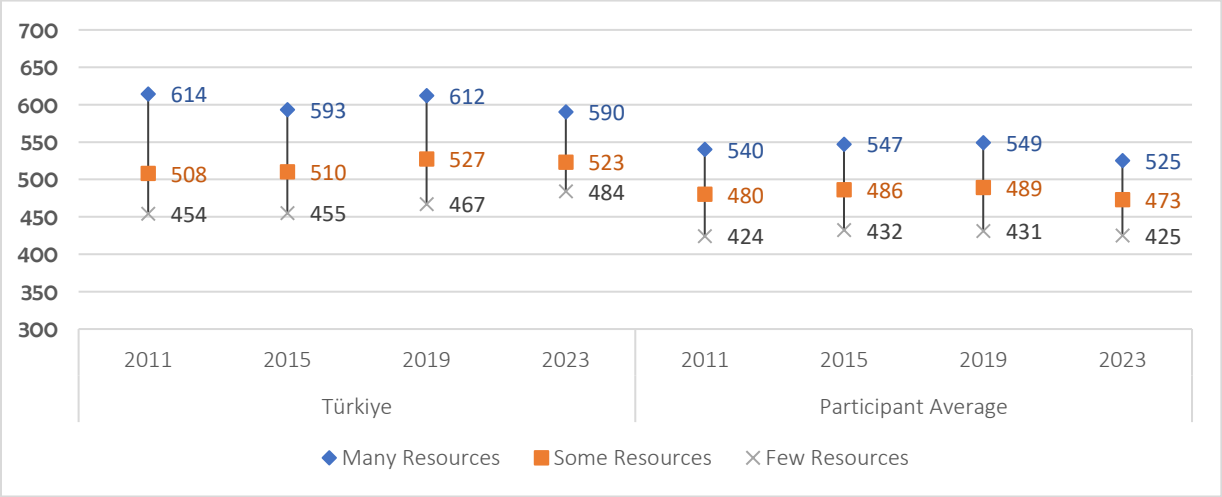


Figure 9c. Average Scores of Students at Different Levels of Home Resources – 8th Grade Science Achievement

Furthermore, as shown in Figures 9b and 9c, the difference between the average achievement of students at different levels in mathematics and science in Türkiye based on their home resources is significantly higher than the average of participants. Accordingly, Türkiye has a stronger correlation between home opportunities and academic achievement in mathematics and science as compared to the average academic achievement of participants. The relatively strong relationship between home resources and academic achievement in Türkiye is evaluated in the context of equality in education, taking into account the fact that home resources are an out-of-school factor.

School Socioeconomic Status

There is evidence that many characteristics of schools, particularly learning environments, are correlated with student outcomes (Günal and Demirtaşlı, 2016; Özer and Suna, 2022; Schwerter et al., 2024; Suna et al., 2021). There are several aspects that contribute to the school climate, including the physical infrastructure, the average number of students per teacher and classroom, the size of the school, etc., as well as the psychological variables that influence the school climate (Amsalu and Belay, 2024; Maxwell et al., 2017). As a measure of the average socioeconomic status of students who continue their education at the school (Suna et al., 2021; von Davier et al., 2024), the socioeconomic status of the school is considered an important indicator. Numerous studies in the literature on education have indicated that students' performance can be influenced by the socioeconomic status of their peers and families (Chzhen and Leesch, 2023; Suna et al., 2021). When considering the relationship between socioeconomic status and academic achievement, it is possible that academic achievement is greater in schools with a higher average socioeconomic status and a school environment which fosters peer learning and success motivation. According to the socioeconomic status of the students in the school, TIMSS classifies

schools into three groups: "more affluent", "neither more affluent nor more disadvantaged", and "more disadvantaged". A summary of the percentages of students attending these schools based on their socioeconomic status and their average achievement can be found in Figure 10.

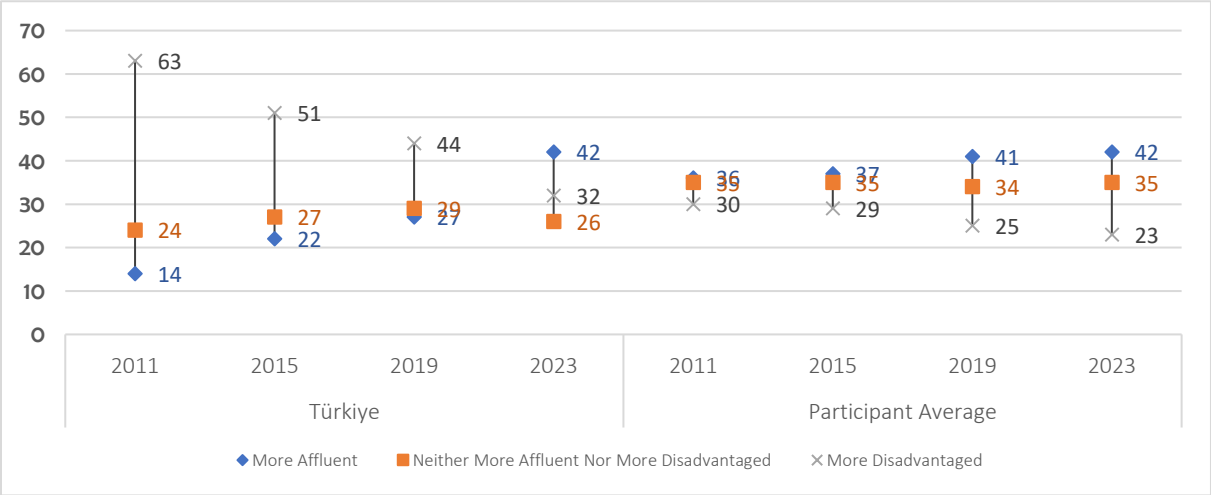


Figure 10a. Student Percentages in Schools with Different Socioeconomic Status –Türkiye and Participant Average

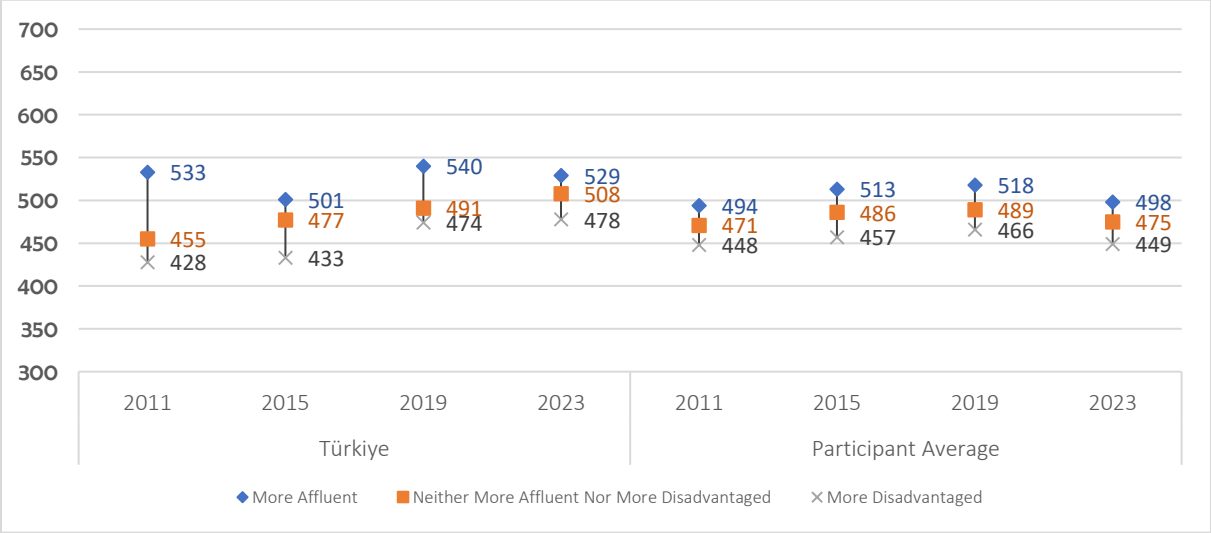


Figure 10b. Average Mathematics Scores in Schools with Different Socioeconomic Status –Türkiye and Participant Averages

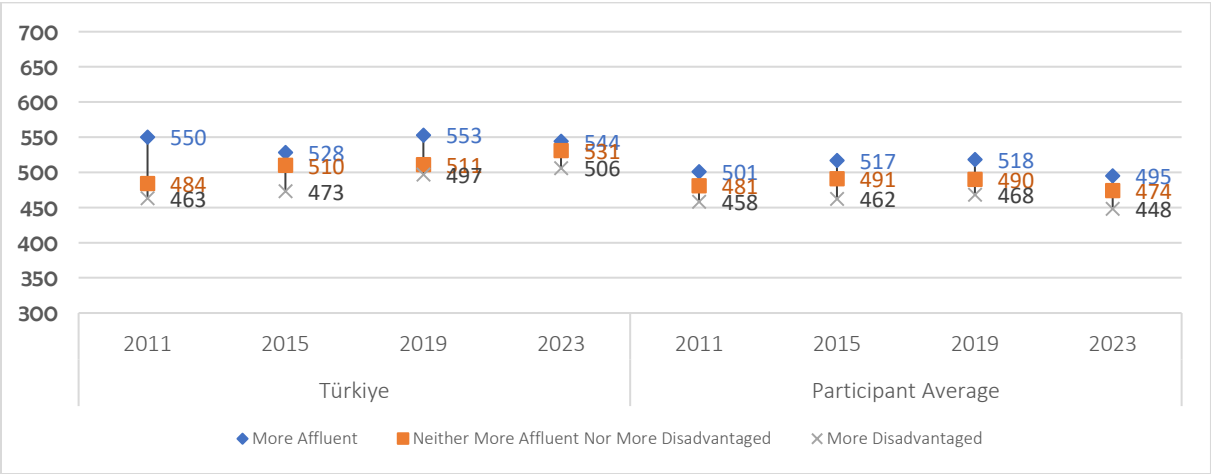


Figure 10c. Average Science Scores in Schools with Different Socioeconomic Status –Türkiye and Participant Averages

As shown in Figure 10, there are significant differences between the averages of Türkiye and TIMSS participants concerning the socioeconomic level of schools. During the 2011-2019 cycles, the number of schools with socioeconomic advantages increased from 14% to 27%, while the average number of TIMSS participants increased from 36% to 41% when the change in socioeconomic status of Turkish schools over time is examined. Accordingly, although the change in the rate of schools with an advantageous socioeconomic status in Türkiye was stronger over this period of nine years, the rates in question in Türkiye remained significantly lower than the average of the participants. In the same period, schools in Türkiye with relatively disadvantaged socioeconomic status also exceeded twice the average of the participants in the 2011 cycle and 1.5 times in the 2015 and 2019 cycles, respectively. As a result, it can be concluded that schools in Türkiye have a greater socioeconomic disadvantage than the average of the participants during this survey period. Due to the improvement trend and partial sample limitations, the socioeconomically advantaged school percentage in Türkiye in the 2023 cycle reached the same level as the average for participants, while the disadvantaged school rate remained slightly higher than the average for participants.

When the changes in the mean scores of schools with different socioeconomic levels in mathematics and science are examined, Figure 10b and Figure 10c reveal a significant trend in Türkiye. Since the 2011 cycle, the mean scores of schools with socioeconomic disadvantages have increased significantly and have exceeded the average of the participants by a significant margin. Meanwhile, the average scores of students from schools with socioeconomic advantages have almost always been higher than those from schools with low socioeconomic advantages. In conclusion, this finding indicates that the significant improvement in the performance of students studying in schools with socioeconomic disadvantages, particularly in recent cycles, plays an important role in the overall improvement in Türkiye's performance. Despite this positive trend, it should be noted that the differences between mean scores between schools with different socioeconomic levels are significantly higher than the average for the participating countries. Unlike previous cycles, the difference between mean scores of schools with different socioeconomic levels has decreased significantly for the first time in the 2023 cycle, approaching the difference between mean scores between participating countries.

Students' Proficiency Levels Starting Primary School

Students' proficiency levels at the beginning of school have important implications for their subsequent learning and skill development (Pagani et al., 2010; Valiente et al., 2021). Research has shown that students who possess basic verbal and numerical literacy skills and are prepared for high school at the primary school level have higher skill levels in the following years than their peers (Ricciardi et al., 2021; Valiente et al., 2021). To put it another way, acquiring basic skills at the beginning of an educational journey will greatly facilitate the development of new skills. As a result, schools in TIMSS are classified as “more than 75% begin with skills”, “25-75% begin with skills” and “less than 25% begin with skills” based on the responses of administrators regarding whether students who begin their education at the school have the basic level of verbal and numerical skills expected in primary school. Figure 11 depicts the average change in scores of students studying in these three groups across TIMSS cycles in Türkiye and among TIMSS participants.

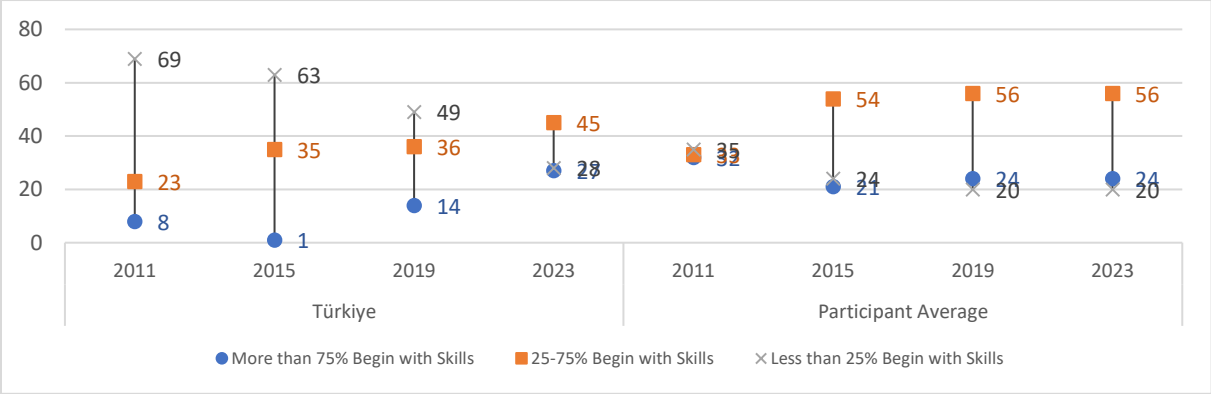


Figure 11a. Student Percentages in Schools with Different Student Proficiency Levels –Türkiye and Participant Average

In Türkiye, the percentage of students who enter primary school with basic skills in verbal and numerical literacy varies between 8% and 14% between the 2011 and 2019 cycles, as shown in Figure 11. On the other hand, TIMSS participants tend to report higher rates, ranging from 21% to 32%, and these rates are significantly higher than in Türkiye. Similarly, the proportion of schools with low student proficiency in Türkiye gradually decreased and partially approached the average for TIMSS participants with a significant decrease in the 2023 cycle.

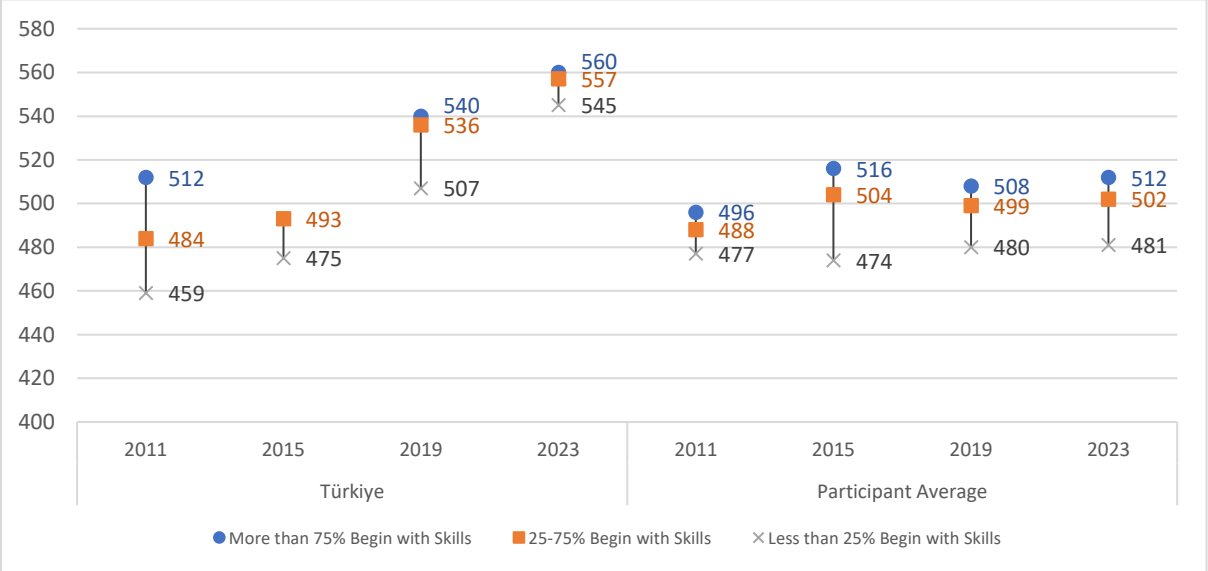


Figure 11b. Mathematics Scores Averages of Students in Schools with Different Student Proficiency Levels – Comparison of Türkiye and Participant Averages

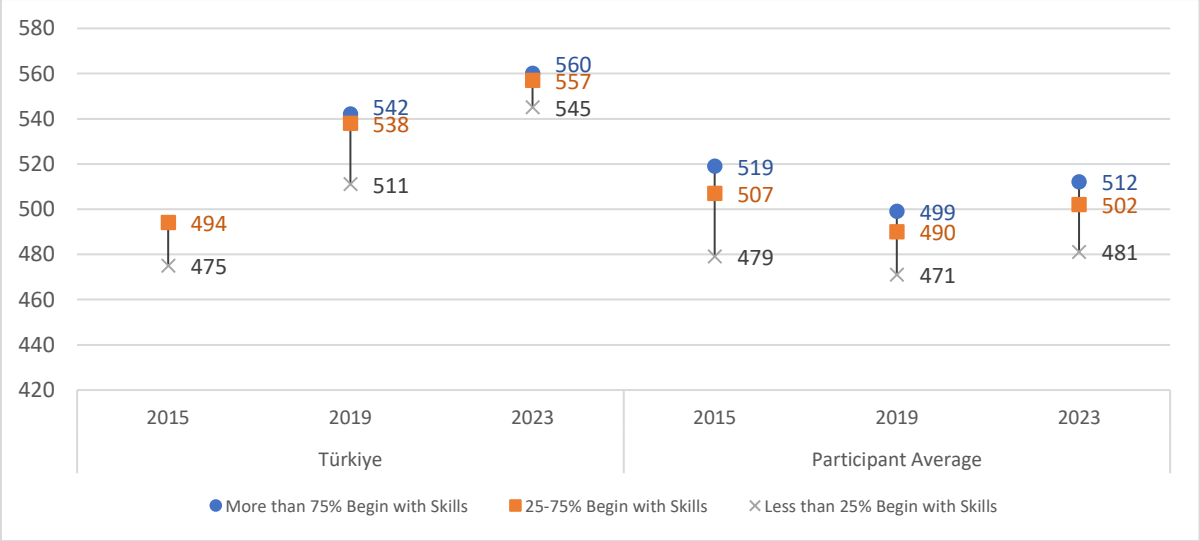


Figure 11c. Science Scores Averages of Students in Schools with Different Student Proficiency Levels – Comparison of Türkiye and Participant Averages

The results of Figures 11b and 11c demonstrate that academic achievement increases with an increase in proficiency at the beginning of primary school both in Türkiye and in other TIMSS participating countries (when the average is taken into account); in other words, a similar change is evident. The results shown in Figures 11b and 11c indicate that the differences in mathematics and science achievement among students with different proficiency levels at the time of entering primary school in Türkiye are similar to the average for TIMSS participants. Consequently, the advantages of entering primary school in Türkiye with basic numerical and verbal literacy skills are similar to the average for TIMSS participants.

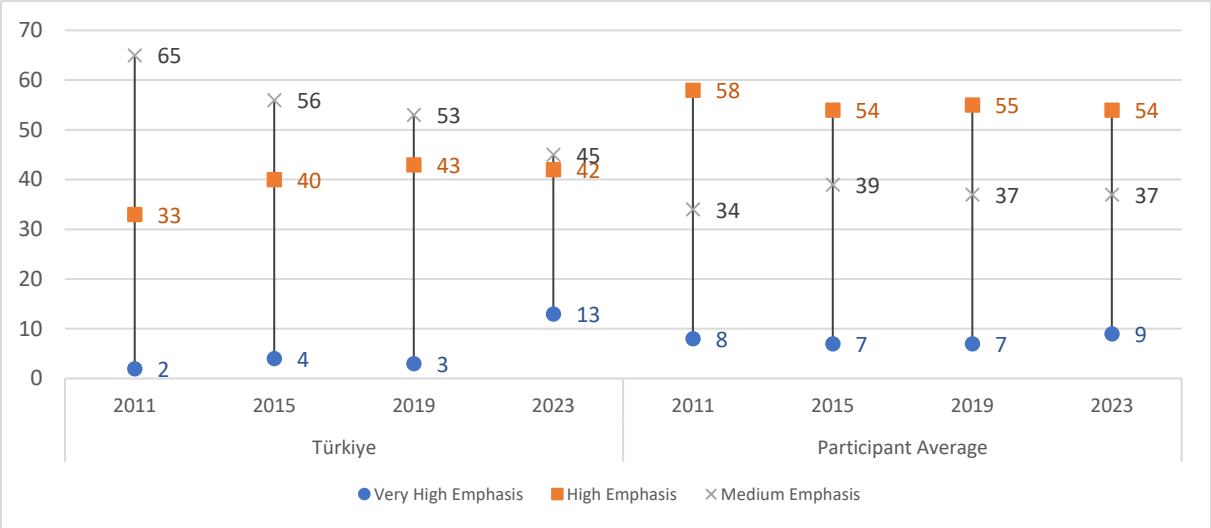


Figure 12a. Student Percentage in Schools with Different Emphasis to Achievement –Türkiye and Participant Average

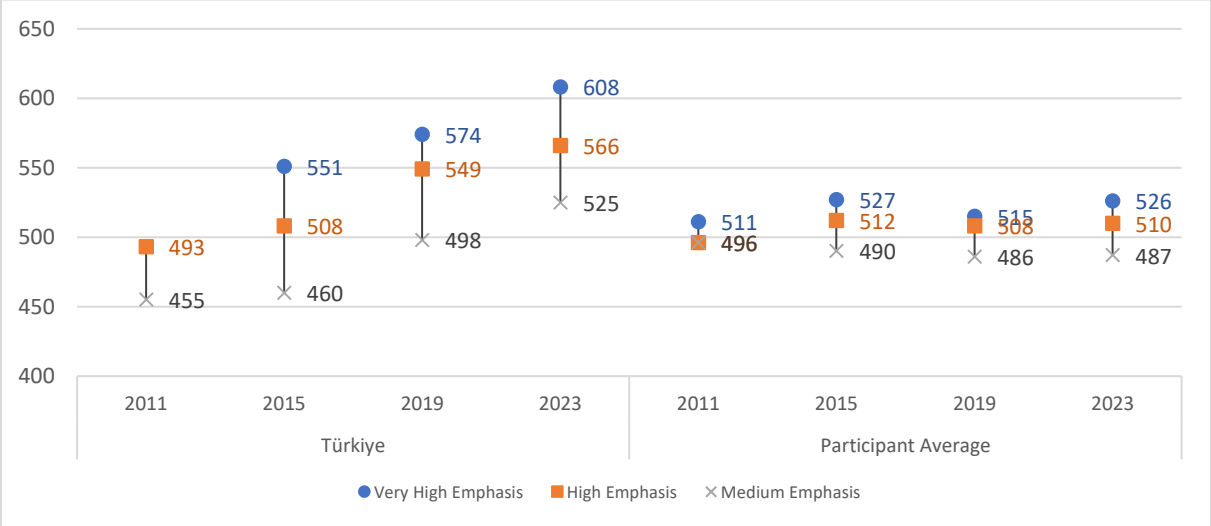


Figure 12b. Mathematics Scores Averages of Students in Schools with Different Emphasis to Achievement – Türkiye and Participant Average

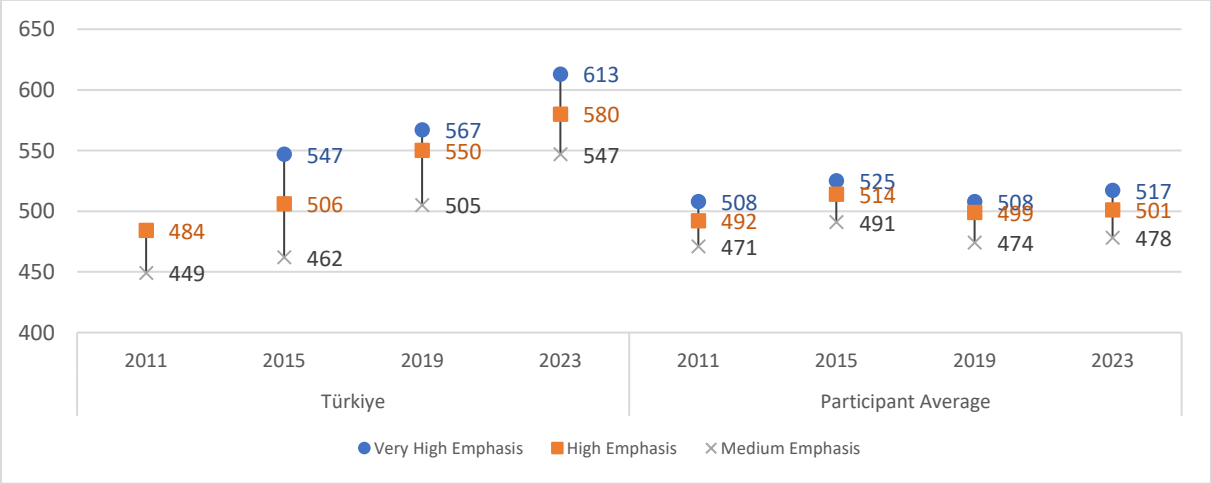


Figure 12c. Science Scores Averages of Students in Schools with Different Emphasis to Achievement –Türkiye and Participant Average

Schools' Emphasis on Academic Achievement

The school environment is characterised by a unique institutional culture involving all contributing stakeholders (Barker et al., 2023; Ohlson, 2009). There is a growing consensus that institutional culture can be defined as a dynamic psychological structure that influences the behaviours of all stakeholders, from school administrators to teachers and from students to parents, as well as being affected by those behaviours (Deal and Peterson , 2016; Ohlson, 2009). Stakeholders are likely to adopt characteristics that have been prioritised for a long time within the institutional culture. Various studies have demonstrated that students make more effort to achieve academic achievement in institutions that value and promote the achievement of their students (Hinnant et al., 2010; Hollenstein et al., 2024). Consequently, it is well known that students feel more important and motivated to achieve academic achievement in schools where teachers encourage academic achievement as part of the school culture (Hinnant et al., 2010; Hollenstein et al., 2024; Rubie-Davis and Hattie, 2024). Accordingly, TIMSS groups schools according to their perceived importance of student success into schools with "very high emphasis", "high emphasis" and "medium emphasis". Figure 12 illustrates the change in average scores for students studying in institutions with different emphases on achievement for their students.

As shown in Figure 12, between the 2011 and 2019 cycles, the proportion of students in Türkiye attending schools with high and very high expectations of success is significantly below the TIMSS average. In fact, approximately two-thirds (65%) of students in Türkiye are enrolled in schools with medium expectations of success in the 2011 cycle and approximately half (53%) in the 2019 cycle. In the same period, the proportion of TIMSS participants who studied in schools with medium expectations of success remained below 40%. Moreover, as a result of the significant change experienced in the 2023 cycle, the proportion of students studying in Türkiye schools with high expectations of success has significantly exceeded the average of TIMSS participants, in addition to a positive trend spreading across cycles.

Empirical evidence reveals that schools' emphasis to achievement is correlated with their students' achievement. As the TIMSS participant average is taken into consideration, it becomes evident that as the school's emphasis on achievement increases in all four cycles, the average student achievement also increases. A further striking finding is that the differences in the average scores of students studying at schools with different emphasis on achievement in Türkiye are significantly higher than the average scores of TIMSS participants. According to the TIMSS average, the average score differences between mathematics and science in Türkiye approach 90 points and 80 points, respectively. The fact that Turkish schools prioritise student achievement stands out as a factor that contributes to student success in this context.

Discussion and Conclusion

Over the past 70 years, ILSAs have provided important feedback on the performance of participating countries' education systems. Due to the changing needs and expectations of education systems, the structure and diversity of ILSAs have also undergone a great deal of change. All stakeholders in education systems need to provide more data-based feedback, as well as expand the scope of existing ILSAs and implement new ILSAs in innovative areas, including digital skills and civic engagement.

Every four years, TIMSS, one of the most established and respected ILSAs provides important feedback to different education systems regarding academic achievement and related variables in mathematics and science. From the 2011 cycle forward, Türkiye has consistently participated in TIMSS at both grade levels. Türkiye's participation in the TIMSS 2023 cycle has been partially limited due to the earthquakes of February 6, 2023, which followed a relatively long closure of schools due to the Covid-19 pandemic in 2020. A decision by the Ministry of National Education and agreed to by the IEA excluded nine provinces that suffered significant damage in the earthquake region from the sample. Still, TIMSS 2023 has been successfully implemented in a majority of earlier-planned regions, and it revealed important insights about the performance of the Turkish education system. Furthermore, it is also noteworthy that the 6th February earthquakes impacted all stakeholders and aspects of the Turkish education system, particularly on students' psychological attributes and well-being. Within this scope, despite the fact that earthquakes' physical impact intensified in particular regions, the reflections and psychological impact

were conspicuous in all parts of Türkiye. These factors also increase the importance of TIMSS 2023 results to indicate insights about the disaster response and coping capacity of the Turkish education system. For the purpose of better understanding the adequate review of TIMSS 2023 results, Türkiye's performance was evaluated by taking into account the trends in previous cycles and the changes in performance of countries with different performance levels over time.

The study's most important finding is that Türkiye's academic achievement increased between 2011 and 2019, with the contribution of partial sampling limitations in the 2023 cycle. It is important to consider that students in the implementation area performed and responded significantly despite substantial psychological negativities of earthquakes. Review of educational policies in the times of TIMSS 2023 implementation revealed that the students' significant response and performance may be related to Support and Training Courses (DYK), Primary School Training Program (İYEP), "1,000 Schools in Vocational Education and Training", "10,000 Schools in Primary Education", "No School Without a Library" and other support mechanisms which were initiated in the following paragraphs (Özer, 2020, 2021, 2022; Özer et al., 2021; Özer and Suna, 2023), which have been increased in intensity especially for students in need of academic support after the Covid-19 pandemic and the February 6, 2023 earthquakes.

A second important finding of the study is that schools in Türkiye are correlated with their students' success based on their socioeconomic status and achievement expectations. One of these findings indicates that average academic achievement rises in schools where relatively advantaged students are concentrated and constitutes a risk area in terms of equal educational opportunities. Therefore, it is critical that schools have the infrastructure and environment to compensate for the negative effects of socioeconomic gaps. Therefore, the initiatives "1,000 Schools in Vocational Education and Training", "10,000 Schools in Primary Education", and "No School Without a Library", which aim to minimise the differences in opportunities between schools, emphasise the importance of providing a similar educational environment for all students (Özer, 2021, 2022; Özer and Suna, 2023). Additionally, a significant improvement in equal opportunities is likely to be attributed to the more than 160 million resources distributed in recent years in order to mitigate material differences between schools and improve educational materials in all schools.

Primary school students who have adequate skills at the beginning of the school year are more likely to succeed in the later years of schooling. This finding is particularly noteworthy since it indicates that new skills can be built more easily on this foundation if primary school is started with a sufficiently strong foundation. This important finding highlights the significance of early childhood education, an issue that education researchers have been focusing on for many years. In fact, early childhood education provides students with a foundation that prepares them for school life and enables them to succeed in primary school both cognitively and emotionally. Türkiye's "Early Childhood Education Campaign", which was regarded as the primary policy area in 2022, has had a great deal of impact on students' ability to begin primary school more competently and increase their readiness for school. As a result, school enrolment rates at this level have increased significantly over time (Özer et al., 2023; Suna and Özer, 2024). Once again, the findings of the 2023 cycle have demonstrated the importance of making early childhood education more socially inclusive.

A final important finding of the study is that student success tends to increase when the expectation of success is part of the school culture. By making academic success a priority for the school, especially for school administrators and teachers, it encourages students to feel the expectation of success and act to fulfil the expectation. This institutional culture is likely to be created in part by the skills development of school administrators and teachers. In Türkiye, the implementation of the Administrator Academy and the regulations within the scope of the Teaching Profession Law in recent years, along with practices aimed at developing teachers' skills (Özer and Suna, 2023), have been important practices in both improving the school climate and creating a school culture focused on achievement.

Due to the magnitude of the February 6, 2023 earthquake and the difficulty in implementing it, the 2023 cycle was the first TIMSS cycle in which Türkiye participated with a partially limited sample size. In spite of the mandatory implementation conditions, the main emphasis behind all findings was that the Turkish education system responded significantly to the straight disasters. We discussed the possible

educational policies which are related to the significant response of Türkiye. As well, the general results obtained from other participating countries provide evidence of the importance of Türkiye's efforts to promote equal opportunity in education.

Acknowledgment

Ethics statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, which all authors contribute to the study, and that all the responsibility belongs to the article authors in case of all ethical violations.

Author Contributions: Both authors contribute to the conceptualization, methodology, data collection, formal analysis, writing, and review section with an identical extent.

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Institutional Review Board Statement: No data were collected from human participants in this study. Since the research was conducted through systematic review, ethical approval was not required.

Data Availability Statement: Data in the present study is revealed by IEA.

Conflict of Interest: There is no conflict of interest.

Generative Artificial Intelligence Statement: No generative artificial intelligence (AI) tools were used in the preparation of this manuscript. All content was developed entirely by the authors.

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