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Education & Training Evaluation Commission

# TIMSS 2019 Report

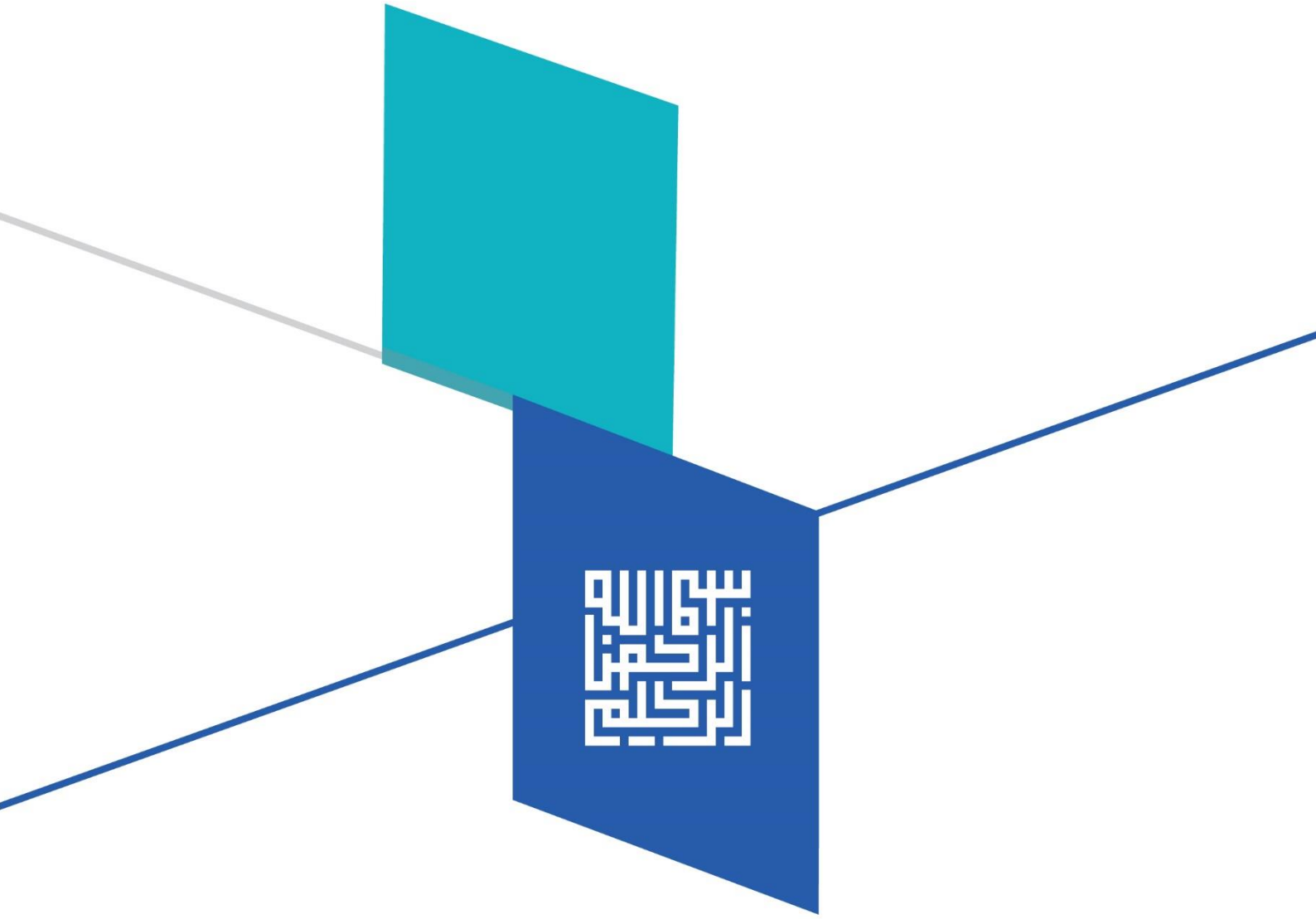
(First Insights into Mathematics and Science Achievements of Saudi Arabia Students in Grades 4 and 8 in an International Context)

Feb 2021

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# **TIMSS 2019 Report**

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[www.etec.gov.sa](http://www.etec.gov.sa)

PO. Box 68566

Eastern Al-Nakheel Dist. – King Khaled Bin Abdulaziz Rd

Postal code: 11534, Riyadh – Saudi Arabia

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## Executive Summary

### What is TIMSS?

TIMSS (Trends in Mathematics and Science Achievement) is the international assessment of students that provides the longest track of student achievement in grades 4 and 8. It measures student achievement in mathematics and science since 1995. TIMSS 2019 provides results for 64 participating countries, from which 58 countries participated in the 4<sup>th</sup>-grade assessment, and 39 countries participated in the 8<sup>th</sup>-grade assessment.

Saudi Arabia participated in the current assessment for both grades. The results for Saudi Arabia can be compared to 2011 and 2015 assessments.

### What is in this report?

This report provides a detailed description of mathematics and science achievement in grades 4 and 8 in TIMSS 2019. It also discusses data related to student home environment, school composition and resources, school climate, school discipline, safety, challenges to teaching, technology access in schools, and curriculum and instruction.

The report provides first insights into Saudi Arabia's results in TIMSS 2019 international student assessment. It will be followed by a more in-depth analysis of the results that will be published in 2021.

### Mathematics achievement in 4<sup>th</sup> and 8<sup>th</sup> grade

Five Asian countries have achieved the highest scores in 4<sup>th</sup>-grade mathematics: Singapore (625), Hong Kong SAR (602), Korea (600), Chinese Taipei (599), and Japan (593). The lowest scores were found in the Philippines (297), Pakistan (328), South Africa (374), Kuwait (383), and Morocco (383).

Considering all the participating countries in the assessment, Saudi Arabia has achieved a 53<sup>rd</sup> position among the 58 participating countries. The average score is 398 points and is higher than that obtained in 2015, but similar to results in 2011.

Many 4<sup>th</sup>-grade students in Saudi Arabia lack basic mathematics knowledge. Half of the students did not reach the Low International Benchmark, which means that they do not possess even some basic mathematics knowledge expected at this age. Most students in the top performing countries reached the Low International Benchmark. In Japan, for example, only 1% of students performed below this benchmark, and 37% reached the Advanced International Benchmark, which indicates that these students excel in mathematics. It should be noted that the Advanced International Benchmark can be reached by those students who show the highest understanding of mathematics knowledge. In Singapore, 51% of students reached the Advanced International Benchmark. However, in Saudi Arabia, nearly none of the students demonstrated knowledge of mathematics at this level.

In regard to the 8<sup>th</sup>-grade assessment, Singapore leads in mathematics achievement with an average result of 616 points, followed by Chinese Taipei (612), Korea (607), Japan (594), and Hong Kong SAR (578). The lowest scores were observed in Morocco (388), South Africa (389), Saudi Arabia (394), Kuwait (403), and Oman (411). Saudi Arabia was placed in the 37<sup>th</sup> position among the participating countries.

In 2011, the 8<sup>th</sup>-grade students from Saudi Arabia scored an average result of 394 points. Then, the average score was 368 in 2015, which means that there was a considerable decline (by 26 points) from 2011 to 2015. During the recent period 2015-2019, an increase (by 26 points) has been observed to the same level as noticed in 2011.

Thus, from the statistical point of view, the average mathematics results in 8<sup>th</sup> grade in 2019 and 2011 are the same.

More than half of the participating countries in the TIMSS 2019 assessment had more than 10% of 8<sup>th</sup>-grade students who did not reach the basic level of mathematical knowledge. The lowest percent of such students was observed in Japan, Chinese Taipei, Singapore, and Korea, where only no more than 3% of 8th graders did not reach this level. Whereas in Saudi Arabia, 53% of 8th graders did not reach the Low International Benchmark.

In five Asian countries: Japan, Singapore, Korea, Chinese Taipei, and Hong Kong SAR, at least 87% of their students reached the Intermediate Benchmark. In the majority of the participating countries in the TIMSS 2019 8<sup>th</sup>-grade mathematics assessment, at least half of the students possessed mathematics skills required at this level. While in Saudi Arabia, only 15% of 8<sup>th</sup>-grade students reached the Intermediate International Benchmark.

The largest share of 8<sup>th</sup>-grade students who reached this level was observed in Singapore (51%), Chinese Taipei (49%), and Korea (45%). In the other two Asian countries, Japan and Hong Kong SAR, more than 30% of the students reached this benchmark. For the remaining participants, those numbers were considerably lower. A very small number of students achieved this level in Saudi Arabia, Morocco, Lebanon, Kuwait, and Jordan.

By comparing mathematical results in both 4<sup>th</sup> and 8<sup>th</sup>-grade assessments, it is clear that the lack of basic mathematics knowledge at an early stage of education might be decisive for not acquiring decent mathematics skills later in school. By observing the

data from countries that participated in both 4<sup>th</sup> and 8<sup>th</sup>-grade assessments, it can be concluded that students who finish early education without mastering even basic knowledge of mathematics will encounter learning problems in higher grades. On the other hand, the data reveal that the best-performing countries in the 8<sup>th</sup>-grade assessment have also obtained top-ranking results in the 4<sup>th</sup>-grade tests.

### Science achievement in 4<sup>th</sup> and 8<sup>th</sup> grade

Among all the 58 participating countries in 4<sup>th</sup>-grade TIMSS science assessments in 2019, the highest scores were observed in Singapore (595), Korea (588), Russian Federation (567), Japan (562), Chinese Taipei (558). Saudi Arabia took 53<sup>rd</sup> position among the participating countries with an average performance of around 402 points.

In 2011, Saudi Arabia achieved its highest score in 4<sup>th</sup>-grade science assessment, which was 429 points. From 2011 to 2015, there was a considerable decline (by 39 points), followed by an increase to 402 points in 2019. Therefore, despite the recent improvement, compared to 2011, the average achievement score dropped by 27 points.

Students who exceed the Low International Benchmark can show and apply limited understanding of scientific principles and concepts and little knowledge of science facts. With regards to this, the data show that nearly all 4<sup>th</sup> graders in Chinese Taipei, Russian Federation, and Korea reached this benchmark. Whereas in Saudi Arabia, only 46% achieved this basic level. The data show that students in Saudi Arabia did better than only the students in Kuwait, Morocco, South Africa, Pakistan, and the Philippines, with regards to the Low International Benchmark.

Singapore and Korea stand out when it comes to the number of students reaching the Advanced International Benchmark for 4<sup>th</sup>-grade science (38% and 29% of students, respectively). In the majority of the participating countries, less than 10% of students

reached this benchmark. While in Saudi Arabia, only 1% of students reached this high level of understanding of science.

In the 8<sup>th</sup>-grade science assessment in 2019, students from four Asian countries achieved the highest average result: Singapore (608 points), Chinese Taipei (574), Japan (570), and Korea (561). Students in Saudi Arabia scored an average of 431 points. With this result, out of the 39 participating countries in the assessment, Saudi Arabia took the 35<sup>th</sup> position. The results in 2019 are similar to those obtained in 2011, but they show significant improvement compared to 2015.

In regard to Saudi Arabia, 36% of students did not reach this basic level. While 33% of them reached The Intermediate Benchmark in science.

The Advanced International Benchmark was reached by 48% of 8<sup>th</sup>-grade students in Singapore. In Japan, Korea, and Chinese Taipei, more than 20% of students achieved this benchmark. Whereas in Saudi Arabia, only 1% of 8<sup>th</sup>-grade students reached this level.

### **Achievement differences between boys and girls**

In 4<sup>th</sup>-grade mathematics, girls scored significantly higher than boys by around 26 points in Saudi Arabia. These results placed Saudi Arabia in the 2<sup>nd</sup> position among the countries with the most significant gaps, where girls score better than boys.

In 8<sup>th</sup>-grade mathematics, boys had significantly higher average achievement than girls in six countries. On the other hand, girls achieved significantly higher average achievement than boys in seven countries, including Saudi Arabia, as well as Oman, Jordan, Bahrain, Romania, Malaysia, and South Africa. The international average of boys (491 points) and girls (488 points) were similar.

In 18 countries, female 4<sup>th</sup> graders had significantly higher average results in science than males, while in seven countries, boys significantly outperformed girls. The international average was 493 points for girls and 489 points for boys. In regard to Saudi Arabia, girls scored significantly higher than boys by around 61 points, which was the largest gap among all participating countries.

In 8<sup>th</sup>-grade science, girls' biggest advantage over boys was found in Oman. The data also reveal that in Saudi Arabia girls scored significantly higher than boys. In general, in 15 countries girls achieved significantly better results than boys, whilst only in six countries boys had higher average science achievement. The international average was 495 points for girls and 485 points for boys.

### **Home Environment, early numeracy activities, and pre-primary education**

In all participating countries, students with more resources at home outperformed, on average, those who did not have such resources. However, in Saudi Arabia, these differences are relatively lower. In Saudi Arabia, 3% of the 4<sup>th</sup> graders who were classified in the group with Many Resources scored on average 466 points in mathematics and 477 points in science, 88% of the students who were classified in a group with Some Resources obtained on average 403 points in mathematics and 409 points in science, and the remaining 9% of them who possessed only a Few Resources scored on average 383 points in mathematics and 382 points in science. A similar pattern is also visible for 8<sup>th</sup>-grade students with regards to the achievements in both mathematics and science.

Engagement in early literacy and numeracy activities before primary school is positively associated with better performance. In Saudi Arabia, 3% of the 4<sup>th</sup> graders who never or almost never engaged in early literacy and numeracy activities before primary



school scored on average 388 points in mathematics and 382 points in science. While students, who engaged sometimes, scored on average 394 points in mathematics and 397 points in science. Students who did often engage in these activities scored, on average, 416 points in mathematics and 426 points in science.

In the majority of participating countries, the low attendance of pre-primary education corresponds to lower achievement, both in mathematics and in science. In Saudi Arabia, 30% of the 4<sup>th</sup> graders who did not attend the pre-primary education scored on average 387 points in mathematics and 389 points in science. Students who attended one year or less (39%) scored on average, 399 points in mathematics, and 406 points in science. Students who did attend the pre-primary education for two years (18%) scored on average 418 points in mathematics and 429 points in science. Lastly, students who experienced this type of education for no less than 3 years (12%) scored, on average, 424 points in mathematics, and 423 points in science.

### School Composition and Resources

In all participating countries, schools with students coming from more wealthy families outperformed the schools with children from less affluent families. However, in 8<sup>th</sup>-grade assessment, the difference between more affluent and more disadvantaged schools was relatively lower in Saudi Arabia in comparison to the other countries, where the difference was only 20 points in mathematics and 14 points in science.

The shortage of science resources, as reported by school principals, is in general related to lower science achievement in most of the participating countries. However, in Saudi Arabia students attending schools where instruction was reported to be affected by shortages in science educational resources obtained on average similar results to those attending schools that were not affected by such shortages.

### Parents' satisfaction and students' sense of belonging

In Saudi Arabia, more than 80% of four graders had parents who were classified as very satisfied, which is higher than the international average (64%). Students in these schools performed higher than in schools where parents reported being less satisfied, but the differences were relatively small (around 10 points).

In Saudi Arabia, more 4<sup>th</sup>-grade students were classified as having a high sense of belonging (65% compared to the international average of 58%). These students also scored higher on average than the other students, both in mathematics and science. In regard to the 8<sup>th</sup>-grade students, there was no difference in achievement between students who had different senses of school belonging.

### School discipline and safety

In regard to school discipline in Saudi Arabia, most school principals reported that their schools had "hardly any problems" (64%), while 23% reported that their schools had minor problems, and the remaining 14% revealed that their schools had moderate to severe problems. Schools reporting no issues with discipline scored higher in mathematics and science by around 20 points than those reporting moderate to severe problems. Internationally, the difference in achievement among these different categories is larger. However, the number of schools reporting larger discipline issues is 8%, which is lower than the percentage in Saudi Arabia. Similar results were also observed for 8<sup>th</sup>-grade students.

In addition, the majority of teachers in both 4<sup>th</sup> and 8<sup>th</sup> grade reported that schools in Saudi Arabia were very safe and orderly and only a small number reported major

issues with safety. Similar to the results above, the achievement of schools with average or low safety was lower than the other schools, but the difference was relatively small.

With regard to the participating countries, 37% of 4<sup>th</sup>-grade students in TIMSS confirmed being exposed to bullying monthly or weekly. In Saudi Arabia, one in two students experienced bullying about monthly (33%) or about weekly (17%). This stands in contrast to teachers' declarations on school safety. Students who experienced more bullying scored significantly worse in both science and mathematics than the students who did not. In mathematics, 4<sup>th</sup>-graders who never or almost never experienced bullying in Saudi Arabia obtained 421 points, while those experiencing bullying about weekly scored on average 349 points. Eighth graders in Saudi Arabia reported less exposure to bullying than 4<sup>th</sup>-graders, with 8% reporting being bullied about weekly. However, similar to the results presented earlier, those students performed much worse than those who never experienced bullying.

### **Student Absenteeism and Students Feeling Tired or Hungry**

On average across the participating countries, 4<sup>th</sup> graders who are absent from school more frequently obtain worse results in mathematics and science than the other students. In Saudi Arabia, a noticeable number of students were absent from school once a week (28%) in comparison to the international average (11%). These students scored 367 points in mathematics, while students who were never or almost never absent from school achieved 419 points. Thus, school absenteeism is associated with a large achievement gap and is more frequent in Saudi Arabia than in the other participating countries. Students in 8<sup>th</sup> grade skipped school days even more often than 4<sup>th</sup> graders and there is a similar achievement gap between those who skipped classes and those who were almost never absent from school.

In Saudi Arabia, 29% of 4<sup>th</sup>-grade students reported coming to school feeling tired every day or almost every day. These students scored 30 points lower in mathematics comparing to students who reported that they never arrived tired at school. The gap in the achievement of science was even larger and reached around 40 points.

Among 4<sup>th</sup>-grade students in Saudi Arabia, 36% reported coming to school hungry every day or almost every day. These students scored lower by around 25 points in mathematics and 35 points in science than students who reported that they never felt hungry at school. In regard to 8<sup>th</sup>-grade, a similar share of students reported being hungry at school but the achievement gap was lower.

### Technology in Instruction

In Saudi Arabia, 31% of 4<sup>th</sup> grade students had access to computers during mathematics classes, which can be compared to the international average of 39%. In a number of countries such as Malta, New Zealand, and Denmark, around 90% of 4<sup>th</sup> graders had access to computers. In science classes in Saudi Arabia, 37% of 4<sup>th</sup> graders had access to computers. Similar numbers were reported for 8<sup>th</sup>-grade students.

The majority of 4<sup>th</sup> graders attended mathematics and science classes where teachers did not support learning by using computers. In Saudi Arabia, only 14% of students in mathematics and 16% of students in science learnt in classes where teacher used computers on a daily basis to support the process of learning in 4<sup>th</sup> grade. For older students, these numbers were even lower, with 75% of students being reported to never use computers for instruction in the 8<sup>th</sup> grade in Saudi Arabia. Internationally, 68% of students reported that they never used computers for mathematics instruction in 8<sup>th</sup> grade. On the other hand, 4<sup>th</sup>-grade students in Saudi Arabia participated more

frequently in computer-based tests, but still the majority of students never took such tests in grade 4 or 8.

### Instructional Time in Mathematics and science

Out of the 57 participating countries, Saudi Arabia ranked 36<sup>th</sup>, with 136 hours being spent on 4<sup>th</sup>-grade mathematics instruction per year (out of 1056 hours), which is equivalent to around 13% of their school time. Internationally, the 4<sup>th</sup> graders spent around 17% of their time in school in mathematics classes (154 out of 895 hours).

In the 8<sup>th</sup> grade, on average across the participating countries, students spent around 13% of their time in school in mathematics classes (137 out of 1023 hours). Even though older students worldwide spent more time in school than 4<sup>th</sup> graders, they devoted relatively less of that time to mathematics. In Saudi Arabia, 8<sup>th</sup> graders spent 136 out of 1069 hours on mathematics, this is around 13% of their school time, which is the same time as 4<sup>th</sup> graders.

Internationally, average 4<sup>th</sup> graders devoted around 8% of their school time to science-related activities (75 out of 895 hours), while in Saudi Arabia this share equals 6% (66 out of 1056 hours). Thus, Saudi Arabia's 4<sup>th</sup> graders spent less of their school time on science, in comparison to the international average.

Saudi Arabia 8<sup>th</sup> graders devoted around 11% of their school time to science-related activities (116 out of 1069 hours). The international average in this matter is relatively greater and equals 13% (137 out of 1023 hours). In general, countries in which students spent more time on science instruction did not perform significantly higher.

### Instructional Clarity in Mathematics and Science Lessons

The TIMSS data reveal that 4<sup>th</sup> graders attending clear instructed mathematics classes scored internationally on average higher than those experiencing unclear

instruction. The same relation applies to Saudi Arabia where students attending lessons with clear instruction achieved considerably better results.

The same pattern is also visible for 8<sup>th</sup> graders in mathematics. Saudi Arabia's 8<sup>th</sup> graders attending easy to understand instruction achieved on average higher results comparing to students who attended classes with moderate clarity (by 22 points), and low clarity (by 30 points).

Internationally, both 4<sup>th</sup> and 8<sup>th</sup> graders attending clearly instructed science classes scored on average higher than the other students who attended less clear classes. Saudi Arabia 4<sup>th</sup> graders who participated in easy to understand classes scored on average higher by 52, and 75 points than 4<sup>th</sup> graders who were in classes with moderate, and low clarity, respectively. Moreover, 8<sup>th</sup> graders who attended lessons that were clear in terms of instructions, scored on average higher by 22 and 30 points than those attending classes with moderate, and low clarity, respectively.

### **What do these results mean for education policy and practice?**

These results are alarming and indicate that a considerable number of students in Saudi Arabia do not have the basic knowledge of mathematics and science. These students will not only be unable to continue education, but their limited knowledge will not allow them to fully participate in modern technology-rich society. Moreover, the shortage of students who excel in mathematics and science presents a challenge for the future of Saudi Arabia where the goal is to develop a knowledge-driven economy. In order to achieve this objective, it is necessary for Saudi schools to improve instruction and to make sure that students are proficient at early grades of their education and showing substantially better knowledge, as well as continuing to develop such knowledge later on.

The TIMSS results offer a range of useful insights for those involved in reforming policy and practice of education in Saudi Arabia. The report explores how the home environment impacts early student learning. The important message here is that both engagement in early education as well as parents' involvement in early learning activities bring positive outcomes and should be strongly encouraged. Early interventions are especially important for the kids from socioeconomically disadvantaged families. For them, high-quality preschool education is the only way to acquire the knowledge required to reach primary education without gaps that could be difficult to fill later on.

In schools, safety and discipline are critical factors correlated with student achievement. Students who are often bullied perform much lower than those who are not. Education policy should address this problem by targeting schools with discipline and behavioral issues with effective interventions. In addition, student absenteeism is a serious issue that needs to be tackled in order to improve learning. A considerable number of students skip classes and school days and thus their performance is below those who attend school without disruptions. These problems are found in both schools for boys and girls, but are much more prevailing among boys and clustered in low-performing schools. Improving the situation in these schools, starting with behavior and limiting absenteeism, should be a priority for education policy.

The report also provides supplementary data related to technology, learning time, school climate and other important factors. It gives international perspective to results for Saudi Arabia, so policy makers and practitioners can compare state of education, student attitudes, teacher opinions, and practices to those in the other countries. The data alone are not enough to change education. One must act upon them

to reform schools and support targeted policies to address the most important issues enlightened by results from international assessments such as TIMSS and PISA. Some findings provide clear guidance with regard to the necessary actions that should be taken. Others require a debate, but this evidence should not be buried in the sand. It should be used to improve the future of children in Saudi Arabia and to ensure that ambitious goals stated in Vision 2030 can be reached by improving knowledge and skills of the youth



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## Introduction

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TIMSS (Trends in Mathematics and Science Achievement) is the international assessment of grades 4 and 8 students. It covers mathematics and science. It is conducted every four years, so TIMSS 2019 edition is the seventh edition. It offers overall data on student outcomes over 24 years since it had been released for countries that participated in the 1995 edition. This is the third assessment for Saudi Arabia, with the first results available in 2011 and later in 2015.

TIMSS is conducted by IEA—the International Association for the Evaluation of Educational Achievement. It is an independent international cooperative of national research institutions and government agencies. Saudi Arabia participates also in PIRLS, which is IEA's assessment of reading in the 4<sup>th</sup> grade. TIMSS data were obtained in Saudi Arabia in April 2019. The execution of the survey was coordinated by the Ministry of Education.

For the first time, the TIMSS 2019 assessment offered the participating countries an option of administering the assessment in a digital format. While Saudi Arabia remained using the test's classic paper form, more than half of the participating countries have administered it in an electronic form. In order to ensure that results are fully comparable, the countries which have chosen the electronic version also remained in using the paper format to solve the trend items. This approach allows making a comparison between the newly obtained results and the previously conducted report analysis.

Sixty-four countries participated in TIMSS 2019, including a variety of independent education systems within countries that have always participated independently throughout IEA's long history (e.g., the Dutch-speaking part of Belgium

and Hong Kong Special Administrative Region (SAR) of the People's Republic of China). Countries opted to test students in the 4<sup>th</sup> or 8<sup>th</sup> grade. In 2019, 58 countries participated in the fourth-grade assessment whereas 39 countries participated in the eighth-grade assessment.

Students participating in TIMSS are in their fourth year of formal schooling, provided that the average age at the time of testing is at least 9.5 years, and in their eighth year of formal schooling, provided that the average age at the time of testing is 13.5 years. Some countries assess students at different grades because of differences in school systems structure. In each country and separately for each grade, a nationally representative sample of around 4000 students from around 150 to 200 schools was randomly drawn. Data were obtained from students, their parents, teachers, and school principals. In Saudi Arabia, the 4<sup>th</sup> grade sample includes results for 5453 students in 220 schools, while the 8<sup>th</sup> grade sample includes results for 5680 students in 209 schools.

This report provides first insights into TIMSS 2019 results for Saudi Arabia. It provides description of student results in grade 4 and grade 8. Chapter 1 and Chapter 2 cover mathematics and science for the 4<sup>th</sup> grade students. Chapter 3 and Chapter 4 cover mathematics and science for the 8<sup>th</sup> grade students. The remaining chapters discuss contextual data collected from students, teachers, and school principals. Chapter 5 addresses student home environment and Chapter 6 outlines data on school composition and resources. Chapter 7 covers indicators of school climate, and Chapter 8 analyses school discipline and safety. Chapter 9 discusses results related to challenges to teaching. Chapter 10 offers details on access to technology in schools. Chapter 11 provides comparisons of mathematics and science curriculum and

instruction. Reports with a more detailed description and analysis of TIMSS 2019 results in Saudi Arabia will be released in 2021.

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## **Chapter 1**

### **Mathematics in Grade 4**

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## Mathematics in Grade 4

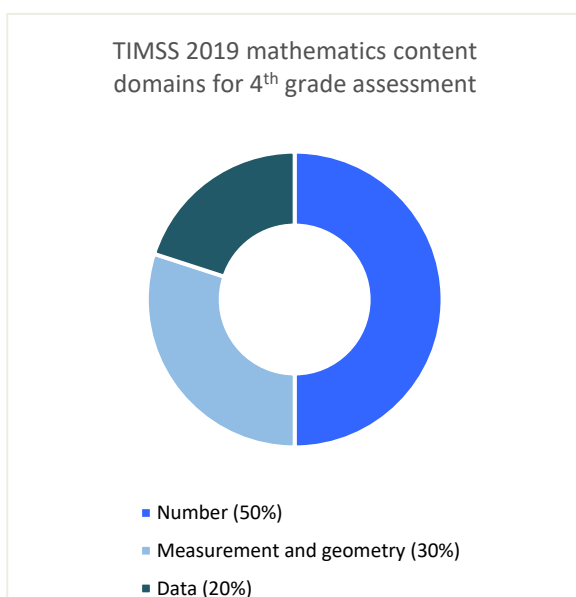
### TIMSS 2019 4th grade mathematics assessment

The TIMSS 2019 assessments in mathematics have been developed using national curricula of the participating countries and represent what is considered to be the core knowledge and skills in this field internationally. From this perspective, TIMSS 2019 provides participating countries internationally comparable data on the performance of students as well as an opportunity of initiating discussions about their national curricula and expectations towards students on the light of their results. The TIMSS assessment in the 4th grade offers a picture of student achievement at a critical stage of education. It is after the initial training in numeracy and before more advanced topics are introduced. It compares the foundations that students obtain in each country.

#### G4 Mathematics

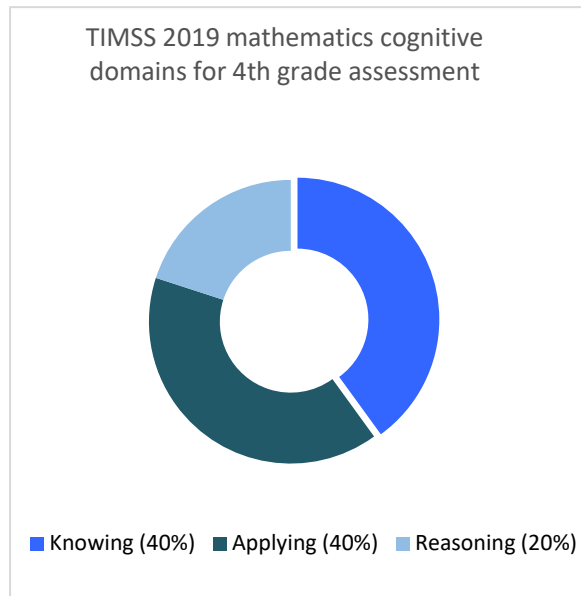


The 2019 TIMSS assessment of mathematics in the 4th grade could be divided into three main categories of tasks:



- number – 50% (e.g., working on digits, operating on fractions, multiples);
- measurement, and geometry – 30% (e.g., knowing the properties of geometric figures, angles, etc.);
- and data – 20% (e.g., analyzing charts and tables).

All of the designed items were aimed at testing not only the knowledge but also applying and reasoning skills. Thus, assessment items devoted to content and cognitive domains were divided into:



- knowing (40% of tasks, which cover the facts, concepts, and procedures students need to know);
- applying (40% of tasks covering students' ability to apply knowledge and conceptual understanding to solve problems or answer questions);
- and reasoning (20% of test items,

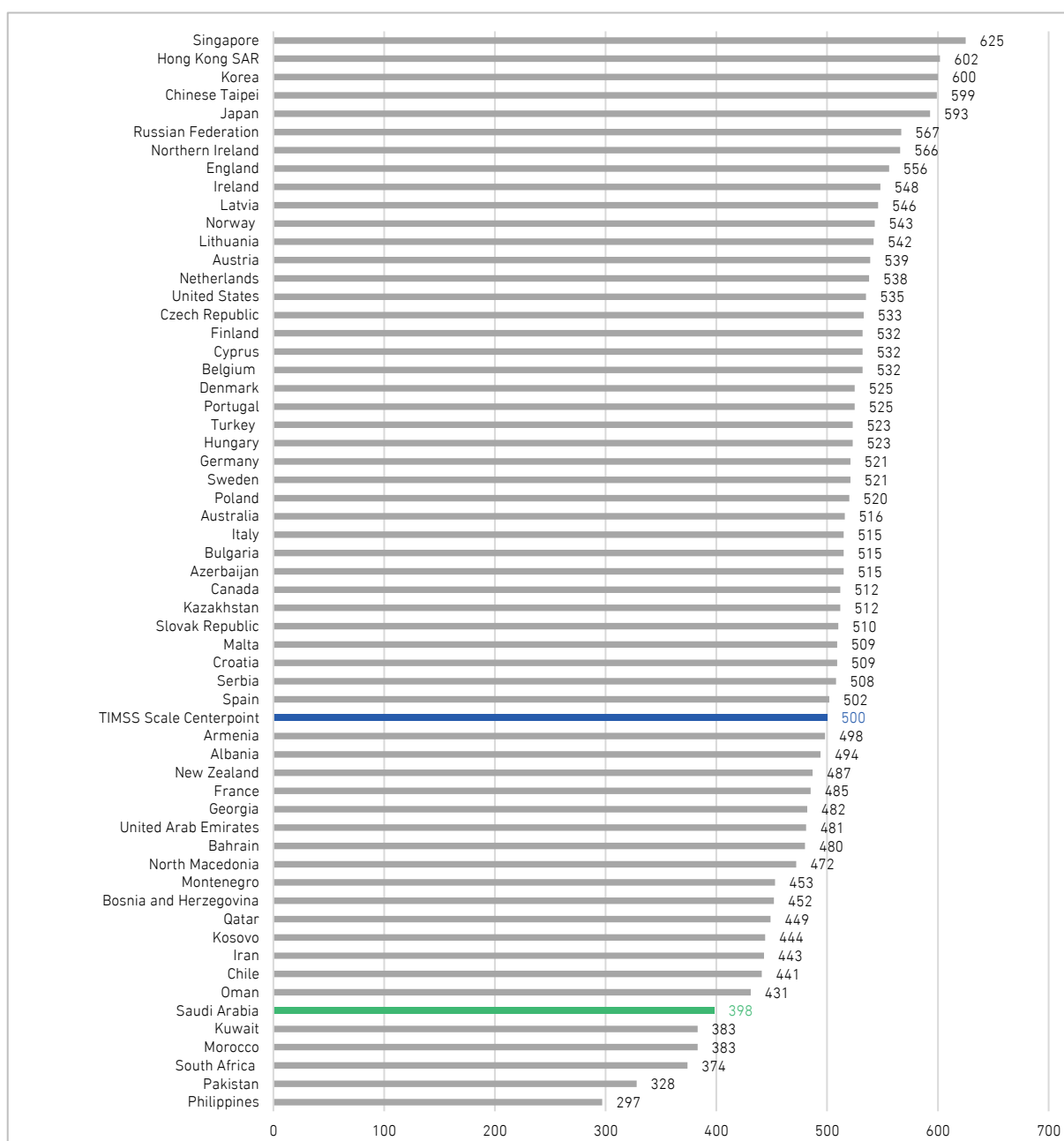
which encompass unfamiliar situations, complex contexts, and multistep problems).

Overall, there were 175 assessment items (questions) used in the TIMSS 2019 assessment of 4<sup>th</sup> grade mathematics, which assures that the tests covered all areas of mathematics, which is internationally taught at this stage of education.

## Average mathematics achievement of 4th grade students

Figure 1.1 shows the average achievement in mathematics for students in the 4th grade (or, in some countries, an equivalent grade with most students at age of 10). The results can be compared to the TIMSS center point, which is 500 points and was the average result for countries participating in the first edition of TIMSS. Most participating countries scored on average above the center point (63% have mean score above 500).

Figure 1.1 Average mathematics achievement of 4th grade students among TIMSS 2019 participants.

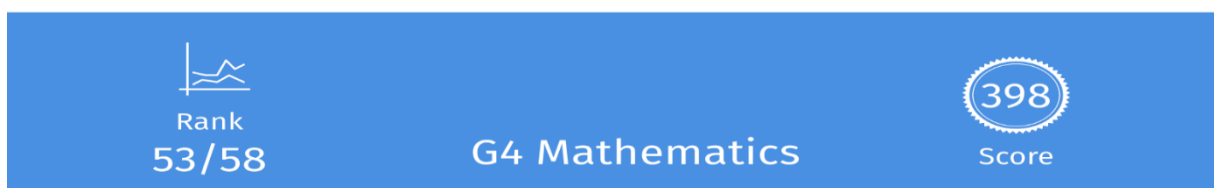


Source: Exhibit 1.1: Average Mathematics Achievement and Scale Score Distributions. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Of the 58 participants of the grade 4 TIMSS mathematics assessments in 2019, 37 countries had higher average achievements than the TIMSS Scale centerpoint. Five Asian countries have achieved the highest scores: Singapore (625), Hong Kong SAR (602), Korea (600), Chinese Taipei (599), and Japan (593). The lowest scores were found in the Philippines (297), Pakistan (328), South Africa (374), Kuwait (383), and Morocco (383). Most of the countries in the Middle East were below the scale centerpoint.

Considering all the participating countries in the assessment, Saudi Arabia has achieved a relatively low score of more 100 points below the centerpoint. As a result, the Kingdom has achieved 53<sup>rd</sup> position among the 58 participating countries. The average score is 398 points with a standard error of 3.6. This value is significantly lower than the TIMSS centerpoint.

### Saudi Arabia



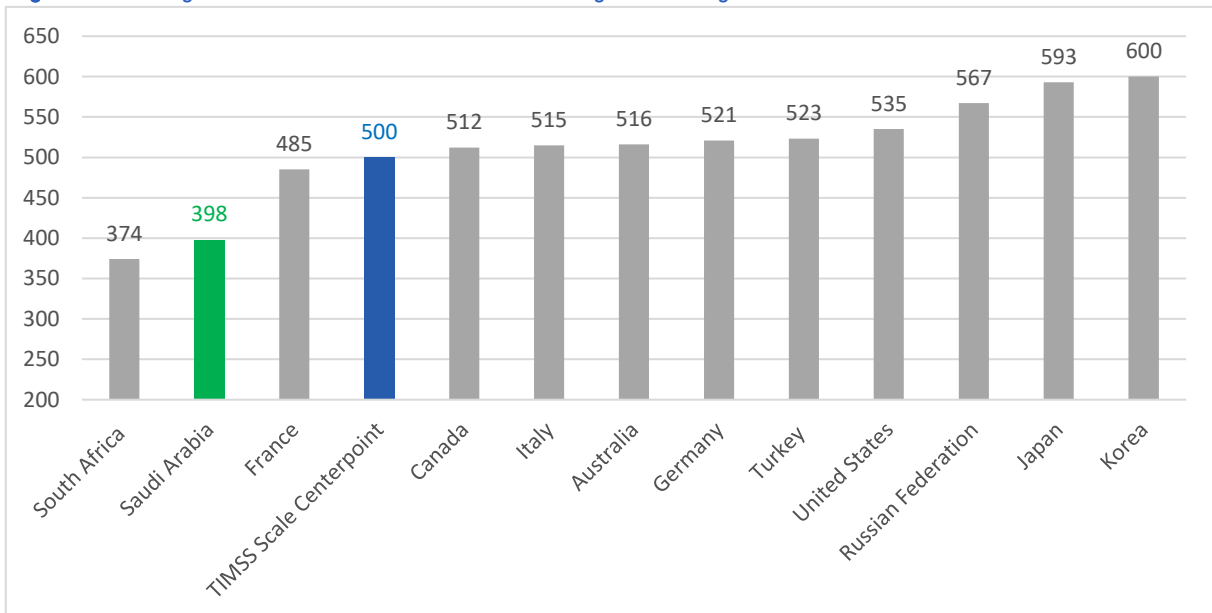
The average achievement in each country is calculated using a representative sample of students. So while the results are representative to the student population, they are measured with some precision that needs to be taken into account when comparing countries. Countries might have slightly different average score, but statistically their performance might be similar if the confidence intervals for their results overlap. In view of this, the average results of Saudi Arabia are higher than average scores of students in Morocco, Kuwait, South Africa, Pakistan, and the Philippines. The rest of the participating countries in the assessment scored on average significantly higher than Saudi Arabia. Students in Oman and Chile scored higher, but



closer to Saudi Arabia than other countries. Students from Singapore have significantly higher results than students in all other participating countries.

Considering the achievement of G20 countries, results can be compared for only 12 countries that participated in TIMSS 2019 4<sup>th</sup> grade assessment. On average, the highest scores were obtained by students from Korea (600), Japan (593), and Russian Federation (567). Out of those 12 countries, Saudi Arabia (398) was placed on 11<sup>th</sup> position. In this ranking, the average results of Saudi Arabia are higher than average scores of students only in South Africa (374).

**Figure 1.2** Average mathematics achievement in the 4<sup>th</sup> grade among G20 countries.



SOURCE: Exhibit 1.1: Average Mathematics Achievement and Scale Score Distributions. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

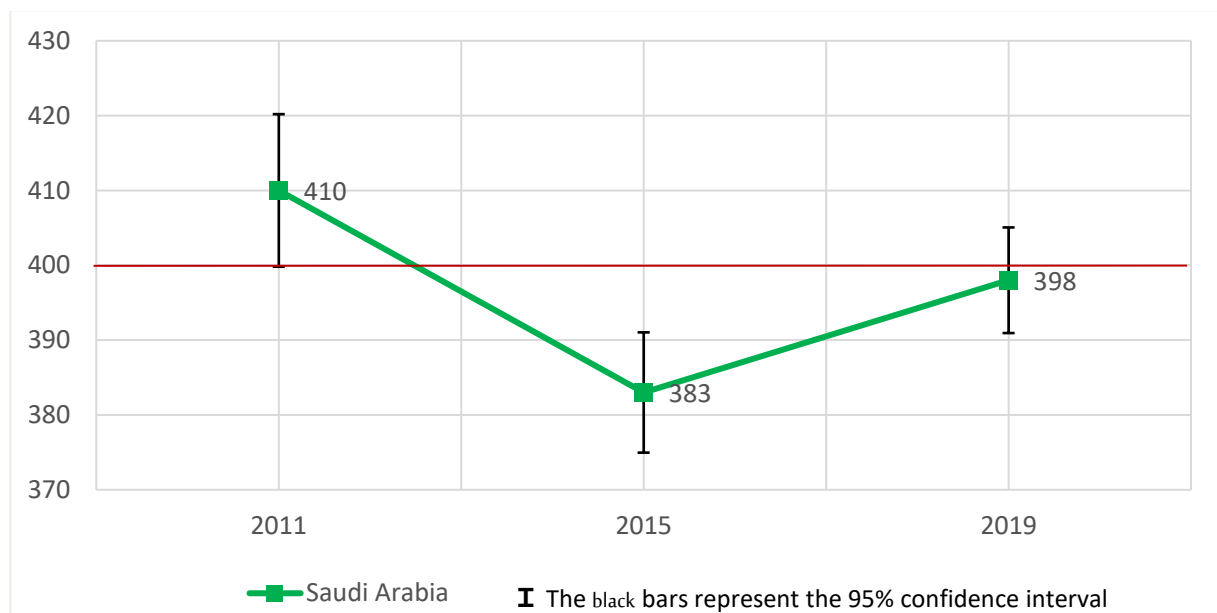
### Trends in student achievement in grade 4 mathematics

Country performance can be compared over time as the TIMSS assessment has been conducted since 1995. Singapore, for example, had participated in all editions of TIMSS 4<sup>th</sup> grade assessment, so the results can be compared across six assessments from 1995 to 2019. For Singapore, the results show a consistent positive trend with student average results improving over time and with 2019 results being the highest of

all participants. For most other countries, the trends are available for shorter periods of time and are rarely as consistent showing ups and downs in student results.

Trends analysis for Saudi Arabia compares results for 4th grade mathematics in 2011, 2015 and 2019. As shown on Figure 1.3, the average score of Saudi Arabia students in 2011 is higher than in 2015 and 2019, but the difference is small, and it is not statistically significant between 2011 and 2019. Thus, provided that the results are calculated with some precision as they are based on samples of students, the analysis of TIMSS data for Saudi Arabia show no change in student results between 2011 and 2019 in grade 4 mathematics. The results were significantly lower in 2015 when compared to 2011 but in 2019 they improved to the level that is statistically similar to 4th grade student average scores in 2011. The improvement between 2015 and 2019 is also statistically significant.

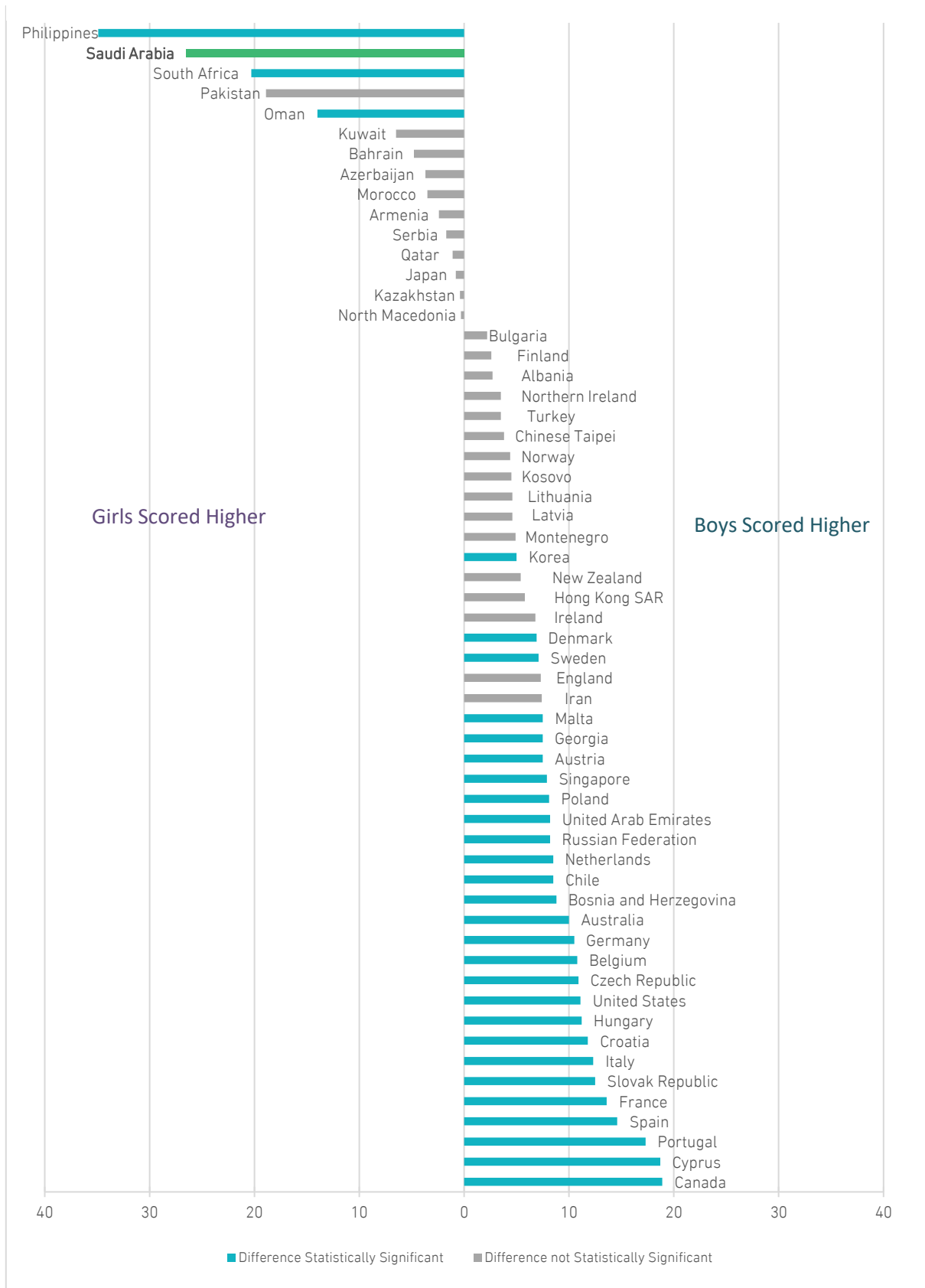
**Figure 1.3** Changes in the 4th grade student average mathematics achievement across TIMSS assessments in Saudi Arabia.



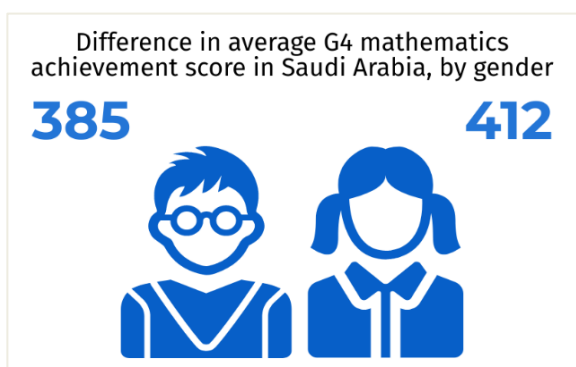
SOURCE: Exhibit 1.3: Trend Plots of Average Mathematics Achievement Across Assessment Years. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Average Achievement by Gender

Figure 1.4 shows the disparity in average mathematics achievement between girls and boys (mean score for girls minus mean score of boys). In countries at the top of the chart, girls on average scored higher than boys. The biggest advantage of girls over boys was noticed in the Philippines, where girls scored better by 35 points. At the bottom of the figure, on the other hand, there are countries where boys scoring better than girls and the last country listed is Canada where boys scored 19 points on average higher than girls. According to **Figure 1.4** in just 4 countries, girls achieved significantly higher scores than boys (the Philippines, Saudi Arabia, South Africa, and Oman). Meanwhile, in almost half (27) of the participating countries, fourth-grade boys achieved higher average achievement than girls. In all participating countries, the international average was 499 points for girls and 503 points for boys.

**Figure 1.4** Gender difference in average mathematics achievement for students in the 4th grade.

SOURCE: Exhibit 1.5: Average Mathematics Achievement by Gender. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>

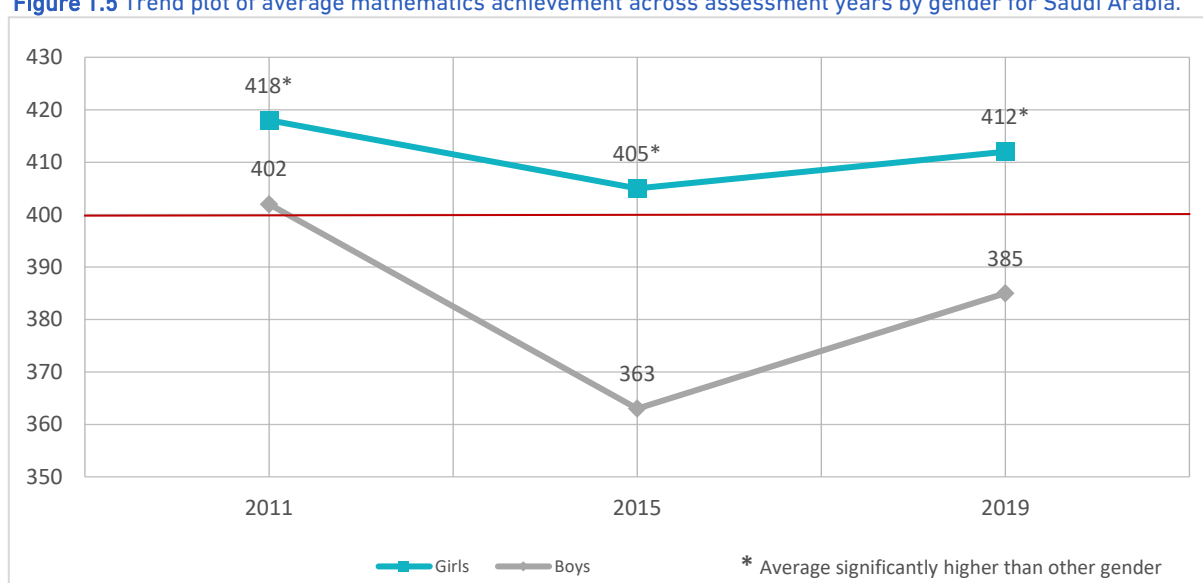


In Saudi Arabia, girls scored significantly higher than boys by around 27 points. These results placed Saudi Arabia in the 2<sup>nd</sup> position among countries with the biggest gaps, where girls score better than boys.

However, it is worth mentioning that there are low and high performing students in both groups.

Figure 1.5 shows how the average achievement of boys and girls had changed over time in Saudi Arabia. The gender gap in TIMSS 2019 for 4<sup>th</sup> grade mathematics was 27 points, while in 2015 the difference was 42 points. A strong drop in the achieved results for both boys and girls has been observed since 2011, followed by an increase. In both cases, the changes noted for boys were much greater than for girls. In none of the assessment editions conducted so far, Saudi Arabia's fourth-graders of both genders have managed to surpass the average international score, leaving boys with a gap of 118 points, and girls of 87 points in the recent edition.

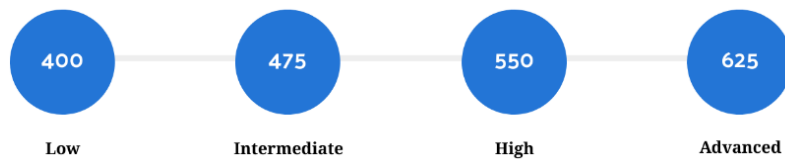
Figure 1.5 Trend plot of average mathematics achievement across assessment years by gender for Saudi Arabia.



SOURCE: Exhibit 1.6: Trend Plots of Average Mathematics Achievement Across Assessment Years by Gender. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Performance at TIMSS International Benchmarks for Grade 4 Mathematics

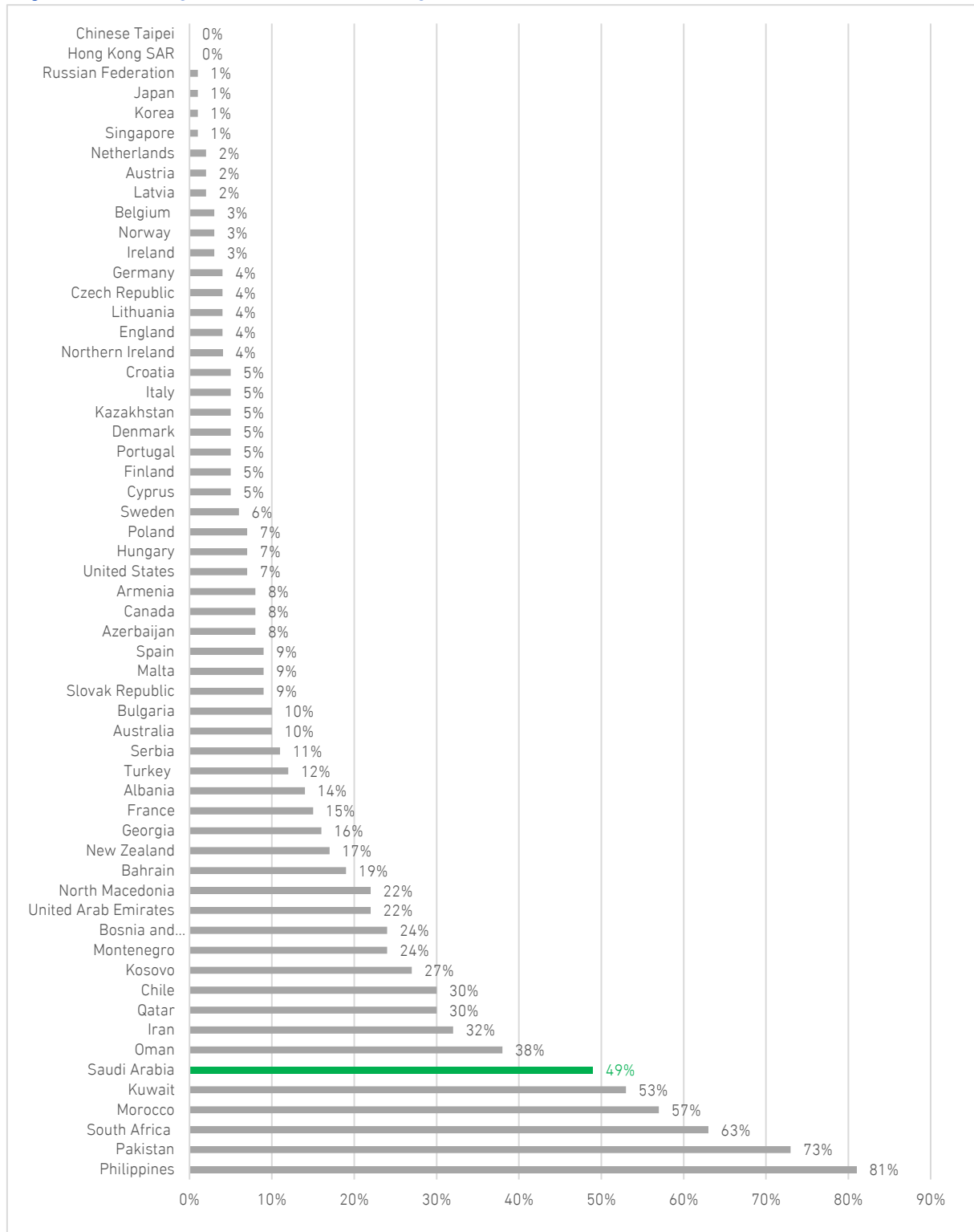
### International Benchmarks



TIMSS 2019 assessment compares student achievement using four international benchmarks, which illustrate what 4<sup>th</sup> grade students reaching them know and can do in mathematics. International Benchmarks are based on score point thresholds, so students reaching a certain score reach the benchmark and those with lower score perform at lower benchmarks or, for very low performing students, they do not reach any benchmark. Students scoring 625 points or more meet the Advanced International Benchmark. Students who score 550 or more reach the High International Benchmark. Students scoring 475 reach the Intermediate International Benchmark. Students who score 400 or above reach the Low International Benchmark, while those scoring below 400 perform below international benchmarks, which also means that their knowledge and skills are so limited, that they cannot be fully described using the TIMSS international assessment.

Students reaching the Low International Benchmark have some basic mathematical knowledge. They have mastered mathematical tasks on two-digit numbers (e.g., multiplication, subtraction). They should recognize basic geometric figures and understand simple graphs and tables. They can also successfully solve short text problems that require one-step solutions. They are familiar with numbers into the thousands and recognize pictorial representations of simple fractions.

In most countries participating in the TIMSS 2019 assessment, less than 10% of 4<sup>th</sup> Grade students do not meet this basic level as shown on **Figure 1.6**. In Hong-Kong SAR, Chinese Taipei, Singapore, Korea, Japan, and the Russian Federation only 1% of students or less do not reach this level. In the United Arab Emirates, 22% of Grade 4 students do not possess mathematics skills to reach this level. In Saudi Arabia, 49% of students do not reach the Low International Benchmark so they do not possess even some basic mathematics knowledge expected at this age. In Oman, this percentage is lower than in Saudi Arabia, but also there a substantial number of children do not master basic mathematics knowledge in the 4<sup>th</sup> grade. In Kuwait, Morocco, South Africa, Pakistan, and the Philippines, still more students are unable to solve the easiest test items from the TIMSS 2019 assessment.

**Figure 1.6** Share of grade 4 students not reaching the Low International Benchmark in mathematics.

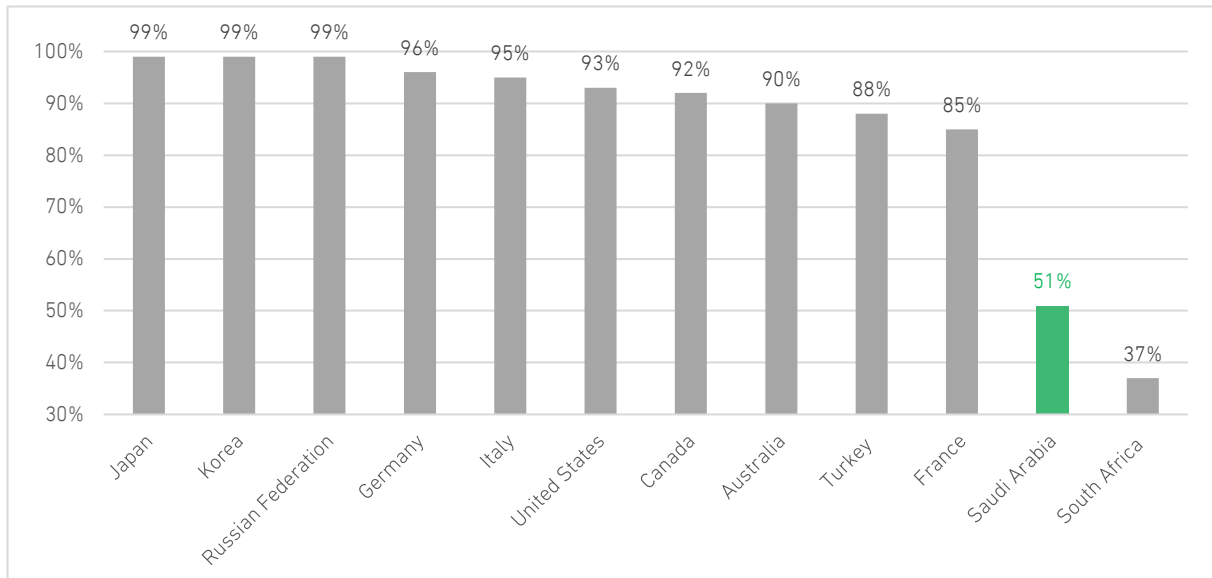
SOURCE: Exhibit 1.8: Percentages of Students Reaching International Benchmarks of Mathematics Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

The majority of students in G20 countries reach the Low International Benchmark as shown on **Figure 1.7** In Korea, Japan, and Russian Federation only a small number of students do not reach this basic mathematics knowledge level at grade 4. In Germany,



Italy, the United States, Canada, and Australia, 10% or less of students do not reach this low achievement level. In Turkey and France, 15% or less of students are below the Low International Benchmark, but among the G20 countries Saudi Arabia and South Africa stand out with, respectively, 49% and 63% of students not reaching this basic level.

**Figure 1.7** Percentage of students reaching the Low International Benchmark in G20 countries that have participated in the TIMSS 2019 4th grade mathematics assessment.



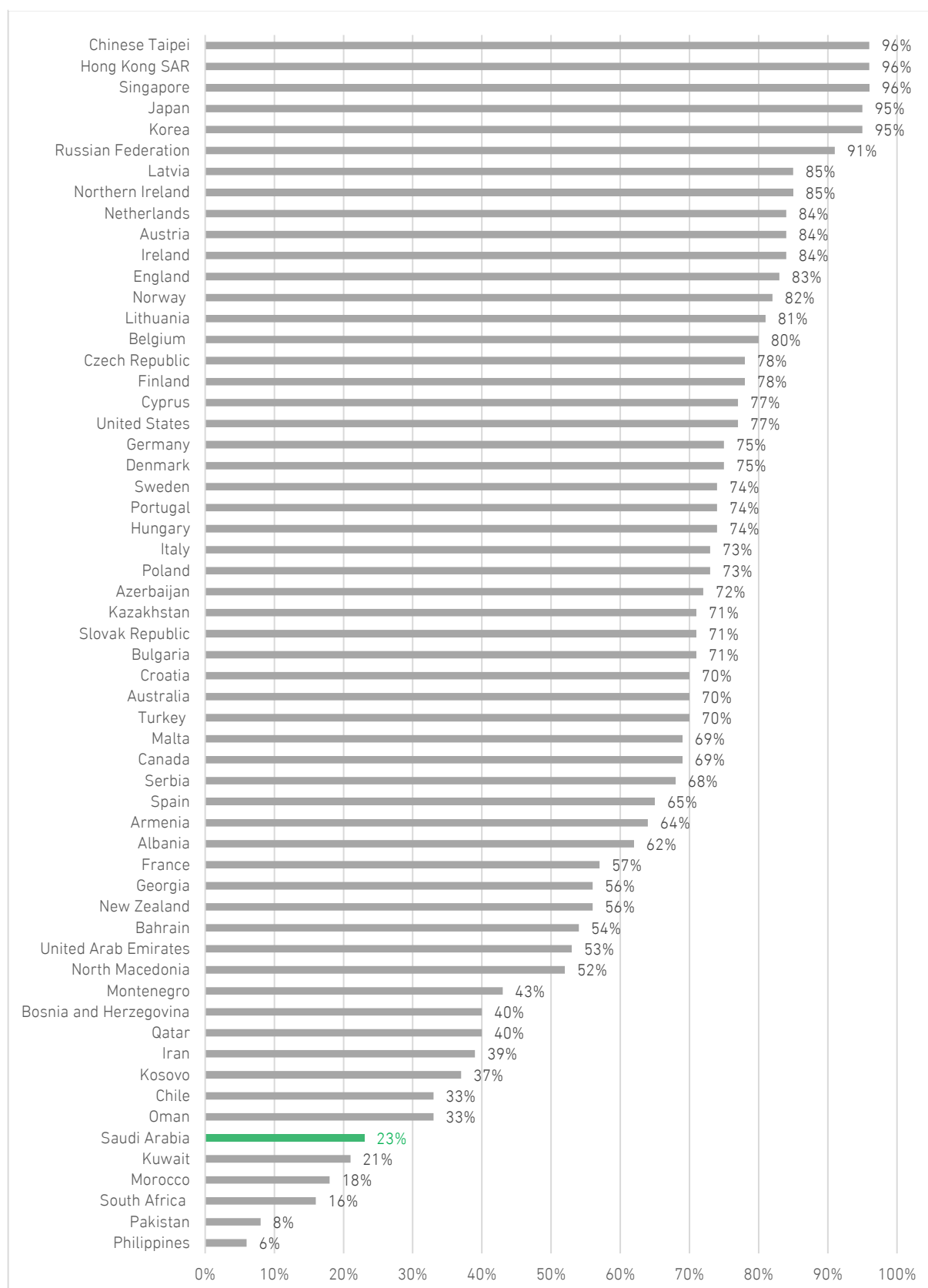
SOURCE: Exhibit 1.8: Percentages of Students Reaching International Benchmarks of Mathematics Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Students reaching the Intermediate Benchmark can solve simple problems using basic mathematical knowledge. These are students who have scored 475 points or higher on the TIMSS scale. They can solve problems with three- or four-digit numbers and have some understanding of fractions and decimal numbers. They can solve simple two-step word problems. They recognize and draw simple shapes and interpret information in tables and graphs.

Almost all students in the top performing countries reach the Intermediate Benchmark (see **Figure 1.8**). In Singapore, Hong Kong SAR, Chinese Taipei, Korea, and Japan, 95-96% of students master mathematics knowledge at this level in grade 4. In the majority of countries participating in the TIMSS 2019 4<sup>th</sup> grade mathematics assessment, at least 2 in 3 students have mathematics skills at this level.

In Saudi Arabia, only 23% of students reach the Intermediate International benchmark. In Oman and Chile, the two countries with average scores just above Saudi Arabia, 33% of students master mathematics knowledge at this level. This level is reached by 21% of the students in Kuwait, and 18% of students in Morocco. A smaller share of students can perform tasks at this level in n South Africa, Pakistan, and the Philippines.

**Figure 1.8 Percentage of grade 4 students reaching the Intermediate International Benchmark in mathematics.**

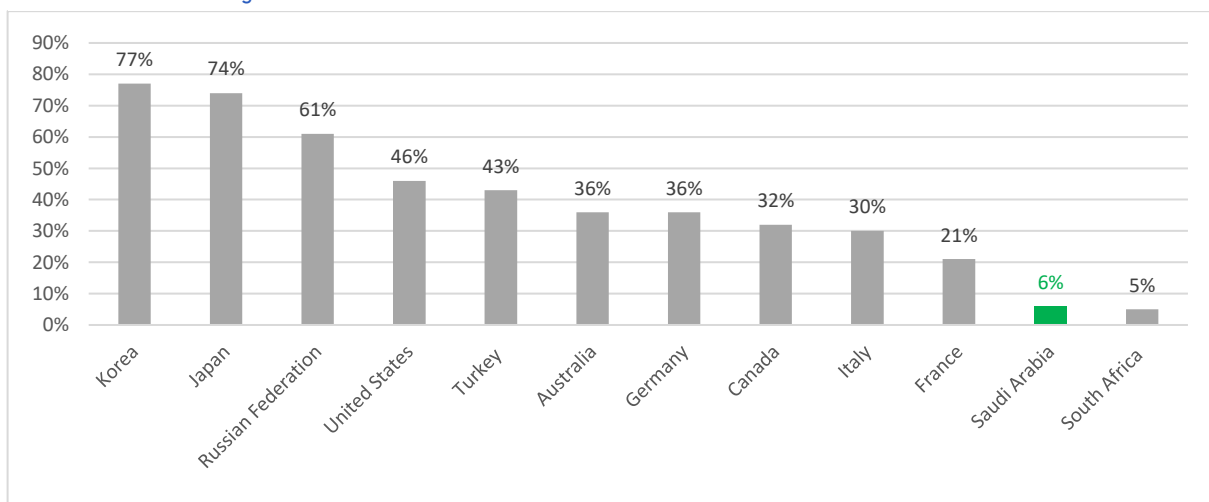


SOURCE: Exhibit 1.8: Percentages of Students Reaching International Benchmarks of Mathematics Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

The High International Benchmark can be reached by students who have mastered mathematics knowledge required at this age and can already apply conceptual understanding to solve problems. They solve two-step word problems with whole numbers and show understanding of the number line, multiples, factors, rounding numbers, and operations with fractions and decimals. They demonstrate understanding of geometric properties of shapes and angles and solve simple measurement tasks. They can use data presented in tables or graphs to solve problems. Students performing at 550 score or higher on the TIMSS scale are classified as reaching this level.

Among the G20 countries, 77% of students in Korea and 74% in Japan have reached this performance level. In Russian Federation, 61% of 4th grade students reach this benchmark. In other countries, less than half of 4<sup>th</sup> graders can solve tasks at this level. In the United States (46%), and Turkey (43%) of students reach this level, but in Australia, Germany, Canada, and Italy something between 30 and 40% of students can possess mathematics knowledge at this level. In France, only 21% of students reach this level, while less than 1 in 10 students perform at the High International Benchmark for 4th grade mathematics. in Saudi Arabia and South Africa.

**Figure 1.9** Percentage of students reaching the High International Benchmark in G20 countries that have participated in the TIMSS 2019 4th grade mathematics assessment.



SOURCE: Exhibit 1.8: Percentages of Students Reaching International Benchmarks of Mathematics Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

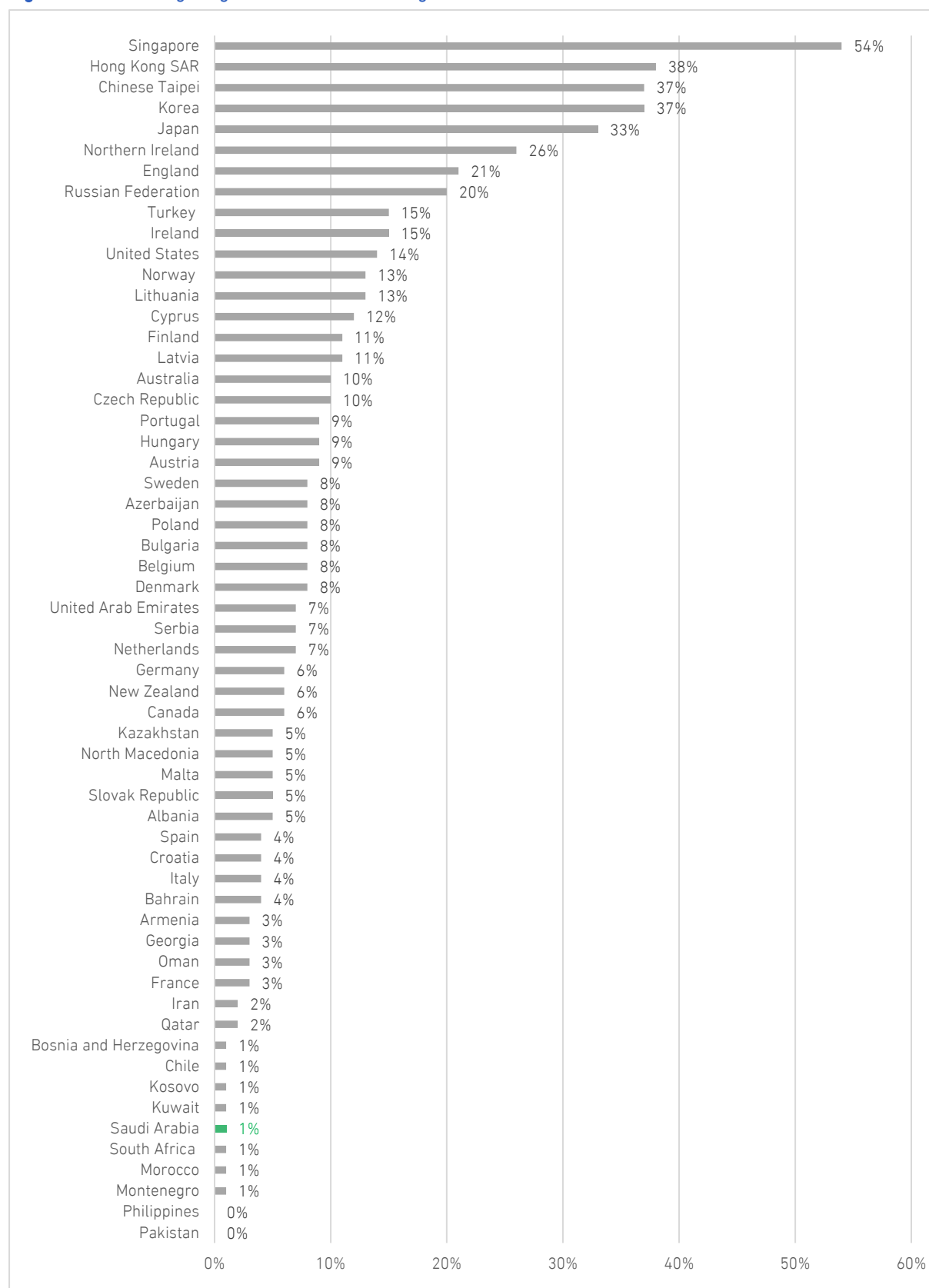
The advanced international benchmark can be reached by students who at this age show the highest understanding of mathematics knowledge. At this level, students can solve tasks and explain their reasoning for relatively complex problems and in a variety of contexts. They can solve multistep word and data problems involving whole numbers and show an understanding of fractions and decimals. They can apply knowledge of two- and three-dimensional shapes in a variety of situations. Students scoring 625 points or higher on the TIMSS scale are classified as reaching this benchmark. As the scale is standardized for countries participating in the first TIMSS assessments, it is obvious that even in the best performing countries many students cannot reach this demanding benchmark.

Only in Singapore, the majority of students reach the advanced international benchmark for 4<sup>th</sup> grade mathematics (54% of students). In Japan, Chinese Taipei, Korea, and Hong Kong SAR more than 30% of students reach this benchmark. Among other countries, only in Northern Ireland, England, and Russian Federation 20% or more students reach this high level of understanding of mathematics. In Saudi Arabia, only 1% of students reach this level in grade 4. Similarly, small number of students reach this level in Montenegro, Morocco, South Africa, Kuwait, Kosovo, Chile, and Bosnia and Hercegovina.

While it is clear that reaching this level requires excellent teaching of mathematics in early education and only in few countries a substantial number of children can reach this level at this young age, these results also show that in many education systems children finish early education without being equipped with knowledge that can allow them to quickly master more advanced concepts in later grades. These results explain why at older ages, as shown by results for the 8<sup>th</sup> grade

TIMSS assessment or in PISA assessment of 15-year-olds, in some countries the share of students showing excellent mathematics skills is low. It also shows that lack of basic mathematics knowledge at an early stage of education might be decisive for not acquiring decent mathematics skills later in school. Too many students lack strong basis from early education and in Saudi Arabia most students finish early education without mastering even basic knowledge of mathematics, which probably translates into later teaching and learning problems in higher grades.

**Figure 1.10** Percentage of grade 4 students reaching the Advanced International Benchmark in mathematics.



SOURCE: Exhibit 1.8: Percentages of Students Reaching International Benchmarks of Mathematics Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Trends in Percentages of Students Reaching International Benchmarks

Taking into consideration the short-term changes at high and advanced educational levels, it is difficult to see a clear leading trend in countries participating in the study. By comparing the 2015 and 2019 results, there were approximate as many decreases as increases in these categories, and most of the countries remained stable in their performance. The exact numbers are as follows (considering all four International Benchmarks).

In terms of low international benchmark, the increases were noticed in 9 countries – Kuwait (14% increase), United Arab Emirates (10%), Bahrain (9%), Armenia (8%), Saudi Arabia (8%), Georgia (6%), Qatar (5%), Italy (2%), and Cyprus (2%), while the decreases occurred in 6 countries – Chile (8% decrease), Poland (3%), Belgium (2%), Portugal (2%), Finland (2%), and the United States (also 2%).

	Increase	Decrease	Difference
Low	9	6	+3
Intermediate	8	9	-1
High	9	9	0
Advanced	8	7	+1

In the intermediate benchmark, there was a rise in the percentage of exceeding it students in 8 countries – Bahrain (13%), United Arab Emirate (11%), Georgia (9%), Armenia (9%), Kuwait (9%),

Saudi Arabia (7%), Slovak Republic (6%), and Italy (4%), while a drop was observed in 9 countries – Chile (9% decrease), Portugal (8%), Belgium (8%), Poland (7%), Denmark (5%), Norway (4%), Finland (4%), Hong Kong SAR (2%), and Korea (2%).

	Increase	Decrease	Difference
Low	11	0	+11
Intermediate	11	0	+11
High	12	1	+11
Advanced	12	2	+10

In the high benchmark, the increase was noticed in 9 countries – United Arab Emirates (8%), Bahrain (8%), Netherlands (7%), Slovak Republic (5%), Georgia (5%), England (4%), Croatia (4%), Saudi Arabia (3%), and Kuwait (3%). A decrease also



occurred in 9 countries – Denmark (by 9%), Poland (8%), Portugal (7%), Belgium (7%), Hang Kong SAR (6%), Hungary (5%), Serbia (5%), Korea (4%), and Chile (3%). Lastly, considering the advance benchmark, 8 countries have their results increased – England (4% increase), Lithuania (3%), Finland (3%), Sweden (3%), Netherlands (3%), Czech Republic (2%), United Arab Emirates (2%), and Bahrain (2%), while 6 countries have their results decreased – Hong Kong SAR (7% decrease), Korea (4%), Hungary (4%), Denmark (4%), Portugal (3%), and Serbia (3%).

A much different situation can be observed when analyzing long-term results. Comparing the situation in the 16 countries that have participated in the assessment since 1995, a steady increase has been observed in about three-quarters of them, and with only a few decreases. Thus, it can be concluded that the level of mathematics education in the world is increasing. The list of countries that observed particular changes is presented below.

In the low benchmark, as many as 11 countries have noted an increase in their results – Portugal (difference of 25%), Iran (24%), Cyprus (16%), England (14%), Ireland (6%), New Zealand (5%), Australia (4%), Austria (4%), Singapore (3%), Hong Kong SAR (3%), and Japan (1%). Meanwhile, one country has noted a significant decrease.

As far as the intermediate benchmark is concerned, the rise in percentage of exceeding it students was also noticed in 11 countries – Portugal (rise by 37%), England (29%), Cyprus (25%), Iran (24%), Ireland (11%), Hong Kong SAR (9%), Australia (9%), Austria (7%), Singapore (7%), Japan (6%), and United States (6%).

In the high benchmark, an increase occurred in 12 countries – England (rise by 29%), Portugal (28%), Hong Kong SAR (22%), Cyprus (21%), Singapore (14%), Japan

(13%), Ireland (12%), Iran (10%), United States (9%), Australia (9%), Korea (7%), and New Zealand (6%), while a significant decrease occurred only in Netherlands (by 7%).

Lastly, the advance benchmark shows a rise in percentage of exceeding of students in 12 countries – Hong Kong SAR (21%), Singapore (16%), England (14%), Korea (12%), Japan (11%), Portugal (8%), Cyprus (7%), Ireland (5%), United States (5%), Australia (4%), New Zealand (2%), and Iran (2%), while 2 countries have their results significantly decreased – Czech Republic (decreased by 6%), and Netherlands (5%).

Percentages of Saudi Students Reaching International Benchmarks of Mathematics Achievement Across Assessment Years			
	2011	2015	2019
<b>High</b>	7%	3%	6%
<b>Advanced</b>	2%	0%	1%

By analyzing changes that have taken place in Saudi Arabia from 2011 to 2015, there was a considerable drop in the percentage of students who exceeded the Advanced and High International Benchmarks: from

2% to 0% (Advanced), and from 7% to 3% (High). The same tendency was also noticed for Intermediate (in 2011 – 24%, in 2015 – 16%, it dropped by 8%) and Low Benchmarks (in 2011 – 55%, in 2015 – 43%, it decreased by (12%). Despite these unfavorable changes in the most recent period (from 2015 to 2019), there was an improvement in students' mathematical knowledge and abilities. On each of the four Benchmarks, the percentage of students reaching them has grown considerably. To be precise: at the advanced level (from 0% to 1%), at the high level (from 3% to 6%), at the intermediate level (from 16% to 23%), and at the low level (from 43% to 51%). It can be seen that in the most recent period, the mathematical performance reached almost the same state as that observed in 2011.



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## Chapter 2

### Science in Grade 4

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## Science in Grade 4

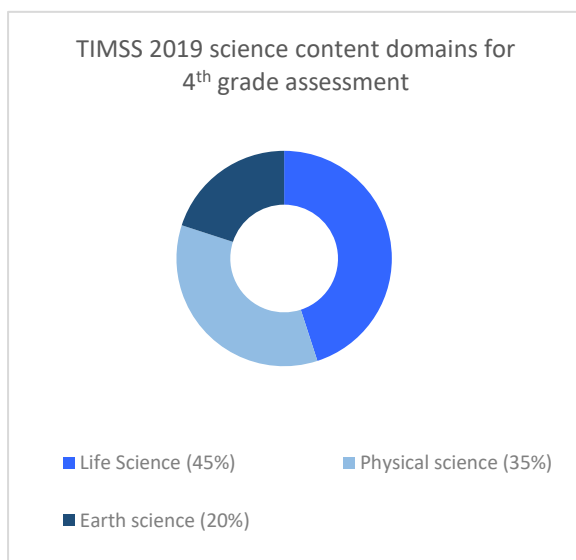
### TIMSS 2019 4th grade science assessment

The TIMSS 2019 assessment in science was developed on the basis of similar principles to the assessment in mathematics. It was developed using national curricula of the participating countries and reflect what internationally is considered as the core knowledge and skills in science. The assessment employed 175 test questions (items), which covered a wide range of curricular areas. Countries can use these results to initiate discussions about their national science curricula, and expectations towards students in light of their achievements.

#### G4 Science



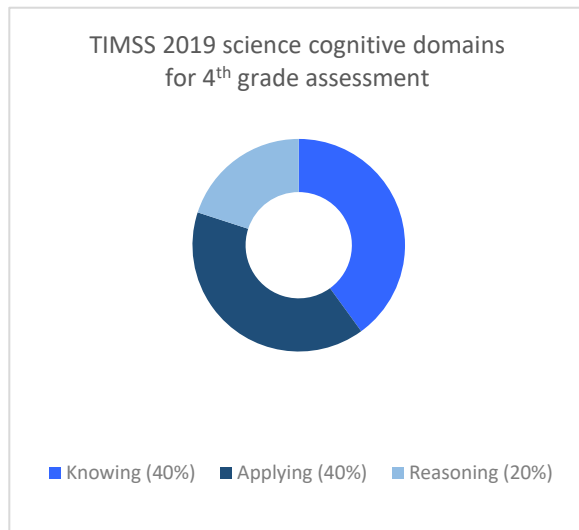
The 2019 TIMSS assessment of science in the 4<sup>th</sup> grade are divided into three main categories of tasks:



- Life science – 45% (e.g., characteristics and life processes of organism, life cycle, human health, etc.);
- Physical science – 35% (e.g., classification and properties of matter and changes in matter, forms of energy and energy transfer, motion, etc.);
- and Earth science – 20% (e.g., Earth's

physical characteristics, resources, and history, etc.).

All of the created items were designed to assess not only the knowledge but also applying and reasoning. Thus, assessment items devoted to content and cognitive domains were divided into:



- knowing (40% of tasks, which cover the facts, concepts, and procedures students need to know);
- applying (40% of tasks covering students' ability to apply knowledge and conceptual understanding to solve practical problems or answer questions);
- and reasoning (20% of test items,

which encompass unfamiliar situations, complex contexts, and multistep problems).

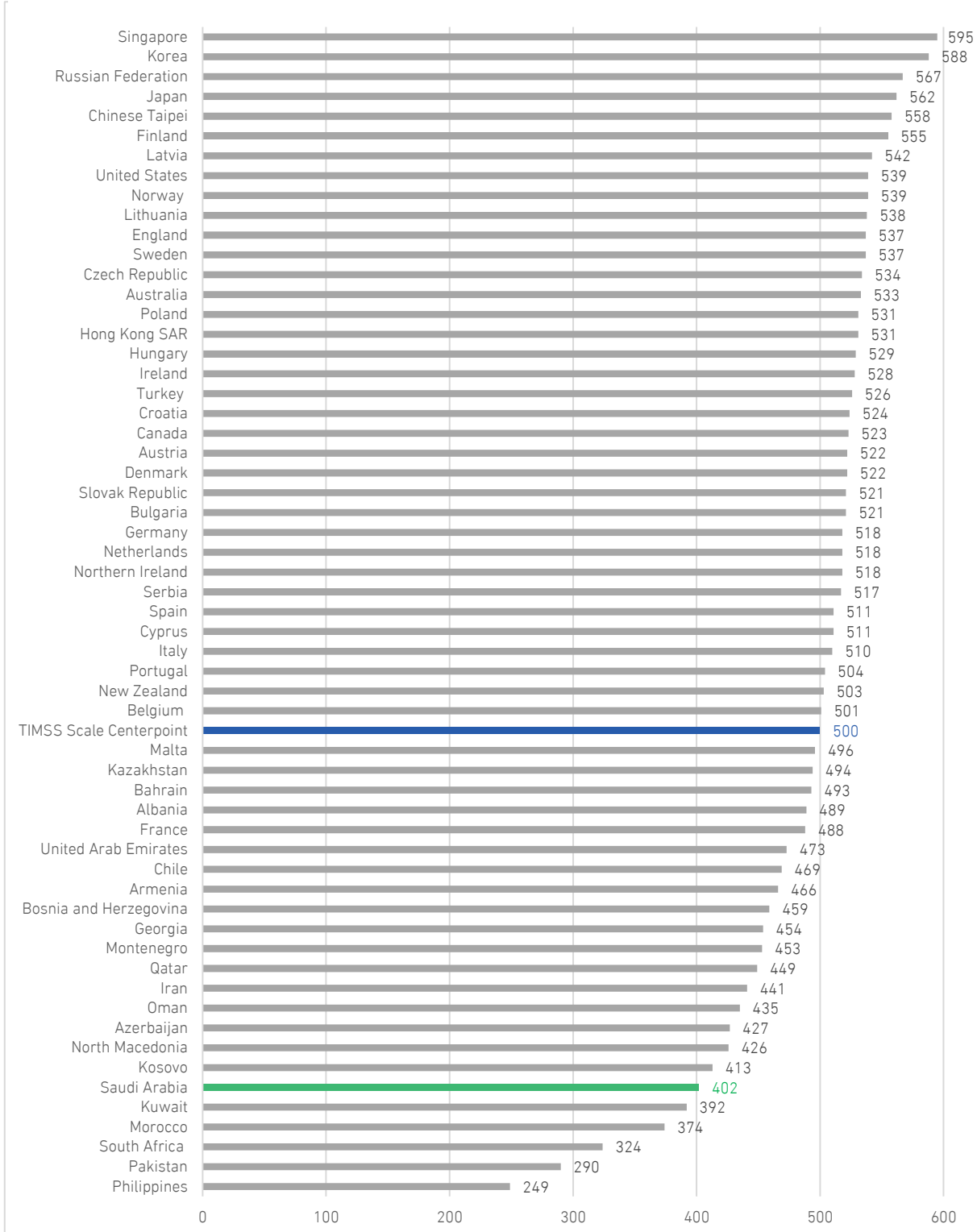
Overall, there were 175 assessment items (questions) used in the TIMSS 2019 assessment of 4<sup>th</sup> grade science, which assures that the tests covered all areas of science, which is internationally taught at this stage of education.

### Average science achievement of 4<sup>th</sup> grade students

Figure 2.1 shows the average achievement in science for students in the 4<sup>th</sup> grade (or, in some countries, an equivalent grade with most students at age of 10). For easier comparison, the average country performance has been ranked from the highest score to the lowest. The results can be compared to the TIMSS centerpoint, which is estimated as 500 points, most of participating countries scored on average above this mark (60%

have mean score above 500). Still, there was a considerable difference in the achieved score between first and last place on the assessment scale.

**Figure 2.1** Average science achievement of 4th grade students among TIMSS 2019 participants.



SOURCE: Exhibit 2.1: Average Science Achievement and Scale Score Distributions. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Of all the 58 participating countries of the grade 4 TIMSS science assessments in 2019, 35 countries had higher average achievements than the TIMSS Scale centerpoint. The highest scores were observed in the following countries: Singapore (595), Korea (588), Russian Federation (567), Japan (562), Chinese Taipei (558). It is worth mentioning that all five best-performing countries are located in Asia (Russian Federation is partially located in Northern Asia). In contrast, the lowest scores were observed in the Philippines (249), Pakistan (290), South Africa (324), Morocco (374), and Kuwait (392). Most of the countries in the Middle East were below the scale centerpoint.

As shown in Figure 2.1, it can be noticed that Saudi Arabia took 53<sup>rd</sup> position among the participating countries. The average science performance in Saudi Arabia of the 4<sup>th</sup> grade students was around 402 points (with a standard error of the mean equal to 4.1). This value is significantly lower than the centerpoint of the TIMSS scale.

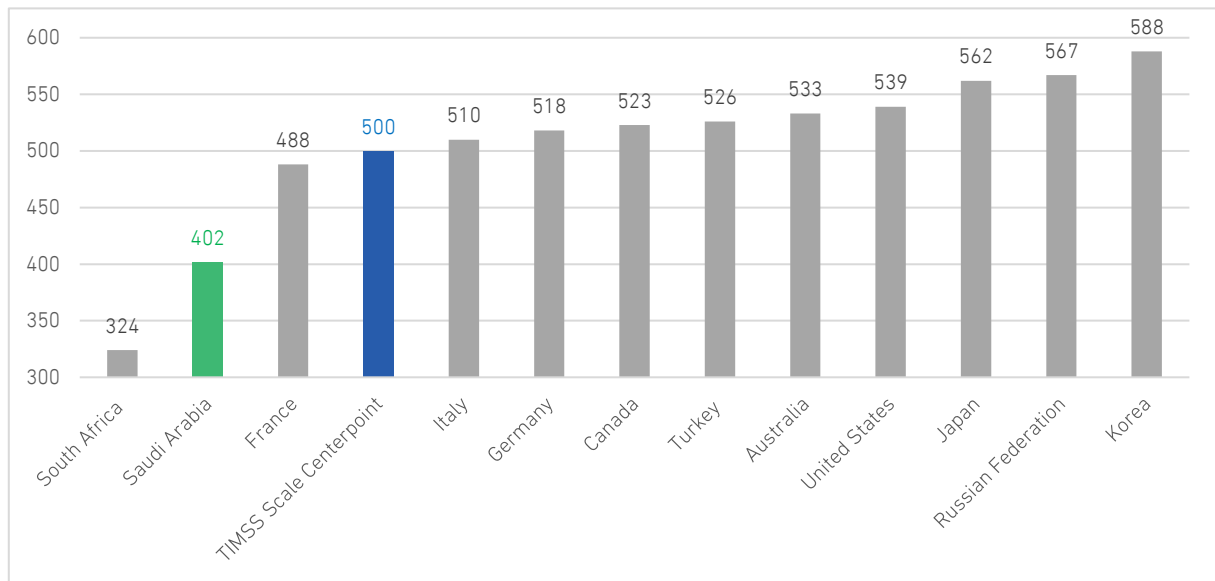
### Saudi Arabia



The average achievement in each country can be also compared in terms of the significance of the occurring differences. Countries may have slightly different average score, but statistically their performance may be similar if the confidence intervals for their results overlap. Taking this into consideration, the average results for Saudi Arabia are higher than those for Morocco, South Africa, Pakistan, and the Philippines. Comparable to Saudi Arabia, results occur in Kuwait. For the rest of the participating countries, Saudi Arabia students achieved a significantly lower average scale score.

Considering the achievement of G20 countries, science results can be compared for only 12 countries that participated in TIMSS 2019 4<sup>th</sup> grade assessment. On average, highest scores were achieved by students from Korea (588), Russian Federation (567), and Japan (562). In this specific ranking, Saudi Arabia (402) took 11<sup>th</sup> position. Just as in 4<sup>th</sup> grade mathematic assessment, the average results of Saudi Arabia are higher only than the ones observed in South Africa (324).

**Figure 2.2** Average science achievement in the 4th grade among G20 countries.



SOURCE: Exhibit SOURCE: Exhibit 2.1: Average Science Achievement and Scale Score Distributions. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

### Trends in student achievement in grade 4 science

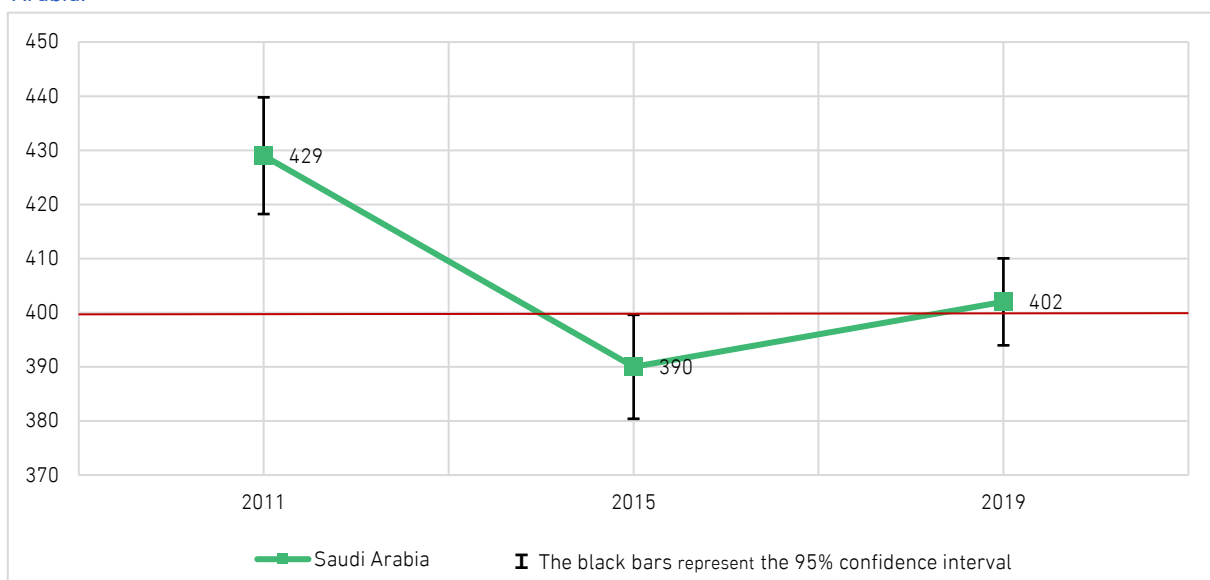
Country performance in science can be compared over time as the TIMSS study is conducted since 1995. However, countries vary considerably in the number of assessments they have participated in during this period.

Looking at **Figure 2.3** which presents the exact results obtained for Saudi Arabia, it can be noticed that this country has participated in three editions of the TIMSS 4th grade science assessment. In 2011, Saudi Arabia achieved its highest observed score at nearly 430 points. From 2011 to 2015, there was a considerable decline (by 39 points). Most recently, during the period 2015-2019, there has been an increase to 402 points,



but this improvement is not statistically significant. Thus, from the statistical point of view, the science average results for the 4<sup>th</sup> grade students in Saudi Arabia are comparable between TIMSS 2015 and 2019. At the same time, trends analysis for Saudi Arabia which compares results for 4<sup>th</sup> grade science from 2011 to 2019 shows that their average achievement score dropped by 27 points. This means that level of science knowledge represented by average fourth grader from Saudi Arabia have decreased.

**Figure 2.3** Changes in the 4th grade student average science achievement across TIMSS assessments in Saudi Arabia.



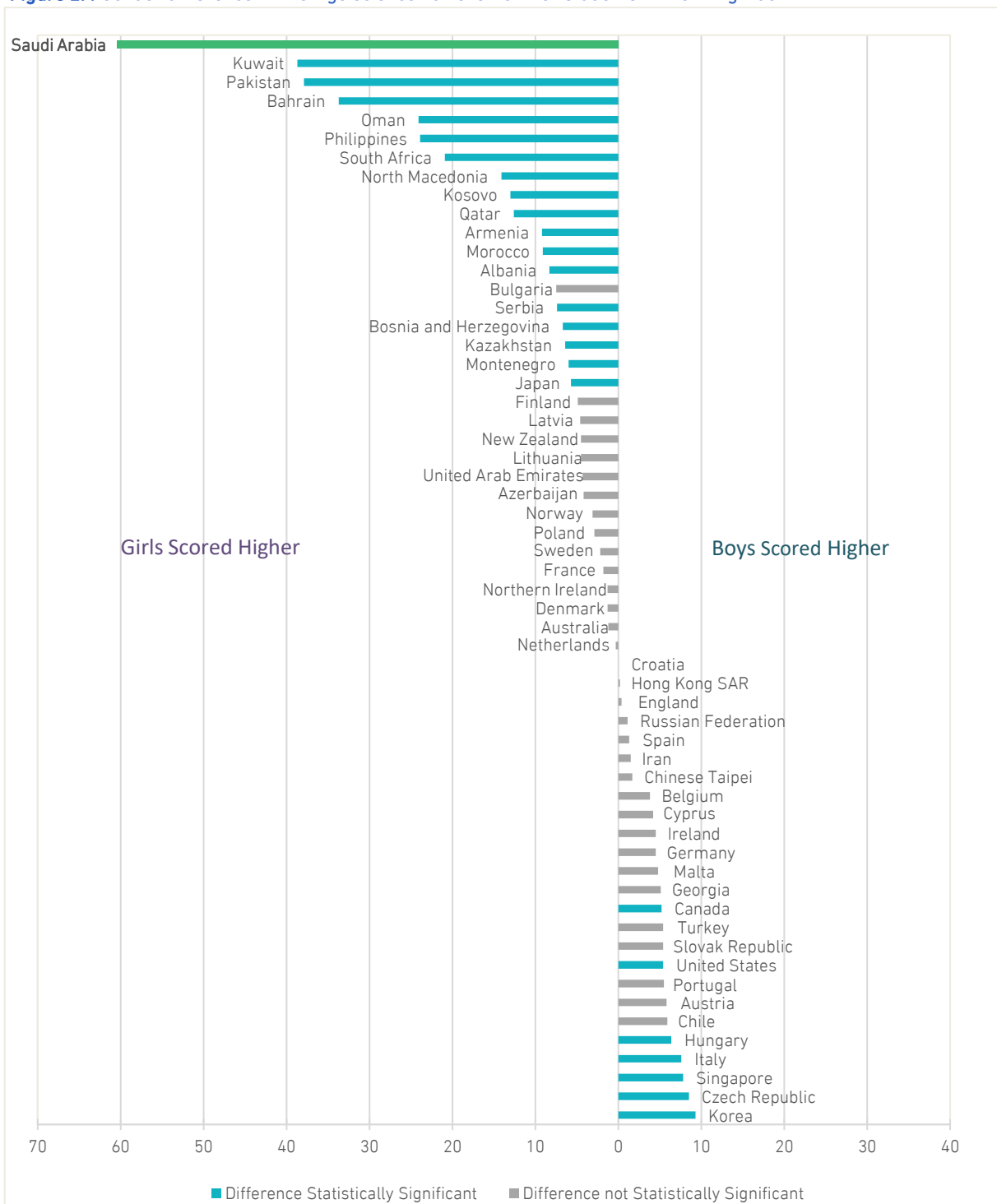
SOURCE: Exhibit 2.3: Trend Plots of Average Science Achievement Across Assessment Years. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

### Average Achievement by Gender

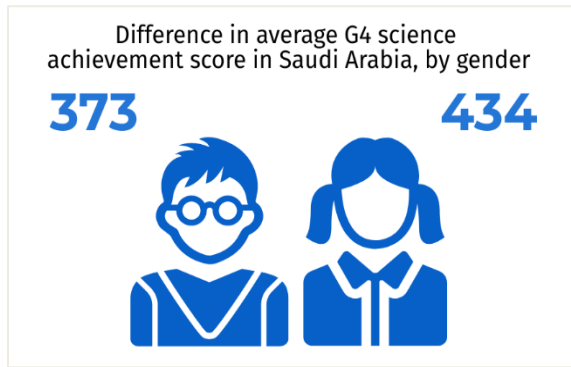
Figure 2.4 shows the difference between average science achievement among girls and boys (mean score of girls minus mean score of boys). In countries at top of the list girls on average achieved much better results than boys. The largest advantage of girls over boys was found in Saudi Arabia, where girls achieved higher scores by 60.4 points. On the other hand, the countries at the bottom of the list are characterized by significantly higher average results achieved by boys, on the bottom of the figure is Korea, where boys scored on average higher than girls by 9.3 points.

Looking at the **Figure 2.4**, one can notice that in 18 countries, girls had significantly higher average results, and in 7 countries, boys significantly outperformed girls in science test for fourth grade. Considering all participating countries, the international average was 493 points for girls and 489 points for boys.

**Figure 2.4** Gender difference in average science achievement for students in the 4th grade.



SOURCE: Exhibit 2.5: Average Science Achievement by Gender. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

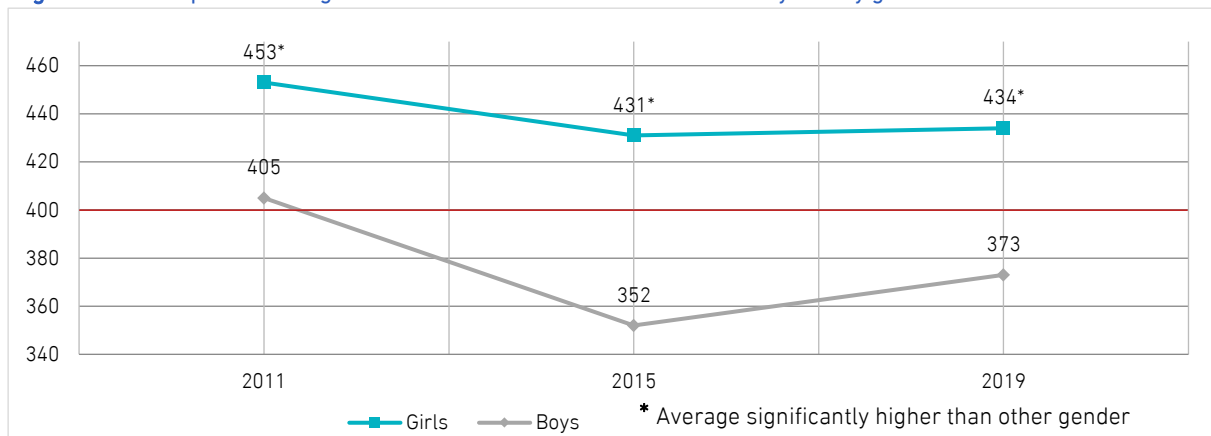


performing students in both groups.

In Saudi Arabia, girls scored significantly higher than boys by around 60 points. These results have placed Saudi Arabia at the very beginning of the list. However, it is worth mentioning that there are low and high

**Figure 2.5** compares trends in average science achievement across assessment years for boys and girls in Saudi Arabia. The difference between boys and girls is stable over time which means that girls have been obtaining significantly better achievements. In all conducted studies from 2011 to 2019, girls scored on average higher in science than boys (48 points more than boys in 2011, 79 in 2015, and 61 in 2019). Additionally, greater fluctuation in achieved scores was observed for boys. From 2011, there was observed a big drop in achieved results for both genders, followed by an increase. In the recent edition (TIMSS 2019), Saudi Arabia' fourth graders of both sexes did not manage to exceed the international centerpoint, boys achieved lower result by 127 points, and girls by 66 points. Such dependency was noticed in all assessment editions in which Saudi Arabia have participated.

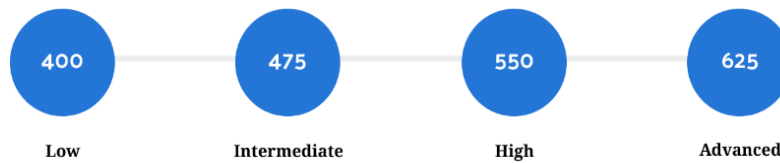
**Figure 2.5** Trend plot of average science achievement across assessment years by gender for Saudi Arabia.



SOURCE: Exhibit 2.6: Trend Plots of Average Science Achievement Across Assessment Years by Gender. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Performance at TIMSS International Benchmarks for Grade 4 Science

### International Benchmarks



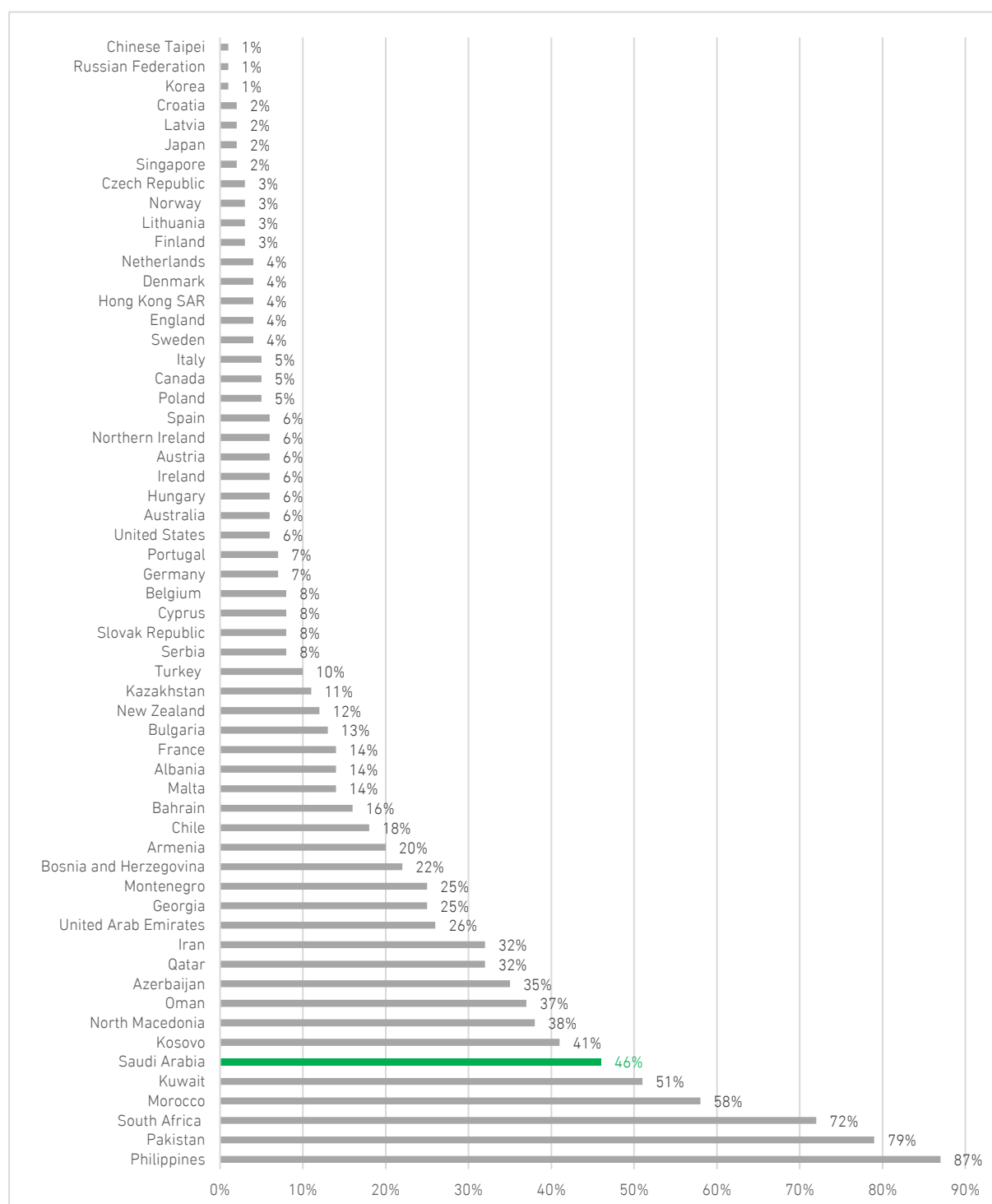
In the area of science assessment, TIMSS 2019 compares student achievement using four international benchmarks, which illustrate what 4<sup>th</sup> grade students reaching them know and can do in this subject. International Benchmarks help to interpret the results on the TIMSS fourth grade science achievement scale by defining the relation between achieved score and student achievement on the assessment items. TIMSS 2019 international benchmarks of science include four levels of student achievement. That breakdown allows to classify students into those who reach Advanced International Benchmark (625), High International Benchmark (550), Intermediate International Benchmark (475), Low International Benchmark (400), and those who score below the lowest Benchmark.

Fourth graders who exceed the Low International Benchmark show limited understanding of scientific concepts and have limited knowledge of science facts. Students at that level should be able to recognize, for example, that some animals have backbones, some materials conduct heat better than others, and that water and soil are natural resources.

More than half of participating countries in the TIMSS 2019 assessment had less than 10% of 4<sup>th</sup> grade students who do not reach this basic level as shown on Figure 2.6. At the top of the list are placed Chinese Taipei, Russian Federation, and Korea, where only 1% of students or less do not reach this level. In Saudi Arabia, that number was

estimated to be 46% of students. This percentage is higher than those in United Arab Emirates and Oman, which are respectively 26%, and 37%. In Kuwait, Morocco, South Africa, Pakistan, and the Philippines, more students were not able to solve item tasks representing the lowest level of science knowledge when compared to Saudi Arabia.

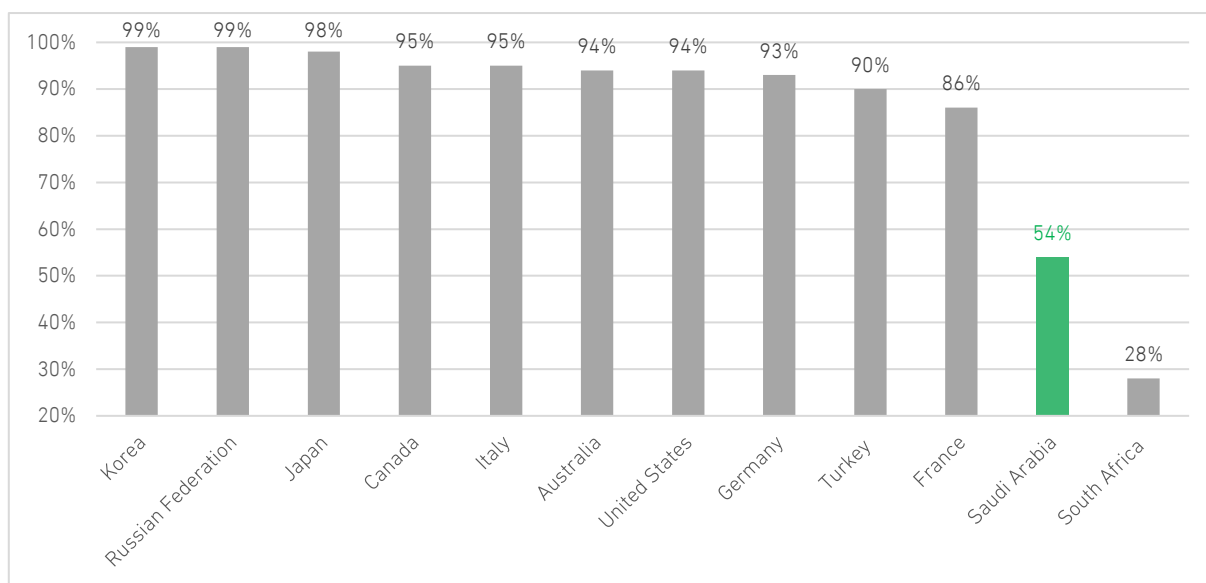
**Figure 2.6** Share of grade 4 students not reaching the Low International Benchmark in science.



SOURCE: Exhibit 2.8: Percentages of Students Reaching International Benchmarks of Science Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 2.7** shows that, the majority of the students from G20 countries reach the Low International Benchmark. Just as in the mathematics 4<sup>th</sup> grade assessment, nearly all the students in Korea, Japan and Russian Federation had acquired basic science knowledge. In this ranking the result that was observed in Saudi Arabia, and South Africa, respectively is that 46% and 72% of students not reaching this basic level. It can be said that, in those two countries, in comparison to mathematics assessment, less percent of student reached Low International Benchmark. In the remaining countries, 14% or less of students do not reach this low achievement level (France, Turkey, Germany, United States, Australia, Italy, Canada).

**Figure 2.7** Percentage of students reaching the Low International Benchmark in G20 countries that have participated in the TIMSS 2019 4th grade science assessment.



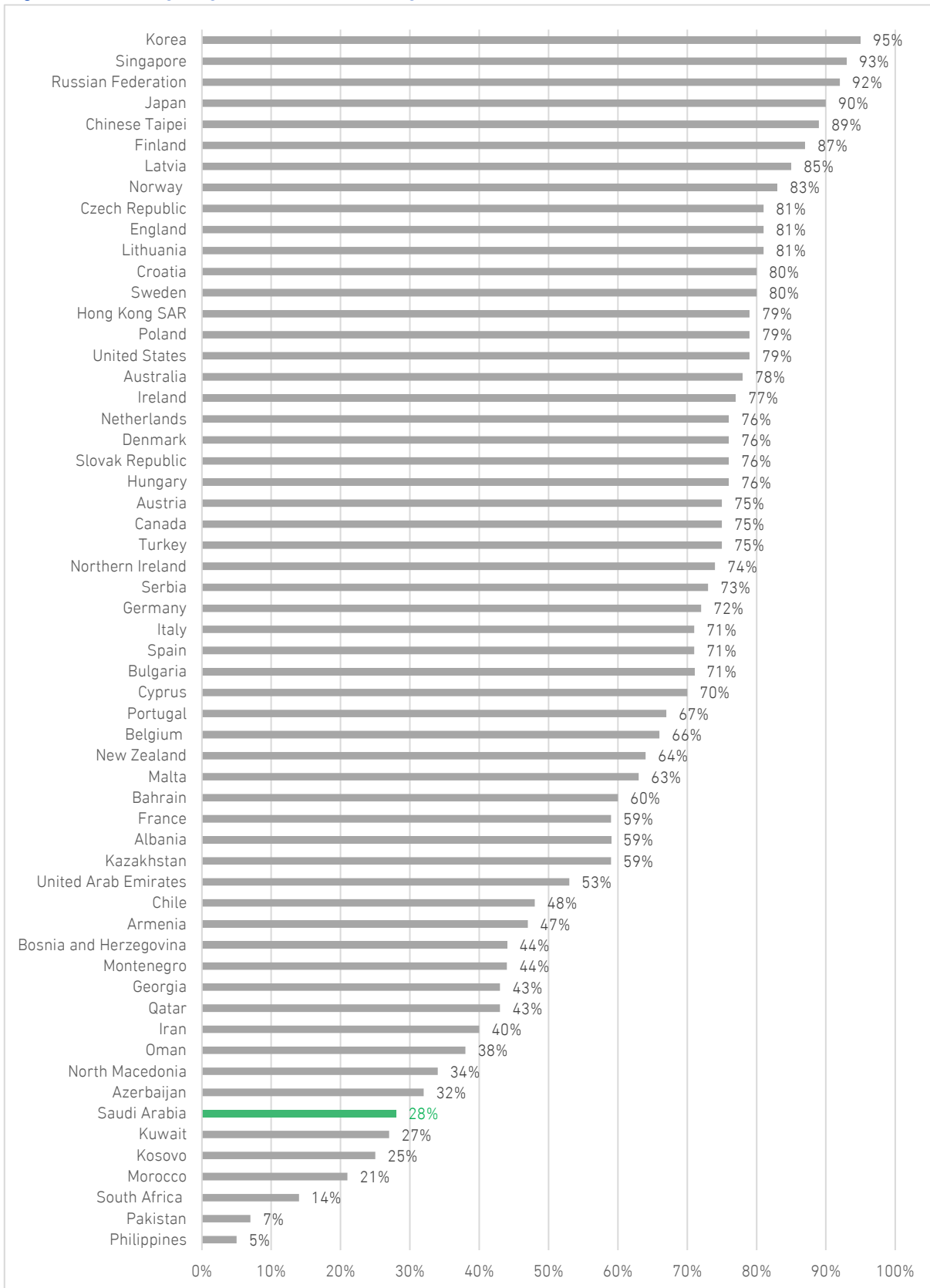
SOURCE: Exhibit 2.8: Percentages of Students Reaching International Benchmarks of Science Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

The fourth-graders, who achieved the Intermediate Benchmark in science, show knowledge and understanding of some aspects of science. These are students who scored 475 points or higher on the TIMSS scale. They demonstrate some basic knowledge of plants and animals. They also demonstrate knowledge about some properties of matter and some facts related to electricity and can apply elementary

knowledge of forces and motion. In addition, those students show some understanding of Earth's physical characteristics.

At the top of the list are placed Korea, Singapore, Russian Federation, and Japan (see **Figure 2.8**). In those countries at least 90% of students master science knowledge at this level in grade 4. Only in 17 countries that participated in the TIMSS 2019 4<sup>th</sup> grade science assessment, less than a half of the students reached this science benchmark.

In Saudi Arabia, only 28% of students reach the Intermediate International benchmark. Worse results were observed only in Kuwait, Kosovo, Morocco, South Africa, Pakistan, and the Philippines.

**Figure 2.8** Percentage of grade 4 students reaching the Intermediate International Benchmark in science.

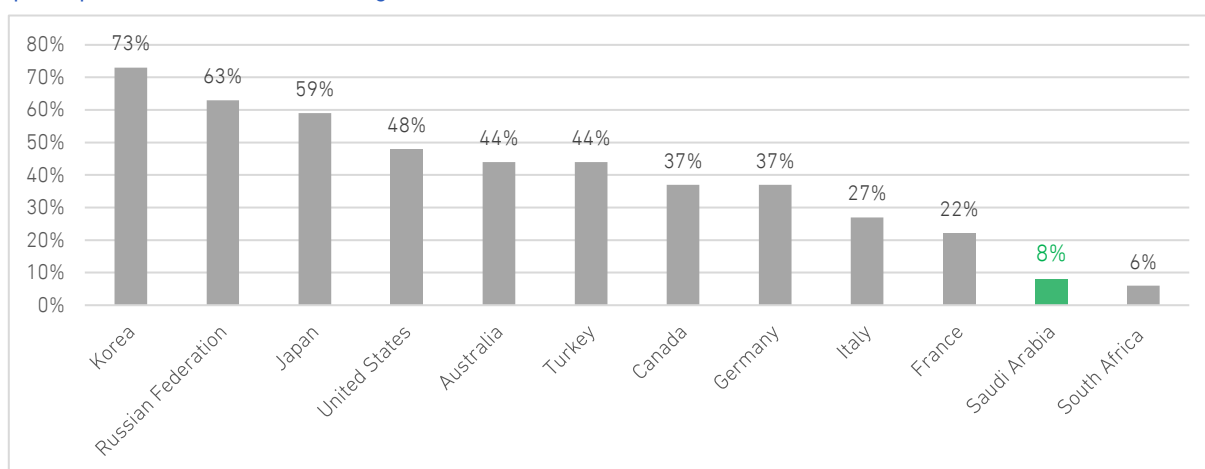
SOURCE: Exhibit 2.8: Percentages of Students Reaching International Benchmarks of Science Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.



The High International Benchmark can be reached by students who communicate and apply knowledge of life, physical, and Earth sciences. The fourth-graders should be able to communicate knowledge of characteristics of plants, animals, and their life cycles, and apply knowledge of ecosystems and of human' and organisms' interaction with their environment. Those who reach that level also demonstrate knowledge of states and properties of matter and energy transfer in practical contexts, they show some understanding of forces and motion. In addition, students reaching high benchmark know various facts about Earth's physical characteristics and understand the basics of the Earth-Moon-Sun system.

Among the G20 countries, the largest percent of students who reached this performance level was observed in Korea (73%). More than a half of 4<sup>th</sup> graders students that can solve tasks at this level was noticed in Russian Federation (63%), and Japan (59%). In the United States (48%), Australia (44%), Turkey (44%), Canada (37%), Germany (37%) more than third of students reach this level. Only between 22-27% of students reach this level in Italy and France, while less than 1 in 10 students perform at the High International Benchmark for 4th grade science in Saudi Arabia and South Africa.

**Figure 2.9** Percentage of students reaching the High International Benchmark in G20 countries that have participated in the TIMSS 2019 4th grade science assessment.



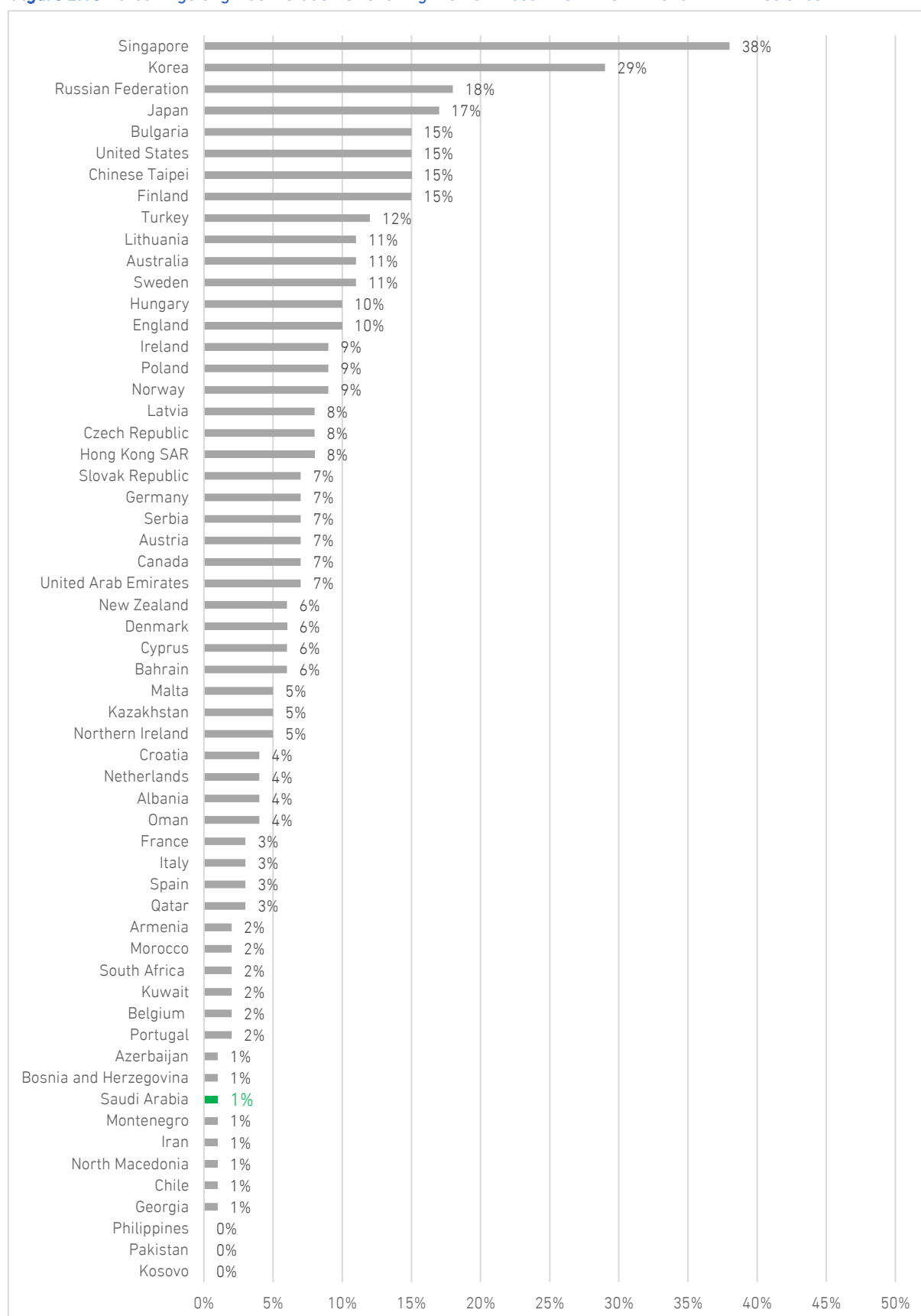
SOURCE: Exhibit 2.8: Percentages of Students Reaching International Benchmarks of Science Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

The advanced international benchmark can be reached by students who show the highest understanding of science knowledge at this age. They communicate their understanding of life, physical, and Earth sciences and demonstrate some knowledge of the process of science inquiry. Those who reached this benchmark know characteristics and life processes of variety of organisms. They understand relationships occurring in ecosystems, and interactions between organisms and their environment. They also are able to communicate their understanding of properties and states of matter, physical and chemical changes. Additionally, they recognize, and know Earth's physical characteristics, processes, and history. Those four-graders also show knowledge of Earth's revolution and rotation.

Only Singapore, and Korea stand out when it comes to number of students reaching the advanced international benchmark for 4<sup>th</sup> grade science (respectively 38%, and 29% of students). In the majority of the participating countries, less than 10% of students reach this benchmark. In Saudi Arabia, only 1% of students reach this high level of understanding of science. The same number has been observed in Azerbaijan, Bosnia and Hercegovina, Montenegro, Iran, North Macedonia, Chile, and Georgia. Approximately, 0% of students reach this level in the Philippines, Pakistan, and Kosovo.

Just as in mathematics assessment, it seems that lack of basic science knowledge at an early stage of education might be decisive for not acquiring decent science skills later in school. A significant number of students lack strong basis from early education, among other countries it is very noticeable in data acquired from Saudi Arabia.

**Figure 2.10** Percentage of grade 4 students reaching the Advanced International Benchmark in science.



SOURCE: Exhibit 2.8: Percentages of Students Reaching International Benchmarks of Science Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Trends in Percentages of Students Reaching International Benchmarks

By analyzing the short-term changes at high and advanced educational levels, there has been nearly the same number of increases and decreases in the percentage of students who exceeded those International Benchmarks. This dependency is noticeable for the period from 2015 to 2019. At the same time, most of the countries remained stable in their performance. The exact numbers are as follows (considering all four International Benchmarks).

Numbers of increases and decreases in different benchmarks among 44 countries taking part in both 2015 and 2019 assessments.

	Increase	Decrease	Difference
<b>Low</b>	9	6	+3
<b>Intermediate</b>	7	9	-2
<b>High</b>	8	7	+1
<b>Advanced</b>	5	5	0

Regarding the low Benchmark, the increase occurred in 9 countries – Kuwait (16% increase), Bahrain (12%), Armenia (10%), Iran (7%), Morocco (7%), United Arab Emirates (7%), **Saudi Arabia (6%)**, Cyprus (6%), Qatar (4%), while the decrease occurred in 6 countries – Belgium (4% decrease), Portugal (3%), Germany (3%), Hong Kong SAR (2%), Poland (2%), and the United States (1%).

In the intermediate Benchmark, the increase was noticed in 7 countries – Cyprus (14%), Bahrain (13%), Kuwait (12%), Armenia (9%), United Arab Emirates (7%), Iran (7%), Saudi Arabia (3%), while a decrease occurred in 9 countries – Hong Kong SAR (9% decrease), Hungary (8%), Belgium (7%), Germany (6%), Bulgaria (6%), Poland (6%), Portugal (5%), Chile (5%), Japan (3%), United States (2%).

In the high Benchmark, the rise in the percentage of students who exceeded it was observed in 8 countries – Cyprus (13%), Bahrain (9%), Kuwait (6%), Lithuania (6%), Australia (5%), United Arab Emirates (5%), Armenia (4%), and Iran (4%), while a decrease

occurred in 7 countries – Hong Kong SAR (14% decrease), Poland (9%), Hungary (8%), Croatia (7%), Japan (4%), Spain (4%), and Serbia (4%).

In the advance benchmark, 5 countries have their results increased – Cyprus (4% increase), Lithuania (4%), Australia (3%), Bahrain (2%), Kuwait (1%), while 5 countries as well have their results decreased – Hong Kong SAR (8% decrease), Hungary (4%), Poland (3%), Croatia (2%), and Spain (2%).

Numbers of increases and decreases in different benchmarks among 16 countries taking part in both 1995 and 2019 assessments.

	Increase	Decrease	Difference
<b>Low</b>	10	1	<b>+9</b>
<b>Intermediate</b>	11	2	<b>+9</b>
<b>High</b>	9	2	<b>+7</b>
<b>Advanced</b>	7	5	<b>+2</b>

An entirely different situation is noticed in the 16 countries that have participated in the assessment since 1995. Countries' performance usually improves or at least remain constant when it comes to long-term trends, with a small number of countries where performance decreases. Thus, it

can be said that the level of science education in the world is increasing. The exact numbers are as follows (considering all four International Benchmarks).

In the low benchmark, 10 countries reported an increase in their results – Portugal (difference of 20%), Iran (19%), Cyprus (18%), Singapore (9%), England (6%), Australia (5%), Hong Kong SAR (5%), Hungary (4%), Ireland (3%), and Czech Republic (2%). In the meantime, only one country has noted a decrease – the Netherlands, where the score has changed from 98% to 96%, creating a difference of 2%. However, this is a relatively small result compared to Portugal, where the difference between these 24 years was 20%. Therefore, the overall long-term trend is that the educational performance in this benchmark improves or remains stable.

In the intermediate benchmark, the increase was noticed in 11 countries – Cyprus (31% rise), Iran (25%), Portugal (24%), Singapore (22%), Hong Kong SAR (10%), England (9%), Hungary (9%), Ireland (7%), Australia (6%), Czech Republic (4%), and Japan (3%) while a decrease occurred in 2 countries – Netherlands (decreased by 6%) and Austria (4%).

In the high benchmark, an increase occurred in 9 countries – Singapore (32% rise), Cyprus (20%), Portugal (13%), Hong Kong SAR (11%), Hungary (10%), Iran (10%), Korea (6%), Ireland (5%), and Japan (5%), while a decrease occurred in Austria (7%) and the New Zealand (5%).

Lastly, in the advance benchmark, 7 countries have their results increased – Singapore (24% rise), Korea (7%), Cyprus (5%), Hungary (3%), Hong Kong SAR (3%), Japan (2%), and Iran (1%), while 5 countries have their results decreased – Austria (decreased by 6%), New Zealand (5%), England (5%), United States (4%), and Czech Republic (4%).

**Percentages of Saudi Students Reaching International Benchmarks of Science Achievement Across Assessment Years**

	2011	2015	2019
<b>High</b>	12%	8%	8%
<b>Advanced</b>	3%	1%	1%

By analyzing changes in data from Saudi Arabia, it can be noticed that from 2011 to 2019, the percentage of students who exceeded the Advanced International Benchmark for Science dropped from 3 to 1 percent. The same tendency was observed for the High International Benchmark, accordingly

from 12 to 8 percent. Besides, the decrease was also noticed for both Intermediate and Low Benchmark. In the intermediate benchmark, the value in 2011 was 35 %, in 2015 – 25 %, and 2019 – 28%. Overall, in eight years, it dropped by 7 %. Meanwhile, in the low

benchmark, in 2011, the value was 63%, in 2015 – 48%, and 2019 – 54%, so in that specific period, it decreased by 9%.

It is also worth mentioning that, despite lower results achieved in 2019 compared to 2011, in the most recent period, there were increases or stability in the percentage of students exceeding all of previously mentioned International Benchmarks. To be exact: in advanced level (from 1% to 1%), in high level (from 8% to 8%), in intermediate level (from 25% to 28%), and in low level (from 48% to 54%).

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## **Chapter 3**

### **Mathematics in Grade 8**

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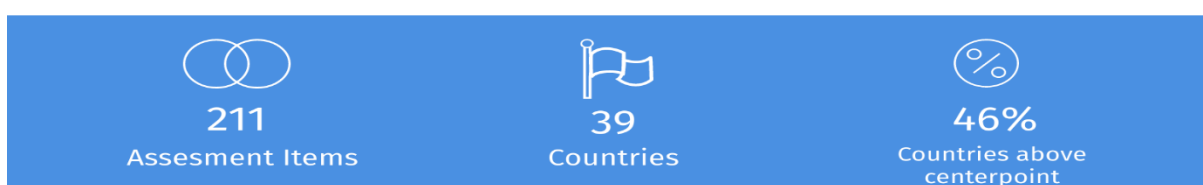


## Mathematics in Grade 8

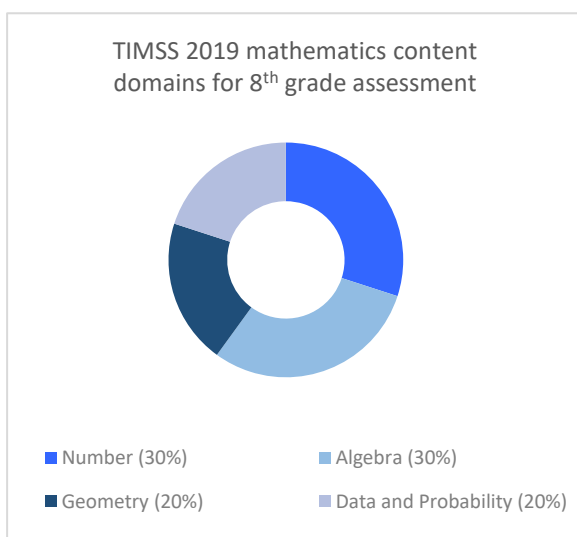
### TIMSS 2019 8<sup>th</sup> grade mathematics assessment

The TIMSS 2019 assessment in mathematics was created also for eighth grade students. This edition of the TIMSS assessment covers different mathematic domains, which framework was created with the participating countries to show their students' proficiency level and evaluate the level of their educational curriculum. A total of 211 items were created to measure mathematical knowledge in different mathematics areas and evaluate participating in the study countries accurately.

#### G8 Mathematics



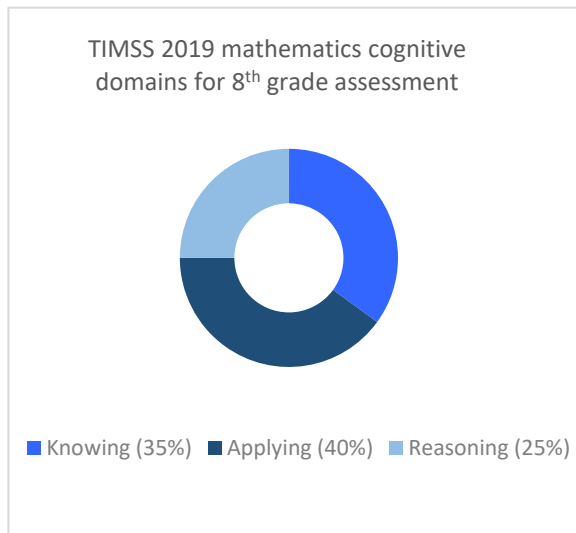
The 2019 TIMSS assessment of mathematics in the 8th grade are divided into four main categories of tasks:



- Number – 30% (e.g., ratio, proportion, integers and fraction, decimals, etc.);
- Algebra – 30% (e.g., relationships and functions, expressions, operations, equations, etc.);
- Geometry – 20% (e.g., analyzing properties, calculating perimeters, areas, and volumes, using geometric relationships, etc.);
- and Data, and Probability – 20% (e.g.,

probability concepts, reading and extracting important meaning, data distribution, etc.).

In addition to the content domain division, the assessment was divided into tasks which inspect three different cognitive skills: knowing, applying, and reasoning. Thus, assessment items devoted to cognitive domains were divided into:



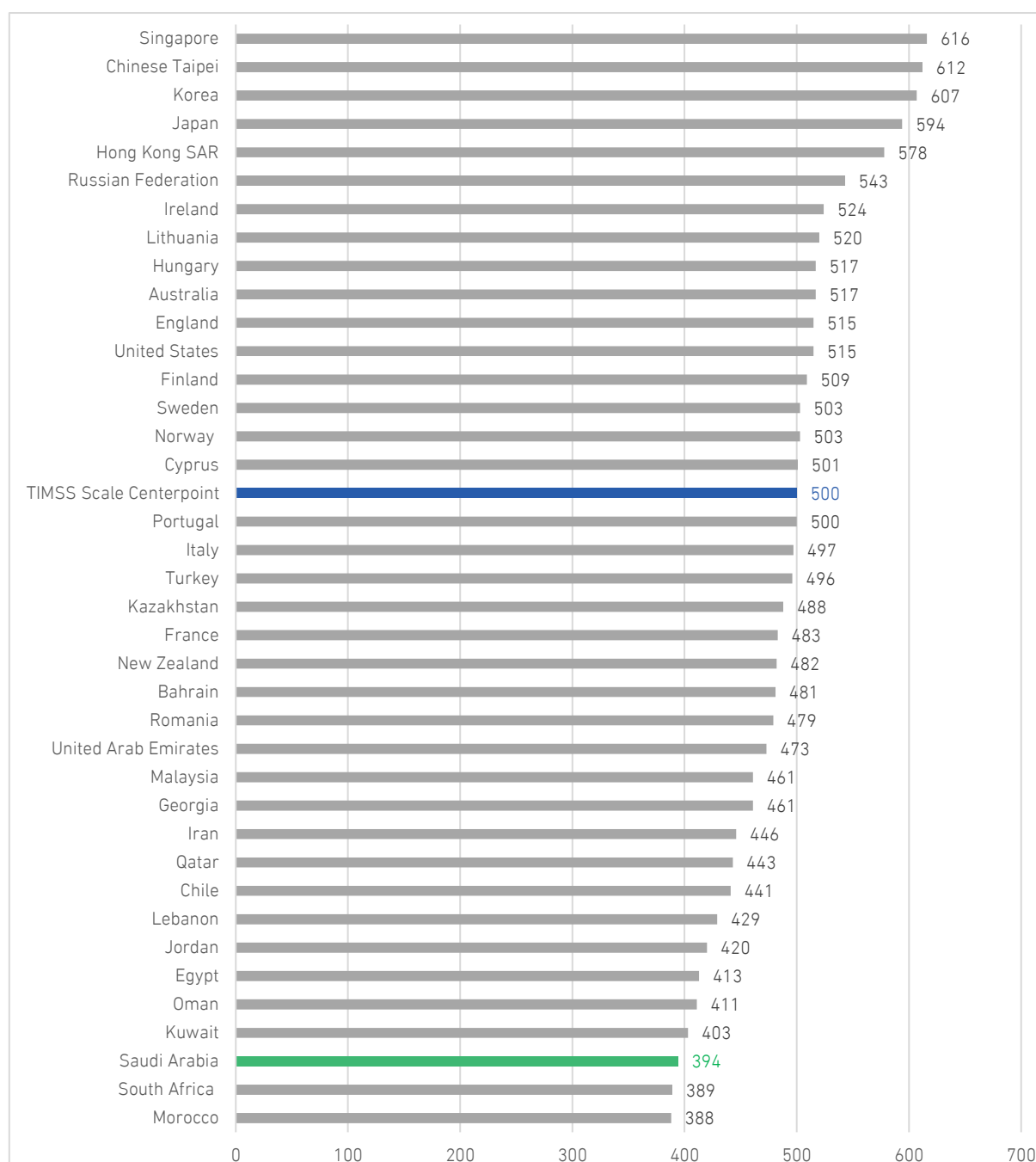
- knowing (35% of tasks, which cover the facts, concepts, and procedures students need to know);
- applying (40% of tasks covering students' ability to apply knowledge and conceptual understanding to solve problems or answer questions);
- and reasoning (25% of test items, which encompass unfamiliar situations, complex contexts, and multistep problems).

Overall, there were 211 assessment items (questions) used in the TIMSS 2019 assessment of 8<sup>th</sup> grade mathematics, which assures that the tests covered all areas of mathematics, which is internationally taught at this stage of education.

### Average mathematics achievement of 8<sup>th</sup> grade students

Figure 3.1 shows the average achievement in mathematics for students in the 8<sup>th</sup> grade. Countries are sorted by the highest average mathematics achievement obtain by their students. The results can be compared to the TIMSS centerpoint, which is estimated as 500 points, less than a half of participating countries scored on average above this mark (43% have mean score above 500). Portugal has reported average scale score at the exact same level as TIMSS centerpoint (including this country that percentage parameter is 46%).

**Figure 3.1 Average mathematics achievement of 8th grade students among TIMSS 2019 participants.**



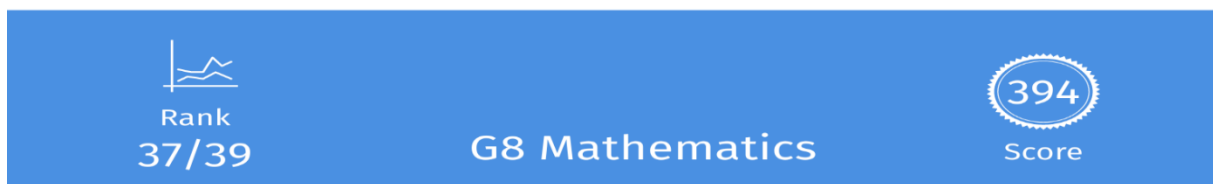
SOURCE: Exhibit 3.1: Average Mathematics Achievement and Scale Score Distributions. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

In comparison to the 4<sup>th</sup> grade assessment, fewer countries have participated in the 8<sup>th</sup> grade assessment. Among all 39 participants of the grade 8 TIMSS mathematics assessments in 2019, 18 countries had higher, or the same average achievements as the TIMSS Scale centerpoint. Singapore leads with an average result of 616 points, followed by Chinese Taipei (612), Korea (607), Japan (594), and Hong Kong SAR (578). It

is worth noticing that all the countries are from the same region, East Asia. The lowest scores were observed in Morocco (388), South Africa (389), Saudi Arabia (394), Kuwait (403), and Oman (411).

As shown in Figure 3.1, Saudi Arabia was placed on 37<sup>th</sup> position among the participating countries. The average mathematics performance in Saudi Arabia of the 8<sup>th</sup> grade students was calculated as 394 points (with a standard error of the mean equal to 2.5). This value is significantly lower than the centerpoint of the TIMSS scale, Saudi Arabia average score was over 100 points below the centerpoint (they were placed on the higher position than only South Africa, and Morocco).

### Saudi Arabia

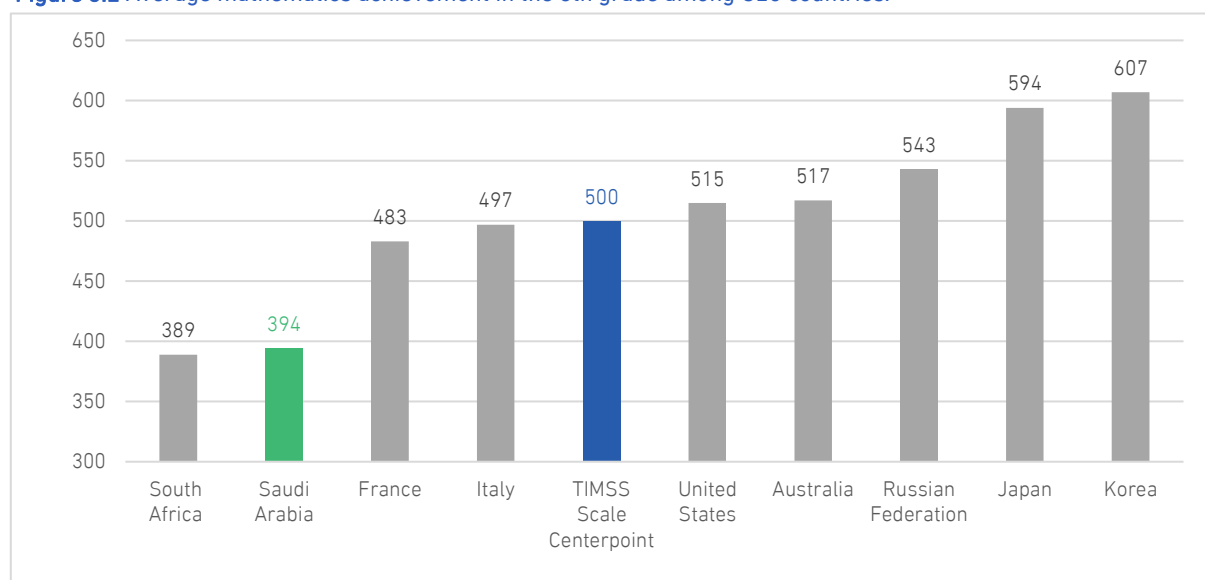


The average achievement in each country can be also compared in terms of the significance of the existing differences. Countries might have slightly different average score, but statistically their performance might be similar if the confidence intervals for their results overlap. In view of this, the average results for Saudi Arabia were not greater than any of the other participants. Comparable to Saudi Arabia score was those achieved by students from Kuwait, South Africa, and Morocco. In comparison to the remaining countries, Saudi Arabia students achieved a significantly lower average mathematics result.

Taking into account the achievement of G20 countries, mathematics results of the eighth graders can be compared to only 10 countries that participated in TIMSS 2019 assessment (in comparison to assessment of the fourth graders, this list do not include Canada, and Germany). On average, highest scores were achieved by students from

Korea (607), Japan (594), and Russian Federation (543). In this specific ranking, Saudi Arabia (394) took penultimate position. Saudi Arabia scored only slightly higher than South Africa, by 5 points.

**Figure 3.2** Average mathematics achievement in the 8th grade among G20 countries.



SOURCE: Exhibit 3.1: Average Mathematics Achievement and Scale Score Distributions. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

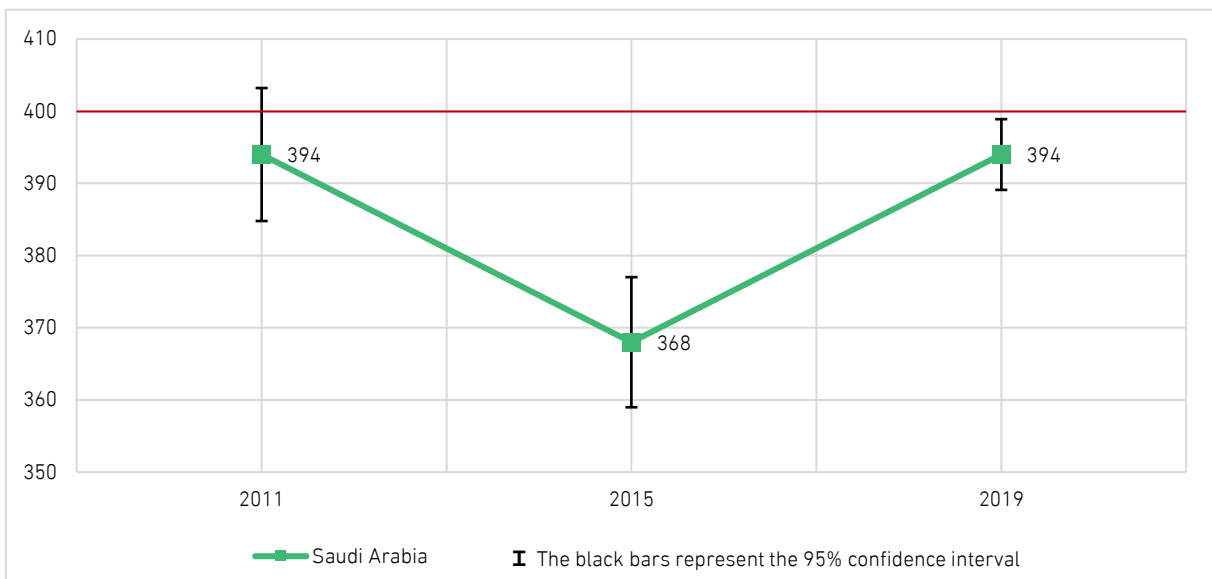
### Trends in student achievement in grade 8 mathematics

Country performance in mathematic can be compared based on trend plots of average mathematics achievement across assessment years in countries with comparable data from previous assessment editions. The trends in mathematics achievement at the eighth-grade level signal more improvements than downturns across the assessment cycles internationally.

**Figure 3.3** shows the average mathematics achievement across TIMSS assessment obtained in Saudi Arabia, which participated in the study since 2011. In 2011, Saudi Arabia scored an average result of 394 points. A considerable decline (by 26 points) was reported from 2011 to 2015. During the recent period 2015-2019, there has been an increase (by 26 points) to the same level as noticed in 2011. Thus, from the statistical point of view, the average mathematics results in TIMSS 2019 and 2011

editions are just the same – 394 points, while the results in 2015 were 26 points lower – 368 points. Therefore, it is impossible to indicate a long-term upward or downward trend in the results for Saudi Arabia. However, based only on recent changes, one might suspect that there will be further increase in level of mathematics knowledge among Saudi Arabia eighth graders.

**Figure 3.3** Changes in the 8th grade student average mathematics achievement across TIMSS assessments in Saudi Arabia.



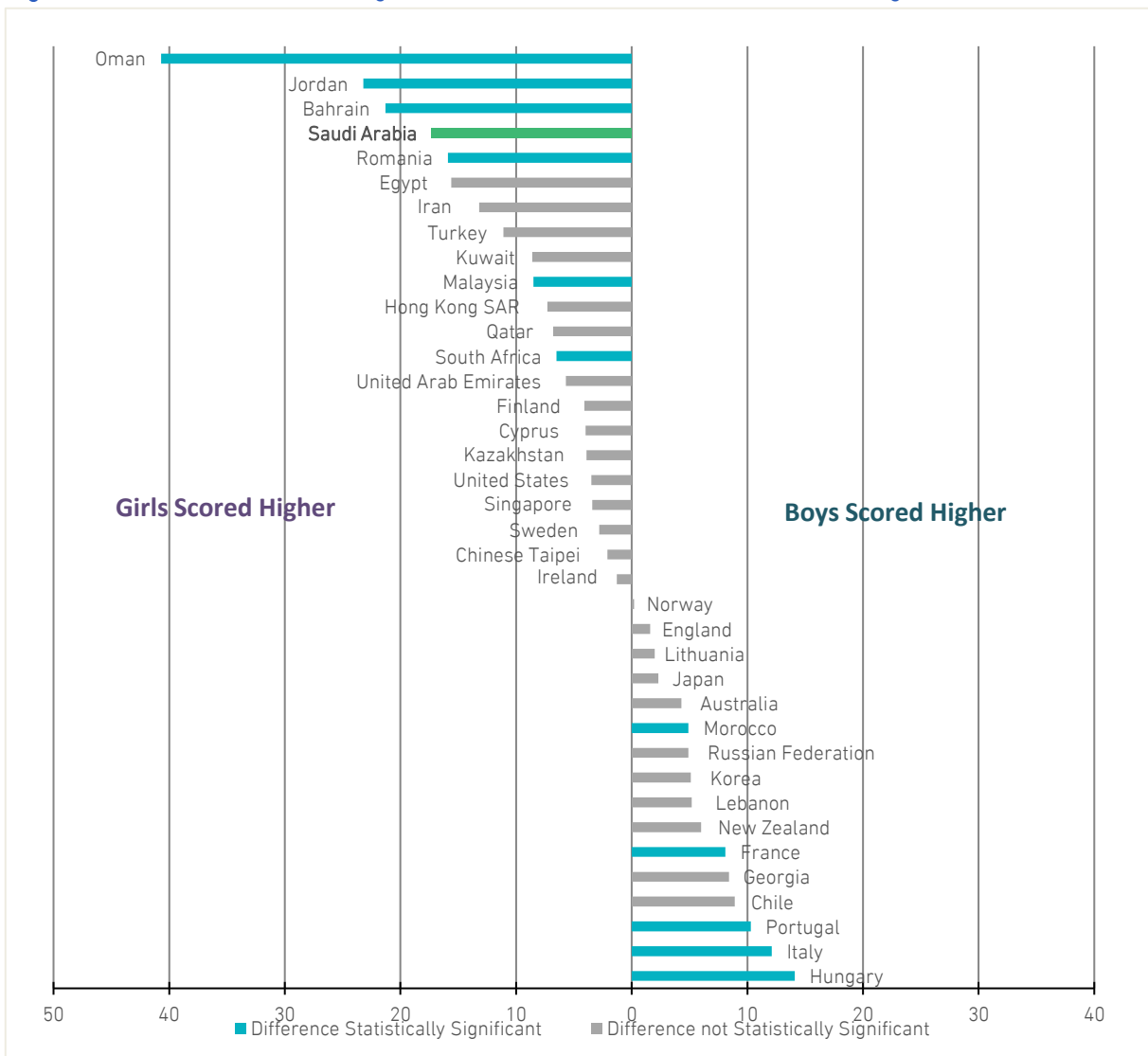
SOURCE: Exhibit 3.3: Trend Plots of Average Mathematics Achievement Across Assessment Years. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

### Average Achievement by Gender

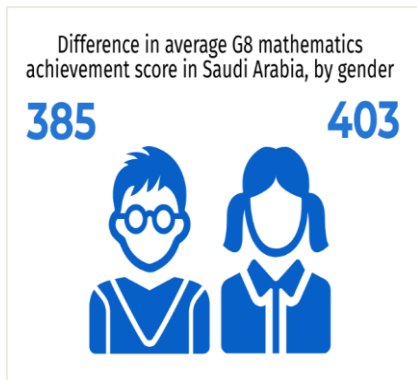
Figure 3.4 shows the difference between the average mathematical achievement among girls and boys in the eighth grade (mean score of girls minus mean score of boys). The list of participating in the assessment countries starts with the participants in which, on average, girls scored much higher than boys. Girls had the highest score advantage over boys in Oman, where they achieved higher achievement by 40.7 points. On the other hand, countries situated at the bottom of the list are characterized by significantly higher average results achieved by boys. The largest gender gap in favor of boys was observed in Hungary (14.1 points).

Looking at **Figure 3.4**, one can notice that, boys had significantly higher average achievement than girls in 5 countries (Hungary, Italy, Portugal, France, and Morocco). Girls achieved significantly higher average achievement than boys in 7 countries (Oman, Jordan, Bahrain, Saudi Arabia, Romania, Egypt, and Iran). Considering all participating countries, the international average was estimated to be 491 points for boys and 488 points for girls.

**Figure 3.4** Gender difference in average mathematics achievement for students in the 8th grade.



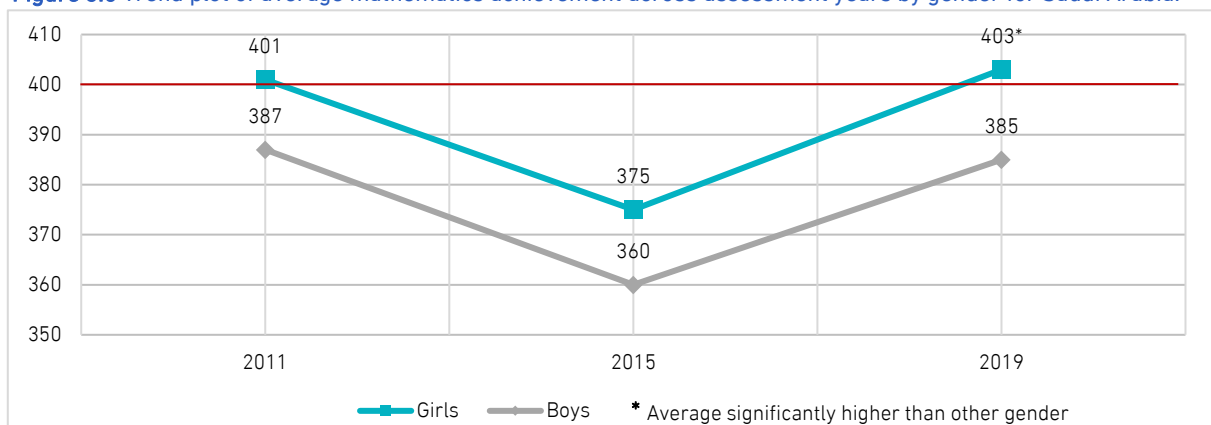
SOURCE: Exhibit 3.5: Average Mathematics Achievement by Gender. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.



In Saudi Arabia, girls scored about 18 points significantly higher than boys. This difference is much lower when compared to the gender achievement gap in the fourth-grade assessment. It placed Saudi Arabia at the 4<sup>th</sup> place on the list

Figure 3.5 shows trends in average mathematics achievement across assessment years for boys and girls in Saudi Arabia. One can see that the difference between boys and girls remain relatively stable over time, in all conducted assessment girls scored higher than boys. (14 points more than boys in 2011, 15 in 2015, and 18 in 2019). In comparison to 4<sup>th</sup> grade mathematics assessment, the gender gap was much smaller in all these years. The results declined for both genders from 2011 to 2015, which was followed by an increase between 2015 and 2019 to the similar average score that was reported in 2011. The exact numbers are: 2011 – 401 points, 2015 – 375 points, 2019 – 403 points for girls, and 2011 – 387 points, 2015 – 360 points, 2019 – 385 points for boys. In none of the conducted editions o TIMSS 2019 study, Saudi Arabia' eighth graders of both genders did manage to exceed the international centerpoint. In TIMSS 2019 boys achieved lower result by 115 points, and girls by 97 points.

**Figure 3.5** Trend plot of average mathematics achievement across assessment years by gender for Saudi Arabia.

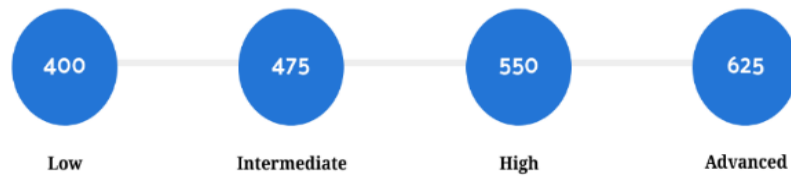


Source: Exhibit 3.6: Trend Plots of Average Mathematics Achievement Across Assessment Years by Gender. IEA's Trends in International Mathematics and Science Study – TIMSS 2019. Downloaded from <http://timss2019.org/download>.



## Performance at TIMSS International Benchmarks for Grade 8 Mathematics

### International Benchmarks



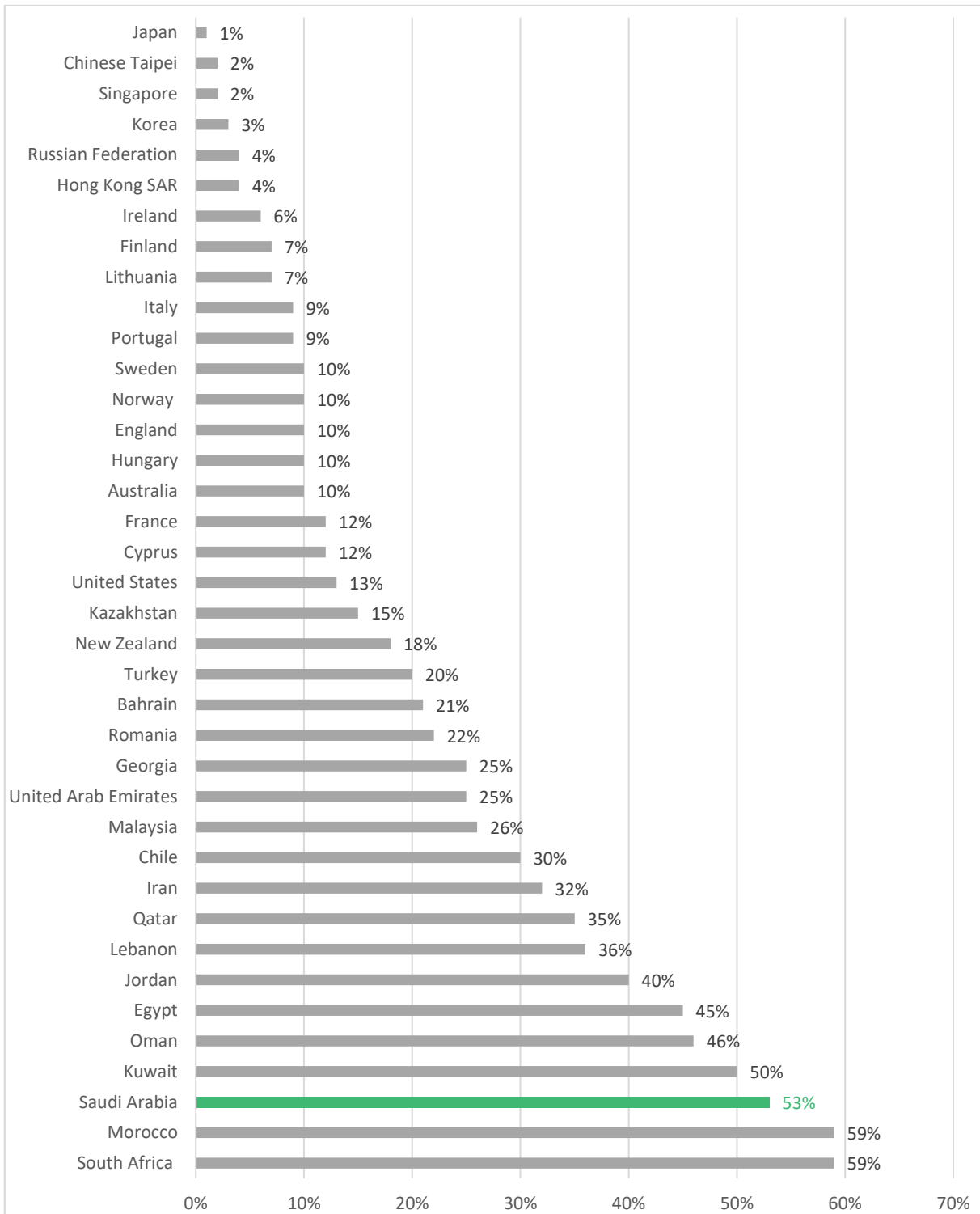
TIMSS 2019 also compares student achievement in the assessment for eighth graders using four international benchmarks which reflect both student knowledge and educational skills. In order to easily interpret student mathematics TIMSS result, TIMSS created four points International Benchmarks: Advanced International Benchmark (625), High International Benchmark (550), Intermediate International Benchmark (475), and Low International Benchmark (400).

Students reaching the Low International Benchmark have some knowledge of whole numbers and basic graphs. At the intermediate level they can apply basic mathematical knowledge in variety of situations. Students exceeding high benchmark can apply their understanding and knowledge in a variety of relatively complex situations. At the highest (Advanced) level, the student can apply and reason in a variety of problems situations, solve linear equations, and make generalizations. Students reaching higher benchmark levels can solve more difficult problems in different areas of mathematics, such as algebra, geometry, probability, data, and number equations.

**Figure 3.6** illustrates that more than a half of participating in the TIMSS 2019 assessment countries, had more than 10% of 8<sup>th</sup> grade students who do not reach basic level of mathematical knowledge. Lowest percent of such students was observed in Japan, Chinese Taipei, Singapore, and Korea, where only 3% of eighth-graders or less do not reach this level. Saudi Arabia (53%) was placed on the third from the end position,

they had slightly less students who was not able to solve item tasks representing the lowest level of mathematics knowledge than Morocco (59%), and South Africa (59%).

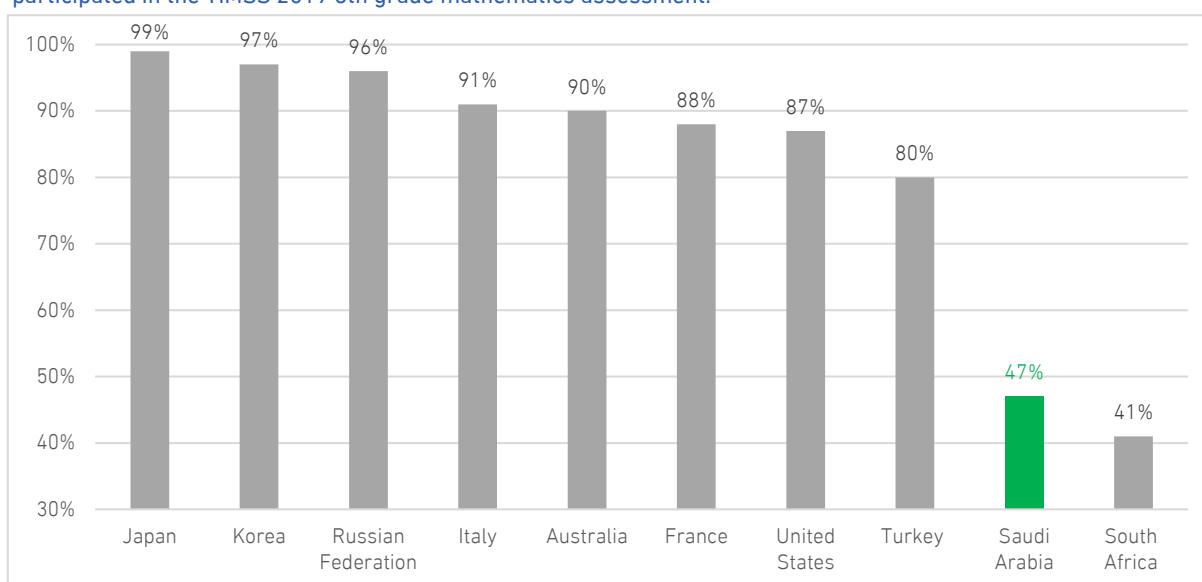
**Figure 3.6** Share of grade 8 students not reaching the Low International Benchmark in mathematics.



SOURCE: Exhibit 3.8: Percentages of Students Reaching International Benchmarks of Mathematics Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 3.7** shows that the majority of the eighth graders in nearly all of G20 countries reached the Low International Benchmark. In the mathematics 8 grade assessment, nearly all the students in Japan, Korea, and Russian Federation had acquired basic mathematical knowledge. The low achievement level was not reached by 20%, or less students in the following countries: Italy, Australia, France, United States, and Turkey. Biggest number of eight graders who did not exceeded this benchmark point was observed in Saudi Arabia, and South Africa, respectively 53% and 59% of students not reaching this basic level.

**Figure 3.7** Percentage of students reaching the Low International Benchmark in G20 countries that have participated in the TIMSS 2019 8th grade mathematics assessment.

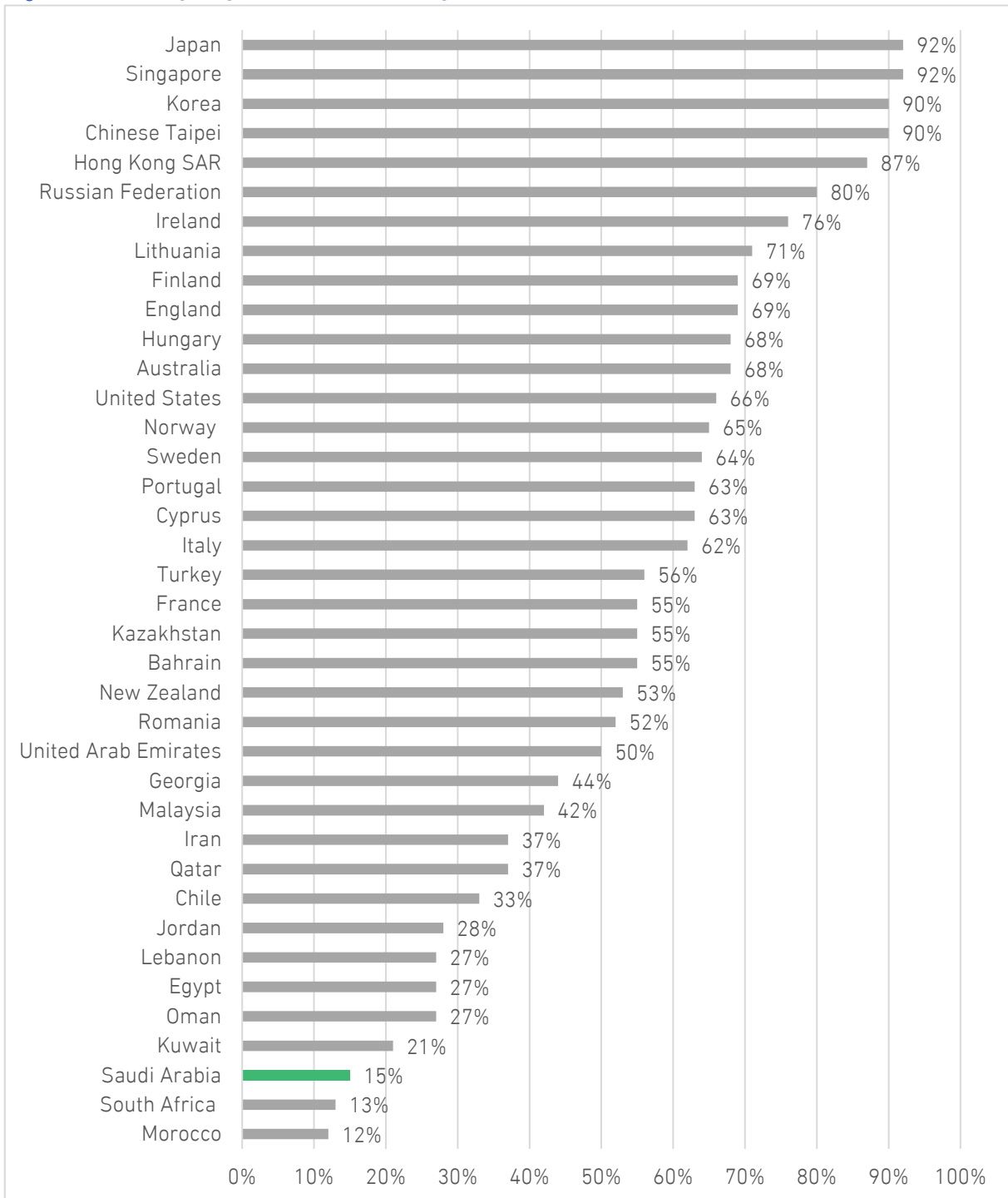


SOURCE: Exhibit 3.8: Percentages of Students Reaching International Benchmarks of Mathematics Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Eighth-graders reaching the Intermediate Benchmark can solve problems involving whole numbers, negative numbers, fractions, decimals, and ratios. These are students who perform at 475 points or higher on the TIMSS scale. They have some basic knowledge about properties of two-dimensional shapes. In addition, those students can read and interpret data in graphs, and have some rudimentary knowledge of probability. Based on **Figure 3.8**, the best results were observed in five Asian countries: Japan, Singapore, Korea, Chinese Taipei, and Hong Kong SAR, at least 87% of their students

reach the Intermediate Benchmark. In majority of countries participating in the TIMSS 2019 8th grade mathematics assessment, at least half of the students possess mathematics skills at this level.

**Figure 3.8** Percentage of grade 8 students reaching the Intermediate International Benchmark in mathematics.



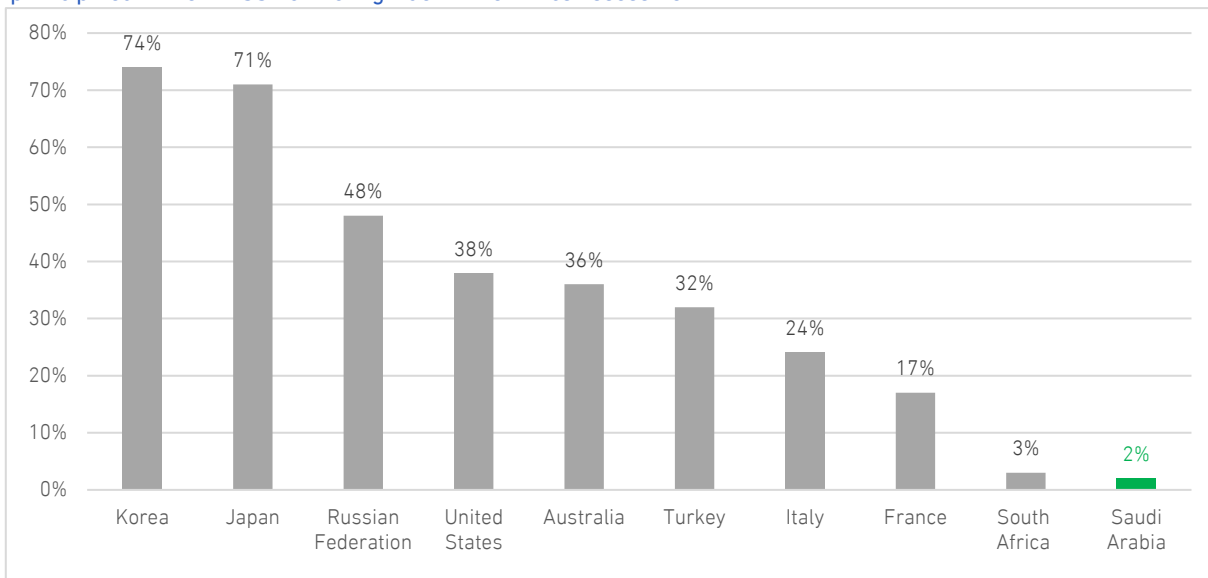
SOURCE: Exhibit 3.8: Percentages of Students Reaching International Benchmarks of Mathematics Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>

In Saudi Arabia, only 15% of students reach the Intermediate International benchmark. With that score Saudi Arabia was placed higher only than South Africa (13%), and Morocco (12%).

The High International Benchmark can be reached by students who mastered mathematics knowledge and can apply it in a variety of relatively complex situations. Those eighth-graders can solve problems with fractions, decimals, ratios, and proportion. Students at this level show basic procedural knowledge related to algebraic expressions and equations. They are able to solve a variety of mathematical problems with angles, including problems involving triangles, parallel lines, rectangles, congruent, and similar figures. Additionally, they can interpret data in a variety of graphs and solve simple problems involving outcomes and probabilities. Students performing at 550 score or higher on the TIMSS scale are classified as reaching this level.

Among the G20 countries, the best student performance was noticed in Korea (74%), and Japan (71%). In the remaining countries, a lot less 8<sup>th</sup> grade students reach this benchmark. In Russian Federation, United States, Australia, and Turkey something between 30 and 50% of students can possess mathematics knowledge at this level. In Italy and France, this level was reached by only 24%, and 17% of students while in Saudi Arabia and South Africa less than 1 in 30 students perform at the High International Benchmark for 8<sup>th</sup> grade mathematics. In this specific ranking, Saudi Arabia was situated on the last position

**Figure 3.9** Percentage of students reaching the High International Benchmark in G20 countries that have participated in the TIMSS 2019 8th grade mathematics assessment.



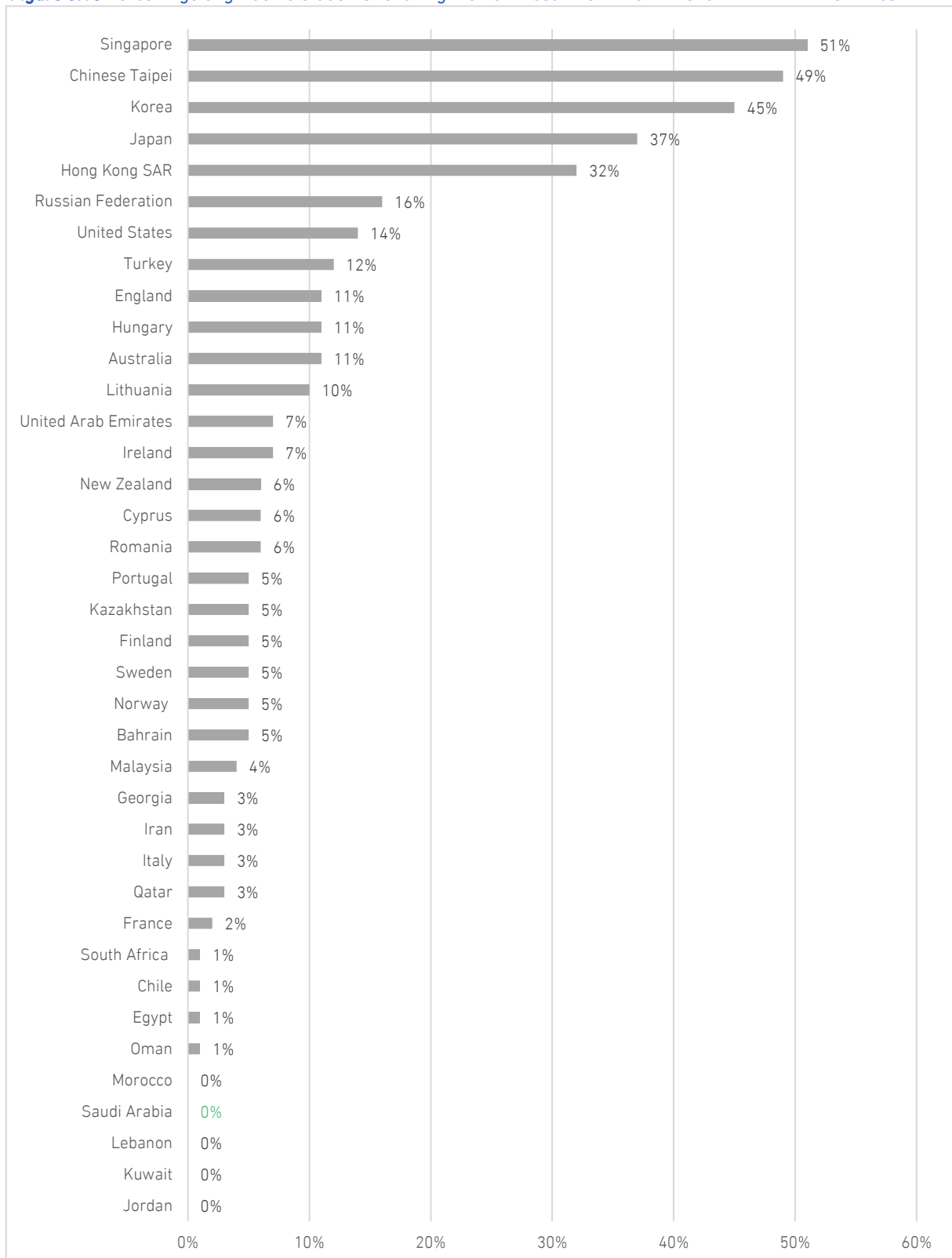
SOURCE: Exhibit 3.8: Percentages of Students Reaching International Benchmarks of Mathematics Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

The advanced international benchmark can be reached by students who at this age show the highest understanding of mathematics knowledge. At this level, students can solve tasks and explain their reasoning for relatively complex problems and in a variety of contexts. They can solve a variety of mathematical issues in fraction, proportion, and even justify their conclusions. They understand linear functions, algebraic expressions, and usage of geometric figures to solve a wide range of problems involving angles, area, and surface area. They are proficient in calculating means and medians, also can interpret a wide variety of data displays, and solve multistep problems. Additionally, student who reached this level can solve mathematical problems involving expected values. It is worth mentioning that even in the best performing countries many students cannot reach this demanding benchmark.

The best mathematical performance was recorded in Singapore (51%), Chinese Taipei (49%), and Korea (45%). In other two Asian countries, Japan and Hong Kong SAR, more than 30% of students reach this benchmark. For the remaining participants, those

numbers were considerably lower. In Saudi Arabia, approximately 0% of students reach this level in grade 8. The same number of students reaching this level was reported in Morocco, Lebanon, Kuwait, and Jordan.

By comparing mathematical results in both 4<sup>th</sup>, and 8<sup>th</sup> grade assessment, it is clear that the lack of basic mathematics knowledge at an early stage of education might be decisive for not acquiring decent mathematics skills later in school. By observing data from countries who participated in both 4<sup>th</sup> and 8<sup>th</sup> grade assessments, it can be concluded that students who finish early education without mastering even basic knowledge of mathematics, probably will encounter learning problems in higher grades. In addition, the best-performing countries in the 8<sup>th</sup> grade assessment have also obtained top ranking results in the fourth-grade tests.

**Figure 3.10** Percentage of grade 8 students reaching the Advanced International Benchmark in mathematics.

SOURCE: Exhibit 3.8: Percentages of Students Reaching International Benchmarks of Mathematics Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.



## Trends in Percentages of Students Reaching International Benchmarks

Unlike the fourth grade, in the recent period 2015-2019 and at high and advanced educational levels, there has been considerably more increases than decreases in the percentage of students who exceeded those International Benchmarks. The same tendency was observed in low, and intermediate benchmarks. At the same time (from 2015 to 2019), most of the countries remained stable in their performance. The exact numbers are as follows (considering all four International Benchmarks).

Numbers of increases and decreases in different benchmarks among 33 countries taking part in both 2015 and 2019 assessments.

	Increase	Decrease	Difference
Low	10	4	+6
Intermediate	10	6	+4
High	7	3	+4
Advanced	9	0	+9

In regard to the low Benchmark, the increase was noticed in 10 countries – Jordan (15% increase), Saudi Arabia (13%), Turkey (10%), Egypt (8%), Chile (7%), South Africa (7%), Iran (5%), Bahrain (4%), Chinese Taipei (1%), Japan (1%), while the decrease occurred in 4 countries – Lebanon (7% decrease),

Norway (4%), United States (4%), and Korea (2%).

In the intermediate Benchmark, the increase was observed in 10 countries – Bahrain (by 16%), Turkey (14%), Jordan (10%), Egypt (6%), Chile (5%), Saudi Arabia (4%), United Arab Emirates (4%), Oman (4%), Japan (3%), and Chinese Taipei (2%), while the decrease occurred in 6 countries – Lebanon (8%), Hong Kong SAR (5%), New Zealand (5%), Norway (5%), Korea (3%), and Morocco (2%).

In the high Benchmark, the rise in the percentage of students who exceeded it was observed in 7 countries – Bahrain (13% increase), Turkey (12%), Australia (6%), United Arab Emirates (4%), Japan (4%), Chinese Taipei (3%), Jordan (3%), while a decrease occurred in 3 countries – Hong Kong SAR (9%), New Zealand (5%), and Lebanon (3%).

Numbers of increases and decreases in different benchmarks among 18 countries taking part in both 1995 and 2019 assessments.

	Increase	Decrease	Difference
Low	5	5	0
Intermediate	6	5	+1
High	9	4	+5
Advanced	13	2	+11

Lastly, in the advance benchmark, 9 countries have their results increased – Turkey (6% increase), Chinese Taipei (5%), United States (4%), Australia (4%), Lithuania (4%), Bahrain (3%), United Arab Emirates (2%), Sweden (2%), and Malaysia (1%). In none of the countries was observed a decrease in

results.

The same tendencies in high and advanced benchmarks were observed in longer period (since 1995). Countries' performance at that levels usually improves or at least remain constant when it comes to long-term trends. However, this does not apply to low and intermediate benchmarks, for those marks similar number of increases, and decreases was noticed. Still, it can be said that the numbers of students with high level of mathematics knowledge is increasing. The exact numbers are as follows (considering all four International Benchmarks).

In the low Benchmark, 5 countries noted an increase in their results – Portugal (difference of 12%), Lithuania (12%), Cyprus (11%), Iran (9%), and Russian Federation (3%). The same number of countries observed a decrease – France (decrease by 9%), New Zealand (7%), Sweden (6%), Hungary (4%), and Singapore (2%).

In the intermediate Benchmark, the increase was noticed in 6 countries – Portugal (28% rise), Lithuania (21%), Iran (13%), Cyprus (12%), England (8%), and Russian Federation (7%), while a decrease occurred in 5 countries – France (decreased by 26%), Sweden (17%), New Zealand (11%), Singapore (6%), and Hungary (6%).

In the high Benchmark, an increase occurred in 9 countries – Lithuania (20% rise), Portugal (18%), United States (12%), Russian Federation (10%), Cyprus (10%), Iran (10%), England (8%), Korea (7%), and Japan (4%), while a decrease occurred in 4 countries – France (21%), Sweden (18%), New Zealand (6%), and Singapore (5%).

Lastly, in the advance benchmark, 13 countries have their results increased – Korea (14% rise), Singapore (11%), United States (10%), Hong Kong SAR (9%), Lithuania (8%), Japan (8%), Russian Federation (7%), England (5%), Australia (4%), Portugal (4%), Cyprus (3%), Iran (3%), and Romania (2%), while a decrease was observed in Sweden (7%), and France (4%).

Percentages of Saudi Arabia Students Reaching International Benchmarks of Mathematics Achievement Across Assessment Years

	2011	2015	2019
High	5%	2%	2%
Advanced	1%	0%	0%

Looking at the data from Saudi Arabia, it can be seen that from 2011 to 2019, the percentage of students who exceeded the Advanced International Benchmark for eighth grade mathematics dropped from 1 to 0 percent. The same trend was observed for the High

International Benchmark, correspondingly from 5 to 2 percent. When it comes to Intermediate Benchmark, the value in 2011 was 20 %, in 2015 – 11 %, and 2019 – 15%. Overall, in eight years, it dropped by 5 %. Meanwhile, in the low Benchmark it dropped by 13%, and then returned to previous level (2011 - 47%, 2015 – 34%, 2019 – 47%).

Despite the negative change in the mathematics results that occurred from 2011 to 2019, comparing results only in TIMSS 2019, and TIMSS 2015, students from Saudi Arabia have improved considering two lowest benchmarks (at intermediate benchmark by 4%, and at low benchmark by 13%). Meanwhile, the number of the students reaching high and advanced benchmarks remain stable

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## **Chapter 4**

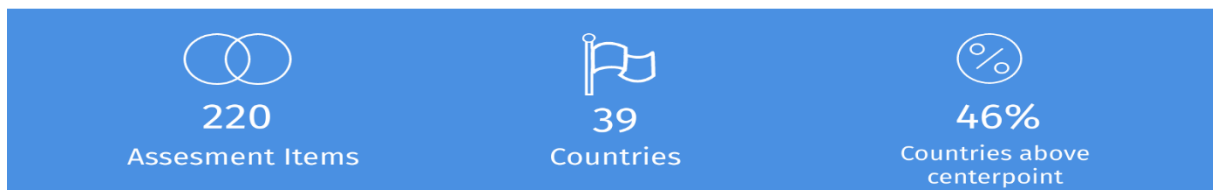
### **Science in Grade 8**

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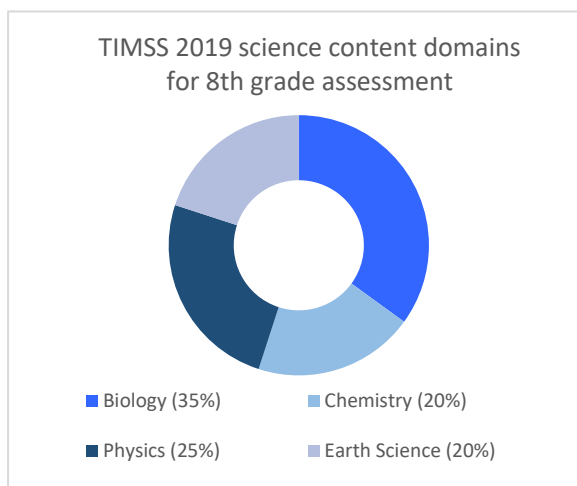
## Science in Grade 8 TIMSS 2019 8<sup>th</sup> grade science assessment

The TIMSS 2019 study also includes the assessment in science for eighth graders, it was conducted based on similar principles to assessment in mathematics. It was developed using national curricula of the participating countries and reflect what internationally is considered as the core knowledge and skills in this area. Once again countries can compare achievement, but also initiate discussions about their national curricula, and expectations towards students in light of their science results. The TIMSS 2019 science assessment for 8<sup>th</sup> grade included 220 test items, which covered a wide range of curricular areas

### G8 Science



The 2019 TIMSS assessment of science in the 8<sup>th</sup> grade are divided into four main categories of tasks:

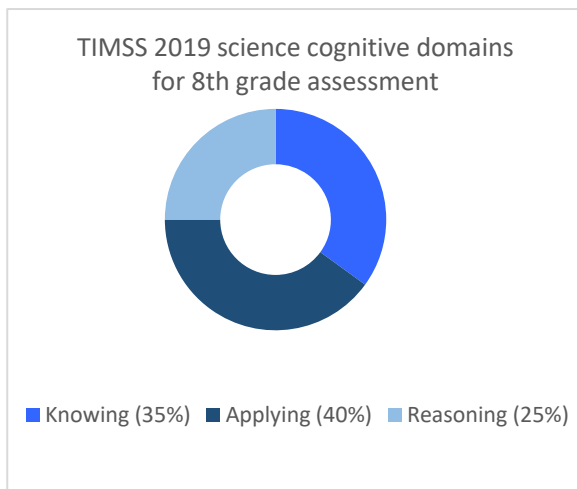


- Biology – 35% (e.g., characteristics and life processes of organisms, cells, and their functions, diversity, natural selection, etc.);
- Chemistry – 20% (e.g., composition of matter, properties of matter, chemical change, etc.);
- Physics – 25% (e.g., electricity and

magnetism, motion, and forces, energy transformation, etc.);

- and Earth science – 20% (e.g., Earth’s structural layers, geological processes, patterns of weather and climate, etc.).

Also, in this assessment all the created items were aimed at testing not only the knowledge but also applying and reasoning skills. Thus, assessment items devoted to cognitive domains were divided into:



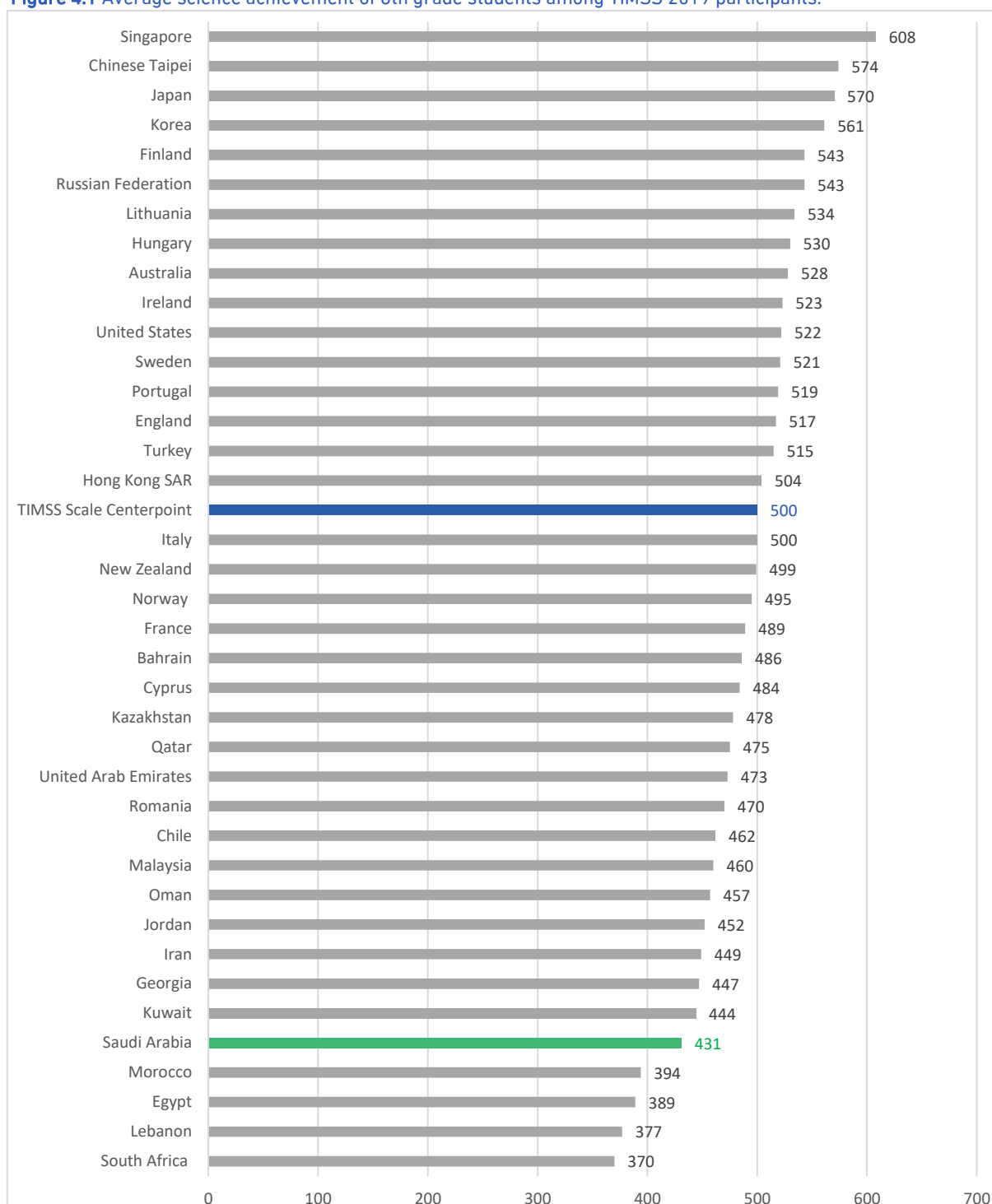
- knowing (35% of tasks, which cover the facts, concepts, and procedures students need to know);
- applying (40% of tasks covering students’ ability to apply knowledge and conceptual understanding to solve practical problems or answer questions);
- and reasoning (25% of test items, which encompass unfamiliar situations, complex contexts, and multistep problems).

Overall, there were 220 assessment items (questions) used in the TIMSS 2019 assessment of 8<sup>th</sup> grade science, which assures that the tests covered all areas of science, which is internationally taught at this stage of education.

### Average science achievement of 8<sup>th</sup> grade students

Figure 4.1 presents the average achievement in science for students in the 8<sup>th</sup> grade. In order to promote the comparison of results, countries have been ranked by the value of the estimated average science score (from the highest score to the lowest). The results can be compared to the TIMSS centerpoint, which is calculated to be 500 points. Less than a half of participating countries scored on average above this mark (46% have mean score equal, or above 500 points).

**Figure 4.1** Average science achievement of 8th grade students among TIMSS 2019 participants.



SOURCE: Exhibit 4.1: Average Science Achievement and Scale Score Distributions. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Of all 38 participants in the grade 8 TIMSS science assessments in 2019, 16 countries had higher or the same average achievements as the TIMSS Scale centerpoint. Students from four Asian countries achieved the highest average result: Singapore (608 pints), Chinese Taipei (574), Japan (570), and Korea (561). On the other hand, the lowest

average score was obtained by students from South Africa (370), Lebanon (377), and Egypt (389). Nearly all the countries in the Middle East were below the scale centerpoint.

Based on Figure 4.1, Saudi Arabian students scored an average of 431 points (with a standard error of the mean equal to 2.6). This is significantly lower than TIMSS Scale Centerpoint (500). With this result, out of 39 participating in the assessment countries, Saudi Arabia took 35th position.

### Saudi Arabia

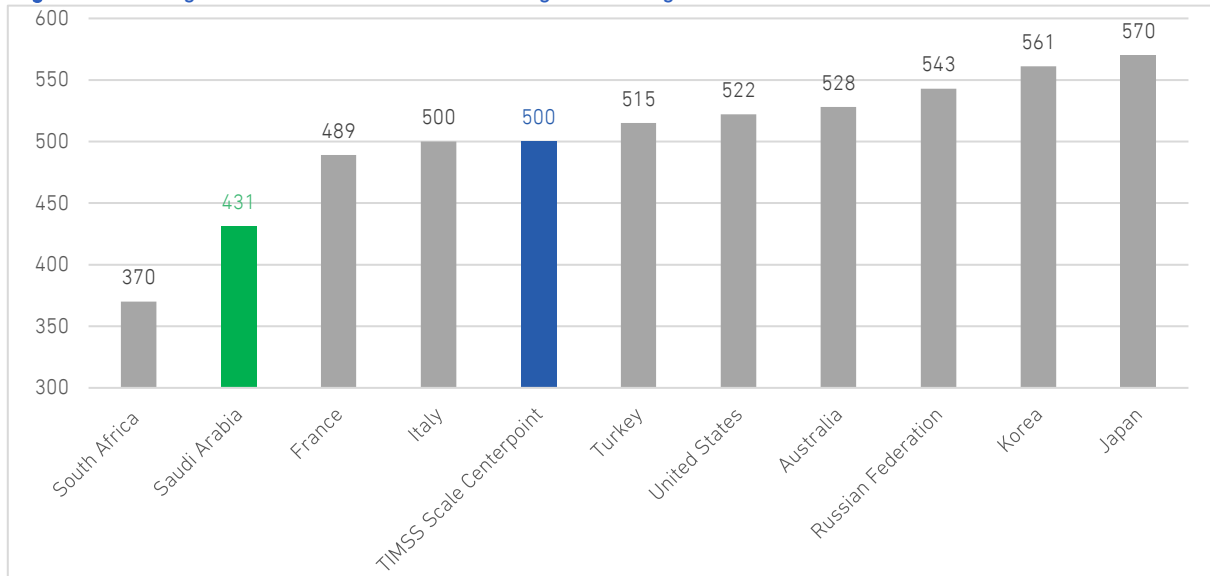


Exactly as in mathematics assessment, the average result obtained in each country can be compared in terms of the significance of the existing differences. Even if countries performance might slightly differ, statistically it may be classified as being on the same level. Considering Saudi Arabia results, it can be said that the average score of only 4 countries (Morocco, Egypt, Lebanon, South Africa) was significantly lower. There is no country with comparable results to those of Saudi Arabia. In comparison to rest of participants, Saudi Arabia students achieved a significantly lower average scale score.

Considering the achievement of G20 countries, science results for eighth graders can be compared for only 10 countries that participated in TIMSS 2019 8<sup>th</sup> grade assessment. In comparison to science 4<sup>th</sup> grade assessment, Canada, and Germany did not participate in the study this time. On average, the highest scores were achieved by students from Japan (570), Korea (561), and Russian Federation (543). In this specific ranking, Saudi Arabia (431) took 9<sup>th</sup> position. Theirs average results are higher only than the ones observed in South Africa (370).



**Figure 4.2** Average science achievement in the 8th grade among G20 countries



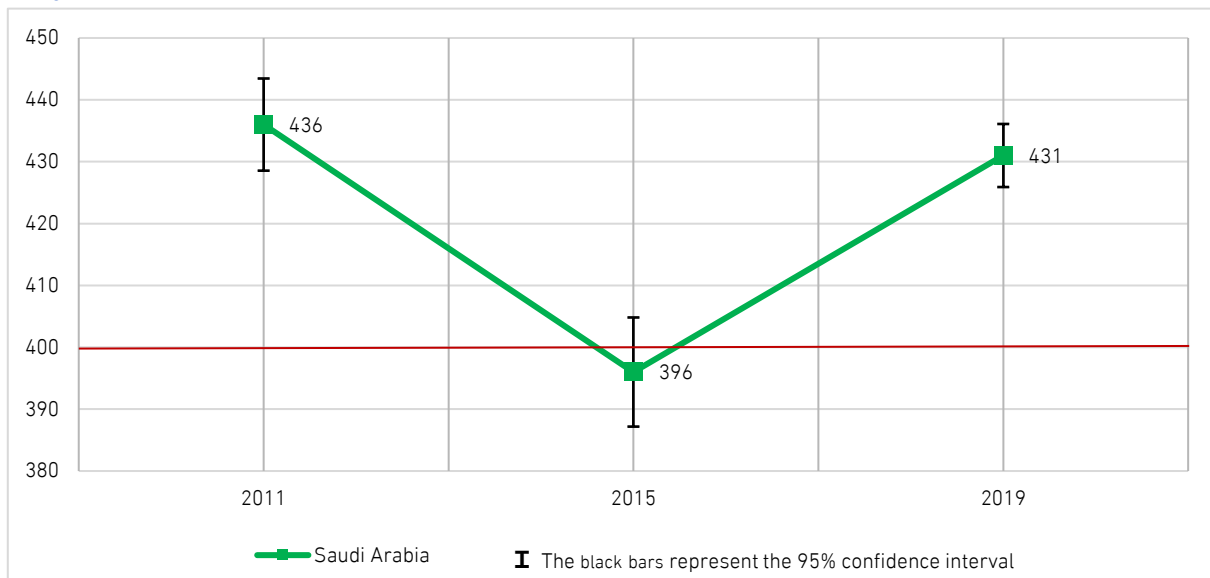
SOURCE: Exhibit 2.1: Average Science Achievement and Scale Score Distributions. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

### Trends in student achievement in grade 8 science

Country performance in science can be compared over time as the TIMSS study is conducted since 1995. Most countries have reported some periods of increases, decreases, and periods of result stability. It is worth mentioning, that countries considerably differ in the number of assessments in which they have participated during this period.

**Figure 4.3** displays the exact results obtained for Saudi Arabia and it can be noticed that this country has participated in three editions of the TIMSS eighth grade science assessment. The best results in Saudi Arabia were observed in 2011, average score was estimated to be 436 points. In 2015, there was a considerable decline (by 40 points). Most recently, during the period (2015-2019), there has been an increase to 431 points, so it returned to comparable level to the one noticed in 2011. Thus, the recent TIMSS study results are statistically indistinguishable from the result achieved in TIMSS 2011.

**Figure 4.3** Changes in the 8th grade student average science achievement across TIMSS assessments in Saudi Arabia.



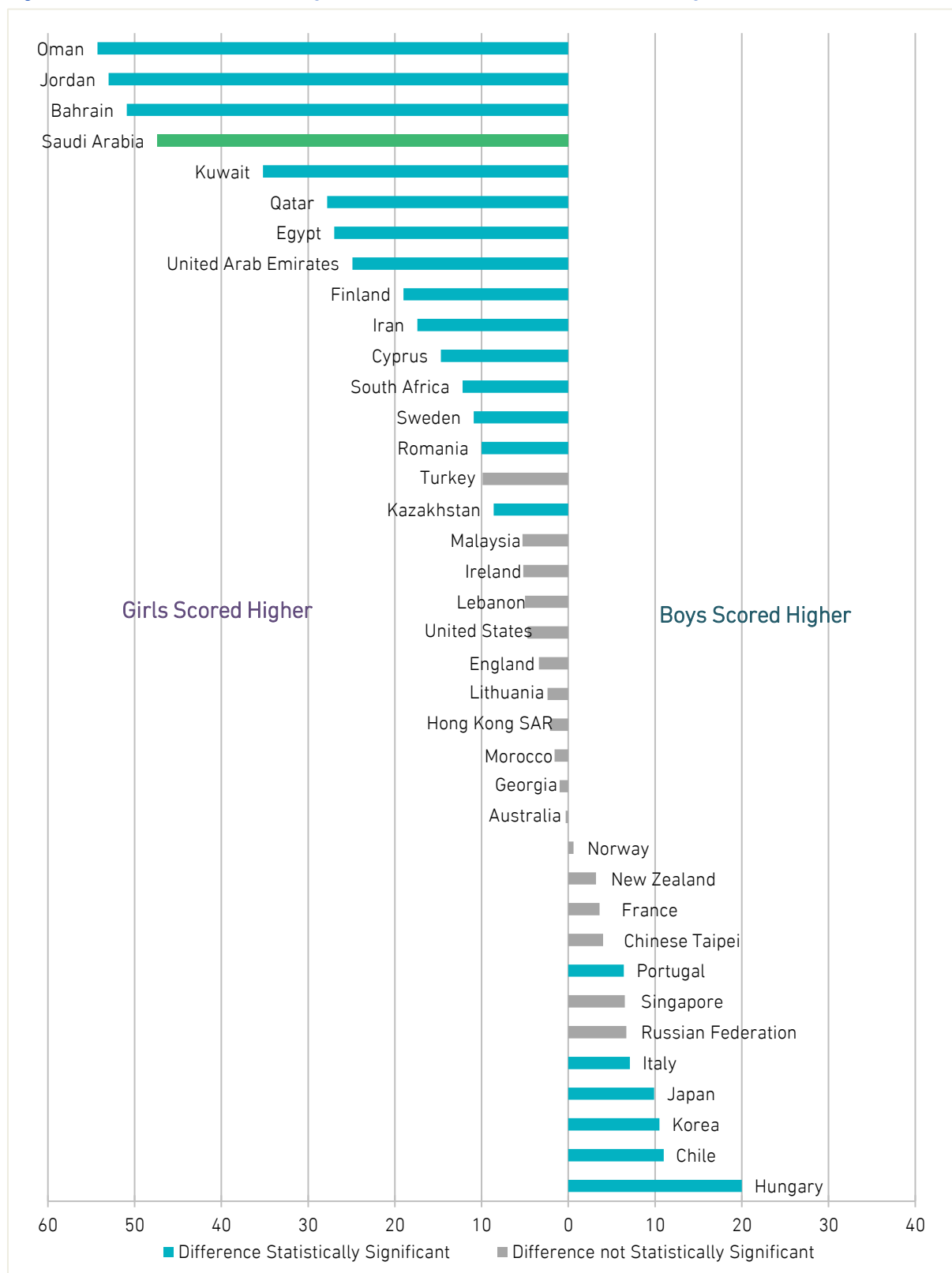
SOURCE: Exhibit 4.3: Trend Plots of Average Science Achievement Across Assessment Years. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

### Average Achievement by Gender

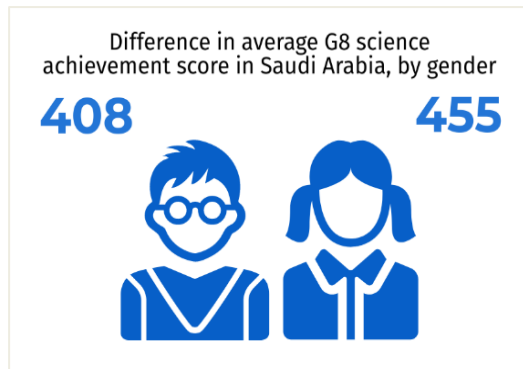
**Figure 4.4** shows the disparity between average science achievement among girls and boys attending eighth grade (mean score of girls minus mean score of boys). In countries that are at the top of the list, girls perform much better than boys. The biggest advantage of girls over boys was found in Oman, where girls obtained, on average better results by 54.3 points. On the other hand, at the bottom of the list is placed Hungary, where boys scored on average by 20 points higher than girls.

Based on **Figure 4.4**, in 15 countries including Saudi Arabia, girls achieved significantly better results than boys in the recent TIMSS edition. There were only 6 countries where boys had higher average science achievement than girls. Considering all participating countries, the international averages were calculated as 495 points for girls and 485 points for boys.

**Figure 4.4** Gender difference in average science achievement for students in the 8<sup>th</sup> grade



SOURCE: Exhibit 4.5: Average Science Achievement by Gender. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>

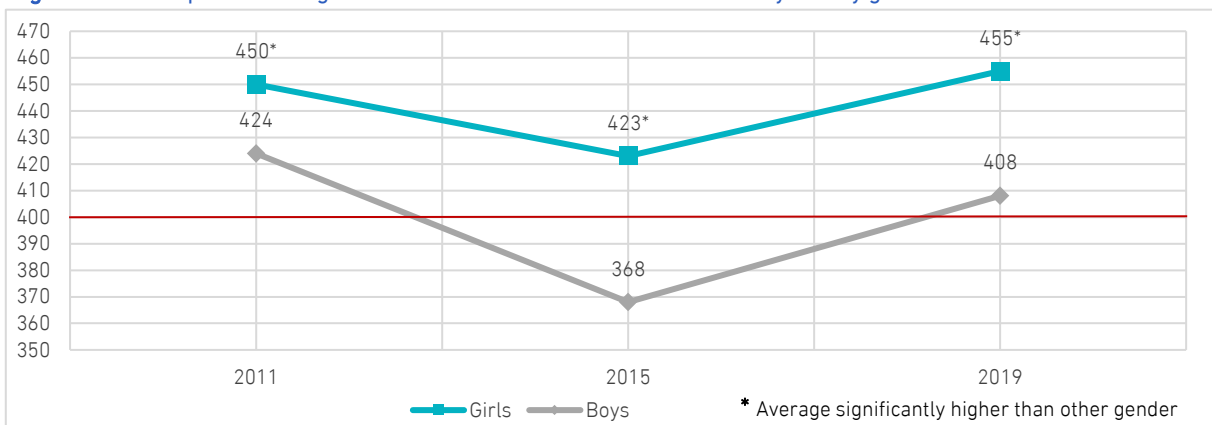


In Saudi Arabia, girls achieved significantly higher results than boys by around 47 points. In this specific ranking, Saudi Arabia was situated at the 4<sup>th</sup> position. However, it is worth mentioning that there are low and high

performing students in both groups.

**Figure 4.5** compares trends in average science achievement of eighth graders across assessment years for boys and girls in Saudi Arabia. In all three editions in which Saudi Arabia participated (2011, 2015, 2019), girls scored better in science than boys (26 points more than boys in 2011, 55 in 2015, and 47 in 2019). From 2011, there has been a decline in the achieved results for both genders, followed by an increase (however, boys' decline was significantly greater). Even though in the current TIMSS 2019 study, both Saudi Arabian girls and boys improved their average result (respectively by 32 and 40 points). Girls' average result has exceeded its level from TIMSS 2011, while boys average result is still 16 points lower than the result from 2011. In all assessment editions in which Saudi Arabia has participated, the eighth graders of both sexes did not manage to exceed the average international score.

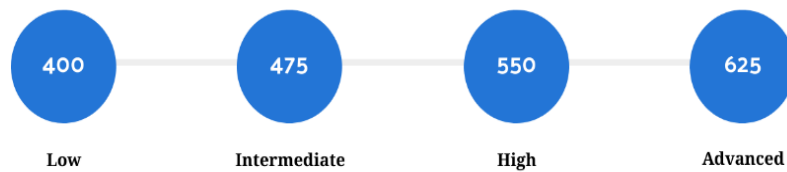
**Figure 4.5** Trend plot of average science achievement across assessment years by gender for Saudi Arabia



SOURCE: Exhibit 4.6: Trend Plots of Average Science Achievement Across Assessment Years by Gender. IEA's Trends in International Mathematics and Science Study TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Performance at TIMSS International Benchmarks for Grade 8 Science

### International Benchmarks



In science eighth grade assessment, TIMSS 2019 also compares student achievement by using four international benchmarks, illustrating level of knowledge and science capabilities acquired by students. TIMSS 2019 international benchmarks of science include four levels of student achievement: Advanced International Benchmark (625), High International Benchmark (550), Intermediate International Benchmark (475), and Low International Benchmark (400).

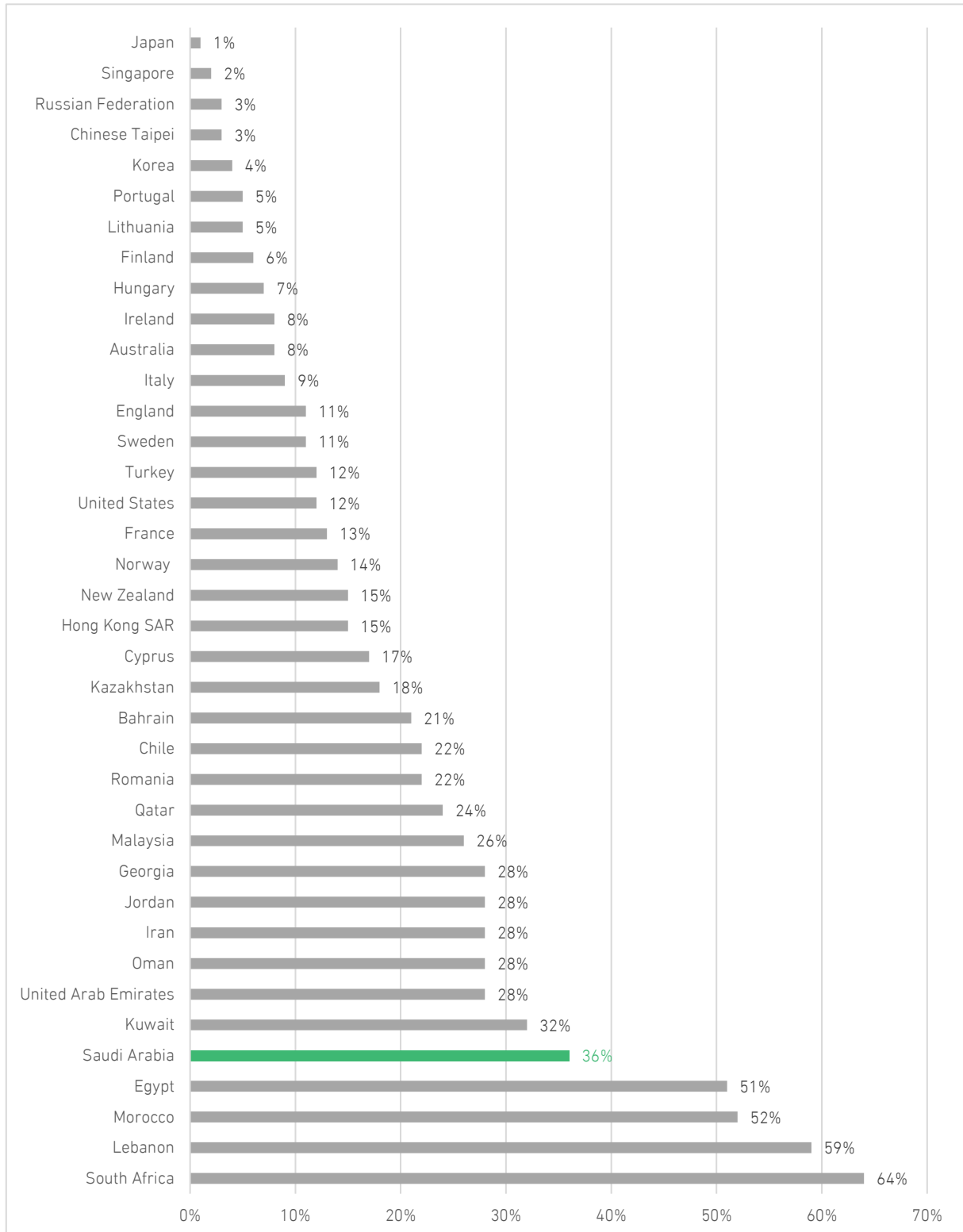
Eighth graders who exceeded the Low International Benchmark can show and apply limited understanding of scientific principles and concepts and limited knowledge of science facts. Students exceeding intermediate benchmark show and apply some knowledge of biology and the physical science. Those reaching high benchmark apply understanding of concept form biology, chemistry, physics, and Earth science. The most gifted students reaching advanced level can communicate understanding of concepts related to biology, chemistry, physics, and Earth science in a variety of contexts.

Less than one- third of the participating countries in the TIMSS 2019 assessment had more than 90% of 8<sup>th</sup> grade students reaching this basic level of science knowledge.

**Figure 4.6** illustrates that the best results were observed in Japan, Singapore, Russian Federation, Chinese Taipei, and Korea, where less than 5% of students do not reach this level. In Saudi Arabia, that number was estimated to be 36% of students. In comparison

to Saudi Arabia, more students were not able to solve item tasks representing the lowest level of science knowledge in Egypt, Morocco, Lebanon, and South Africa.

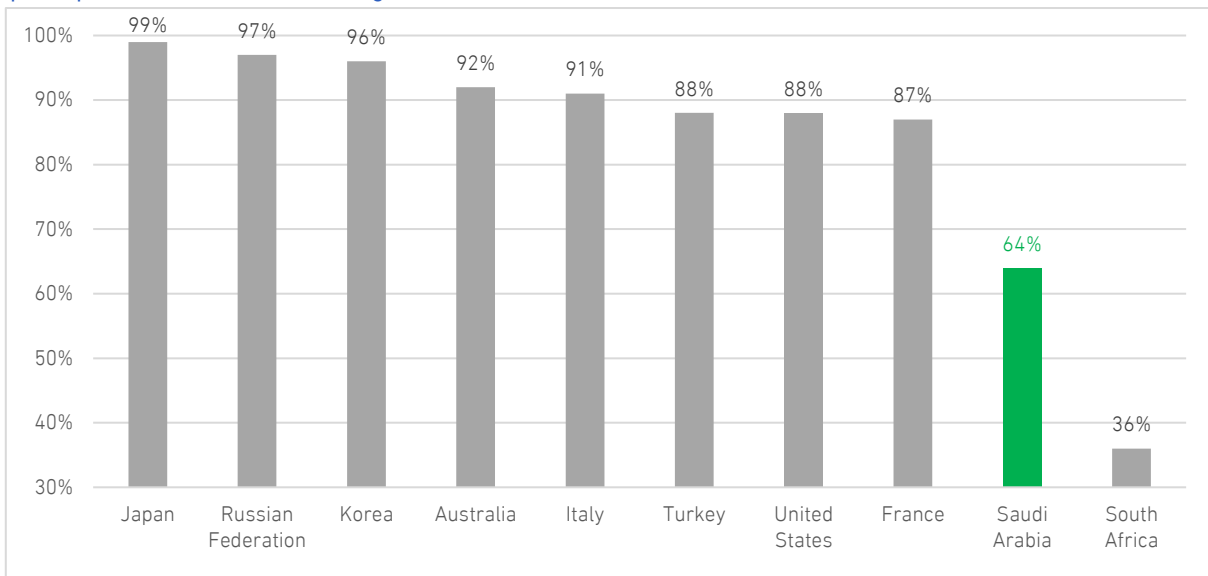
**Figure 4.6** Share of grade 8 students not reaching the Low International Benchmark in science.



SOURCE: Exhibit 4.8: Percentages of Students Reaching International Benchmarks of Science Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Within an international context, **Figure 4.7** illustrates that most of the students from G20 countries reached the Low International Benchmark, except South Africa. Exactly as in the mathematics 8 grade assessment, nearly all the students in Japan, Russian Federation, and Korea had obtained basic science knowledge. In this specific ranking worst results were observed in Saudi Arabia, and South Africa, respectively 64% and 36% of students have reached this basic level. In the remaining countries, 13% or less of students do not reached this low achievement level (Australia, Italy, Turkey, United States, France).

**Figure 4.7** Percentage of students reaching the Low International Benchmark in G20 countries that have participated in the TIMSS 2019 8th grade science assessment.



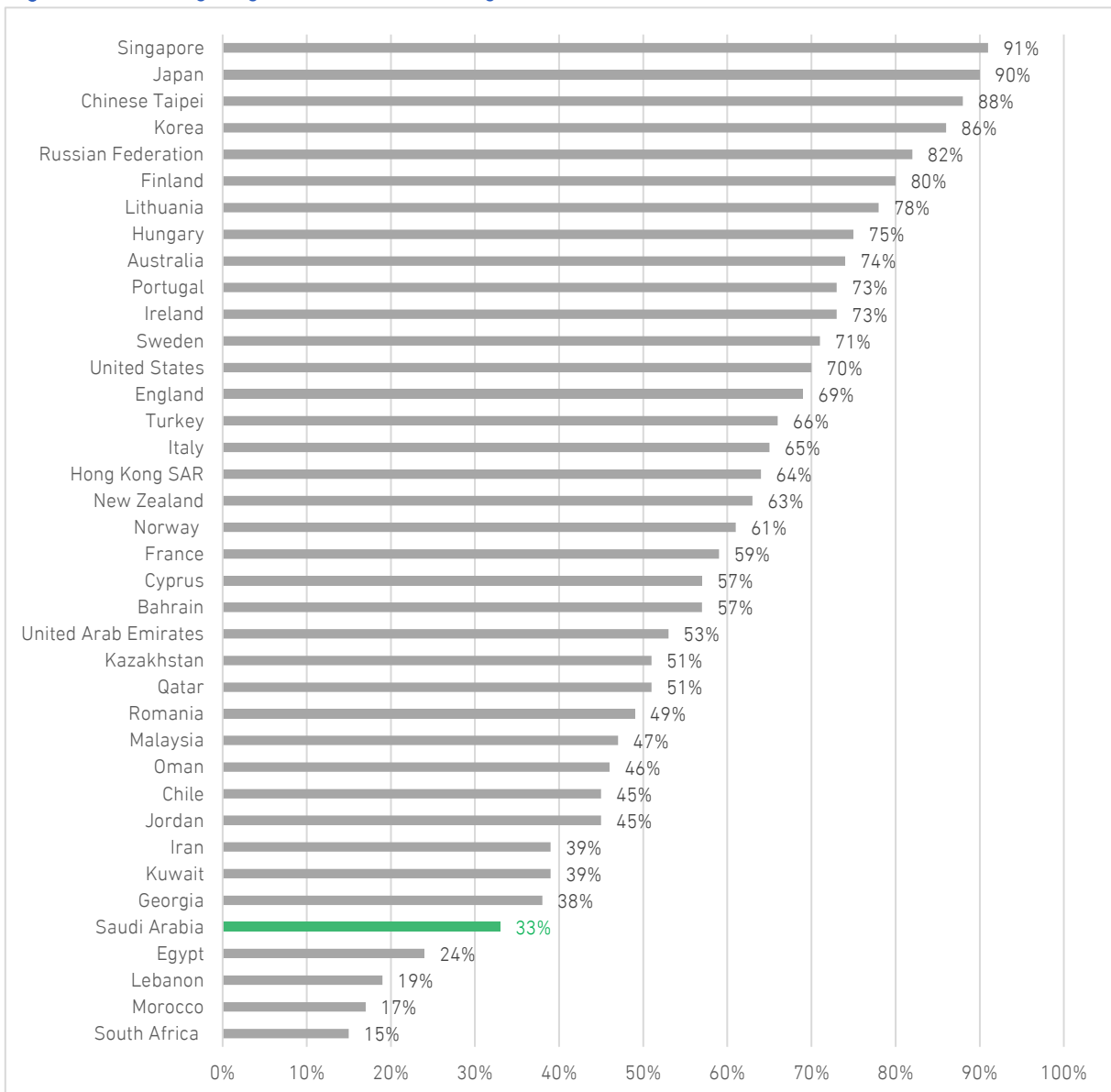
SOURCE: Exhibit 4.8: Percentages of Students Reaching International Benchmarks of Science Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Students reaching the science Intermediate Benchmark show and apply some knowledge of biology and physical science. These are students who score 475 points or higher on the TIMSS scale. They demonstrate some knowledge of characteristics of animals, and ecosystems. In addition, eighth graders who reached this benchmark point have some familiarity with the properties of matter, chemical changes, and some physics concepts.

In the two best performing countries (Singapore, Japan), at least 90% of all students reach the Intermediate Benchmark (see **Figure 4.8**). In the majority of countries participating in the TIMSS 2019 8<sup>th</sup> grade science assessment, more than half of students possess science skills at this level.

In Saudi Arabia, this number was calculated to be 33% of students. They achieved better average score than eighth-graders from Egypt (24%), Lebanon (19%), Morocco (17%), and South Africa (15%).

**Figure 4.8** Percentage of grade 8 students reaching the Intermediate International Benchmark in science.



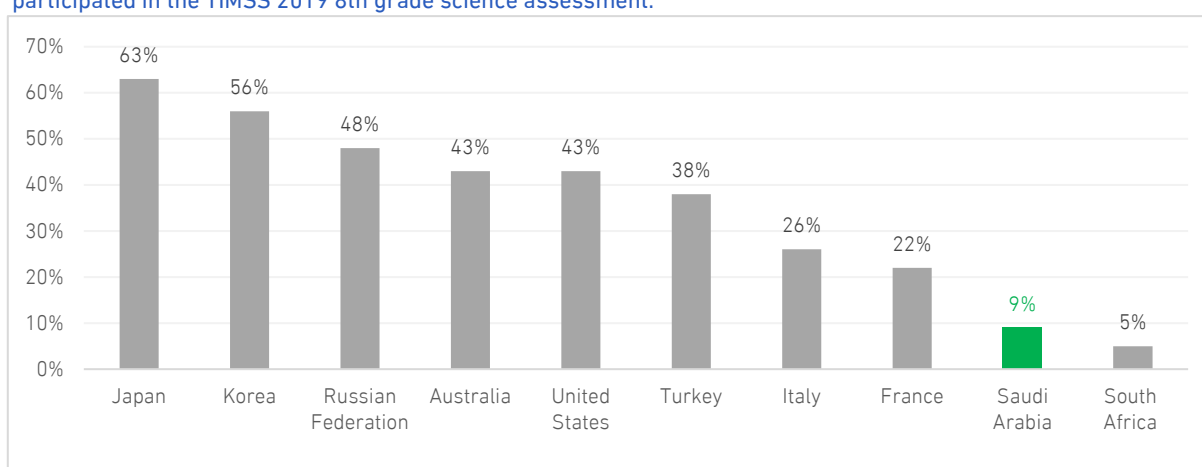
SOURCE: Exhibit 4.8: Percentages of Students Reaching International Benchmarks of Science Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.



The High International Benchmark can be reached by students who can apply understanding of concepts from biology, chemistry, physics, and Earth science. Those students know characteristics of groups of animals, life processes in humans, cells and their functions, genetic inheritance, ecosystems, and nutrition. They show some knowledge and understanding of the composition and properties of matter and chemical reactions. They are familiar with energy transformation and transfer, electronic circuits, properties of magnets, light, sound, and forces. In addition, eighth-graders reaching this level have some knowledge of Earth's resources, physical features, processes, cycles, and history. Students performing at 550 score or higher on the TIMSS scale are classified as reaching this level.

Among the G20 countries, 63% of students who have reached this performance level is found in Japan. In Korea, Russian Federation, Australia, and United States, between 40 and 60% of students possess science knowledge at this level. In Turkey, Italy, and France, the percentages were estimated as respectively to be 38%, 26%, and 22%. In Saudi Arabia, around 1 in 10 students perform at the High International Benchmark for 8<sup>th</sup> grade science, they scored higher than only South Africa (5%).

**Figure 4.9** Percentage of students reaching the High International Benchmark in G20 countries that have participated in the TIMSS 2019 8th grade science assessment.



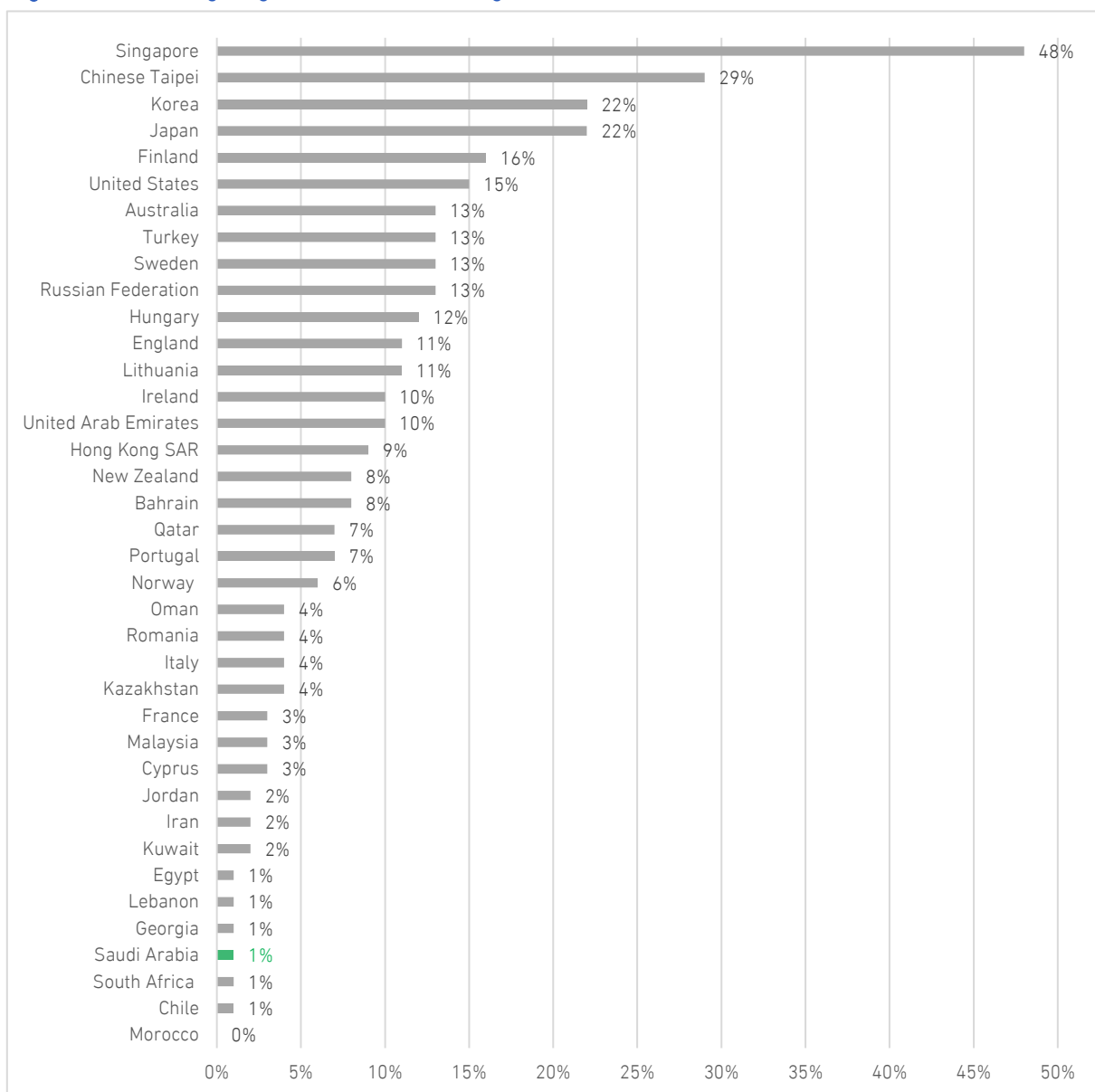
SOURCE: Exhibit 4.8: Percentages of Students Reaching International Benchmarks of Science Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

The advanced international benchmark can be reached by students who at this age show the highest understanding of science knowledge. At this level, students can communicate their understanding of concepts related to biology, chemistry, physics, and Earth science in a variety of contexts. They can classify animals into taxonomic groups, apply knowledge of cell structures and their functions, and also understand concept of diversity, adaptation, and natural selection. Those students are able to recognize the interdependence of populations of organisms in an ecosystem. Eighth-graders who reached this level use physical properties of matter to sort, classify, and compare substances and materials. They recognize evidence that a chemical reaction has occurred, understand particle spacing and motion in different physical states, apply knowledge of energy transfer, and electronic circuits, can relate the properties of the light and sound to common phenomena, and demonstrate understanding of forces in everyday contexts. Additionally, those students have knowledge of Earth's resources and their conservation, Earth's structure, physical features, and processes. Students performing at 625 points or higher on the TIMSS scale are classified as reaching this benchmark. Even in best performing countries many students cannot reach this demanding benchmark.

The highest and outstanding result was observed in Singapore, where 48% of students have reached this science benchmark point. In Japan, Korea, Chinese Taipei more than 20% of students reach this benchmark. In the remaining countries, at least 84% of students was not able to reach this high level of understanding of science. In Saudi Arabia, only 1% of students reach this level in grade 8. This result was observed also in Egypt, Lebanon, Georgia, South Africa, and Chile, with less than 1% of students at this level in Morocco.

Just as in mathematics assessments, by comparing science results in both 4<sup>th</sup>, and 8<sup>th</sup> grade, it can be noticed, that students who finish early education without mastering even basic knowledge of science will probably encounter learning problems in higher grades and poorly perform in science tests. Too many students in Saudi Arabia lack strong basis from early education and most students finish 8<sup>th</sup> grade without mastering even basic knowledge of science, which later will affect their educational results.

**Figure 4.10** Percentage of grade 8 students reaching the Advanced International Benchmark in science.



SOURCE: Exhibit 4.8: Percentages of Students Reaching International Benchmarks of Science Achievement. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Trends in Percentages of Students Reaching International Benchmarks

Comparing the situation observed in the 18 countries that have participated in the assessment in 1995 and 2019, one can observe that countries' performance usually improves or at least remain stable when it comes to long-term trends for all except low level of educational benchmark. Thus, the level of science education among eighth graders has been internationally increasing. The exact numbers are as follows (considering all four International Benchmarks).

Numbers of increases and decreases in different benchmarks among 18 countries taking part in both 1995 and 2019 assessments.

	Increase	Decrease	Difference
<b>Low</b>	5	6	-1
<b>Intermediate</b>	7	3	+4
<b>High</b>	8	2	+6
<b>Advanced</b>	7	2	+5

In the low benchmark, five countries noted an increase in their results – Lithuania (difference of 16%), Portugal (11%), Cyprus (11%), Russian Federation (5%), and Japan (2%). Meanwhile, six countries have noted a decrease – Iran (9%), Sweden (8%), New Zealand (4%), England (4%), Hungary (2%), and Singapore (1%).

In the intermediate benchmark, the increase was noticed in seven countries – Lithuania (33% rise), Portugal (24%), Cyprus (14%), Russian Federation (11%), Japan (5%), Korea (5%), and Australia (5%), while a decrease occurred in three countries – Sweden (decreased by 12%), England (6%), and Hungary (5%).

In the high benchmark, an increase occurred in eight countries – Lithuania (29% rise), Portugal (19%), Singapore (13%), Russian Federation (10%), Japan (9%), Australia (7%), Cyprus (7%), and Korea (6%), while a decrease occurred in Sweden (11%) and England (5%).

Lastly, in the advance benchmark, seven countries have their results increased – Singapore (19% rise), Lithuania (9%), Portugal (5%), Korea (5%), United States (4%), Japan (4%), and Cyprus (1%), while 2 countries have their results decreased – Sweden (decreased by 6%), and England (4%).

Percentages of Saudi Students Reaching International Benchmarks of Science Achievement Across Assessment Years

	2011	2015	2019
High	8%	6%	9%
Advanced	1%	1%	1%

Looking at the changes in percentages of Saudi Arabia students, it can be noticed that from 2011 to 2019, the percentage of students who exceeded the Advanced International Benchmark remain at the level of 1%. For the High International Benchmark, one can observe a small increase

from 8 to 9%. Besides, in the intermediate benchmark, the following values have been observed: in 2011 was 33 %, in 2015 – 22%, and 2019 – 33%, so overall, it remains at the same level. Meanwhile, in the low benchmark, in 2011, the value was 68%, in 2015 – 49%, and 2019 – 64%, so in that specific period, it decreased only by 4%.

Despite the negative changes occurring in the eighth-grade science assessment between 2011 to 2015, there were recorded increases in three out of four benchmarks in the following period 2015-2019, (at the advanced level it remained stable). To be exact: in advanced level (from 1% to 1%), in high level (from 6% to 9%), in intermediate level (from 22% to 33%), and in low level (from 49% to 64%). Overall, there was no considerable change in the share of students at any benchmark level between 2011 to 2019.

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## Chapter 5

### Home Environmental Support

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## Home Environmental Support

### Home Resource

TIMSS 2019 data reveals the existing close relationship between students' educational achievements and the socioeconomic environment. In order to assess the House Resources impact for Learning, students were scored on the basis of five types of Home Resources for learning. These were the following categories:

- Number of books in home (students' survey),
- Number of home study supports (students' survey);
- Number of children's books in the home (parents' survey),
- the highest level of education of either parent (parents' survey),
- and the highest level of occupation of either parent (parents' survey).

The three levels of resources availability were defined based on the students' and parents' declarations: Few Resources, Some Resources, and Many Resources.

- Students with Few Resources profile corresponds to a score corresponding to, on average, having 25 or fewer books at home and no home study support. Their parents reported that they had 10 or fewer children's books in their home, and neither of the parents in this group had gone beyond upper secondary education. Besides, neither owned a small business or worked in a clerical or professional occupation.
- Students with Many Resources profile has a score corresponding to respondents with more than 100 books, internet connection, and their own room as a home study support. According to their parents, students had more than 25 of their own books, and at least one of the parents had

graduated from a university. Also, students had at least one parent with a professional occupation (on average).

- All students between the above-specified determinants were classified as a person possessing Some Resources. The entire task was conducted in the form of a survey.

**Error! Reference source not found.** presents the structure of G4 Home Resources for Learning in KSA compared to the International Average.

**Table 5.1** Structure of G4 Home Resources for Learning in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Few Resources	9%	Math-383 Science-382	8%	Math-433 Science-414
Some Resources	88%	Math-403 Science-409	75%	Math-498 Science-488
Many Resources	3%	Math-466 Science-477	17%	Math-562 Science-557

SOURCE: Exhibit 5.2, and Exhibit 5.3: Home Resources for Learning. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

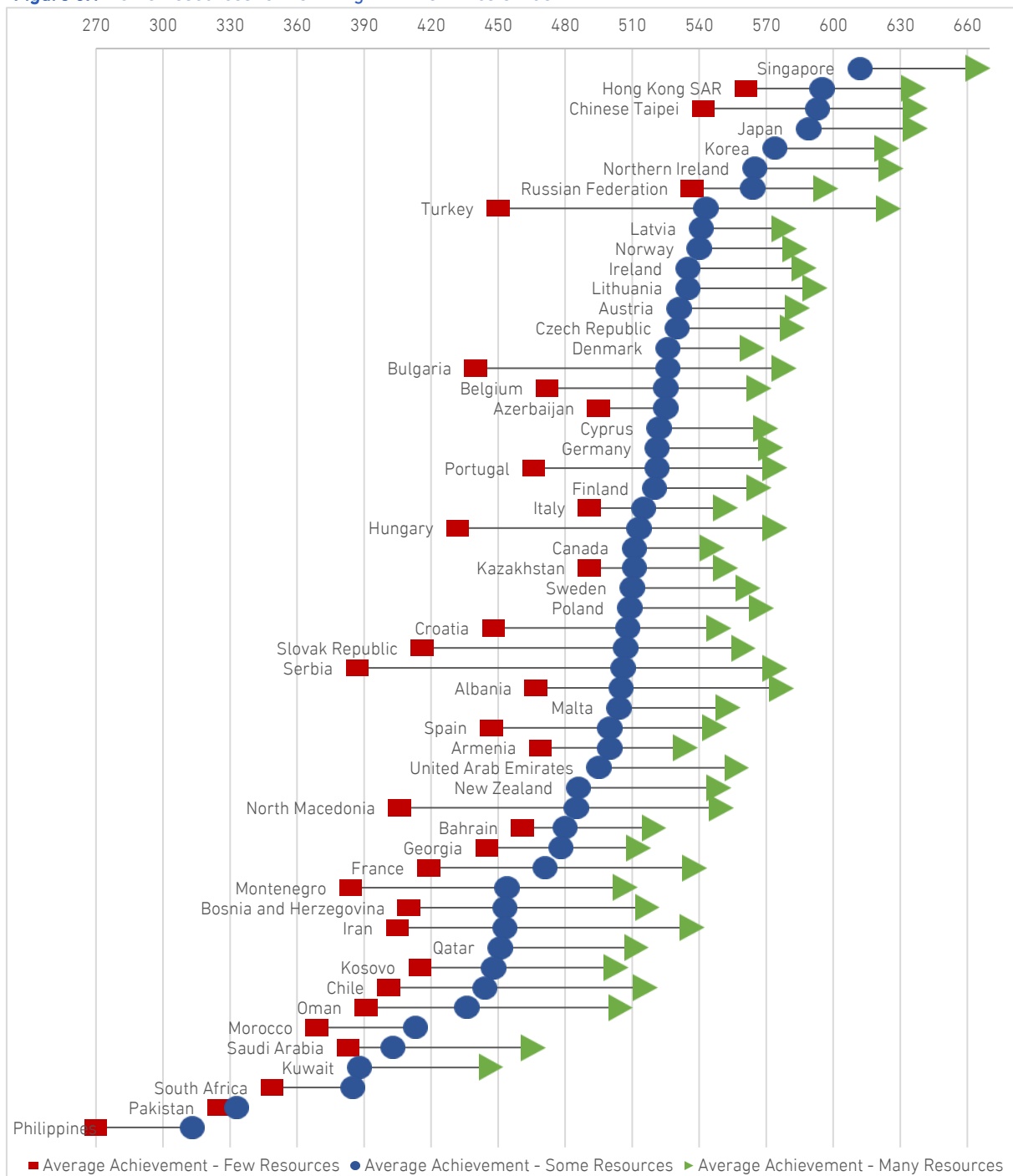
In Saudi Arabia, 3% of the fourth-graders who classified in the group of Many Resources scored 466 points in Mathematics and 477 points in Science on average. 88% of the students who were classified in a group of Some Resources obtained 403 points in Mathematics and 409 points in Science on average, and the remaining 9% who possess only a Few Resources scored 383 points in Mathematics and 382 points in Science on average. Therefore, there is a visible correlation between access to resources and student's performance, both in the Kingdom of Saudi Arabia and internationally.

**Figure 5.1** shows grade-four students' achievement classified according to the three categories described above (Many Resources, Some Resources, Few Resources)



across countries participating in the mathematics assessment. The list of the countries is sorted from the highest average score in the middle resources' category to the lowest. The highest score was achieved by Singapore, Hong Kong SAR, Chinese Taipei, Japan, and Korea.

**Figure 5.1 Home Resources for Learning – Mathematics Grade 4**

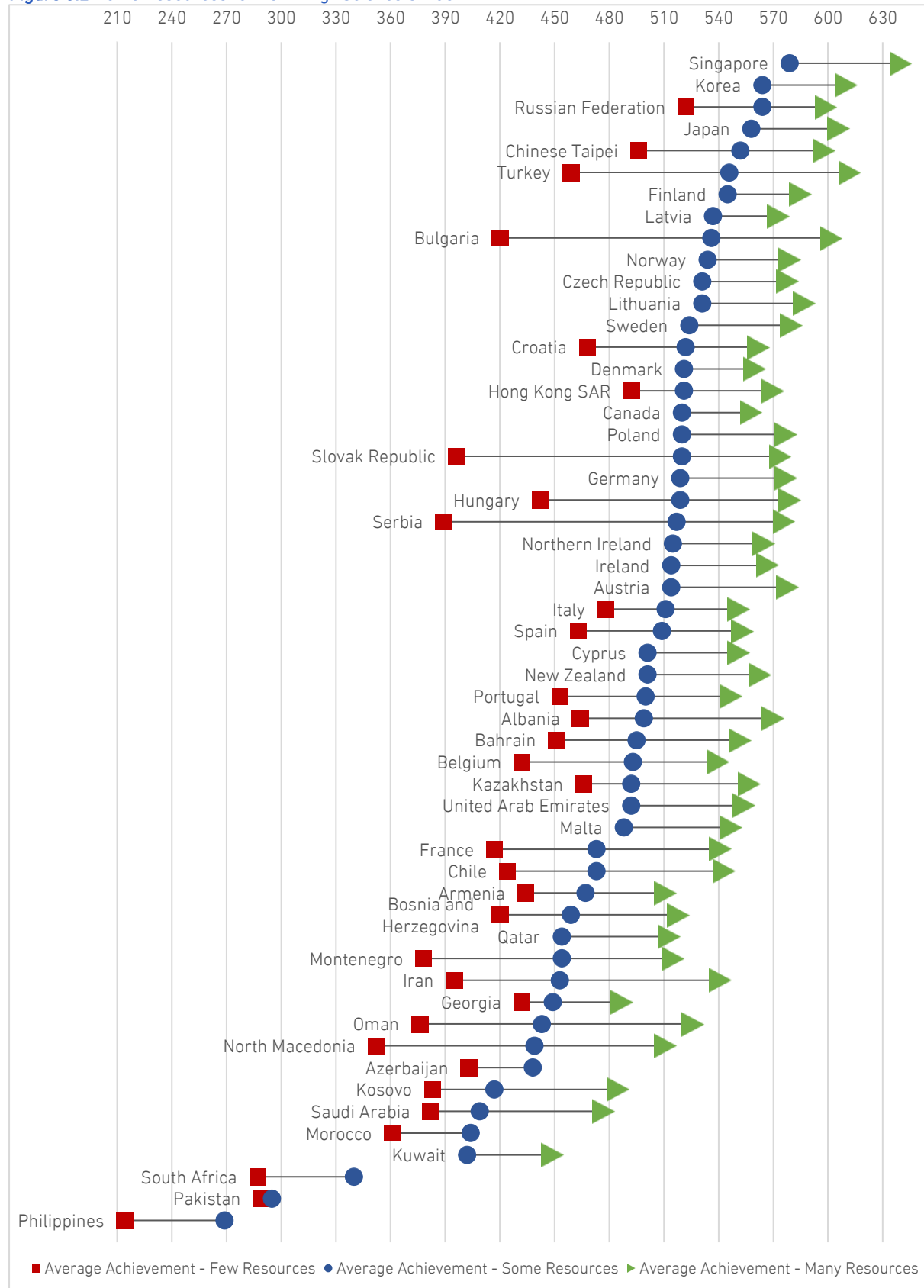


SOURCE: Exhibit 5.2: Home Resources for Learning. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

In this ranking Saudi Arabia took the 50<sup>th</sup> position out of 54 countries, revealing the same pattern as other countries - with the increase in the number of educational resources held by students, the growth in the average achieved score is observed. It is worth noting that in Saudi Arabia, achievement difference in mathematics is much lower between those who exhibit some and few resources than between those with many and some resources.

A similar pattern is observed in regard to achievement in Science **Figure 5.2** shows achievement in science by possessed home resources. Of all the countries participating in TIMSS Science assessment of grade 4, Saudi Arabia stands in the category of the average achievement in "some resources," on the 49<sup>th</sup> place.

Figure 5.2 Home Resources for Learning- Science Grade 4



SOURCE: Exhibit 5.3: Home Resources for Learning. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

The inequalities in achievement regarding home resources are much lower in Saudi Arabia for 8-graders (see **Figure 5.3** and **Figure 5.4**). For 8-graders, a similar scale was used. However, for eight-graders, the home resources scale is based on only three questions for participating students:

- the number of books in the home,
- number of home study supports,
- and the highest level of occupation of either parent.

The defined scale was based on assignment to three categories of home assets corresponding to the fourth-graders' scale.

**Table 5.2** shows the data for the Kingdom of Saudi Arabia compared to the International Average results.

**Table 5.2** Structure of G8 Home Resources for Learning in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Few Resources	27%	Math-369 Science-405	13%	Math-433 Science-431
Some Resources	69%	Math-402 Science-441	73%	Math-488 Science-489
Many Resources	4%	Math-432 Science-471	14%	Math-546 Science-549

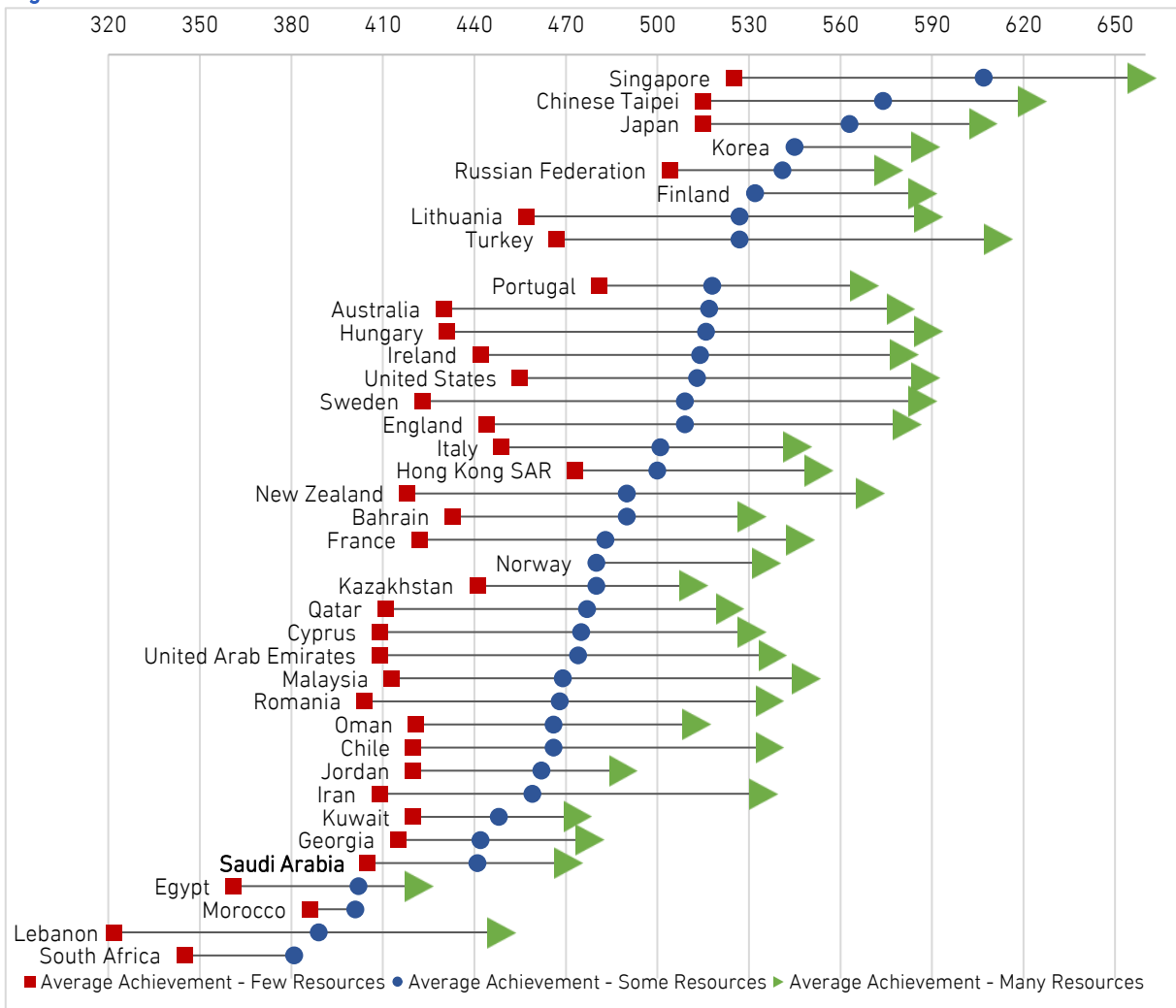
SOURCE: Exhibit 5.5, and Exhibit 5.6: Home Resources for Learning. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

In Saudi Arabia, 4% of the eighth-graders who classified in the group with Many Resources scored 432 points in Mathematics and 471 points in Science, on average. 69% of the students who were classified in a group with Some Resources obtained 402 points in Mathematics and 441 points in Science on average, and the remaining 27% who possess only a Few Resources scored 369 points in Mathematics and 405 points in

Science on average. It is worth noting that a much higher percentage of eighth-graders declared a few educational resources compared to the fourth-graders.

**Figure 5.3** shows students' scores in one of the three described above categories for countries participating in the eighth-grade science assessment. A positive relationship between having more resources and achieving better results can be noticed across the participating in the study countries. The list of the countries is sorted in the same way as was described in **Figure 5.3**. In this ranking out of 39 countries, Saudi Arabia took the 35th place.

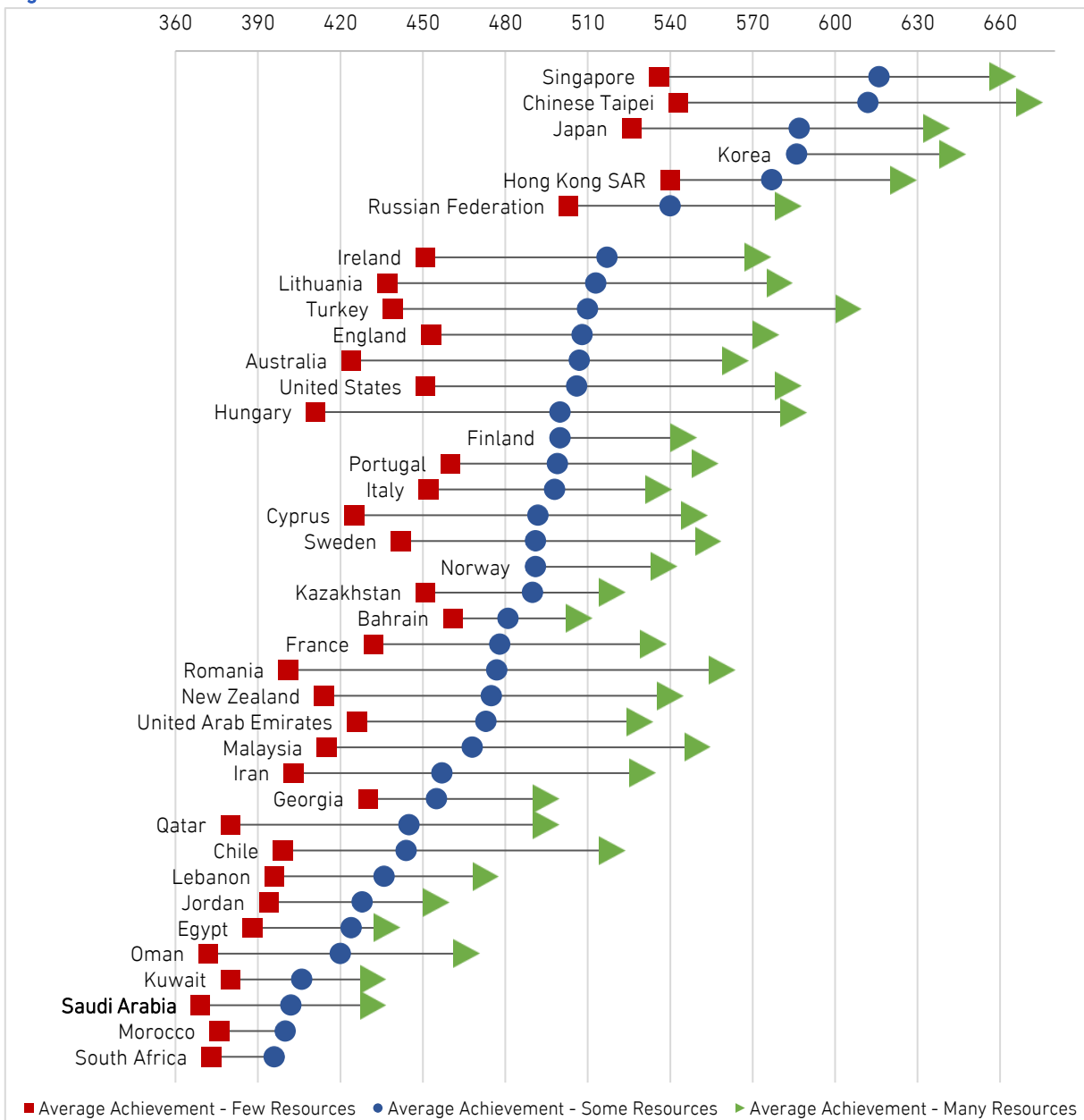
**Figure 5.3 Home Educational Resources – Science Grade 8**



SOURCE: Exhibit 5.6: Home Educational Resources. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 5.4 illustrates the Average Mathematics Achievement of eight-graders in the participating countries. Eighth graders in Saudi Arabia scored worse in mathematics than in science, but in relation to home resources, the same tendencies were observed. The difference in achievement for students who exhibit many resources, and those with few resources is around 63 points (for science, it was 66 points of difference).

Figure 5.4 Home Educational Resources – Mathematics Grade 8



SOURCE: Exhibit 5.5: Home Educational Resources. IEA's Trends in International Mathematics and Science Study -TIMSS 2019.  
Downloaded from <http://timss2019.org/download>

## Emphasis on Early Literacy and Numeracy Development

### *Home Early Literacy and Numeracy Activities Before Primary School*

In order to examine the importance of learning and participating in educational activities during students' early childhoods, students were scored according to their parents' answers regarding the frequency they or someone in their household engaged their children in the eighteen activities on the Early Literacy and Numeracy Activities. The following definition divided the scale into three categories.

- Students Often engaged in early literacy and numeracy activities before primary school had a score at or above the cut score corresponding to their parents reporting they "often" did nine of the eighteen activities and "sometimes" did the other nine, on average.
- Students Never or Almost Never engaged in early literacy and numeracy activities before primary school had a score at or below the cut score corresponding to their parents reporting they "never or almost never" did nine of the eighteen activities and "sometimes" did the other nine, on average.
- All other students Sometimes engaged in early literacy and numeracy activities. In this category, only a very limited share of students was classified across countries.

Table 5.3 Structure of G4 Home Early Literacy and Numeracy Activities Before Primary School in Saudi Arabia and international average shows the data for the Kingdom of Saudi Arabia compared to the International Average results in the matter of the structure of grade-four Home Early Literacy and Numeracy Activities Before Primary School.

**Table 5.3** Structure of G4 Home Early Literacy and Numeracy Activities Before Primary School in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Never or Almost Never	3%	Math-388 Science-382	3%	Math-456 Science-421
Sometimes	68%	Math-394 Science-397	55%	Math-495 Science-484
Often	28%	Math-416 Science-426	42%	Math-516 Science-507

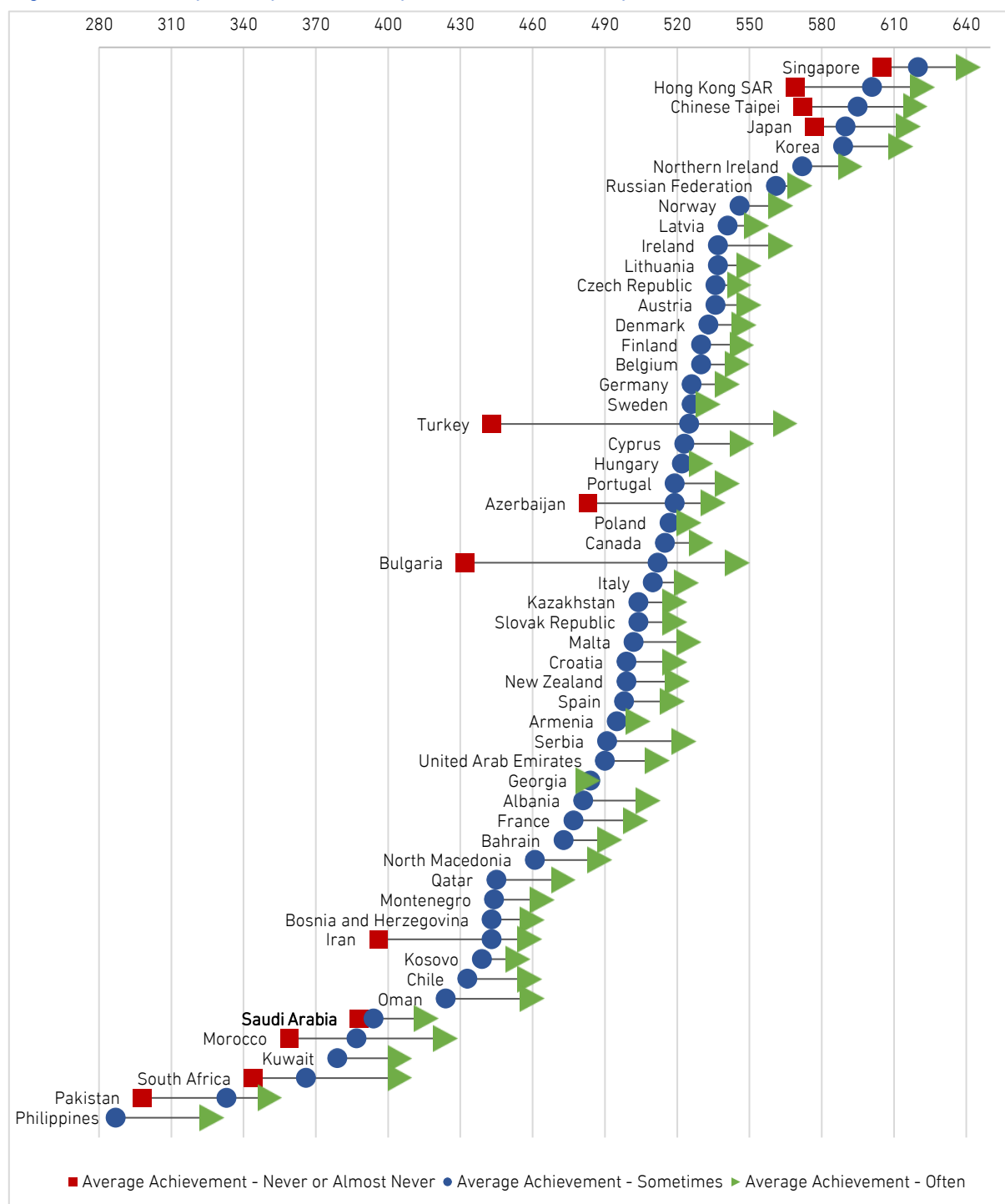
SOURCE: Exhibit 5.12, and Exhibit 5.13: Home Early Literacy and Numeracy Activities Before Primary School. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

In Saudi Arabia, 3% of the fourth-graders who never or almost never have had engaged in early literacy and numeracy activities before primary school scored 388 points in Mathematics and 382 points in Science on average. Students, who engaged sometimes, scored on average 394 points in Mathematics and 397 points in Science. Students who did often engage in these activities scored, on average, 416 points in Mathematics and 426 points in Science. Thus, there is a visible correlation between the engagement in early literacy and numeracy activities before primary school and student's performance in their later life, both in the Kingdom of Saudi Arabia and internationally.

**Figure 5.5** presents average achievement in mathematics for four graders by the above-defined Home Early Literacy and Numeracy Activities categories.



**Figure 5.5** Home Early Literacy and Numeracy Activities Before Primary School – Mathematics Grade 4:



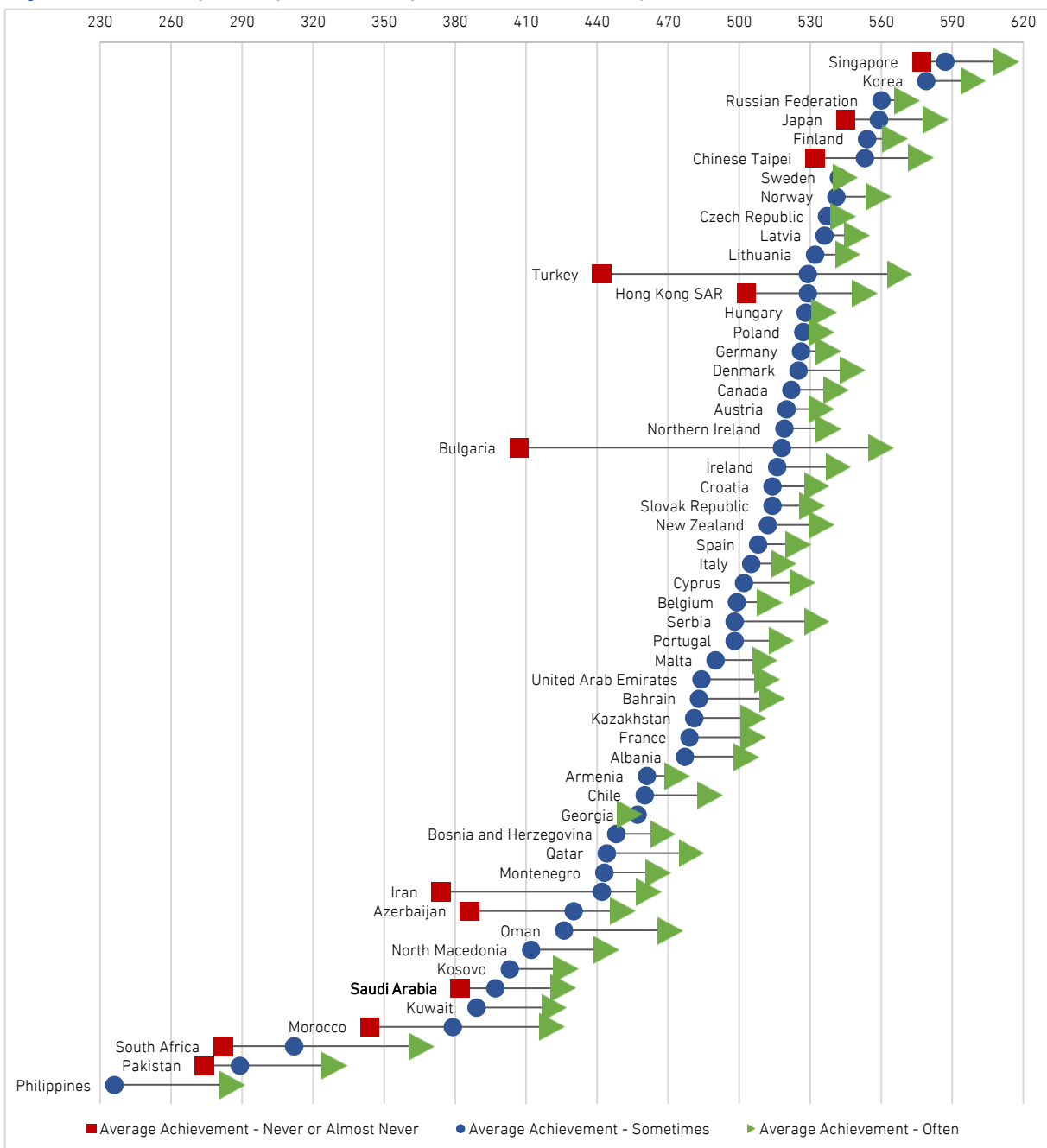
SOURCE: Exhibit 5.12: Home Early Literacy and Numeracy Activities Before Primary School. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 5.6 presents the science achievement in the participating countries for Grade 4 across Home Early Literacy and Numeracy Activities Before Primary School. The same tendency as in mathematics was noticed: there is a positive relationship

between the amount of time spent on pre-school educational activities and obtaining later science achievements.

The disparity in achievement between those who often experienced Home Early Literacy and Numeracy Activities and those who have experienced those activities sometimes is around 29 points for Saudi Arabia.

**Figure 5.6 Home Early Literacy and Numeracy Activities Before Primary School – Science Grade 4**



SOURCE: Exhibit 5.13: Home Early Literacy and Numeracy Activities Before Primary School. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

### Students Attended Preprimary Education

Preschool attendance is significantly related to further achievement in mathematics and science Figure 5.7 and Figure 5.8 show how the length of pre-primary education attendance corresponds to future educational results. Students were assigned to the following categories:

- Attended 3 Years or More,
- Attended 2 Years,
- Attended 1 Year or Less, and
- Did Not Attend.

Table 5.4 shows the Structure of G4 Students Attendance in Preprimary Education in Saudi Arabia compared to the International Average.

**Table 5.4** Structure of G4 Students Attendance in Preprimary Education in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Did Not Attend	30%	Math-387 Science-389	12%	Math-464 Science-452
Attended 1 Year or Less	39%	Math-399 Science-406	15%	Math-483 Science-472
Attended 2 Years	18%	Math-418 Science-429	17%	Math-495 Science-489
Attended 3 Years or More	12%	Math-424 Science-423	56%	Math-509 Science-500

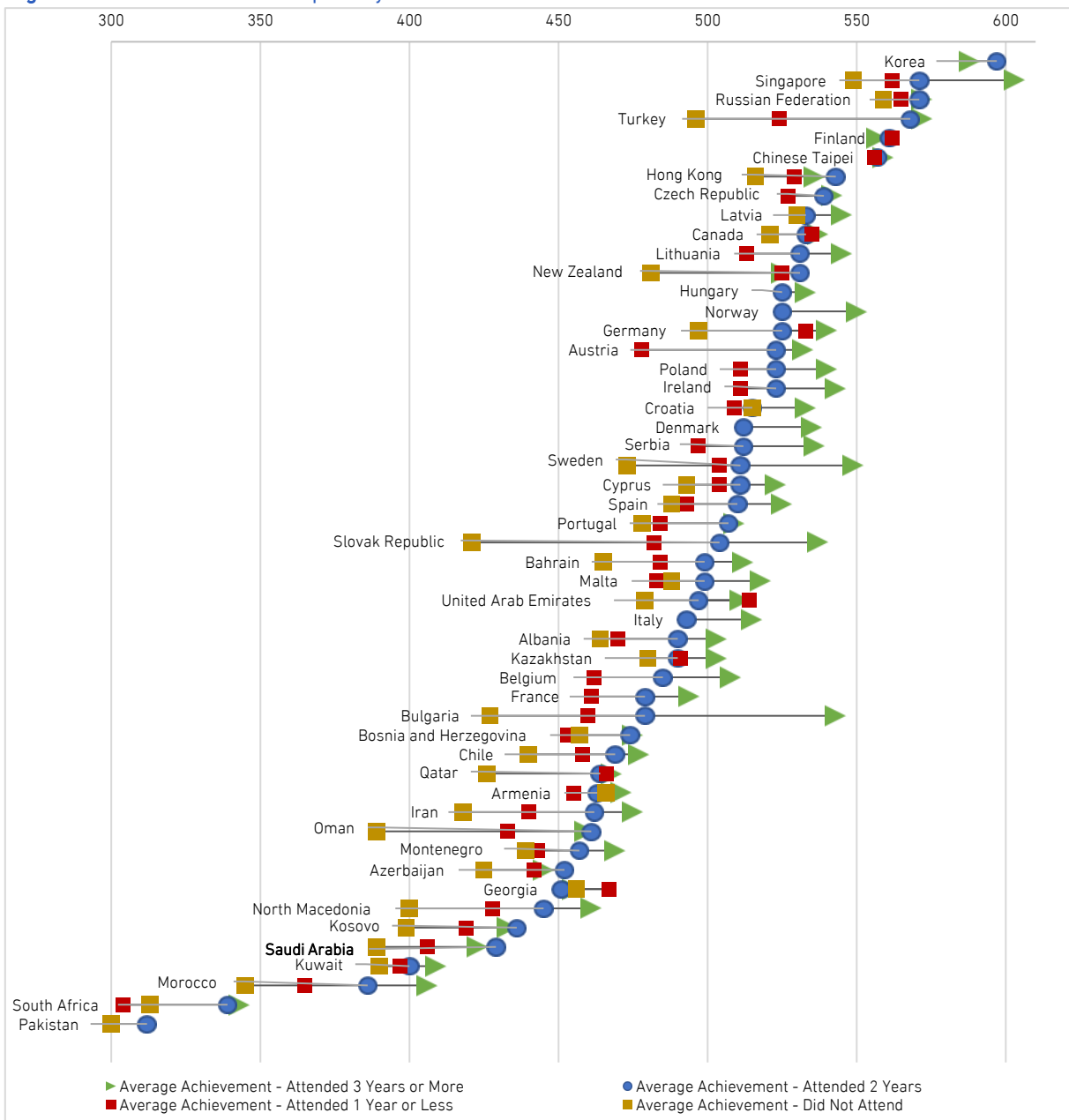
SOURCE: Exhibit 5.14, and Exhibit 5.15: Students Attended Preprimary Education. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

In Saudi Arabia, 30% of the fourth-graders who did not attend the pre-primary scored on average 387 points in Mathematics and 389 points in Science. Students who attended one year or less (39%) scored on average, 399 points in Mathematics, and 406

points in Science. Students who did attend the pre-primary education for two years (18%) scored on average 418 points in Mathematics and 429 points in Science. Lastly, students who experienced this type of education for 3 years or more (12%) scored on average, 424 points in Mathematics, and 423 points in Science.

**Figure 5.7** illustrates students' attendance in pre-primary education and their later scores in Science

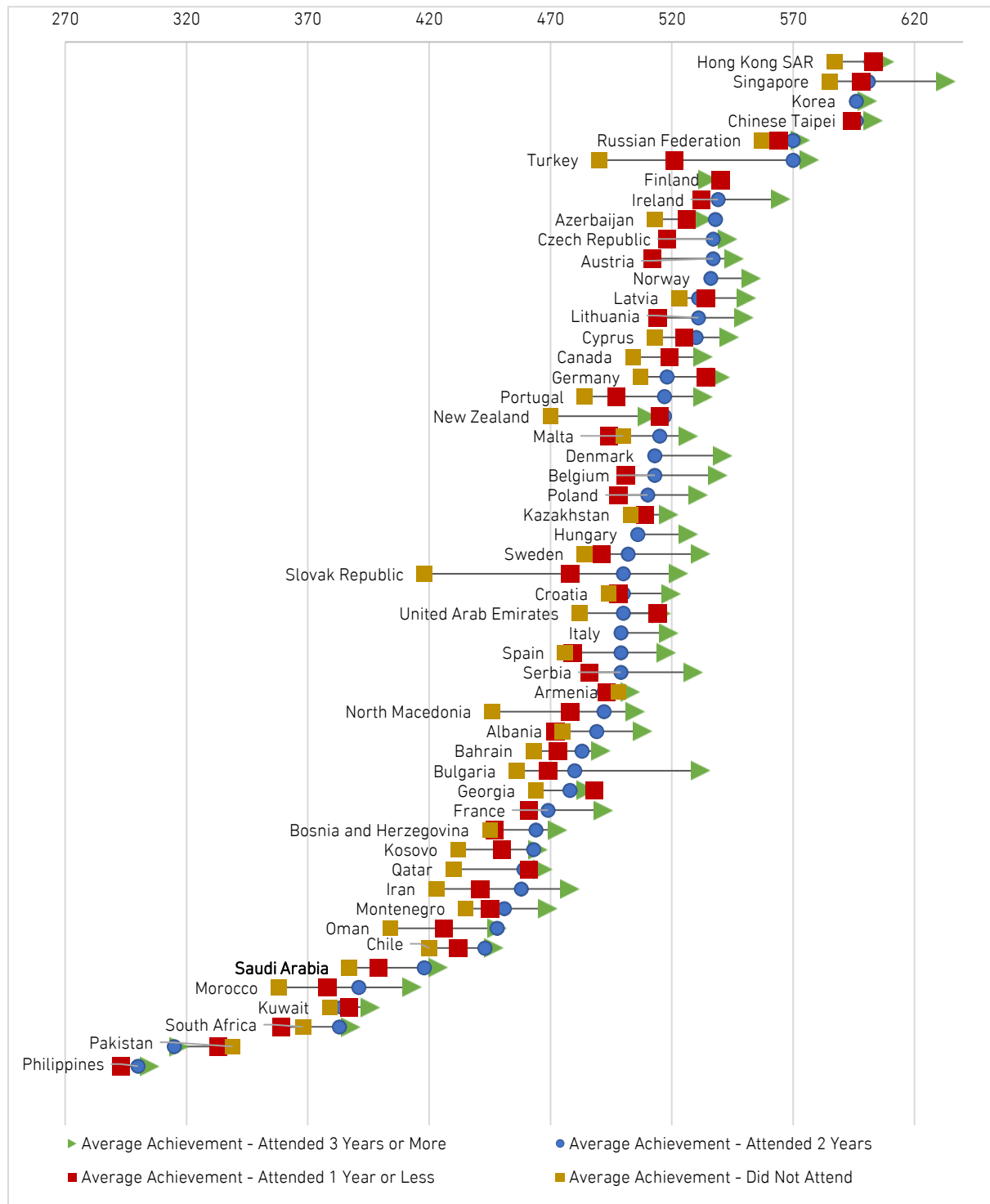
**Figure 5.7** Students Attended Preprimary Education – Science Grade 4



SOURCE: Exhibit 5.15: Students Attended Preprimary Education. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 5.8 presents the data for Mathematics achievement. The countries with the lowest share of not-attending students are Hungary, Denmark, and Chinese Taipei.

Figure 5.8 Students Attended Preprimary Education – Mathematics Grade 4



SOURCE: Exhibit 5.14: Students Attended Preprimary Education. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

In the majority of countries, the low attendance of pre-primary education corresponds to lower achievement, both in mathematics and in science – almost for each of the participating countries, the positive relationship between the number of years fourth-graders attended pre-primary education and their mathematics achievements are being observed. The same tendency was noticed in Saudi Arabia. In light of very low pre-primary education attendance, these results suggest increasing pre-primary education participation, although deeper analysis is required to guide such a policy, considering the importance of the quality of pre-primary education as well as the issue of equality of opportunity.

Both pre-school educational activities and pre-primary education attendance proved to be significantly correlated to one another and with achievement in mathematics and science. It is worth to underline that parental involvement in literacy and numeracy activities cannot be fully replaced by pre-primary education. Children whose parents were often involved in preparing them for later education and had greater home resources had, on average higher results in mathematics and scientific tests at each level of pre-primary attendance. The same pattern can be observed for Saudi Arabia, but parents' involvement in preparing their children for later education even more strongly differentiate students.



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## Chapter 6

### School Composition and Resources

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## School Composition and Resources

### Socioeconomic Background of the Student Body

The School Composition by Socioeconomic Background is an important factor in school performance analysis. This scale characterizes participating schools in terms of the socioeconomic backgrounds of attending students. This scale is often used to adjust educational achievement by the household factors.

To construct the scale, the approximate percentage of students in the school who had economically disadvantaged homes and economically affluent homes was assessed. In both questions, principals could choose one of the four answers: from 0% to 10%, from 11% to 25%, from 26% to 50%, and more than 50%. Schools were being divided into three of the following categories:

- More Affluent (are described as educational establishments where more than 25% of its students come from economically affluent homes, and additionally not more than 25% come from economically disadvantaged homes),
- More Disadvantaged (schools, which are characterized by having more than 25% of their students from economically disadvantaged homes, and less than 25% of them from economically affluent homes), and
- Neither More Affluent nor More Disadvantaged (this category describes all schools, which could not be assigned to any of the other two groups).

**Table 6.1** presents the structure of G4 School Composition by Socioeconomic Background of the Student Body in Saudi Arabia and the international average.



**Table 6.1** Structure of G4 School Composition by Socioeconomic Background of the Student Body in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
More Disadvantaged	24%	Math-371 Science-365	25%	Math-479 Science-467
Neither More Affluent Nor More Disadvantaged	38%	Math-393 Science-395	34%	Math-499 Science-489
More Affluent	38%	Math-425 Science-432	41%	Math-521 Science-512

SOURCE: Exhibits 6.2, and 6.3: School Composition by Socioeconomic Background of the Student Body. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

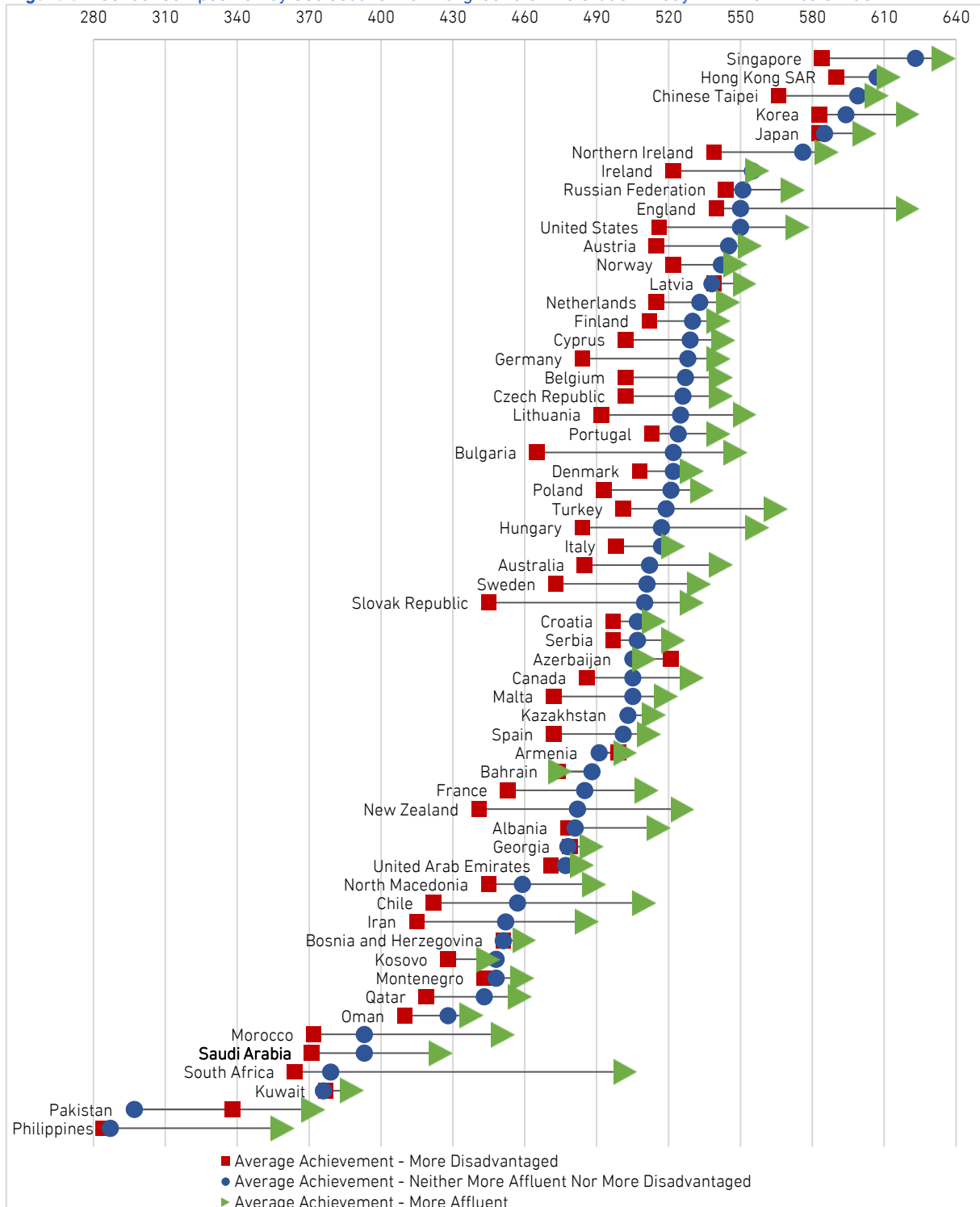
Table 6.1 shows how different socioeconomic backgrounds are related to the obtained average mathematics and science achievements. In general, as confirmed by most of the international assessments, students from disadvantaged families have lower achievement in all subjects. The scale of these inequalities in achievement across the socioeconomic background serves as a measure of how the educational system is able to equalize opportunities for youths.

Saudi Arabia has a similar school composition by socioeconomic background as the international average. To be precise: 38% of schools were described as More Affluent, 38% as Neither More Affluent nor More Disadvantaged, and the remaining 24% as More Disadvantaged. In the International Average, 41% of schools are in the More Affluent category, 34% of schools are in Neither More Affluent nor More Disadvantaged category, and there are 25% of schools in More Disadvantaged category.

The International Average difference in school performance between the "More Affluent" and "More Disadvantaged" category is equal to 42 points, while in Saudi Arabia, this difference equals 54 in grade four in mathematics. **Figure 6.1** shows the achievement of students by the Schools Composition by Socioeconomic Background of

the Students Body for all countries participating in the mathematics assessment for fourth-graders.

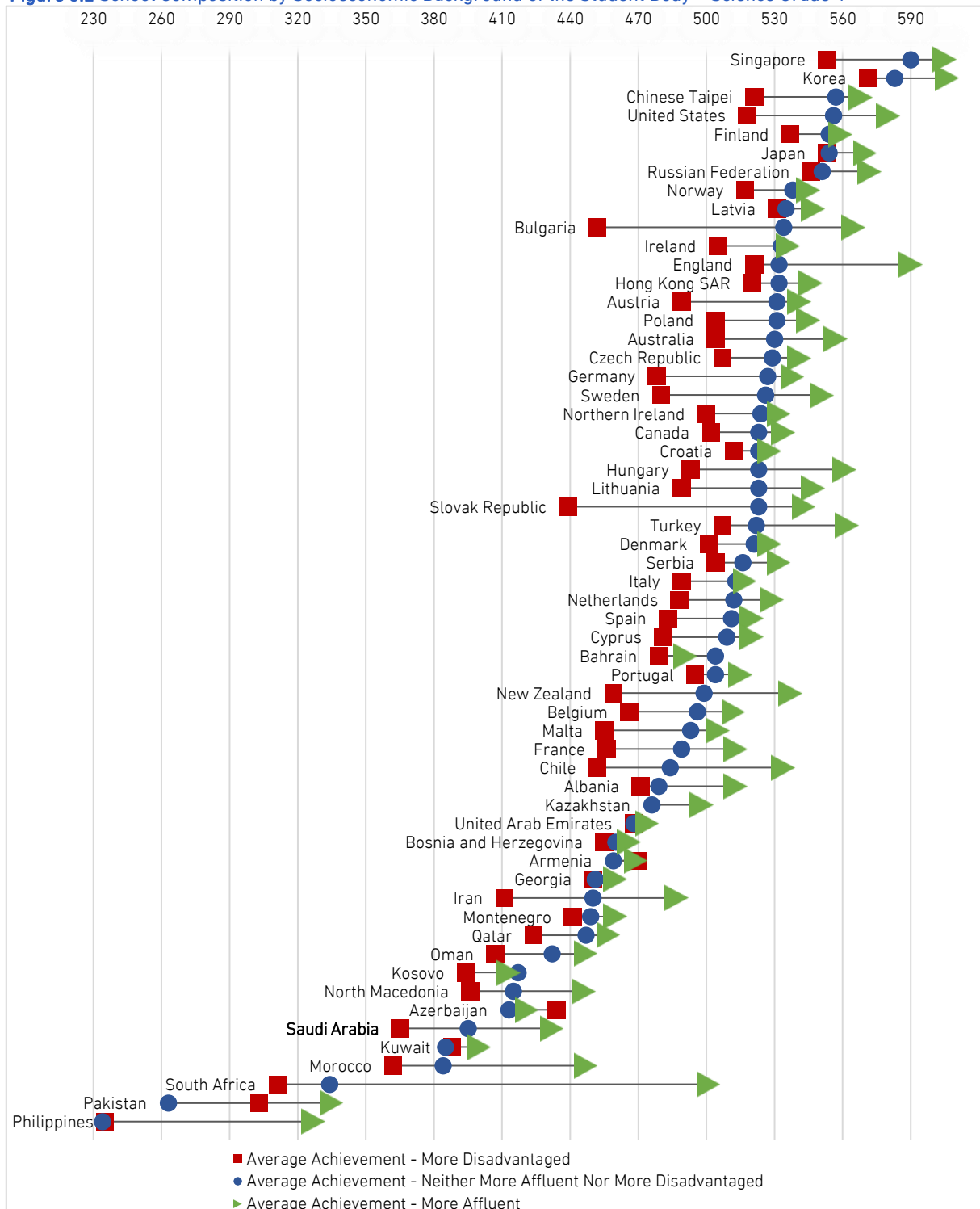
**Figure 6.1 School Composition by Socioeconomic Background of the Student Body – Mathematics Grade 4**



SOURCE: Exhibit 6.2: School Composition by Socioeconomic Background of the Student Body. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 6.2 shows similar data for science achievement. In Saudi Arabia, fourth-graders from "More Affluent" schools scored in science on average by 67 points more than their peers attending school with a "More Disadvantaged" student body.

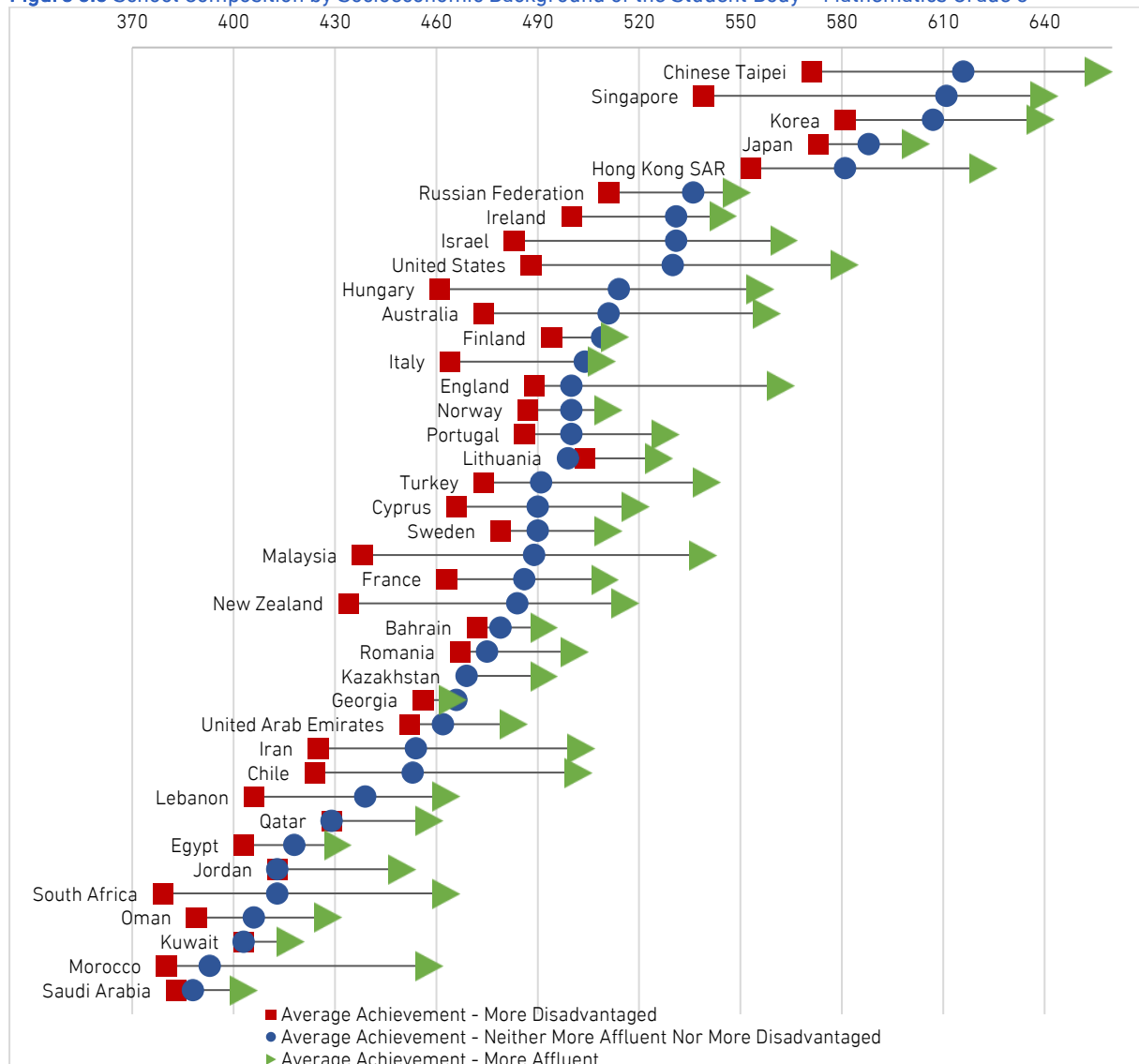
Figure 6.2 School Composition by Socioeconomic Background of the Student Body – Science Grade 4



SOURCE: Exhibit 6.3: School Composition by Socioeconomic Background of the Student Body. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

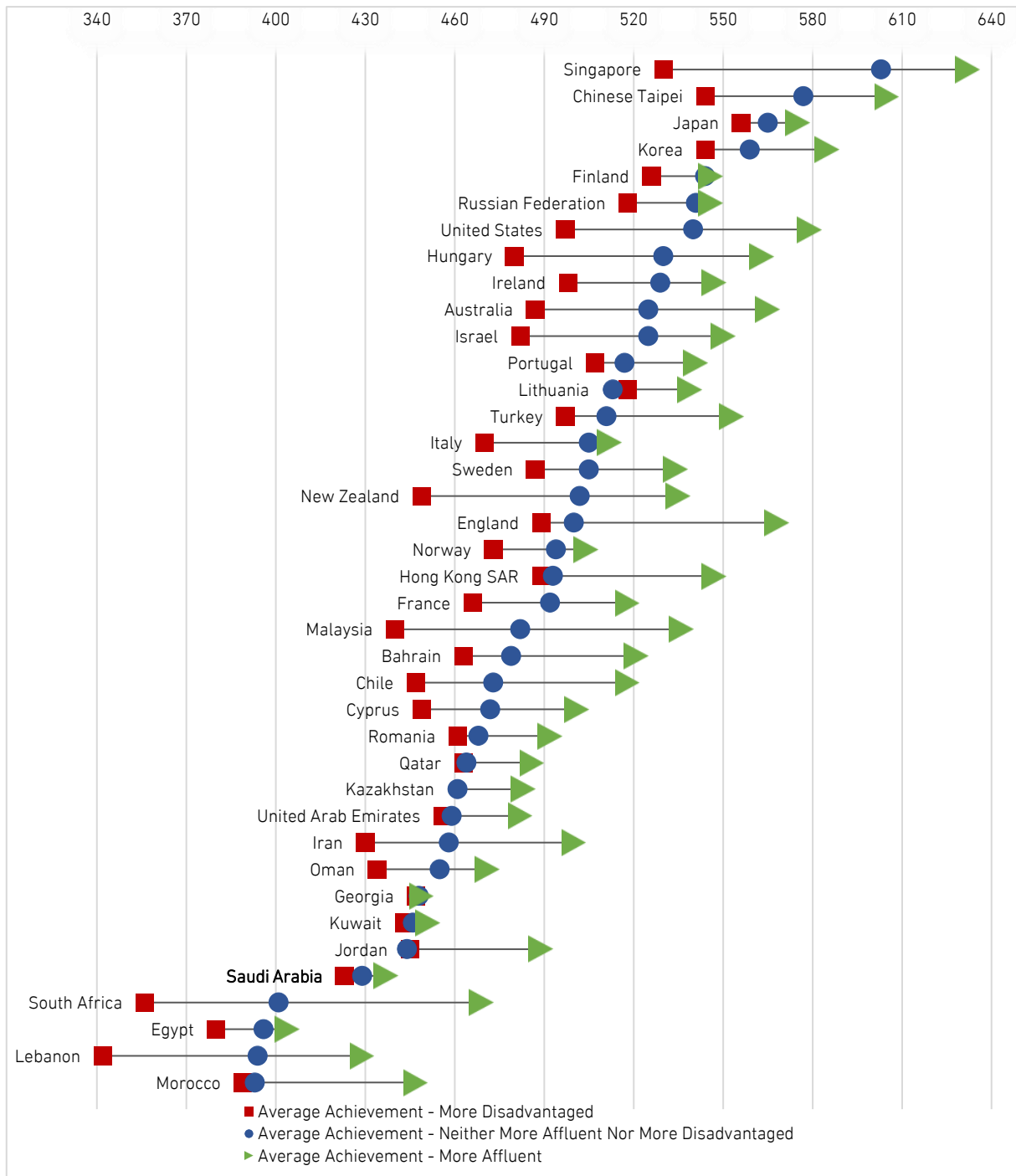
One of the key aims of the educational systems worldwide is to provide equal opportunities for children, regardless of their socioeconomic status. Comparing socioeconomic inequalities in achievement for four-graders to eight-graders allows seeing if the system deepened or equalized youths' opportunities over the years. The next two figures (**Figure 6.3** and **Figure 6.4**) also present School Composition by Socioeconomic Background of the Students Body, but this time they concern Average Achievements for eight-graders, respectively, in mathematics (all TIMSS countries) and science assessments.

**Figure 6.3 School Composition by Socioeconomic Background of the Student Body – Mathematics Grade 8**



SOURCE: Exhibit 6.4: School Composition by Socioeconomic Background of the Student Body. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>

**Figure 6.4 Schools Composition by Socioeconomic Background of the Student Body – Science Grade 8**



SOURCE: Exhibit 6.5: School Composition by Socioeconomic Background of the Student Body. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

In general, data confirm patterns visible among the fourth-graders: as the number of students from more wealthy families increases, schools record better average mathematical, and science results for their students. The same dependency can be noticed for data obtained from Saudi Arabia. However, both for mathematics and

science, the difference between 'More Affluent and "More Disadvantaged" schools is much lower in Saudi Arabia than in other countries (only 54 points in mathematics, and 67 points in science).

### **Instruction Affected by Resource Shortages**

Not only household shortages and socioeconomic backgrounds are relevant to students' achievement. This section takes up the issue of how learning is affected by school instructional Resource Shortages. The mathematics resources scale was created based on questions about 13 school and classroom resources and if their shortage or inadequacy was affecting the carried activities. The following general resources categories were assessed: instructional materials, supplies, school buildings, and grounds, heating/cooling, and lighting systems, instructional space, technologically competent staff, audio-visual resources for the delivery of instruction, and computer technology for teaching and learning. Besides, there were also 5 other categories of specifically Mathematical Instruction Resources: a teacher with a specialization in mathematics, computer software/applications for mathematics instruction, library resources to mathematics instruction, calculators for mathematics instruction, and concrete objects or materials to help students understand quantities or procedures. The schools in Saudi Arabia as well as in the other participating countries were measured by three school resource index values, namely: "Highly Affected", "Somewhat Affected", and "Not Affected".

Table 6.1 and Table 6.2 present the percentages of students at each level and their average achievement (for Saudi Arabia and the International Average) respectively for mathematics and science.

**Table 6.2** Structure of G4 Instruction Affected by Mathematics Resource Shortages in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Affected A Lot	19%	416	6%	473
Somewhat Affected	72%	393	68%	499
Not Affected	9%	409	26%	514

SOURCE: Exhibits 6.14: Instruction Affected by Mathematics Resources Shortages – Principals' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Table 6.3** Structure of G4 Instruction Affected by Science Resource Shortages in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Affected A Lot	21%	422	7%	472
Somewhat Affected	69%	394	69%	488
Not Affected	9%	424	24%	508

SOURCE: Exhibits 6.17: Instruction Affected by Science Resources Shortages – Principals' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

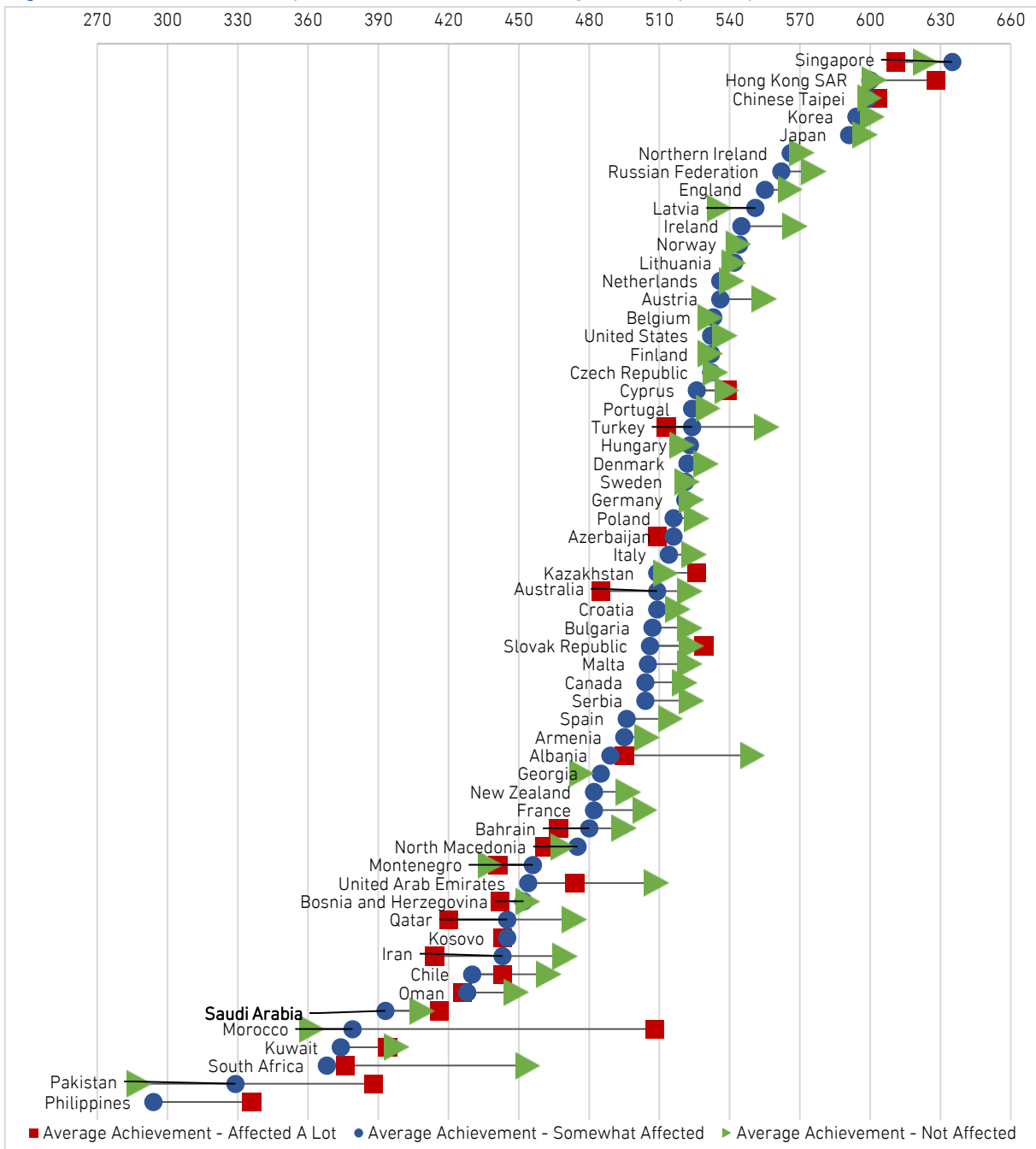
In general, the analysis shows that students attending better-equipped facilities are achieving slightly better mathematical results. Surprisingly, the opposite relation was noticed in Saudi Arabia in mathematics. In schools where instruction was affected a lot by mathematics resources shortages, fourth-graders scored on average 416 points compared to 393 and 409 points in respectively, "Somewhat affected" and "Not affected" category.

Similarly, the Science Resources Shortage is in general related to lower achievement in science in most of the countries. Students attending better-equipped facilities score on average higher. However, in the case of Saudi Arabia, students attending schools where instruction was reported to be affected by shortages in science

educational recourses obtained on average similar results as those attending schools not affected by science resource shortages.

Figure 6.5 and Figure 6.6 presents the relation of the instruction affected by mathematics, and science resource shortages, and achievements in mathematics and science respectively, across the participating countries.

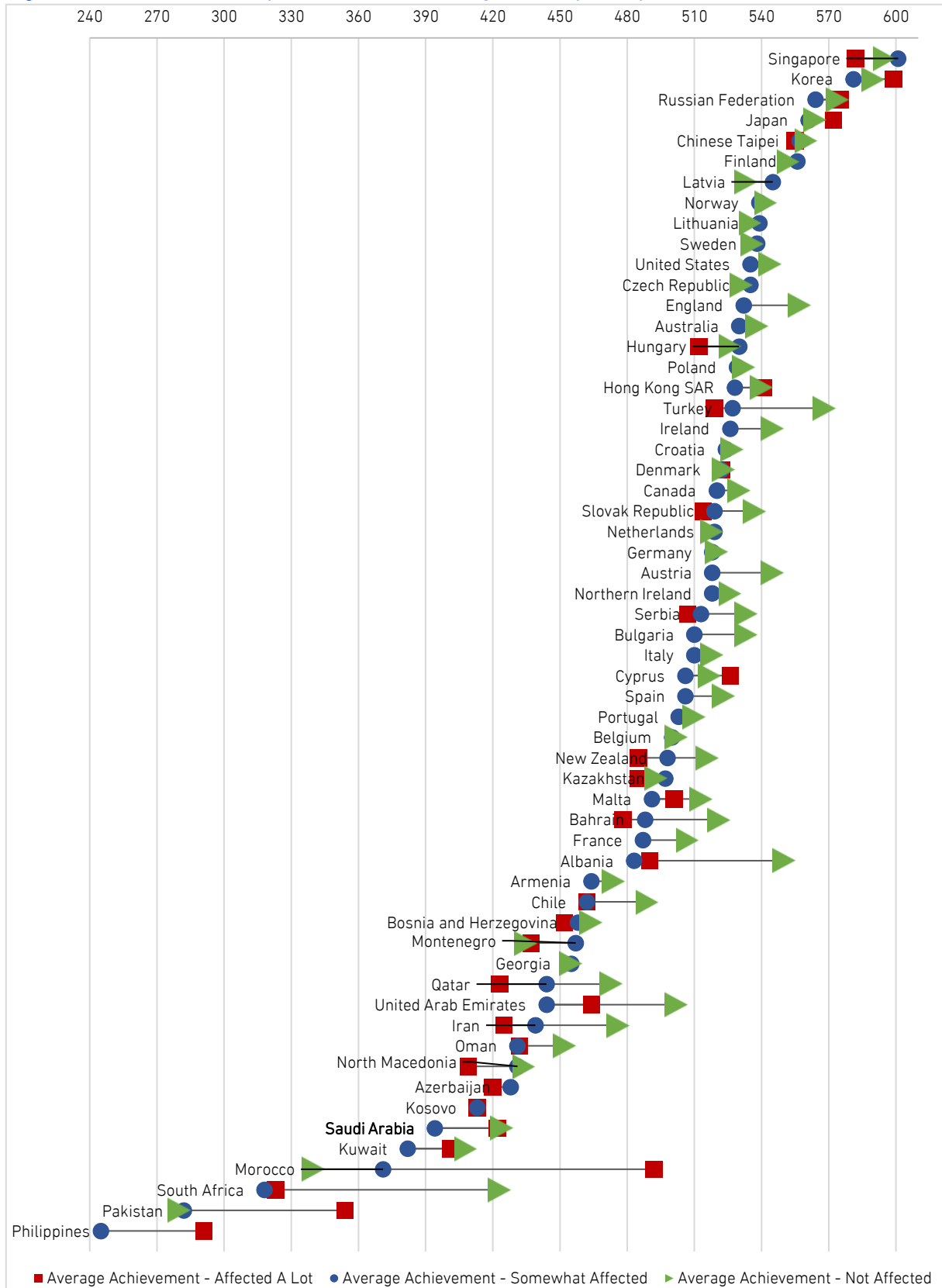
**Figure 6.5 Instruction Affected by Mathematics Resource Shortages – Principals' Reports – Mathematics Grade4**



SOURCE: Exhibit 6.14: Instruction Affected by Mathematics Resource Shortages – Principals' Reports. IEA's Trends in International Mathematics and Science Study – TIMSS 2019. Downloaded from <http://timss2019.org/download>



Figure 6.6 Instruction Affected by Science Resource Shortages – Principals' Reports - Science Grade 4



SOURCE: Exhibit 6.17: Instruction Affected by Science Resource Shortages – Principals' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>

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## **Chapter 7**

### **School Climate**

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## School Climate

### Parents' Satisfaction with the School

An interesting perspective of the quality of schooling is provided by parents' views. Parents of four-graders were asked about the extent to which they are satisfied with the extent their child's school promotes academic standards and fosters a positive school climate. Respondents could have marked one of the following answers: "Agree a lot", "Agree a little", "Disagree a little", or "Disagree a lot" in regard to several school-related statements. **Table 7.1** presents the share of students and their average achievement (for Saudi Arabia and the International Average) in each of the categories.

**Table 7.1** Structure of G4 Parents' Perceptions of Their Child's School in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Less than Satisfied	3%	Math-393 Science-388	5%	Math-495 Science-491
Somewhat Satisfied	17%	Math-390 Science-388	31%	Math-497 Science-487
Very Satisfied	80%	Math-404 Science-410	64%	Math-504 Science-493

SOURCE: Exhibits 7.7, and Exhibit 7.8: Parents' Perceptions of Their Child's School. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

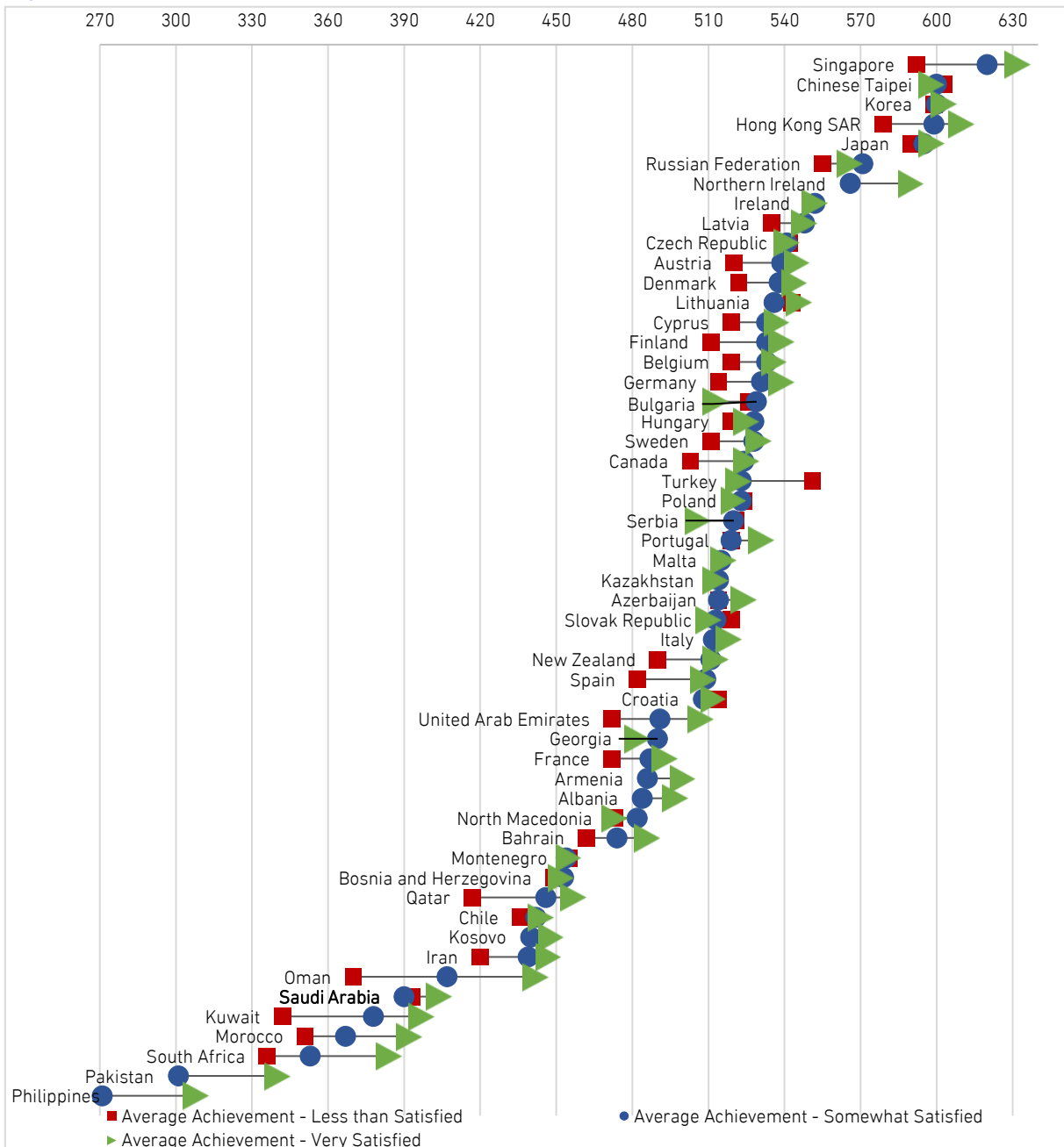
Saudi Arabia stands out in terms of how satisfied are parents with their children's schools. 80% of four-graders had parents classified as Very Satisfied (The International Average is 64%). The average mathematical achievement was only slightly better across top-performing countries in the "Very Satisfied" category.

An even lower correlation was found internationally for science achievement (the International Averages were estimated at 493, 487, and 491 points, respectively in the Very Satisfied, Somewhat Satisfied, and Less than Satisfied group). In Saudi Arabia, students assigned to the Very Satisfied category (410 points) scored on average 22

points more than the others (Somewhat Satisfied – 388 points, and Less than Satisfied – 388 points). Achievements in mathematics reveal similar patterns.

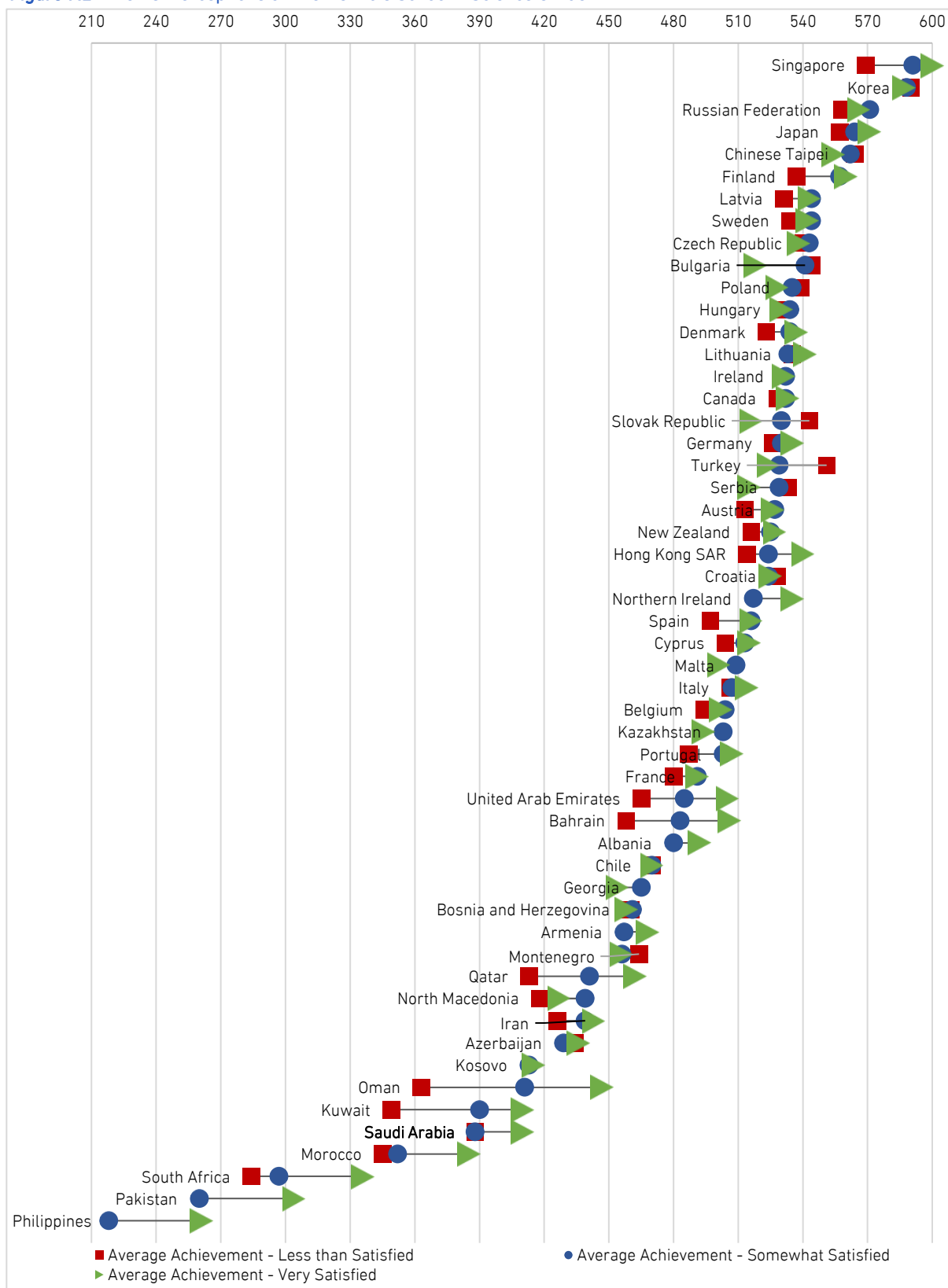
Figure 7.1 and Figure 7.2 present fourth-graders achievement by these three categories in mathematics and science respectively.

Figure 7.1 Parents' Perceptions of Their Child's School – Mathematics Grade 4



SOURCE: Exhibit 7.7: Parents' Perceptions of Their Child's School. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 7.2 Parents' Perceptions of Their Child's School – Science Grade 4



SOURCE: Exhibit 7.8: Parents' Perceptions of Their Child's School. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Students' Sense of School Belonging

International evidence shows that Students' Sense of School Belonging is an important factor in education for many reasons. The TIMSS Student's Sense of School Belonging scale measures what the student's attitude towards their school is.

- Students with a High Sense of School Belonging had a score at or above the cut score corresponding to "agreeing a lot" with three of the five statements and "agreeing a little" with the other two statements, on average.
- Students with Little Sense of School Belonging had a score at or below the cut score corresponding to "disagreeing a little" to three of the five statements and "agreeing a little" with the other two statements, on average.
- All other students had Some Sense of School Belonging.

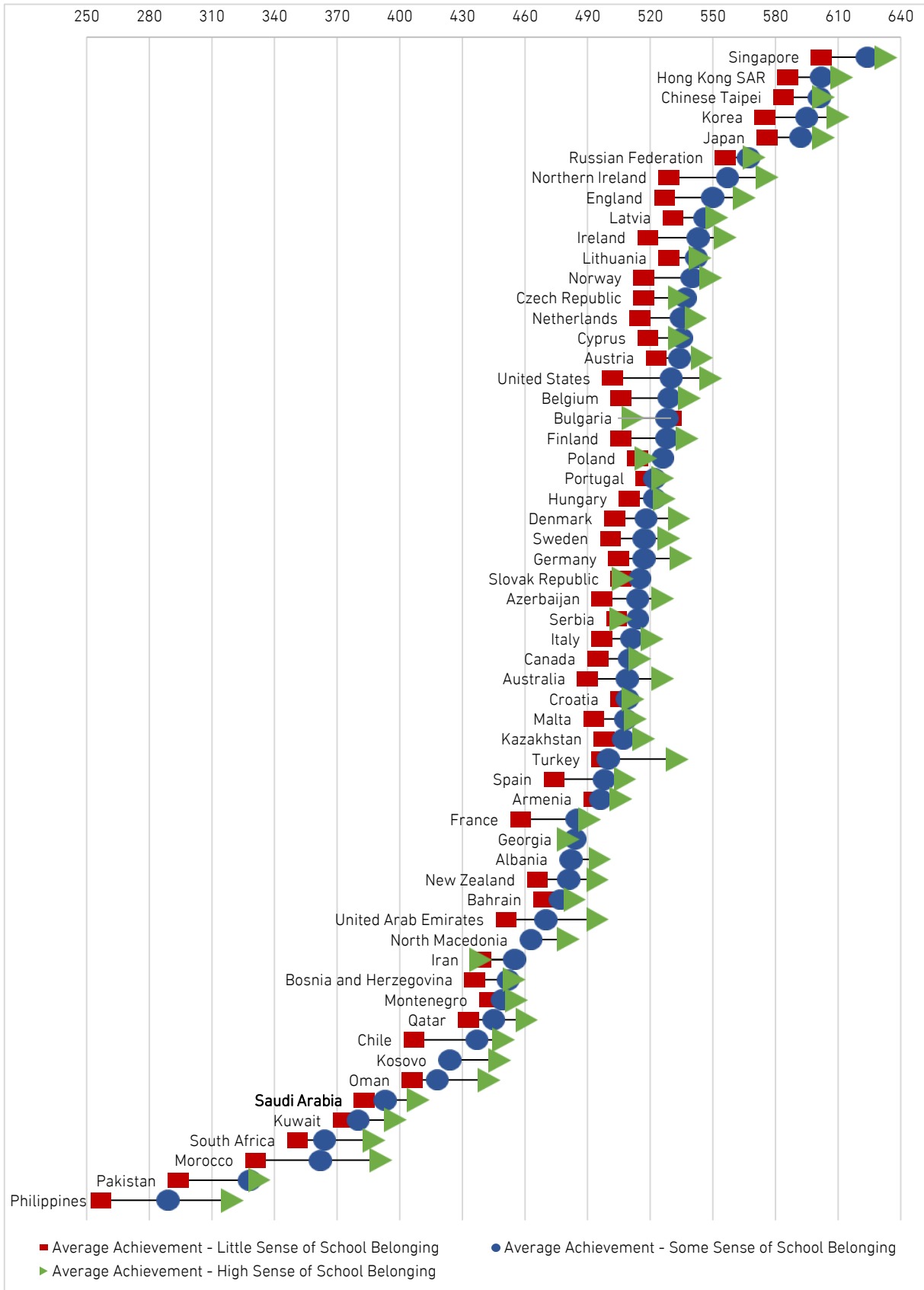
**Table 7.2** shows the share of students in each category and their corresponding achievement in Saudi Arabia and the International Average. In relation to the International Average (High Sense of School Belonging - 58%, Average Achievements – 508 points in Mathematics, and 497 points in Science; Some Sense of School Belonging – 34%, Average Achievements – 498 points in Mathematics, and 487 points in Science, and in Little Sense of School Belonging– 8%, Average Achievements – 484 points in Mathematics, and 476 points in Science), in Saudi Arabia, the index of Sense of School Belonging is relatively higher (65% of students were assigned to "High Sense of Belonging" category).

**Table 7.2** Structure of G4 Students' Sense of School Belonging in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Little Sense of School Belonging	8%	Math-383 Science-381	8%	Math-484 Science-476
Some Sense of School Belonging	27%	Math-393 Science-395	34%	Math-498 Science-487
High Sense of School Belonging	65%	Math-409 Science-416	58%	Math-508 Science-497

SOURCE: Exhibits 7.10, and Exhibit 7.11: Students' Sense of School Belonging. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

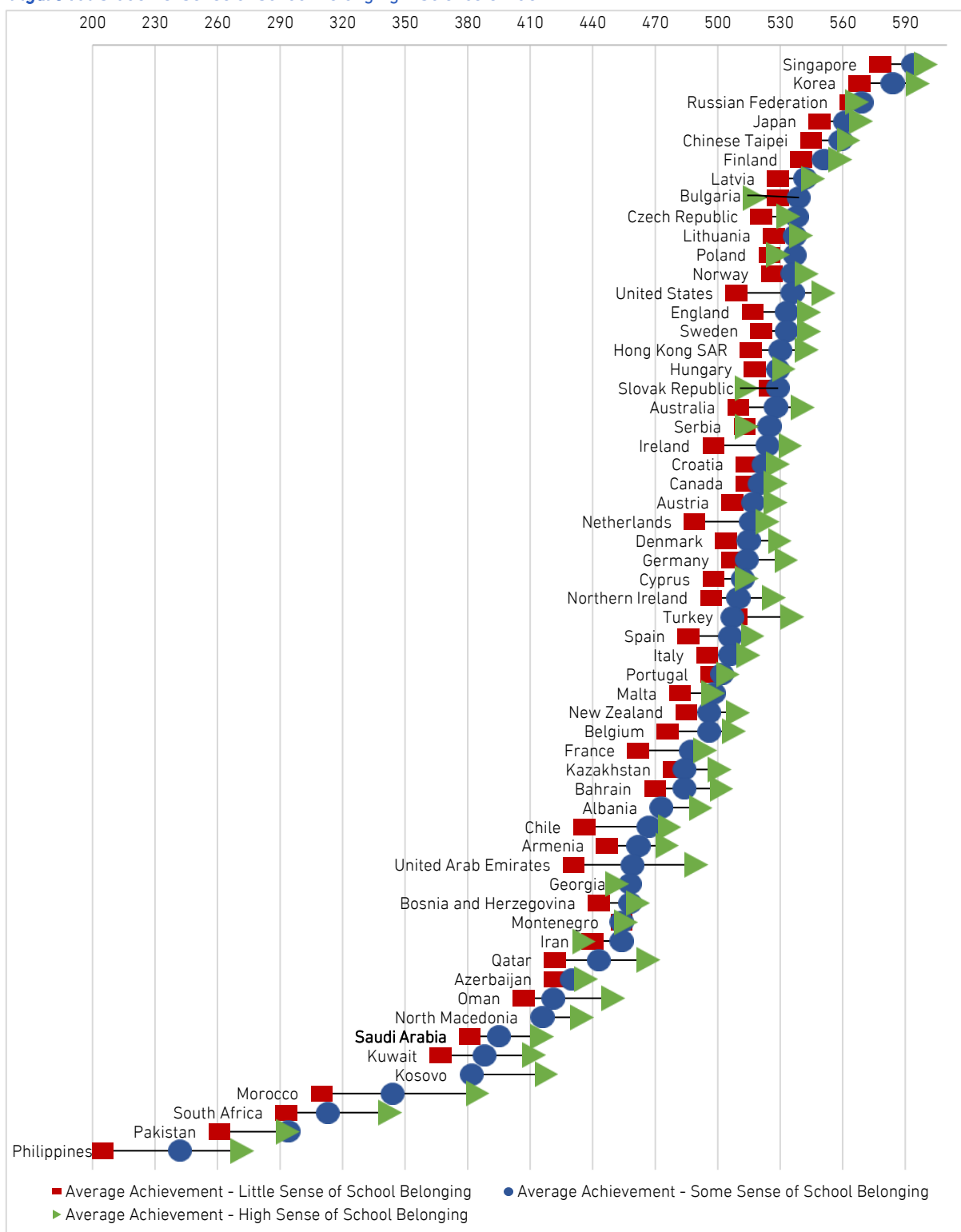
It can be observed that fourth-graders with a higher sense of belongings score on average higher. That pattern was also observed in data from Saudi Arabia (in mathematics - 409, 393, and 383 points, and in science - 416, 395, and 381 points, respectively. **Figure 7.3** and **Figure 7.4** show the achievement of fourth-graders by three categories of Students' Sense of School Belonging, respectively, for mathematics and science assessment.

**Figure 7.3 Students' Sense of School Belonging – Mathematics Grade 4**

SOURCE: Exhibit 7.10: Students' Sense of School Belonging. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.



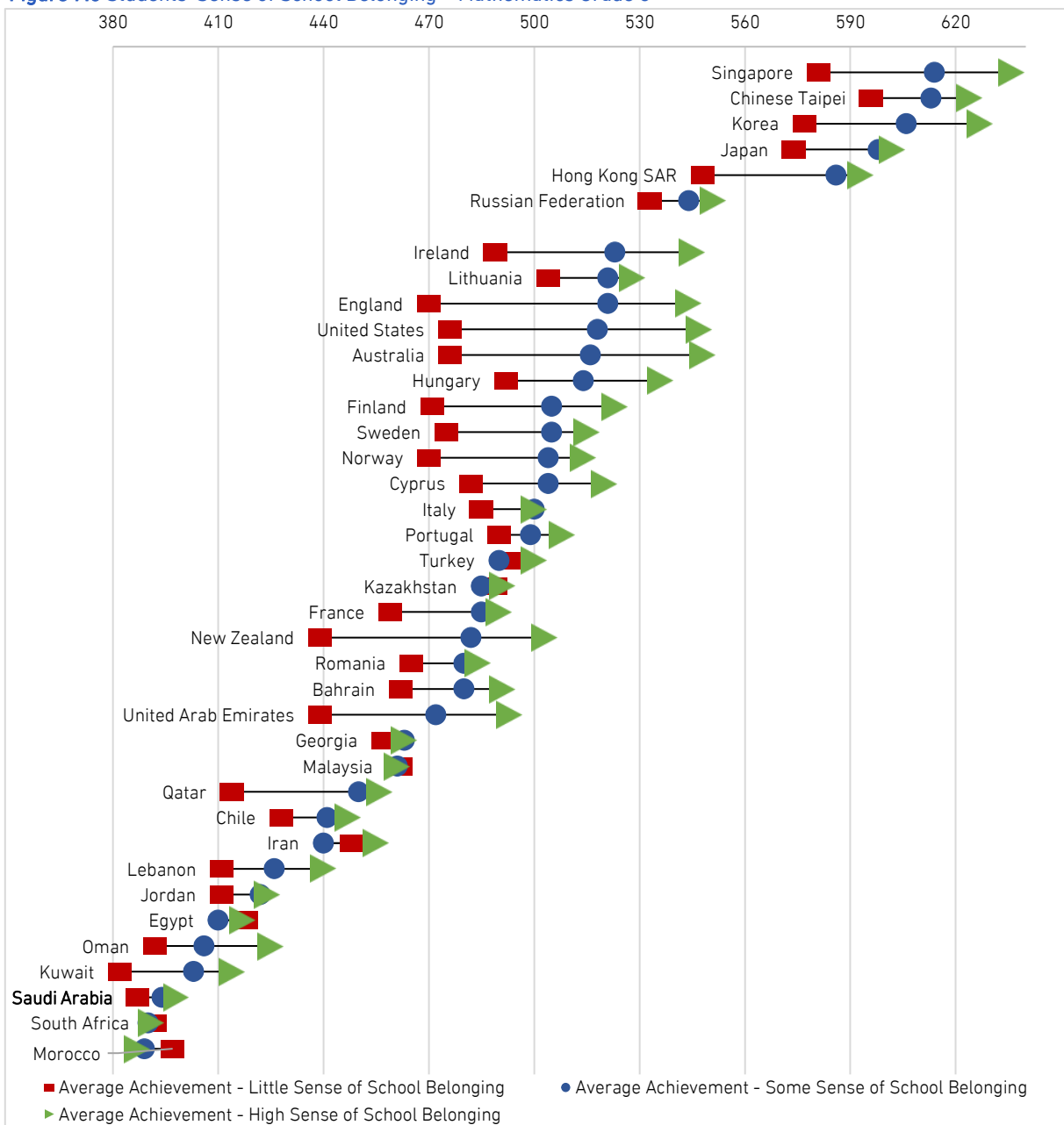
Figure 7.4 Students' Sense of School Belonging – Science Grade 4



SOURCE: Exhibit 7.11: Students' Sense of School Belonging. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

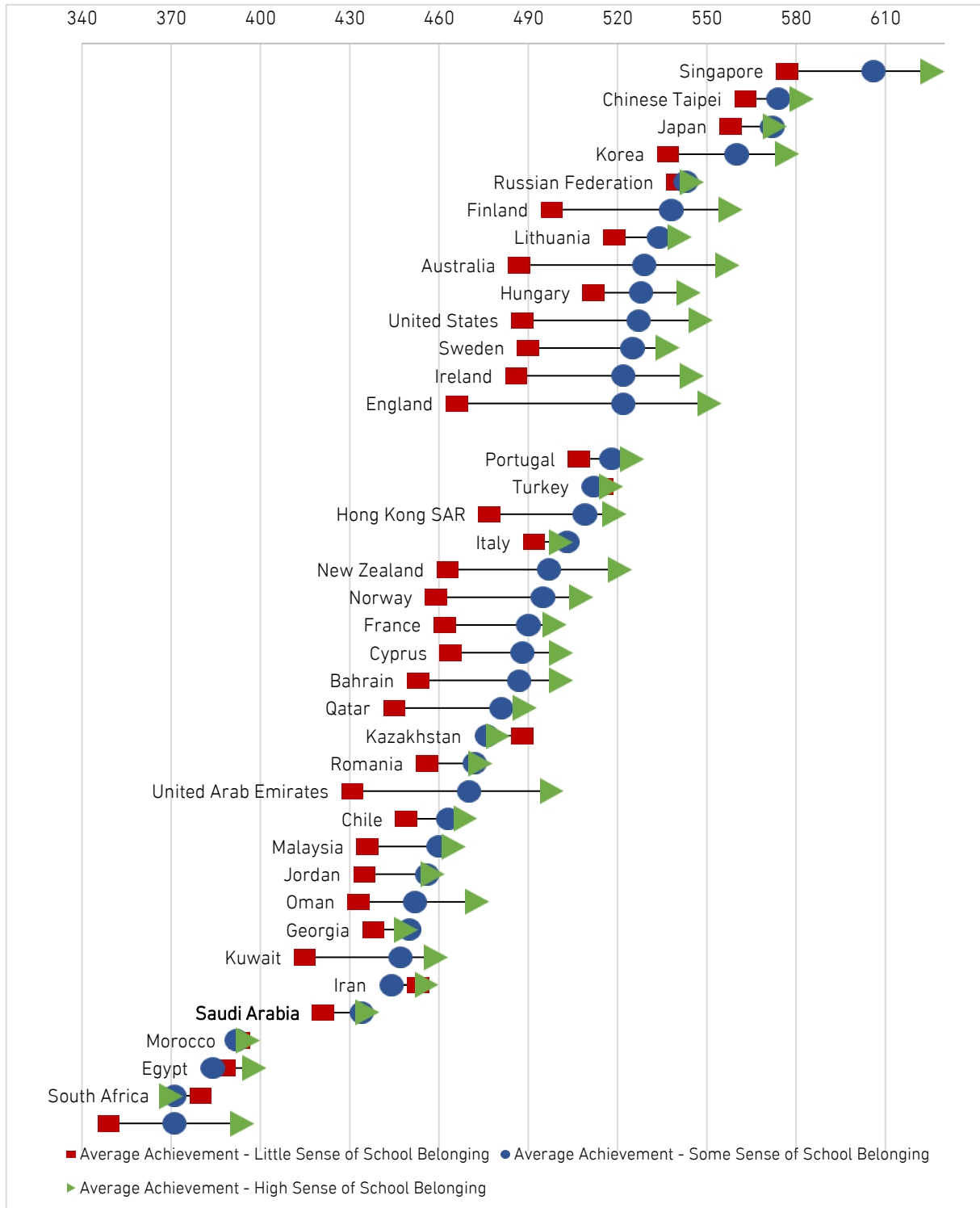
For eighth-graders in Saudi Arabia, the differences in achievement between categories of sense of belonging index are much lower. In Saudi Arabia, in both mathematics and science achievement, no significant difference between the results of students having high or some sense of school belongings was spotted. Figure 7.5 and Figure 7.6 show eighth-graders' achievement for participating in the assessment countries by the perceived sense of belonging.

**Figure 7.5 Students' Sense of School Belonging – Mathematics Grade 8**



SOURCE: Exhibit 7.12: Students' Sense of School Belonging. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 7.6 Students' Sense of School Belonging – Science Grade 8



SOURCE: Exhibit 7.13: Students' Sense of School Belonging. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

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## **Chapter 8**

### **School Discipline and Safety**

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## School Discipline and Safety

### School Discipline

In TIMSS assessment, school principals were asked for their perceptions about the extent that discipline, disorder, and bullying behaviors are problems in their school. To construct the scale, students were assigned to one of three categories based on principals' indicating potential problems on the School Discipline:

- Students in schools with Hardly Any Problems had a score at or above the cut score corresponding to their principals reporting that six of the eleven issues are "not a problem" and the other five are a "minor problem," on average.
- Students in schools with Moderate to Severe Problems had a score at or below the cut score corresponding to their principals reporting that six of the eleven issues are a "moderate problem" and the other five are a "minor problem," on average.
- All the other students were in schools with Minor Problems.

**Table 8.1** presents the share of the students at each level of discipline problems ("hardly any", "moderate to severe" and "minor") and corresponding average achievement according to the principals' reports.

**Table 8.1** Structure of G4 School Discipline – Principals' Reports in Saudi Arabia and international average

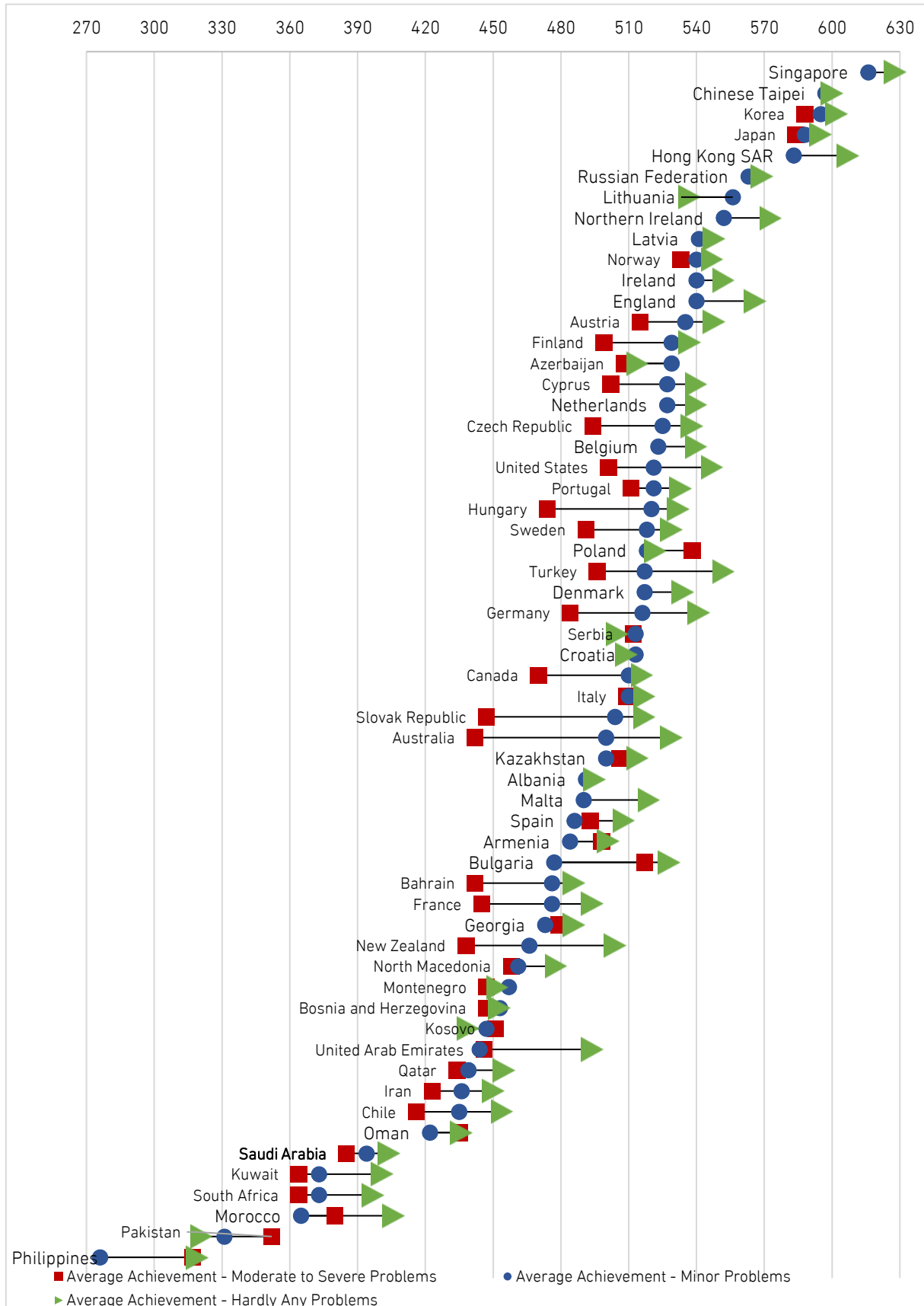
Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Moderate to Severe Problems	14%	Math-385 Science-389	8%	Math-466 Science-457
Minor Problems	23%	Math-394 Science-390	32%	Math-494 Science-483
Hardly Any Problems	64%	Math-404 Science-410	60%	Math-508 Science-498

SOURCE: Exhibits 8.2, and Exhibit 8.3: School Discipline – Principles' Reports. IEA's Trends in International Mathematics and Science Study – TIMSS 2019. Downloaded from <http://timss2019.org/download>.

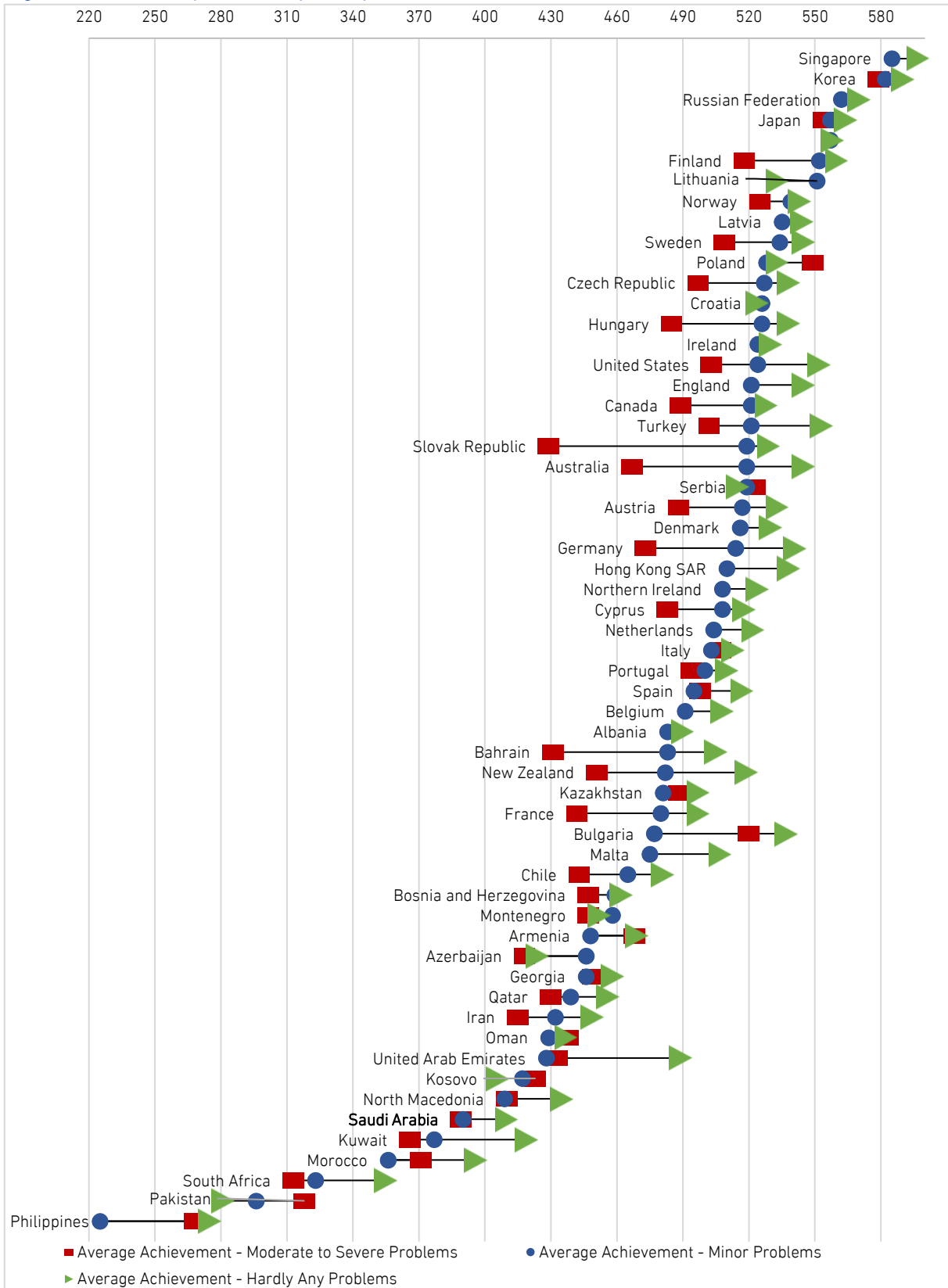
Consistently with other international evidence both averages of mathematics and science achievement were higher for students in schools with "hardly any problems" than for students in schools with "minor problems." In Saudi Arabia, as in most of the countries, students attending schools with greater levels of school discipline achieved, on average, better educational results. However, differences were minor (respectively 404, 394, and 385 points in mathematics, or 410, 390, and 389 points in science).

**Figure 8.2** and **Figure 8.3** present the achievement of fourth-graders attending school classified in each of the three categories, respectively, for mathematics and science assessments in each of the participating countries.

Figure 8.1 School Discipline – Principals' Reports – Mathematics Grade 4



SOURCE: Exhibit 8.2: School Discipline – Principals' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

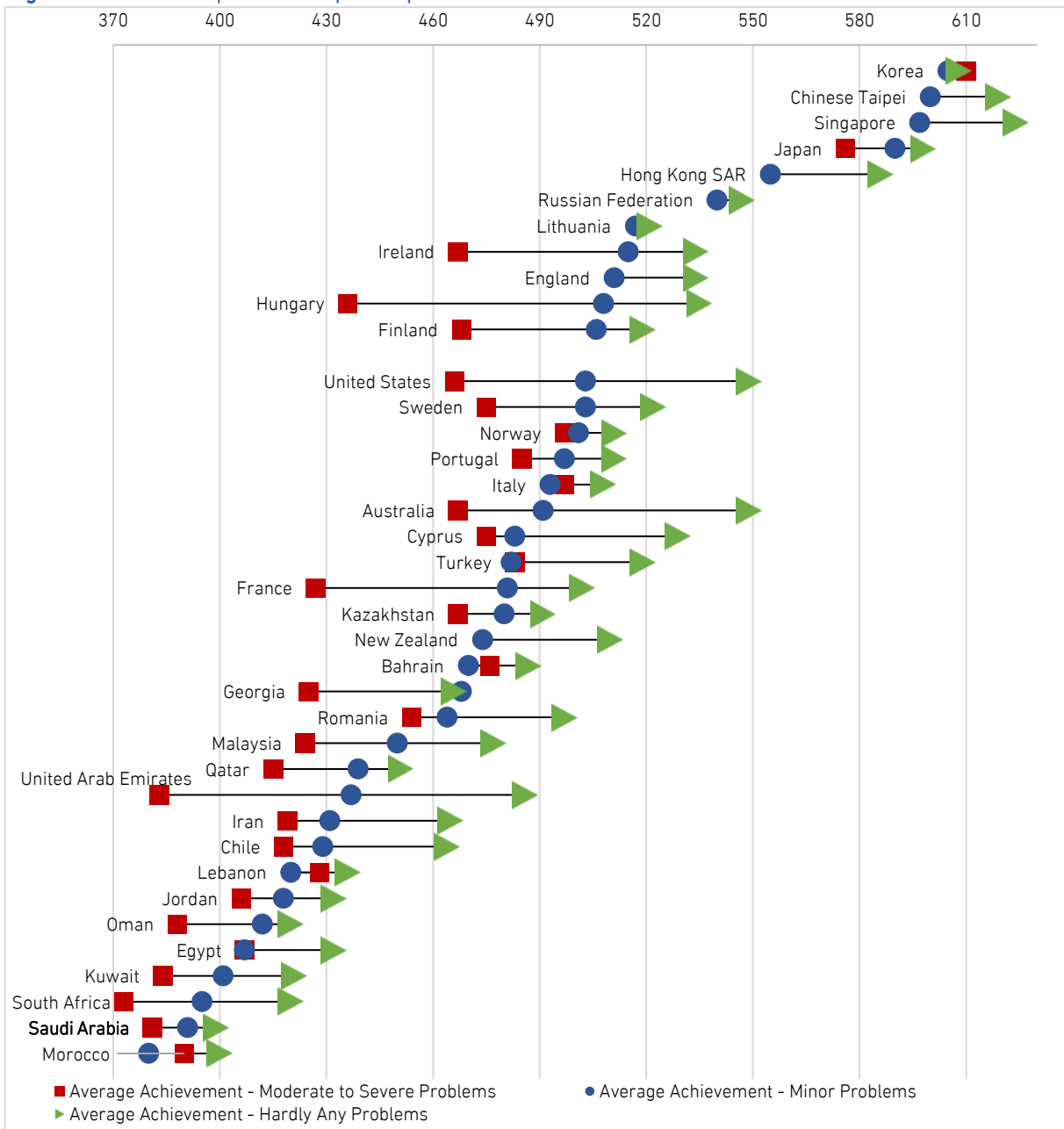
**Figure 8.2 School Discipline – Principals' Reports – Science Grade 4**

SOURCE: Exhibit 8.3: School Discipline – Principals' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

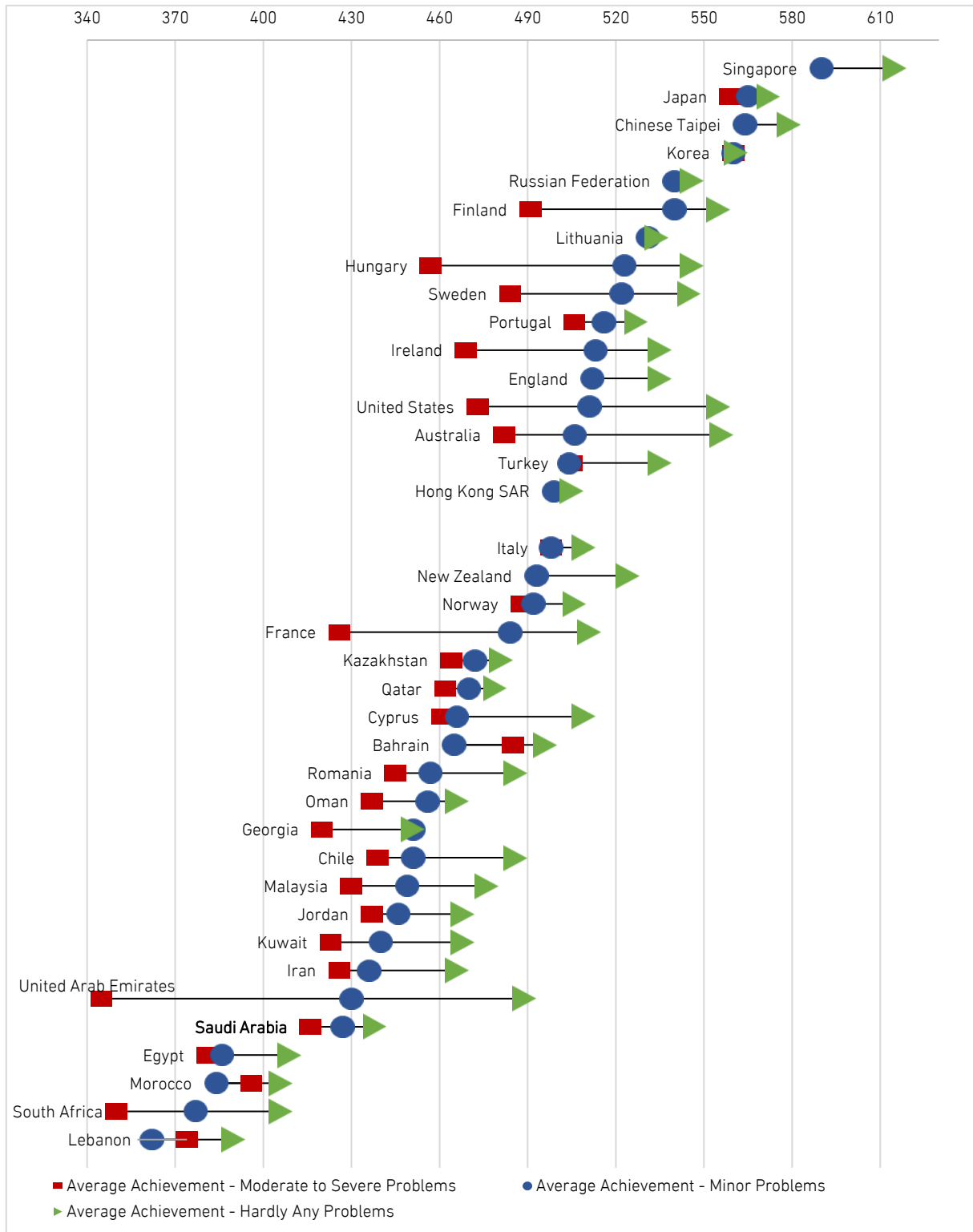


Similar patterns are observed for eight-graders. **Figure 8.3** and **Figure 8.4** present eighth-graders achievement by school discipline scale. Saudi Arabia has a relatively higher share of students in the "Hardly Any Problems" category than the international average. At the same time, the differences in achievement across the school discipline levels in the Kingdom are relatively small contrary to the e.g. Australia, Hungary, and United Arab Emirates.

**Figure 8.3 School Discipline – Principals' Reports – Mathematics Grade 8**



SOURCE: Exhibit 8.4: School Discipline – Principals' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 8.4 School Discipline – Principals' Reports – Science Grade 8**

SOURCE: Exhibit 8.5: School Discipline – Principals' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Safe and Orderly School

As proved by international evidence, a strong perception of safety and order in school is related to higher average achievement in mathematics and science. **Table 8.2** presents the average achievements and the share of students in schools regarding, perceived by teachers, safety and order in schools in G4.

**Table 8.2** Structure of G4 Safe and Orderly School – Mathematics and Science Teachers' Reports in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Less Safe and Orderly	Math-1% Science-2%	Math- ~ Science-~	Math-4% Science-4%	Math-495 Science-493
Somewhat Safe and Orderly	Math-20% Science-21%	Math-382 Science-387	Math-36% Science-35%	Math-495 Science-484
Very Safe and Orderly	Math-79% Science-76%	Math-403 Science-412	Math-61% Science-61%	Math-507 Science-497

SOURCE: Exhibits 8.7, and Exhibit 8.8: Safe and Orderly School – Teachers' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Across countries, more than half the fourth-grade students (61%) attending schools judged by teachers to be "very safe and orderly," with almost all of the remaining students (36%) perceived to be "somewhat safe and orderly" in schools. Internationally, students attending "very safe and orderly" schools, as reported by their teachers, had the highest average mathematics achievement (507) and science achievement (497) compared to students in "somewhat safe and orderly" schools (495 in mathematics and 484 in science). Only small percentages of students (4%, on average) were judged to be "less safe and orderly" in schools. Teachers rarely indicated that their school is not safety and orderly.

Saudi Arabia ranked in the 9<sup>th</sup> position in mathematics (79% of students in Very Safe and Orderly schools) and in the 13<sup>th</sup> position in in science (76% in Very Safe and

Orderly schools) in the ranking sorted by the teacher's opinions on school safety. When it came to taking into account eighth-graders, Saudi Arabia took in both rankings the 5<sup>th</sup> places (70% and 69% respectively).

In Saudi Arabia, as in most of the countries, a positive correlation is observed in this respect: students learning in a safe and orderly school environment achieved better results (on average). This dependency is noticed in both subjects, regardless of the grade.

### Student Bullying

On the other hand, as confirmed by scientific evidence, bullying proved to be negatively related to student performance. Regardless of gender, scores in both mathematics and science decline with increased frequency of bullying. Based on students' reported bullying experience, three scale categories were created:

- Students bullied Never or Almost Never had a score at or above the cut score corresponding to reporting that they "never" experienced six of the eleven bullying behaviors and experienced the other five "a few times a year," on average.
- Students bullied About Weekly had a score at or below the cut score corresponding to reporting that they experienced six of the eleven behaviors "once or twice a month" and the other five "a few times a year," on average.
- All other students were bullied About Monthly.

Bullying experience is, unfortunately, very widespread in education. 37% of four-graders in TIMSS confirmed being exposed to bullying at least monthly or weekly. In

Saudi Arabia (Table 8.3), one in two students (50%) experienced bullying about monthly (33%) or about weekly (17%). This stands in contrast with teachers' declarations on school safety.

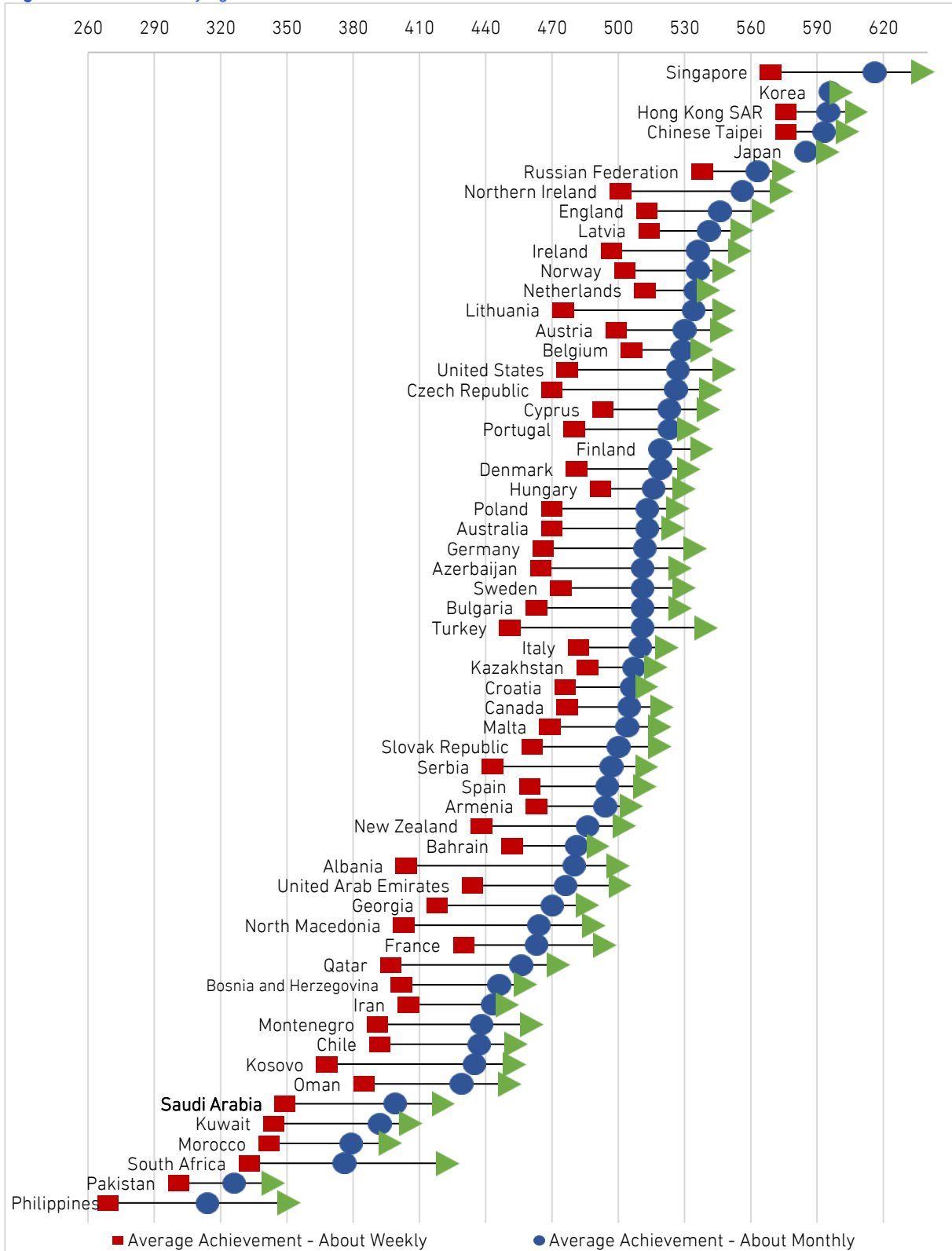
**Table 8.3** Structure of G4 Student Bullying in Saudi Arabia and the international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
About Weekly	17%	Math- 349 Science-335	8%	Math-451 Science-437
About Monthly	33%	Math-399 Science-404	29%	Math-495 Science-486
Never or Almost Never	50%	Math-421 Science-432	63%	Math-512 Science-503

SOURCE: Exhibits 8.12, and Exhibit 8.13: Students Bullying. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

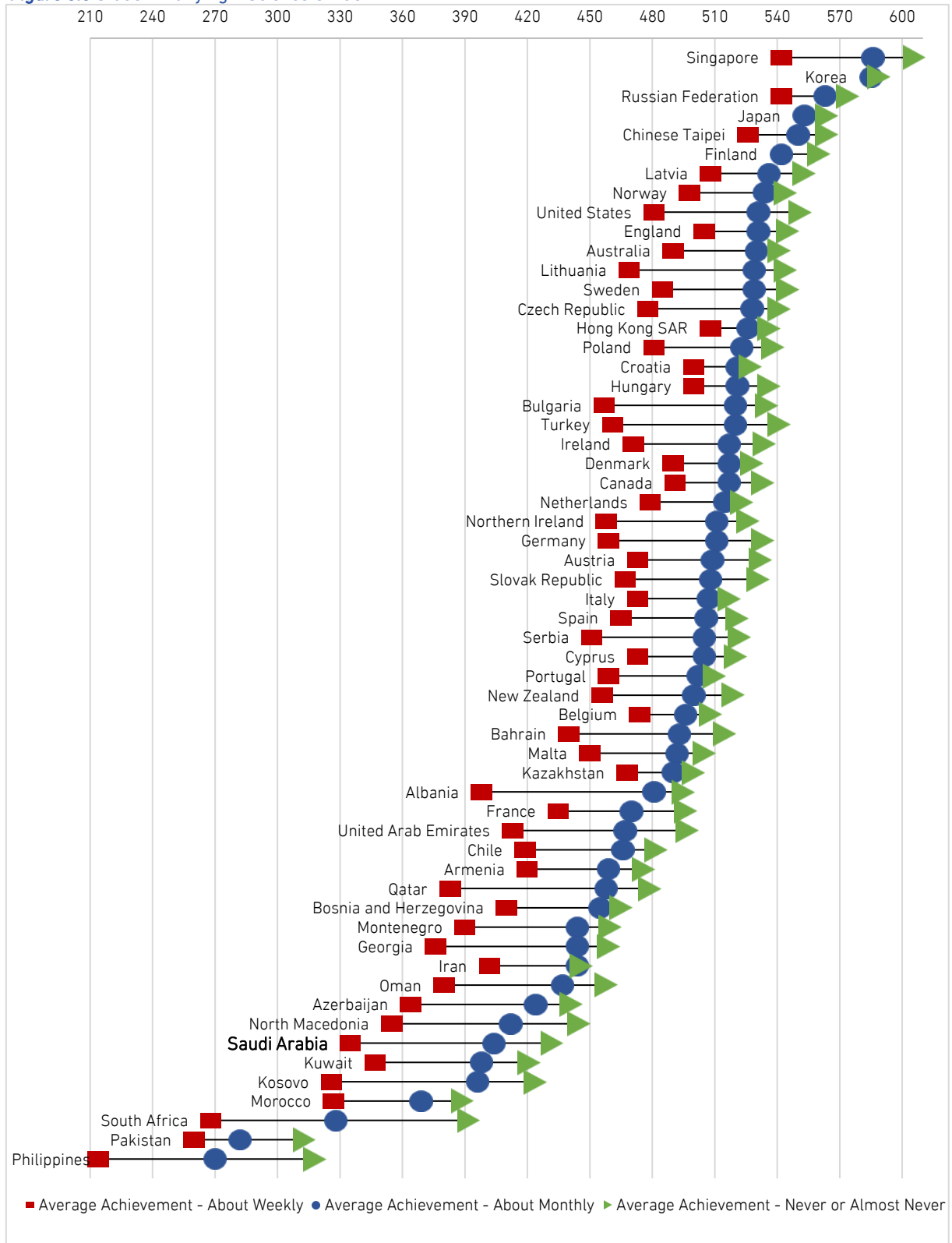
In TIMSS data, bullying experience is one of the strongest predictors of achievement. Students who experience more bullying scored significantly worse. The same strong dependency was observed in Saudi Arabia: in mathematics (421 – Never or Almost Never, 399 – About Monthly, 349 – About Weekly), and science (432 – Never or Almost Never, 404 – About Monthly, 335 – About Weekly). **Figure 8.5** and **Figure 8.6** show the achievement of fourth-graders by three categories of Student Bullying, respectively, for mathematics and science assessment.

Figure 8.5 Student Bullying – Mathematics Grade 4



SOURCE: Exhibit 8.12: Student Bullying. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 8.6 Student Bullying – Science Grade 4



SOURCE: Exhibit 8.13: Student Bullying. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

For eight-graders, the exposure to bullying in Saudi Arabia seems to be lower and close to the International Average. In Saudi Arabia Table 8.4, one in four eight-graders (28%) experienced bullying about monthly (8%) or weekly (20%).

**Table 8.4** Structure of G8 Student Bullying in Saudi Arabia and the international average

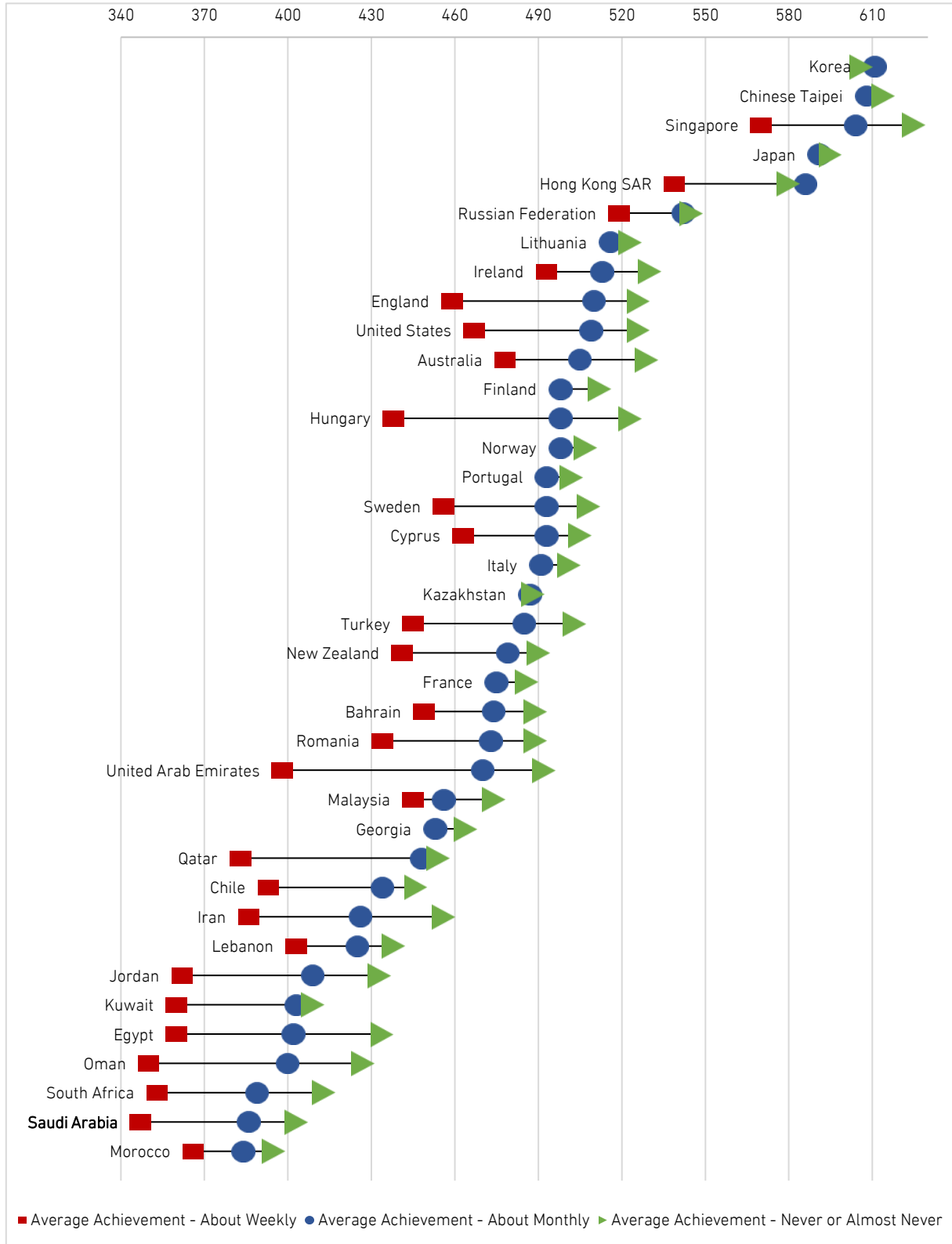
Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
About Weekly	8%	Math- 347 Science-358	6%	Math-428 Science-421
About Monthly	20%	Math-386 Science-418	23%	Math-482 Science-482
Never or Almost Never	72%	Math-403 Science-446	71%	Math-496 Science-499

SOURCE: Exhibits 8.15, and Exhibit 8.16: Students Bullying. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

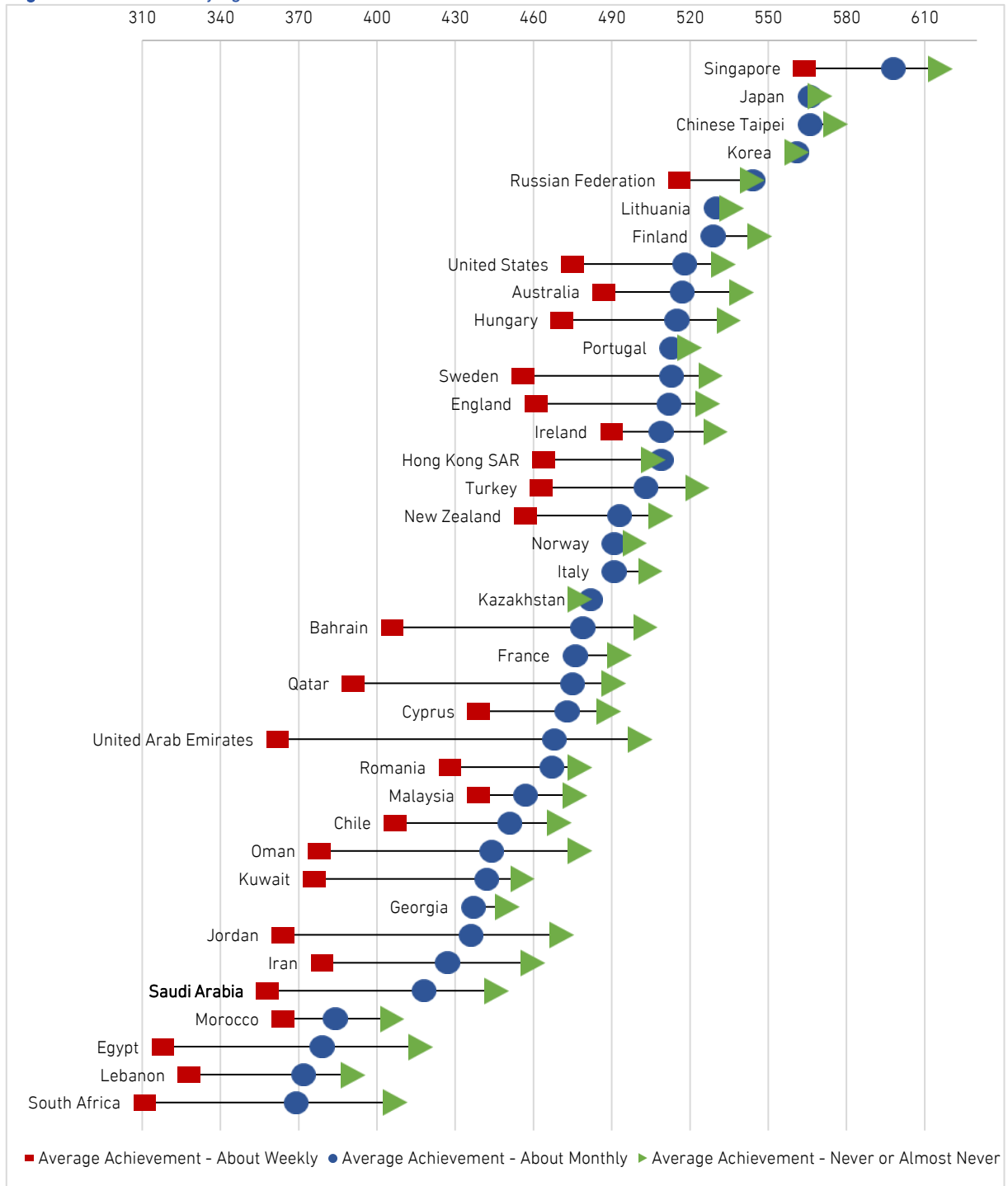
**Figure 8.7** and **Figure 8.8** show the achievement difference for eighth-graders in the participating countries. Only a few top-performing countries did not exhibit significant problems with bullying and its impact on achievement. For some of the countries, the difference in achievements between those who experience weekly bullying and those who Never or Almost Never experience bullying are almost 100 points. Data from Saudi Arabia also indicate that the difference between those who never or almost never experience bullying and those who experience bullying on a weekly basis is equal to 88 points in science (446 Never or Almost Never, 418 – About Monthly, and 358 – About Weekly).



Figure 8.7 Student Bullying – Mathematics Grade 8



SOURCE: Exhibit 8.15: Student Bullying. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 8.8 Student Bullying – Science Grade 8**

SOURCE: Exhibit 8.16: Student Bullying. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

In light of such a substantial educational impact and contrast between the teachers' and students' reports on school safety, the problem of bullying should stand as one of the most urgent issues for policy measures in Saudi Arabia

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## Chapter 9

### Challenges to teaching and learning

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## Challenges to teaching and learning

### Student Absenteeism

TIMSS provides important insights on the main barriers that teaching, and learning is exposed to, namely: absenteeism, feeling tired or hungry, and Not Readiness for Instruction. All these factors play significant negative role in education by building cognitive barriers. However, these factors can be targeted by educational policy measures.

The absenteeism was assessed on the basis of students' reports about the frequency they are absent from school. Participating in the assessment students were assigned to one of the five categories distinguished by frequency of student absences: "never or almost never", "once every two months", "once a month", "once every two weeks" or "once a week". According to the international average shown in Table 9.1, fourth-graders who are absent more frequently, on average obtain worse results in mathematics, and science (each subsequent level of absence means a greater decline in achievement).

**Table 9.1** Structure of G4 students Absenteeism in Saudi Arabia and international average

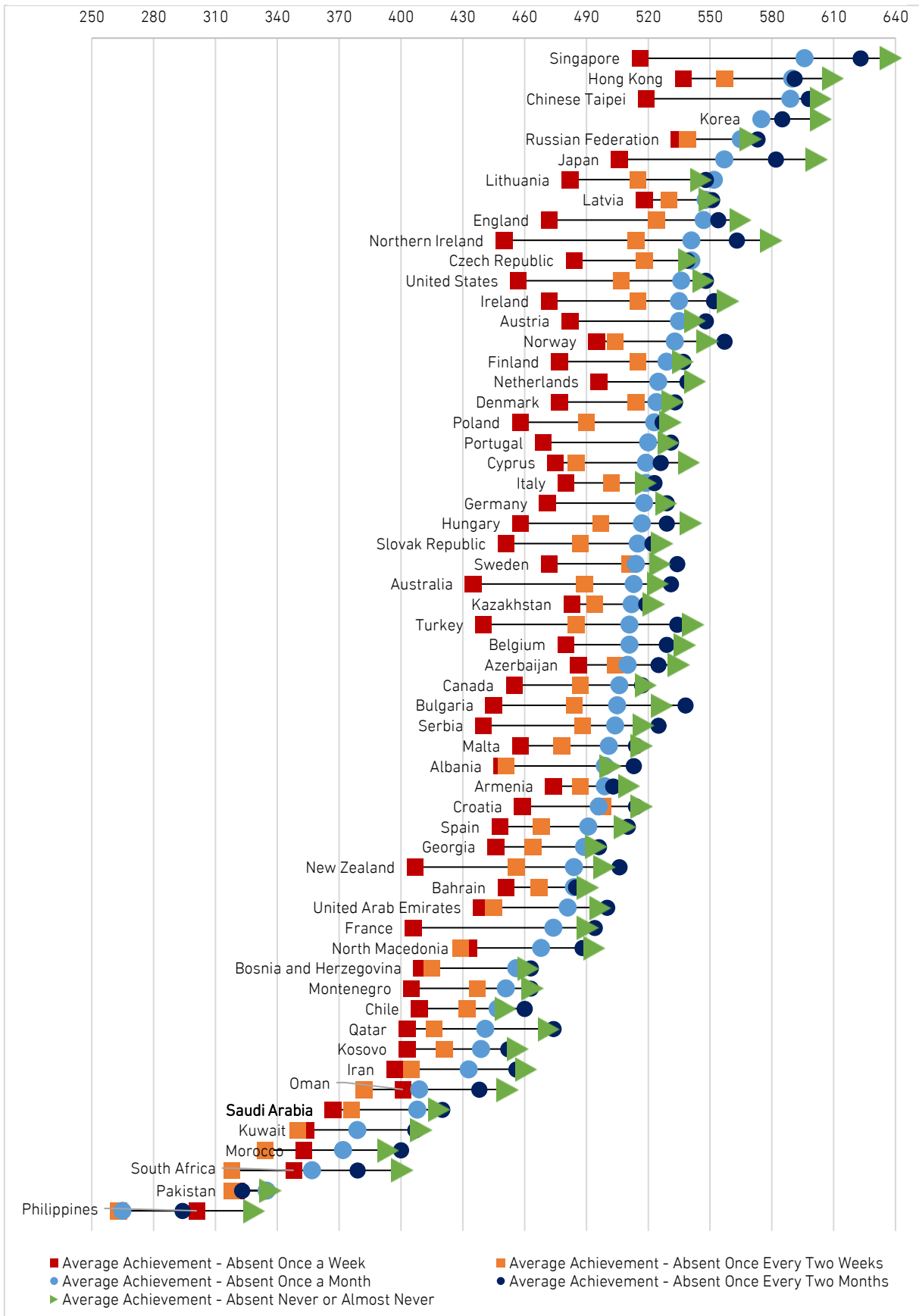
Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Never or almost never	42%	Math-419 Science-422	61%	Math-512 Science-503
Once every two months	10%	Math-420 Science-424	13%	Math-509 Science-498
Once a month	11%	Math-408 Science-411	10%	Math-495 Science-484
Once every two weeks	9%	Math-376 Science-383	5%	Math-462 Science-455
Once a week	28%	Math-367 Science-375	11%	Math-448 Science-437

SOURCE: Exhibit 10.1, and Exhibit 10.2: Frequency of Student Absences. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

The same relation applies to Saudi Arabia where significant difference was not noticed only between first and second group of students (never or almost never, and once every two months). The problem of absenteeism is more visible in Saudi Arabia than internationally. The biggest differences in percentages of students between international averages and Saudi Arabia, concerned students assigned to the extreme categories. Far more students in Saudi Arabia miss the classes at least once a week (28%) while the international average is 11%.

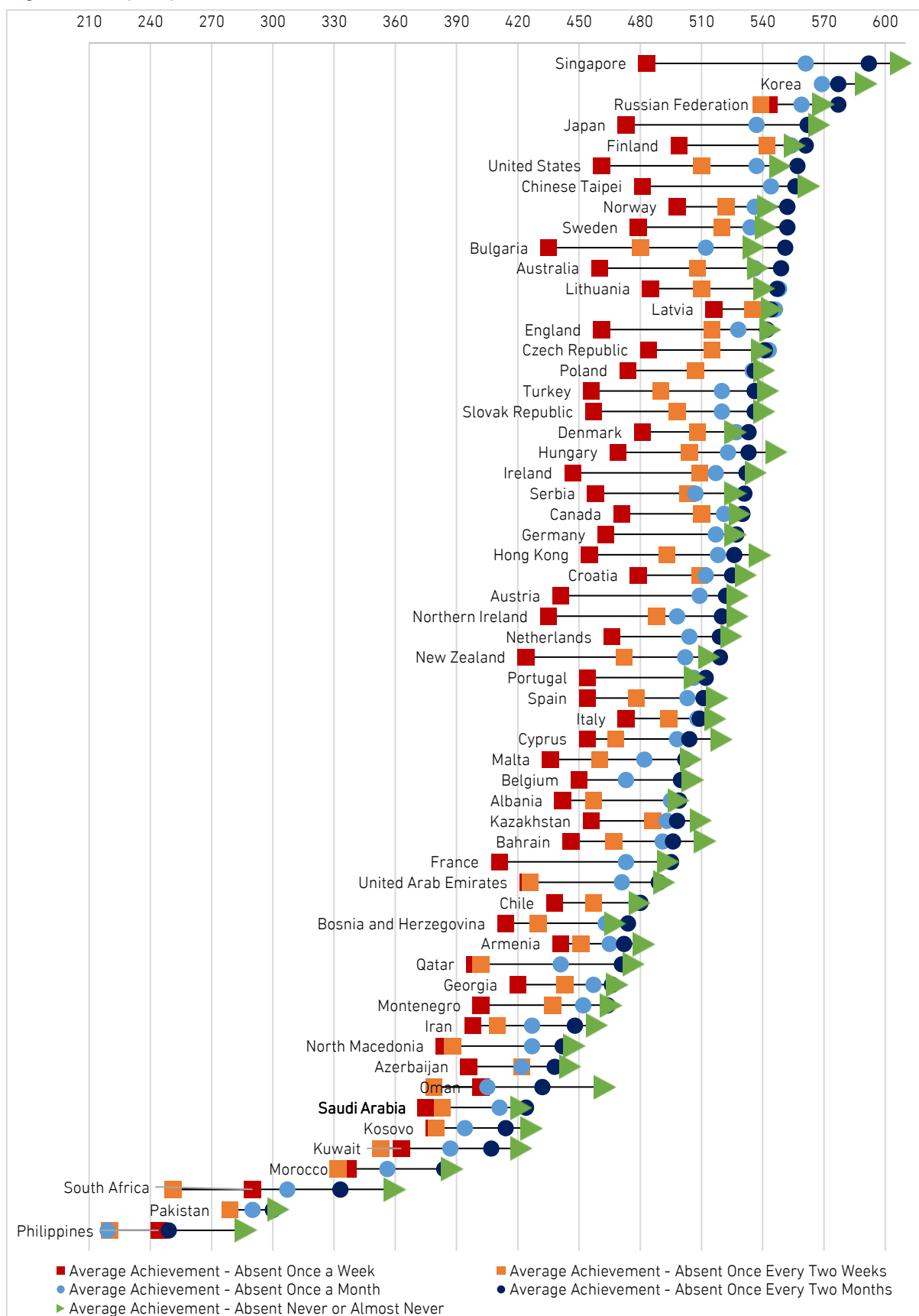
**Figure 9.1** and **Figure 9.2** present the average achievement in mathematics and science respectively of fourth-grade students by their reports about the frequency of absence from school. In the graph, the participating countries were sorted from the highest score in the average achievement to the lowest in the middle intensity of absence level (once a month). As expected, in the majority of the countries, fourth-graders who are frequently absent obtain worse results in mathematics tests. It is worth mentioning that the biggest differences in scores by the absenteeism level are visible for top performing countries where they reach over 100 points. It is clear how skipping classes is harmful for the education. The same pattern applies to Saudi Arabia. Differences between the groups of fourth-graders with lowest and greatest absenteeism reach 52 points in mathematics. For the achievement in science, the difference is calculated as 47 points.

Figure 9.1 Frequency of Student Absences – Mathematics Grade 4



SOURCE: Exhibit 10.1: Frequency of Student Absences. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 9.2 Frequency of Student Absences – Science Grade 4



SOURCE: Exhibit 10.2: Frequency of Student Absences. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Even though older students are less likely to skip classes once a week, the overall problem of absenteeism is more spread among eighth-graders. In the participating countries, older students tend to skip some of the classes more often than the younger ones. Table 9.2 presents the shares of the students in each category of absenteeism in Saudi Arabia compared to the International Average.

**Table 9.2** Structure of G8 students Absenteeism in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of Students	Average score	Percentage of students	Average score
Never or almost never	27%	Math-419 Science-449	55%	Math-502 Science-504
Once every two months	14%	Math-407 Science-443	16%	Math-495 Science-497
Once a month	20%	Math-398 Science-439	14%	Math-475 Science-479
Once every two weeks	18%	Math-388 Science-434	7%	Math-452 Science-457
Once a week	22%	Math-358 Science-397	8%	Math-412 Science-413

SOURCE: Exhibit 10.3, and Exhibit 10.4: Frequency of Student Absences. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

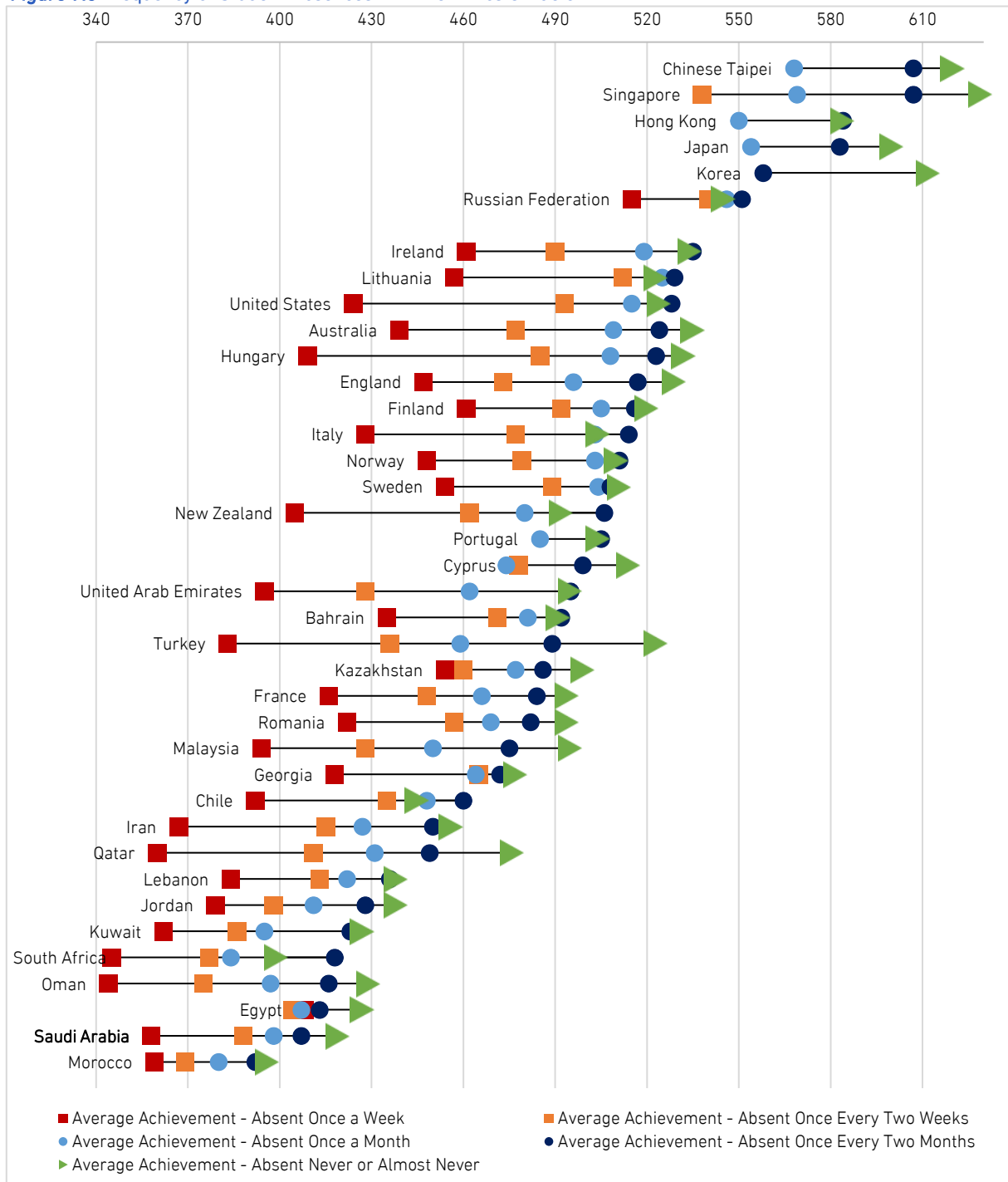
In comparison to the International Averages, eighth-graders in Saudi Arabia more often tend to skip the classes. the biggest difference in number of students assigned to each of the category is visible in group that never or almost never are absent (the percentage of non-skipping-classes students for the international average is more than twice than this share in Saudi Arabia).

In terms of the relation between absenteeism and achievement, the same pattern is visible for eight-graders as in the case of fourth-graders: students who attended school classes frequently scored higher in both mathematics and science. **Figure 9.3** and **Figure 9.4** present the achievement of eight graders by the Frequency of Student

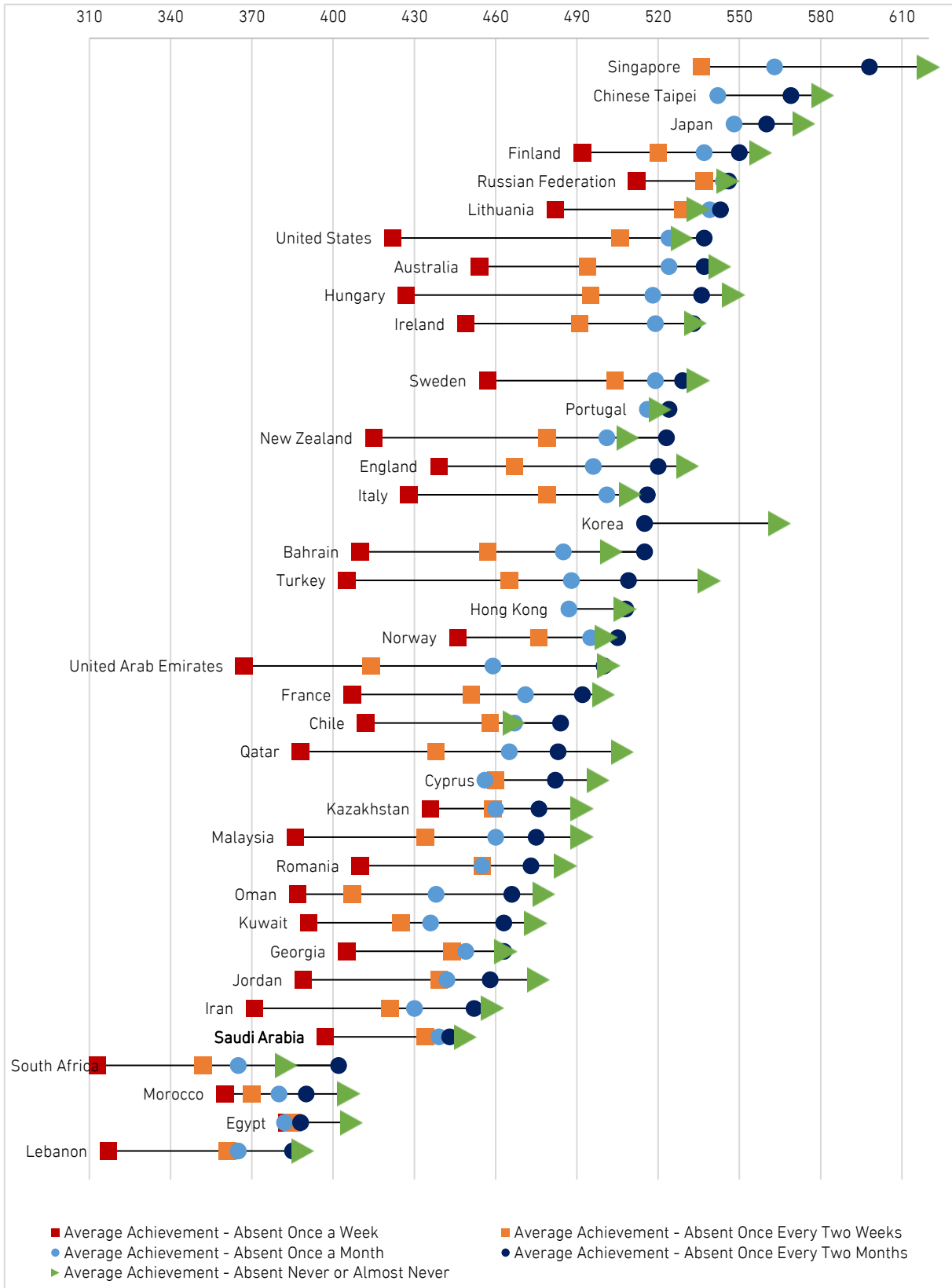


Absences. Internationally, the highest percentage of eighth-graders who never or almost never missed classes was observed in four Asian countries: Korea (94%), Japan (84%), Chinese Taipei (83%), and Hong Kong SAR (81%). Unfortunately, Saudi Arabia is one of countries with the greatest problems with absenteeism.

**Figure 9.3** Frequency of Student Absences – Mathematics Grade 8



SOURCE: Exhibit 10.3: Frequency of Student Absences. IEA's Trends in International Mathematics and Science Study - TIMSS 2019.  
Downloaded from <http://timss2019.org/download>

**Figure 9.4** Frequency of Student Absences – Science Grade 8

SOURCE: Exhibit 10.4: Frequency of Student Absences. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Students Feel Tired or Hungry

Students' mental and physical well-being undoubtedly influences their educational performance. **Table 9.3** below summarizes the share of students who are physically exhausted (due to being tired or hungry) in Saudi Arabia vs. the International Average. According to the TIMSS data, it is evident that fourth-graders who feel hungry frequently obtain relatively lower results in both Mathematics and Science. Similarly, looking at the data for students feeling tired, frequently arriving at school being exhausted corresponds to lower achievement.

In both the assessments, the lowest achievements were obtained by students who feel tired every day or almost every day. Interestingly, the greatest achievement characterizes students in the "Sometimes" category. It may happen because students assigned to "Sometimes" category might spend a lot of time studying which leads to feeling tired "sometimes". Similar patterns are visible in data in both Saudi Arabia and the International Average. In regard to arriving to school feeling hungry, there was analogically direct negative relationship between the frequency of arriving at school hungry and average achievement in both grades and subjects.

Table 9.3 and Table 9.4 summarize achievement by the level of Students Report Arriving at School Feeling Tired or Hungry.

**Table 9.3** Structure of G4 students report arriving at school feeling tired in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Never	26%	Math-409 Science-418	19%	Math-503 Science-490
Sometimes	45%	Math-412 Science-417	47%	Math-511 Science-501
Every day or almost every day	29%	Math-379 Science-379	35%	Math-490 Science-481

SOURCE: Exhibit 10.5, and Exhibit 10.6: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Table 9.4** Structure of G4 students report arriving at school feeling hungry in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Never	24%	Math-417 Science-429	31%	Math-515 Science-504
Sometimes	39%	Math-412 Science-417	41%	Math-507 Science-497
Every day or almost every day	36%	Math-393 Science-396	28%	Math-488 Science-478

SOURCE: Exhibit 10.5, and Exhibit 10.6: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Similar patterns to those of fourth-graders were also observed among eighth-graders, and they apply as well to Saudi Arabia. Internationally, more eighth-graders regularly felt tired and hungry during school lessons. Frequent hunger appeared to be even a problem as in eighth grade internationally, data reveal that 33% of students reported that they arrived at school hungry “every day or almost every day” and another 42% reporting that they did so “sometimes.” Only 25% said they “never” arrived at school hungry. For eighth-graders in Saudi Arabia, these statistics are more positive – relatively less students experience hunger and being often tired (see Table 9.5 and Table 9.6).

**Table 9.5** Structure of G8 students report arriving at school feeling tired in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Never	14%	Math-400 Science-438	8%	Math-488 Science-485
Sometimes	53%	Math-397 Science-434	47%	Math-493 Science-494
Every day or almost every day	32%	Math-390 Science-429	45%	Math-487 Science-488

SOURCE: Exhibit 10.7, and Exhibit 10.8: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Table 9.6** Structure of G8 students report arriving at school feeling hungry in Saudi Arabia and international average

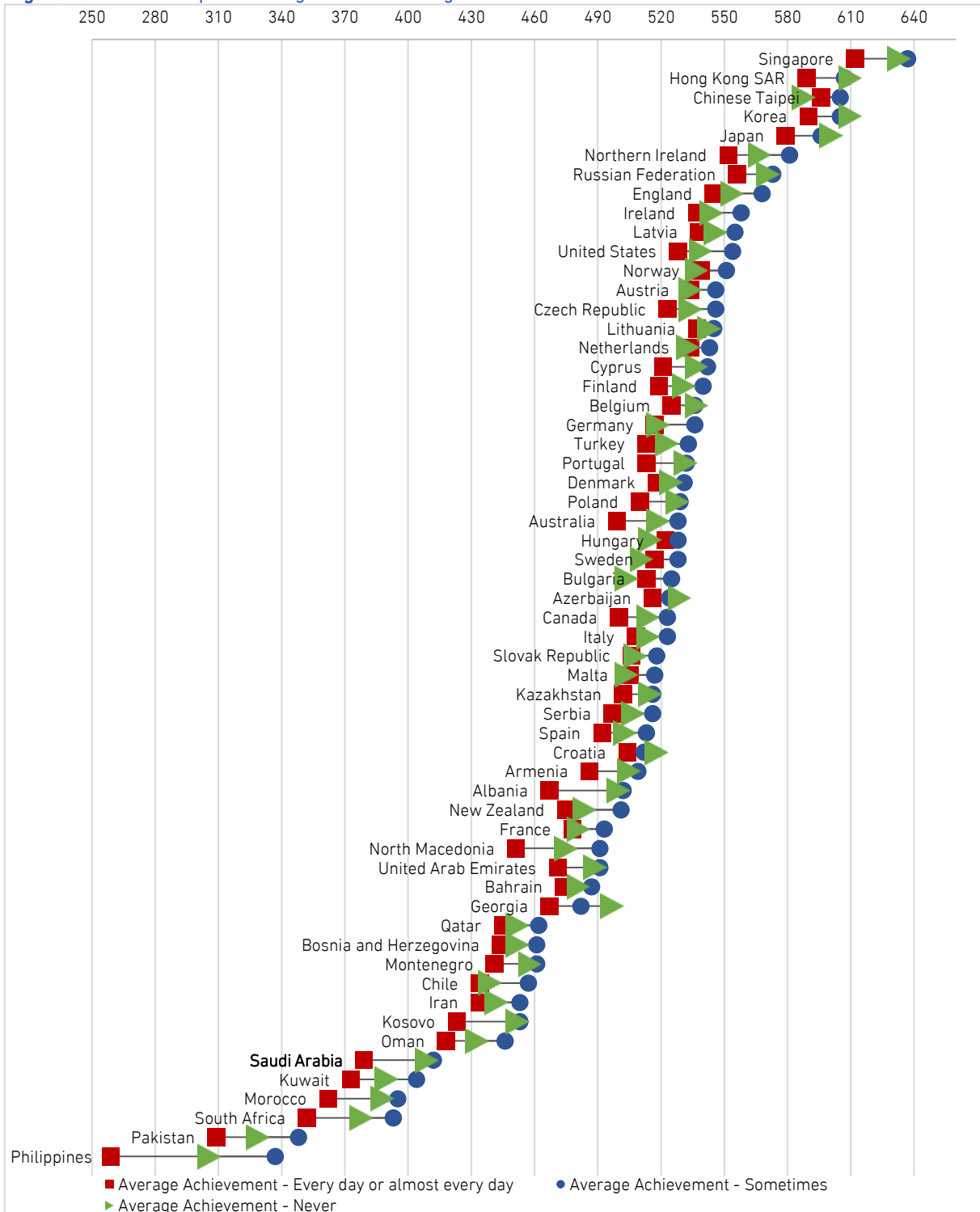
Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Never	30%	Math-403 Science-444	25%	Math-504 Science-507
Sometimes	43%	Math-396 Science-433	42%	Math-492 Science-493
Every day or almost every day	28%	Math-394 Science-433	33%	Math-480 Science-480

SOURCE: Exhibit 10.7, and Exhibit 10.8: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

As presented, even though internationally more eighth-graders than four-graders regularly felt hungry during school lessons, this does not apply to data in Saudi Arabia. However, in grade-four the achievement differences between the frequencies of feeling tired are in general stronger for low-performing countries, with “every day or almost every day” category negatively outstanding. Worth to mention that for eight-graders the inequalities in achievement across presented levels for Saudi Arabia is much lower (around 10 points).

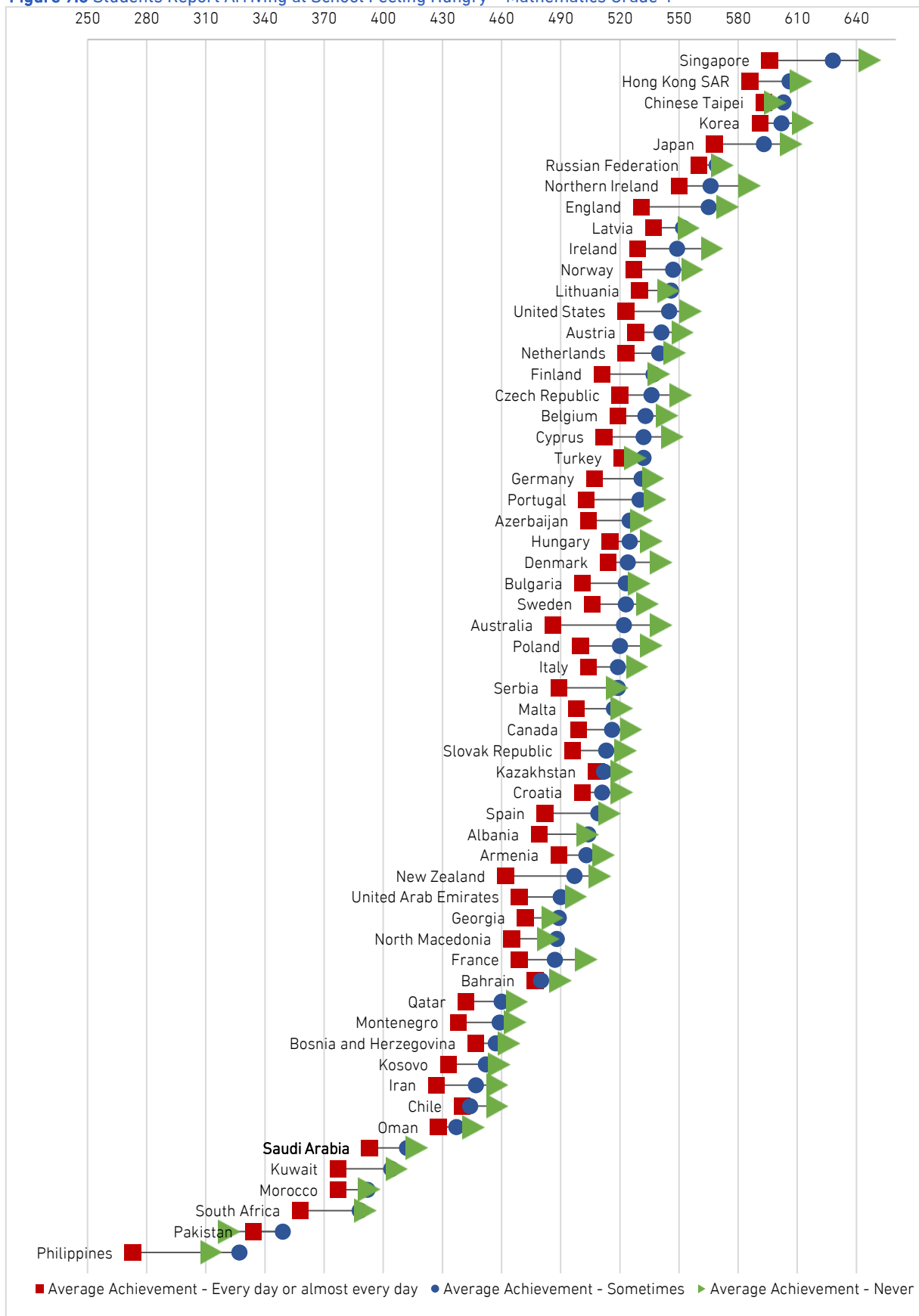
The following figures (from **Figure 9.5** to **Figure 9.12**) present countries average achievement of fourth, and eighth-graders by the Students Report Arriving at School Feeling Tired or Hungry for both mathematics and science assessments.

**Figure 9.5 Students Report Arriving at School Feeling Tired – Mathematics Grade 4**

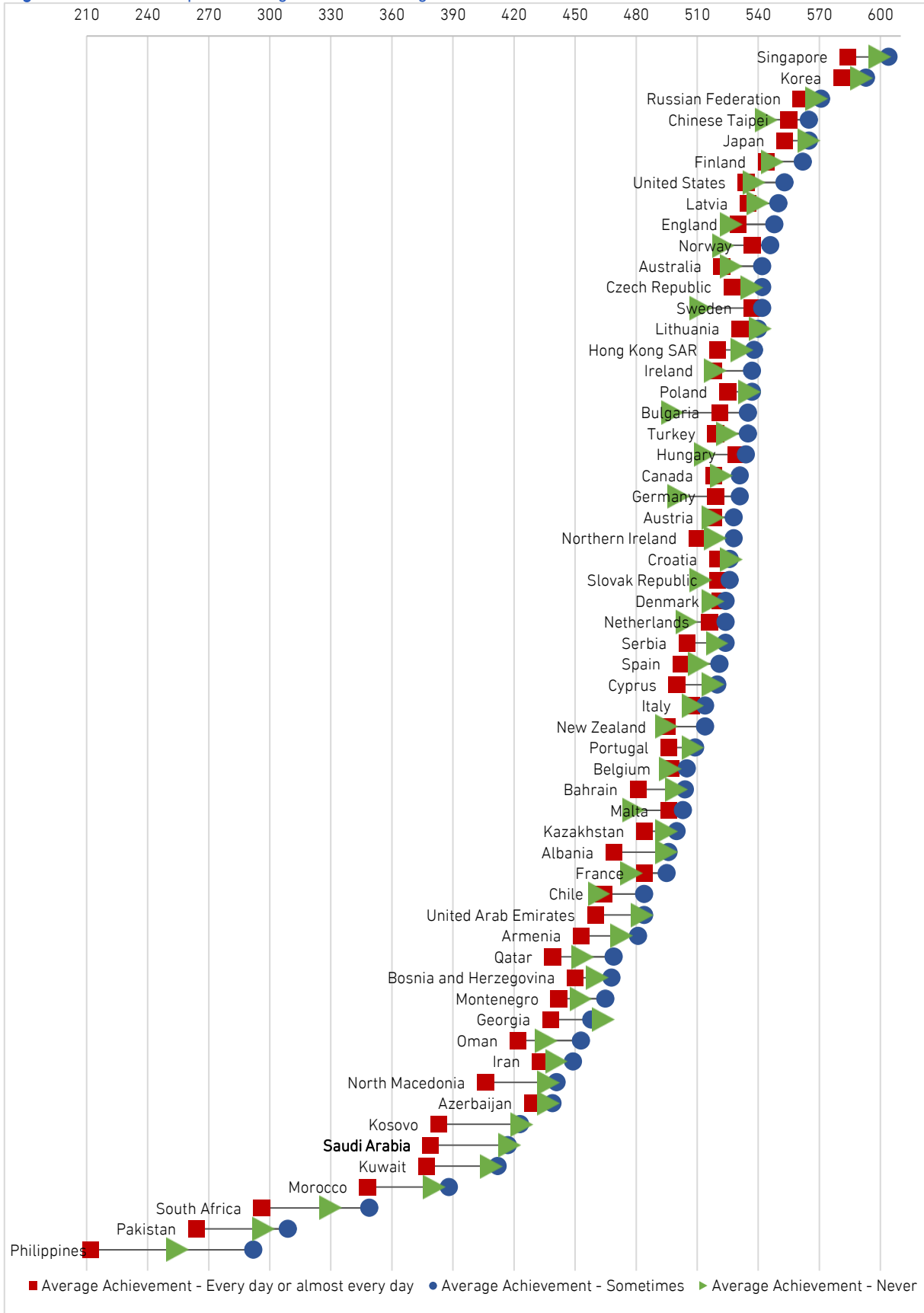


SOURCE: Exhibit 10.5: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 9.6 Students Report Arriving at School Feeling Hungry – Mathematics Grade 4



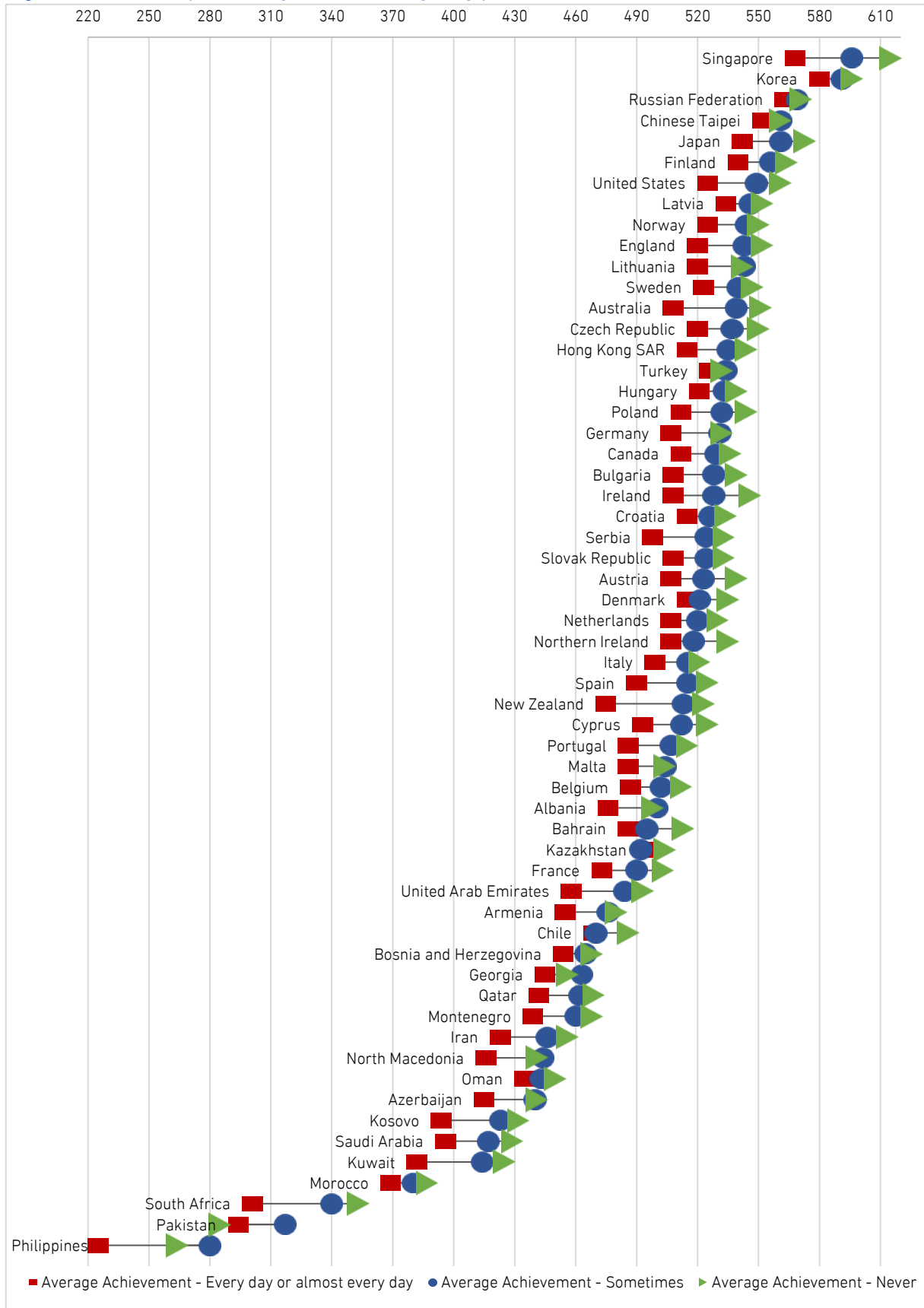
SOURCE: Exhibit 10.5: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 9.7 Students Report Arriving at School Feeling Tired – Science Grade 4**

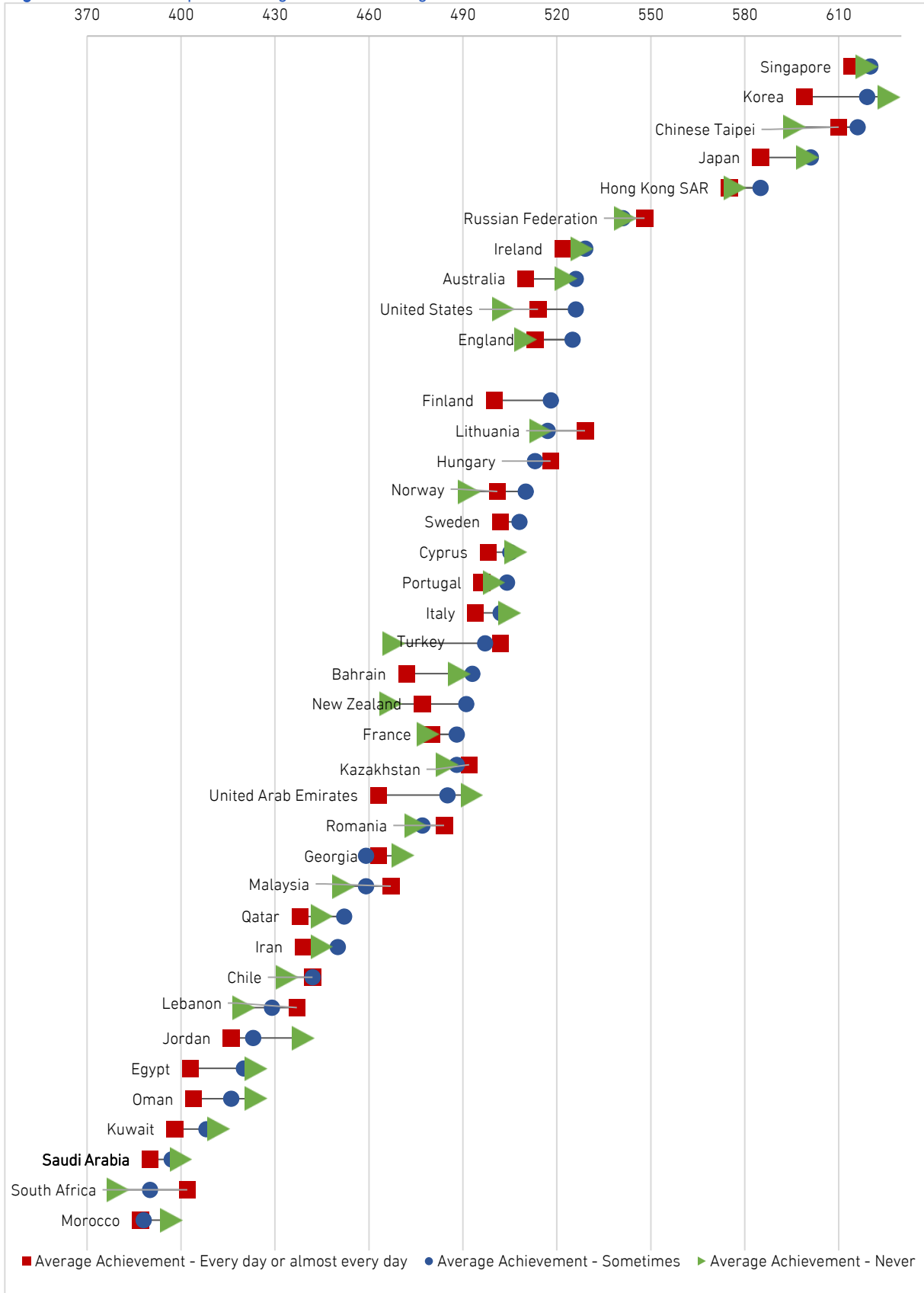
SOURCE: Exhibit 10.6: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.



Figure 9.8 Students Report Arriving at School Feeling Hungry – Science Grade 4

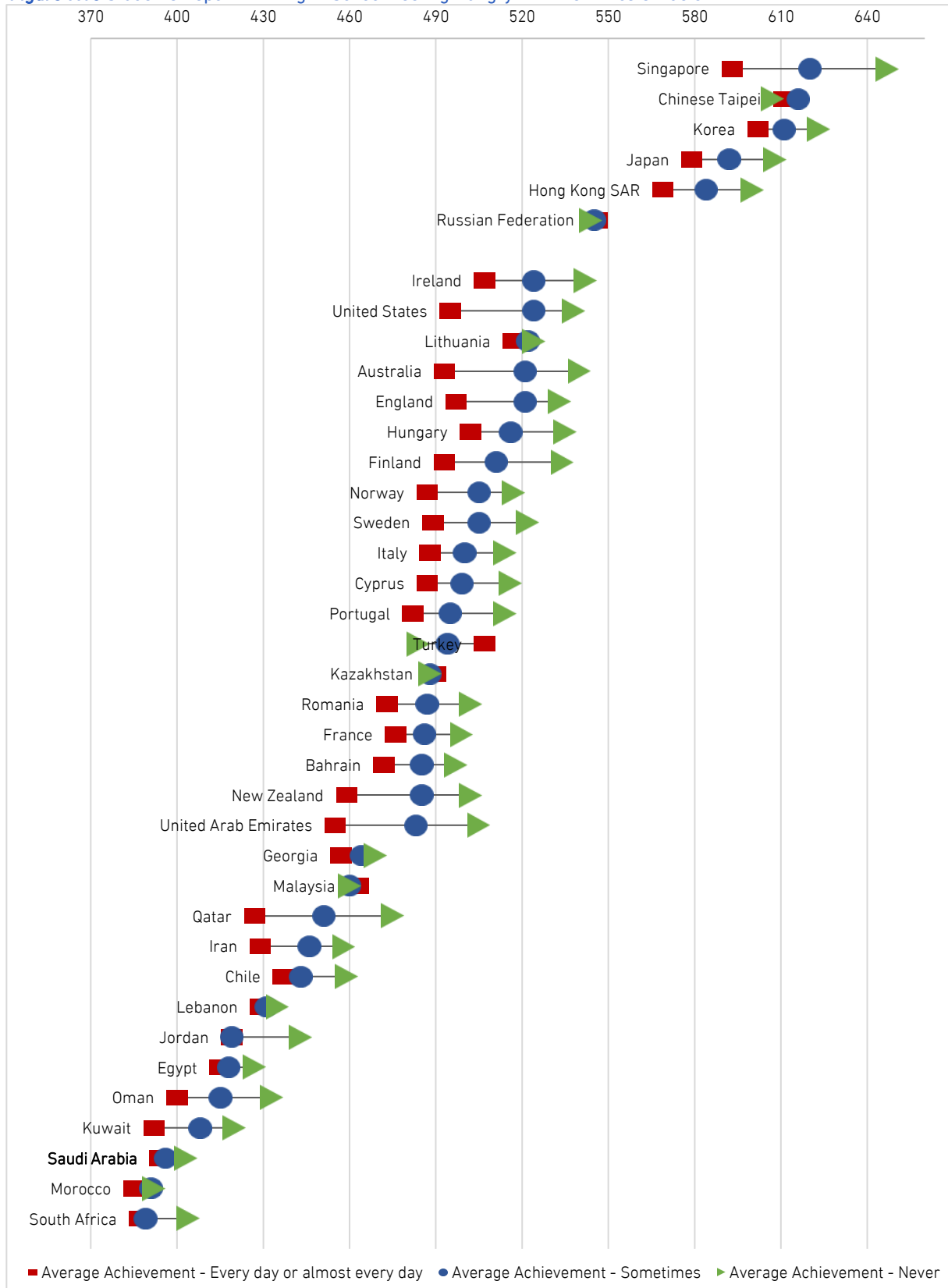


SOURCE: Exhibit 10.6: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

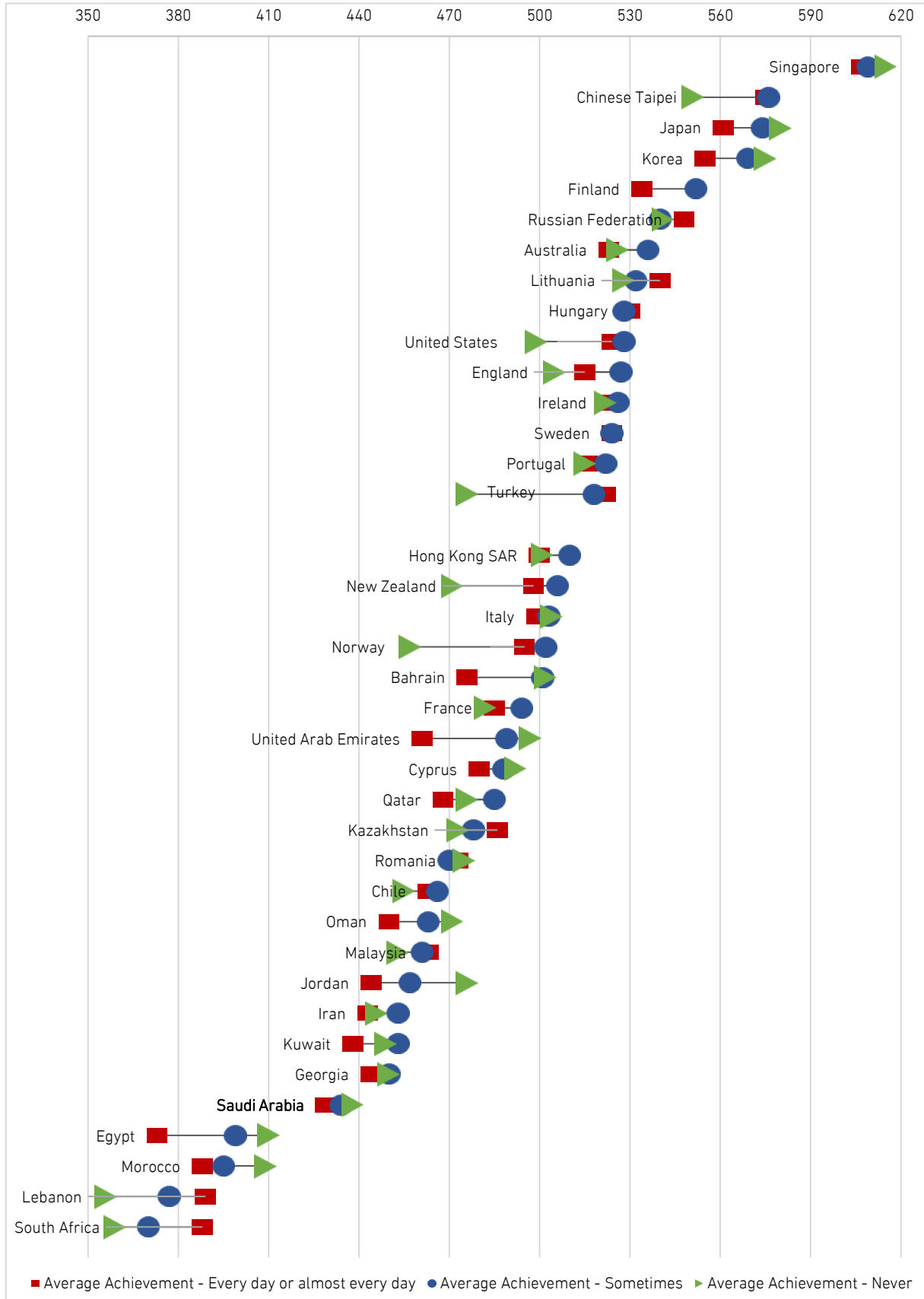
**Figure 9.9 Students Report Arriving at School Feeling Tired – Mathematics Grade 8**

SOURCE: Exhibit 10.7: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 9.10 Students Report Arriving at School Feeling Hungry – Mathematics Grade 8

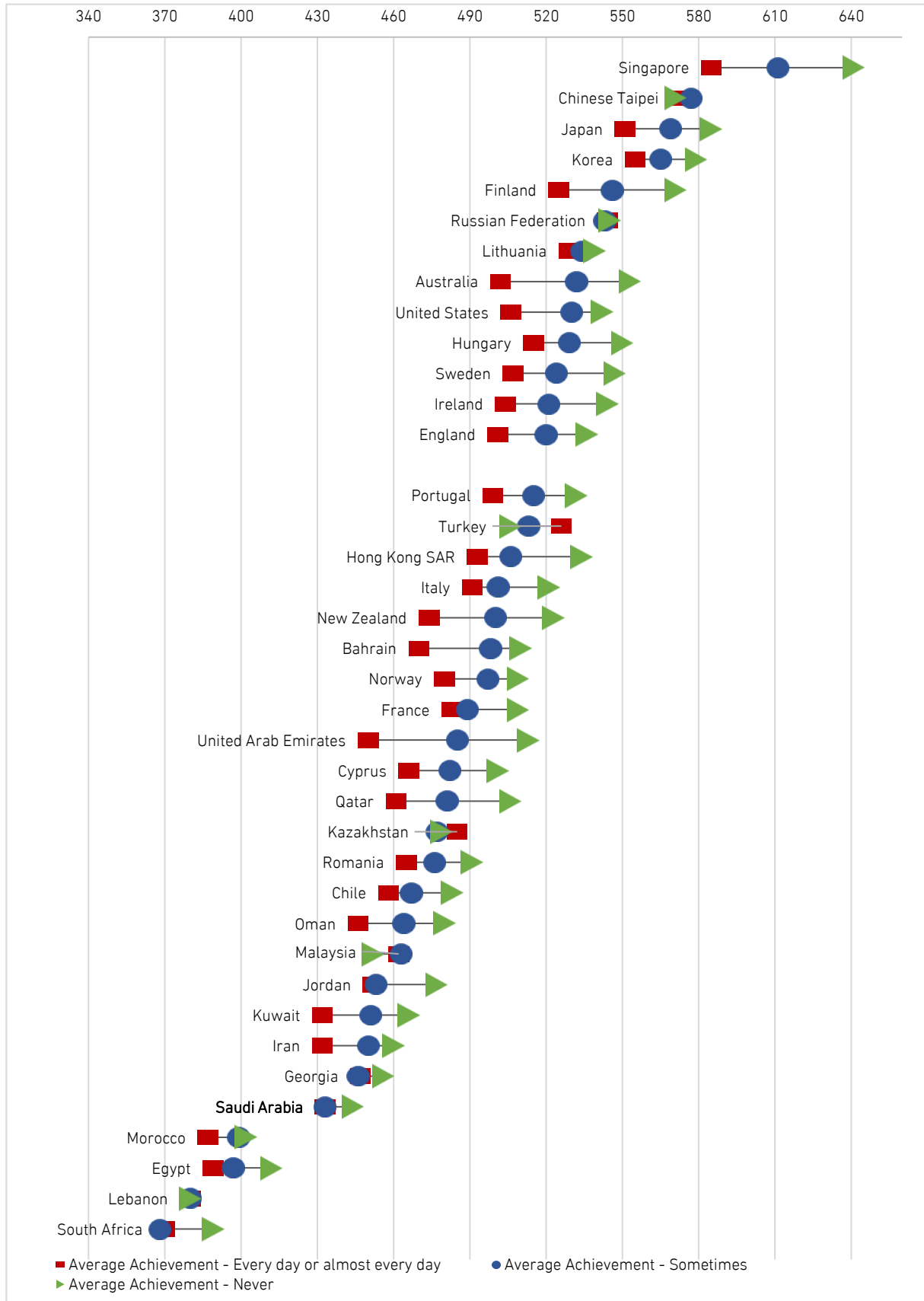


SOURCE: Exhibit 10.7: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 9.11** Students Report Arriving at School Feeling Tired – Science Grade 8

SOURCE: Exhibit 10.8: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 9.12 Students Report Arriving at School Feeling Hungry – Science Grade 8



SOURCE: Exhibit 10.8: Students Report Arriving at School Feeling Tired or Hungry. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Classroom Teaching Limited by Students Not Ready for Instruction

Enriching the previous discussion of areas that make learning difficult, it is worth looking at some other features, such as suffering from lack of basic nutrition, suffering from not enough sleep, mental, emotional, or psychological impairment, or difficulties with understanding the language of instruction. In other words, phenomena that limit learning by not being prepared for instructions.

In this matter, students were scored according to their teachers' reports regarding eight student attributes on the Classroom Teaching Limited by Students Not Ready for Instruction scale. Cut scores divide the scale into following categories:

- Students with teachers who felt their teaching was limited Very Little had a score at or above the cut score corresponding to their teachers reporting they were "not at all" limited by four of the eight student attributes and were limited "some" by the other four, on average.
- Students with teachers who felt their teaching was limited A Lot had a score at or below the cut score corresponding to their teachers reporting they were limited "a lot" by four of the eight attributes and were limited "some" by the other four, on average.
- All other students had teachers who felt their teaching was limited Some.

**Table 9.7** presents the share of students assigned to each category for Saudi Arabia and the International Average. In Saudi Arabia, among fourth-grade teachers, 18% (Mathematics) and 20% (Science) of them admitted that their teaching is "very little" limited by students not ready for instructions, while as much as 76% (Mathematics) and 78% (Science) of teachers admitted to "some" category.

**Table 9.7** Structure of G4 classroom teaching limited by students not ready for instruction – teachers' reports in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Very Little	Math-18% Science-20%	Math-419 Science-409	Math-36% Science-37%	Math-517 Science-506
Some	Math-76% Science-78%	Math-393 Science-397	Math-59% Science-58%	Math-495 Science-484
A Lot	Math-6% Science-2%	Math-385 Science- ~	Math-6% Science-6%	Math-476 Science-465

SOURCE: Exhibit 10.10, and Exhibit 10.11: Classroom Teaching Limited by Students Not Ready for Instruction – Teachers' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Fourth-graders who attended classes where classroom teachers reported that their teaching was limited to the “very little” extent by students not ready for instruction, scored relatively better results (compared to “some” and “a lot “category) in both mathematics and Science tests (with the exception observed in Russian Federation, Croatia, Serbia, Armenia, and Georgia). The achievement of students in G4 for mathematics and science by the Classroom Teaching Limited by Students Not Ready for Instruction are presented in Figure 9.13 and Figure 9.14, respectively.

When it comes to eight-graders (**Table 9.8**), the same dependency as for fourth-graders is clearly visible both internationally and in Saudi Arabia. Besides, generally fewer eighth-graders (compared to fourth-graders) attended not Limited by Students Not Ready for Instruction classes. This indicates that the problems with disturbed by lack of readiness classes are deepening over the time in the education process

**Table 9.8** Structure of G8 classroom teaching limited by students not ready for instruction – teachers' reports in Saudi Arabia and international average

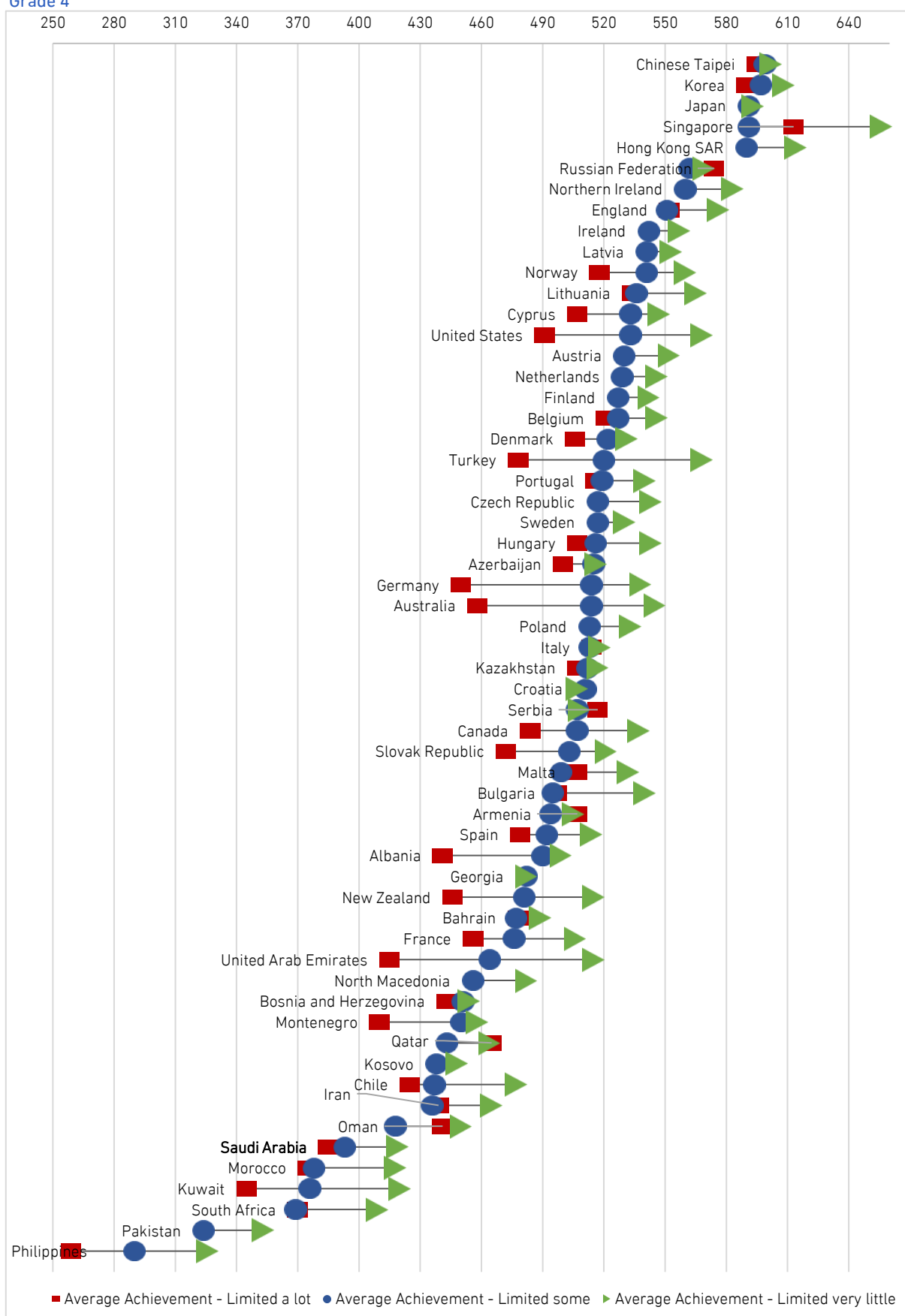
Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Very Little	Math-20% Science-19%	Math-407 Science-459	Math-24% Science-26%	Math-520 Science-515
Some	Math-72% Science-71%	Math-390 Science-426	Math-67% Science-66%	Math-482 Science-484
A Lot	Math-8% Science-9%	Math-393 Science-415	Math-9% Science-8%	Math-458 Science-457

SOURCE: Exhibit 10.12, and Exhibit 10.13: Classroom Teaching Limited by Students Not Ready for Instruction – Teachers' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

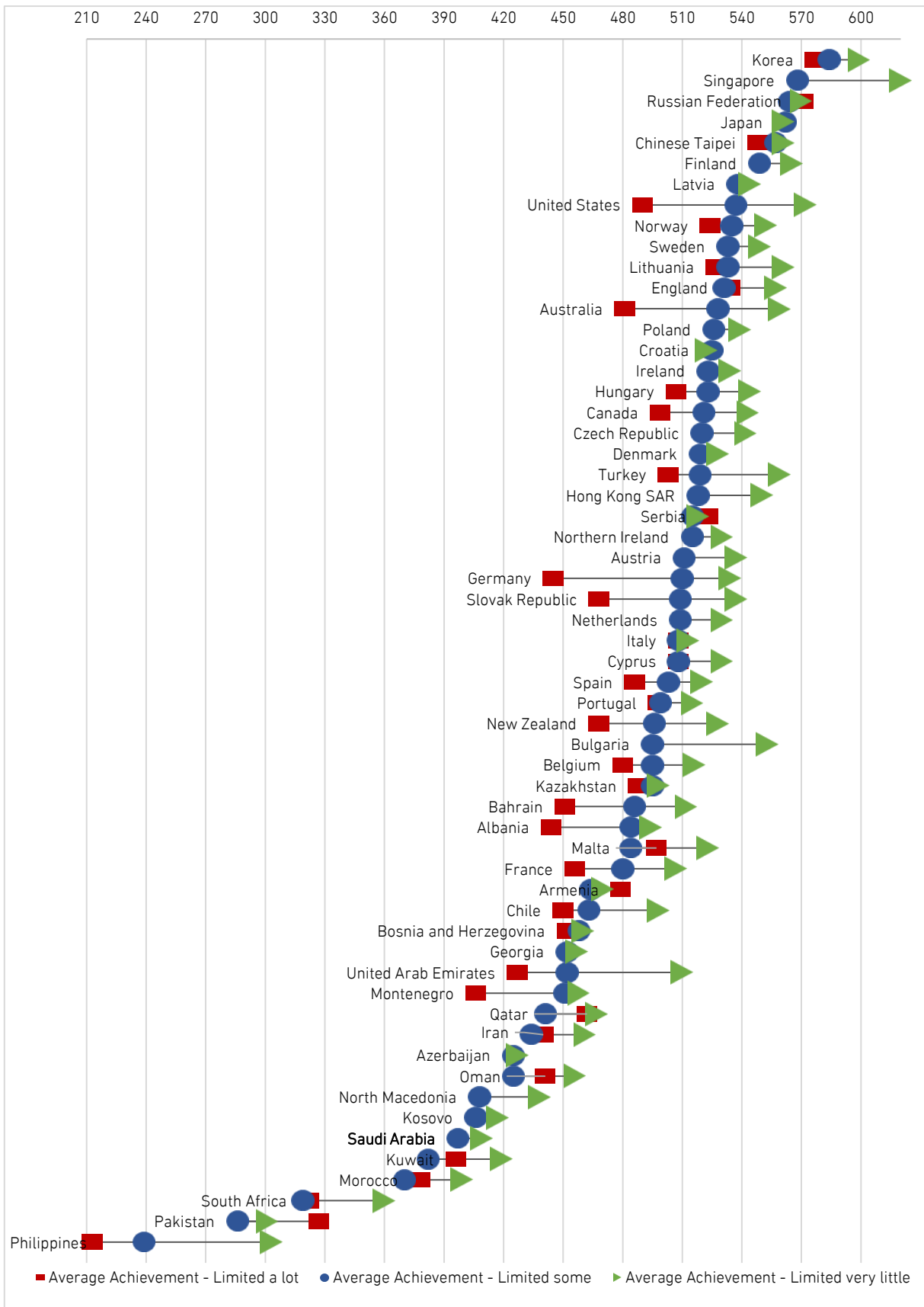
The following figures (from **Figure 9.13** to **Figure 9.16**) present countries average achievement of fourth, and eighth-graders by the Classroom Teaching Limited by Students Not Ready for Instruction.



**Figure 9.13** Classroom teaching limited by students not ready for instruction – teachers' reports – Mathematics  
Grade 4

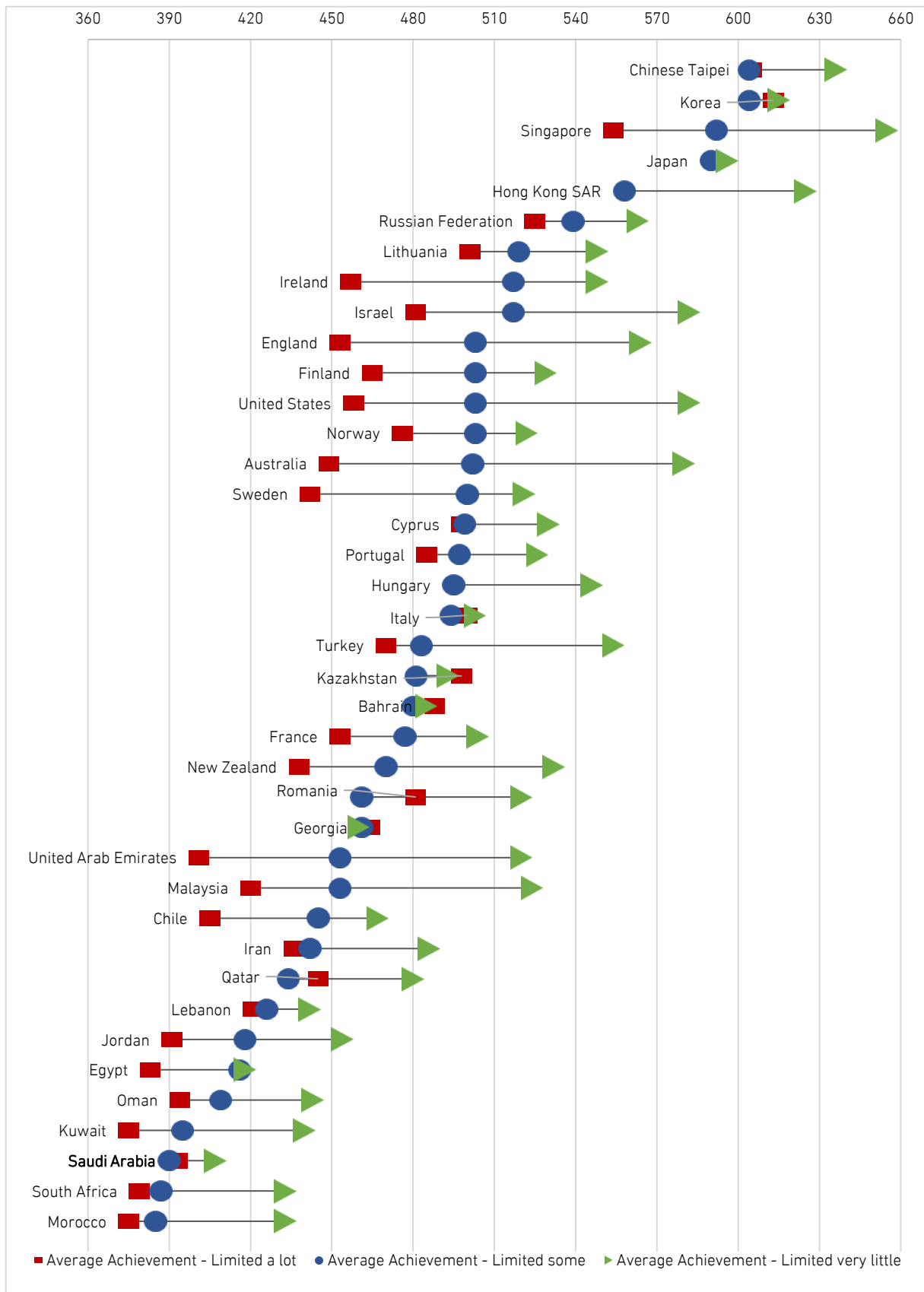


SOURCE: Exhibit 10.10: Classroom Teaching Limited by Students Not Ready for Instruction – Teachers' Reports. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

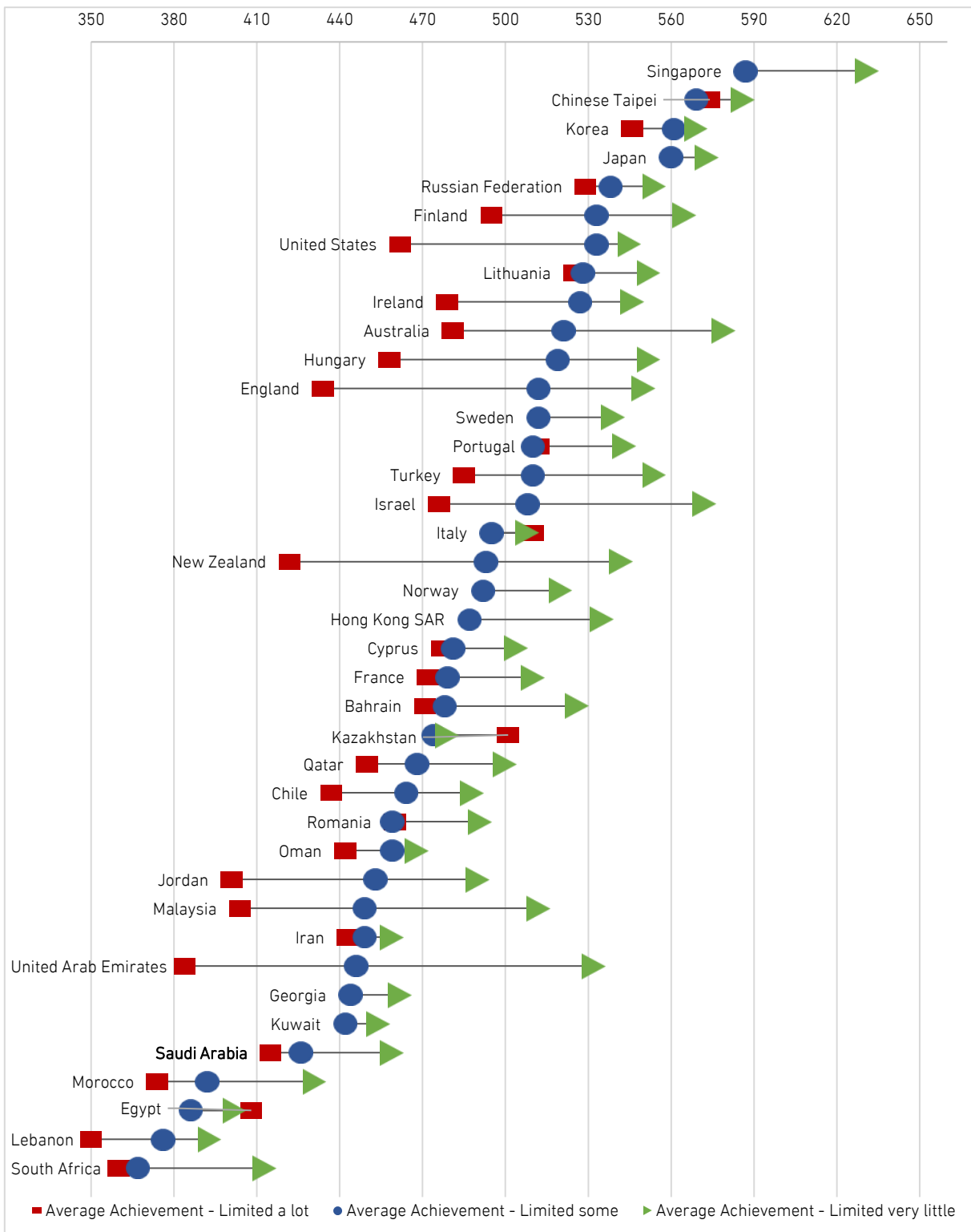
**Figure 9.14** Classroom teaching limited by students not ready for instruction – teachers' reports – Science Grade 4

SOURCE: Exhibit 10.11: Classroom Teaching Limited by Students Not Ready for Instruction – Teachers' Reports. IEA's Trends in International Mathematics and Science Study – TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 9.15** Classroom teaching limited by students not ready for instruction – teachers' reports – Mathematics  
Grade 8



SOURCE: Exhibit 10.12: Classroom Teaching Limited by Students Not Ready for Instruction – Teachers' Reports. IEA's Trends in International Mathematics and Science Study – TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 9.16** Classroom teaching limited by students not ready for instruction – teachers' reports – Science Grade 8

SOURCE: Exhibit 10.12: Classroom Teaching Limited by Students Not Ready for Instruction – Teachers' Reports. IEA's Trends in International Mathematics and Science Study – TIMSS 2019. Downloaded from <http://timss2019.org/download>.



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## Chapter 10

### Technology in Instruction

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## Technology in Instruction

### Computer Access for Instruction

In the 21<sup>st</sup> century, technological tools have become a worldwide need of education. The COVID-related crisis has given rise to the role of the digital world in providing education. In just a few months, the role of technology has changed from just an additional supporter to an essential basis for teaching and learning. Several factors define technology access in schools. These are mainly:

1. Access to computers (hardware and software);
2. Teachers' usage of Computer Activities to Support Learning;
3. Usage of computers for tests and assessments.

#### *Students by Computer Access in grade-four*

As far as access to computers during the lessons is concerned, students were assigned to one of 3 categories based on teachers' reports on whether 1) each student in the class has a computer, 2) the class has computers that students can share, and/or 3) the school has computers that the class can sometimes share (teachers could indicate more than one type of access to computers).

**Table 10.1** presents the percentage of students in each level in regard to having access to computer in grade 4 according to mathematics and science teachers' reports. In each of the categories, smaller numbers were reported in Saudi Arabia than those of the International Averages.

**Table 10.1** Structure of G4 students by Computer Access in Saudi Arabia and international average

Category	Saudi Arabia	International Average
	Percentage of students	Percentage of students
Each student has a computer	Math-4% Science-3%	Math-13% Science-14%
The class has computers that students can share	Math-9% Science-16%	Math-17% Science-22%
The school has computers that the class can sometimes use	Math-26% Science-31%	Math-29% Science -36%

SOURCE: Exhibit 14.1: Access to Computers for Mathematics Lessons, and Exhibit 14.2: Access to Computers for Science Lessons. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

### *Computers availability for fourth-graders to use during lessons in grade-four*

Internationally, there is just a small disparity in the average achievement based on existing accessibility to computers during lessons. Malta – 95%, New Zealand – 92%, and Denmark – 87% accounted for the highest share of fourth-grade students attending mathematics and having access to the computer during lessons. In Saudi Arabia, 31% of students had access to computers during mathematics classes, that number is lower by 8 p.p. than the international average. In Saudi Arabia, the fourth-graders who had access to a computers during classes scored on average, about 18 points more than those who had no access. This is shown in **Table 10.2**, which shows the students' achievement in relation to teachers' reports regarding access to computers in mathematics and science classes. It is worth mentioning that during mathematics classes, more students did not have access to school computers than science classes.

Concerning access to computers in science fourth-grade classes, Denmark (93%), New Zealand (91%), and Belgium (90%) have the highest share of students meeting with the greatest access. In Saudi Arabia, 37% of students had access to the computer during science classes. It can be noticed that, just as in fourth-grade math classes, in the international average there is just a small disparity in fourth-graders science scores

depending on computers availability. Looking at the data acquired from Saudi Arabia, a greater distinction can be found again. Saudi Arabia's fourth-graders attending science classes with accessibility to computers scored on average by 19 points more than those without access.

**Table 10.2** Structure of G4 students by computers availability for fourth-graders to use during lessons in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Computers available	Math-31% Science-37%	Math-411 Science-413	Math-39% Science-45%	Math-506 Science-496
Computers unavailable	Math-69% Science-63%	Math-393 Science-394	Math-61% Science-55%	Math-500 Science-490

SOURCE: Exhibit 14.1: Access to Computers for Mathematics Lessons, and Exhibit 14.2: Access to Computers for Science Lessons. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

#### Computer access for instruction in eight-grade

In the case of the same matter among eighth-graders attending mathematics and science classes, quite similar observations may be made as in the case of fourth-graders. In mathematics, students from Sweden (89%), Norway (82%), and New Zealand (81%) had the highest share of students having access to the computer. In science, the list starts with Sweden (96%), New Zealand (90%), and Australia (87%). **Table 10.3** below shows the Percent of Students by the different levels of Computer Access in grade eight from Saudi Arabia and the international average.

**Table 10.3** Structure of G8 students by Computer Access in Saudi Arabia and international average

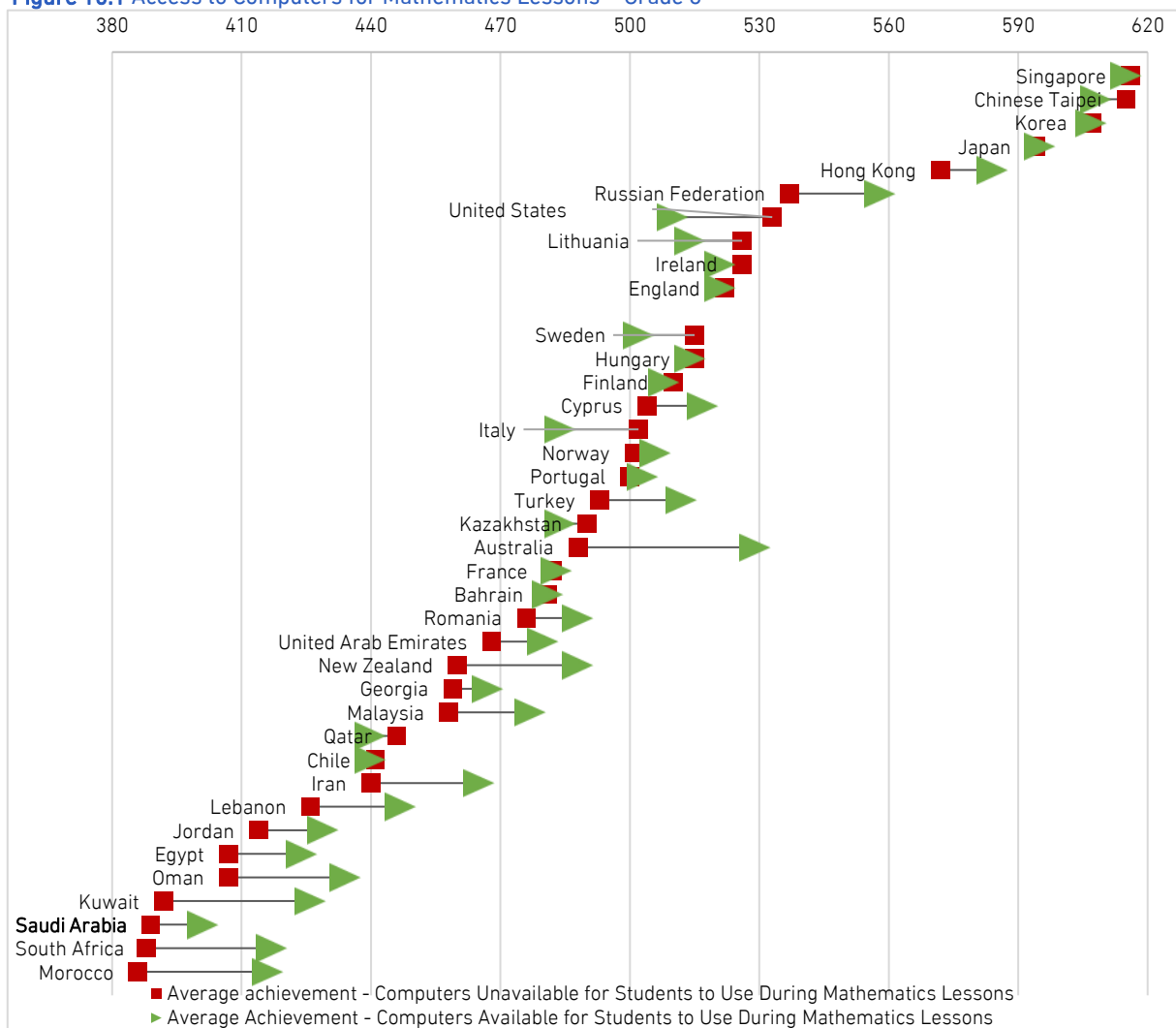
Category	Saudi Arabia	International Average
	Percentage of students	Percentage of students
Each student has a computer	Math-5% Science-5%	Math-17% Science-19%
The class has computers that students can share	Math-14% Science-11%	Math-11% Science-17%
The school has computers that the class can sometimes use	Math-23% Science-26%	Math-28% Science -39%

SOURCE: Exhibit 14.3: Access to Computers for Mathematics Lessons, and Exhibit 14.4: Access to Computers for Science Lessons. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.



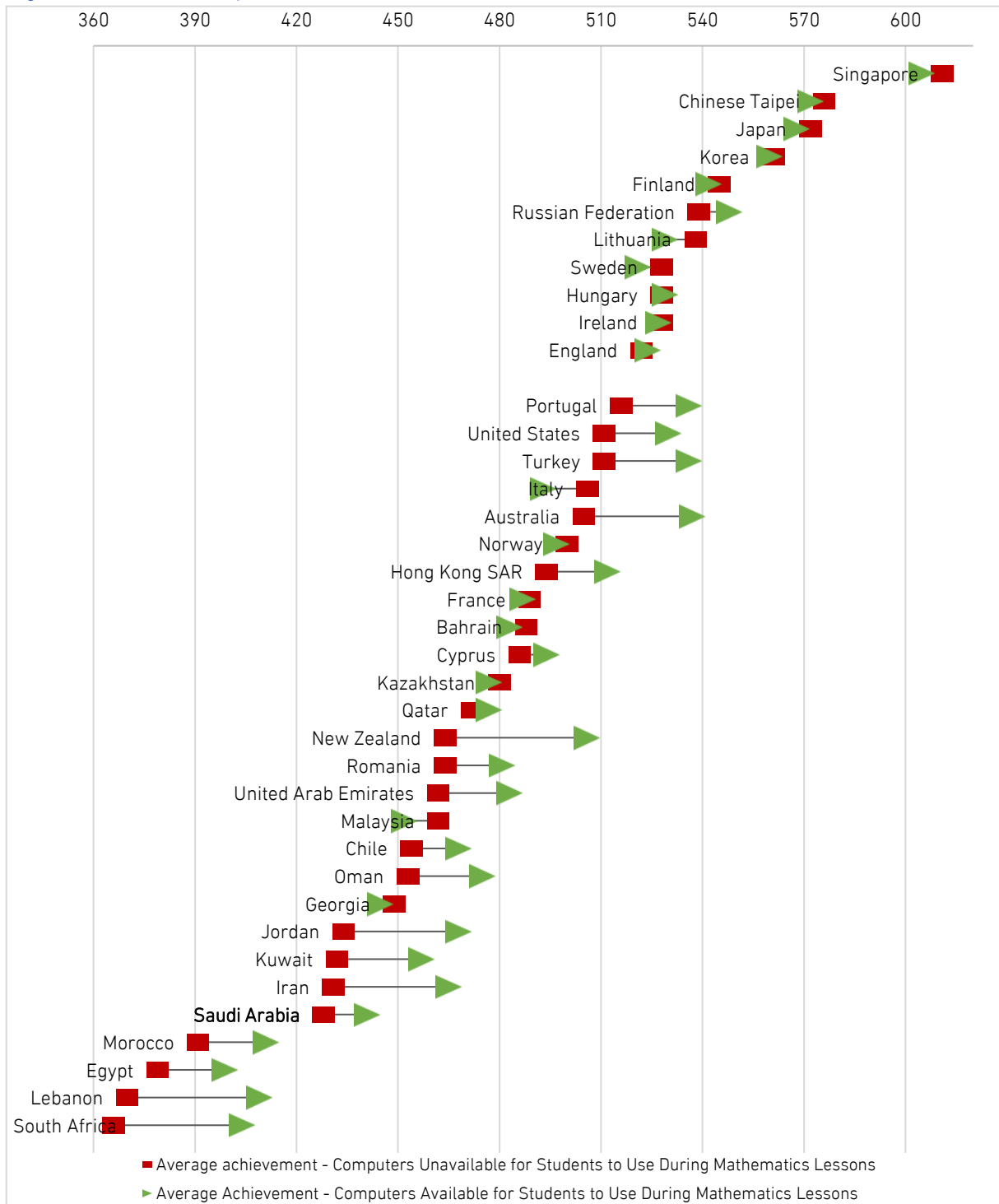
In almost all the categories, smaller shares of students were reported in Saudi Arabia, in comparison to International Averages. In most of the participating countries, eighth-graders who had access to computers scored on average better results than those with no access. Figure 10.1 and Figure 10.2, present achievement in relation to computer accessibility in the 8<sup>th</sup> grade mathematics and science, respectively. In the case of Saudi Arabia, the same dependency as for fourth-graders can be seen. Saudi Arabia's eighth-graders attending mathematics and science classes with access to computers during lessons scored on average by 12, and 13 points more than those with no access.

**Figure 10.1 Access to Computers for Mathematics Lessons – Grade 8**



SOURCE: Exhibit 14.3: Access to Computers for Mathematics Lessons. IEA's Trends in International Mathematics and Science Study TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 10.2 Access to Computers for Science Lessons – Grade 8**



SOURCE: Exhibit 14.4: Access to Computers for Science Lessons. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

### Technology to Support Learning

The computer is not only a necessity but also an opportunity to introduce a new dimension in learning aids. This is also why it is especially important to know how frequently Teachers Do Computer Activities to Support Learning in respectively

Mathematics and Science in fourth-grade Lessons. Based on teachers' reports, fourth-graders were assigned to one of four categories of how frequent their teachers do computer activities in the classroom: Every or Almost Every Day, Once or Twice a Week, Once or Twice a Month, and Never or Almost Never. **Table 10.4** and **Table 10.5** present teachers' reports on the frequency they do activities on computers to support learning during mathematics and science lessons in Saudi Arabia vs. the international average.

**Table 10.4** Structure of G4 students by frequency of teachers doing computer activities to support learning, in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Every or Almost Every Day	Math-14% Science-16%	Math-409 Science-417	Math-7% Science-6%	Math-515 Science-498
Once or Twice a Week	Math-11% Science-13%	Math-420 Science-420	Math-14% Science-13%	Math-509 Science-498
Once or Twice a Month	Math-5% Science-6%	Math-398 Science-390	Math-13% Science-20%	Math-510 Science-500
Never or Almost Never	Math-70% Science-65%	Math-393 Science-394	Math-67% Science-60%	Math-500 Science-490

SOURCE: Exhibit 14.5: Teachers Do Computer Activities to Support Learning in Mathematics Lessons, and Exhibit 14.6: Teachers Do Computer Activities to Support Learning in Science Lessons. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

The majority of fourth-graders attended mathematics and science classes where teachers did not support learning by using computers. An important observation is that relatively greater shares of students were reported to be in the extreme categories "Every or Almost Every Day" and "Never or Almost Never" in Saudi Arabia. Eight percent of students in mathematics and 11% of students in science learn in classes where teachers use computers on a daily basis to support the process of learning. It is worth noting that, in general, there is no clear correlation between the frequency of using computers in class and students' test results. Generally speaking, the results seem to be inconsistent. Although the average scores of fourth graders who attended classes in

which their teachers never or almost never used computers were relatively lower than the rest of their classmates, the data show that the highest average scores in the high-performing countries (such as Singapore and Hong Kong) were achieved by students who attended classes where the teachers never or almost never used computers. The data also reveal that the daily use of computers by students in Saudi Arabia may be associated with a lower achievement compared to those who use them on a weekly basis. However, the weekly use of computers was associated with better performance (in Saudi Arabia), compared to the monthly use or non-use. In any case, it is difficult to say that the use of a computer is associated with the academic achievement of students.

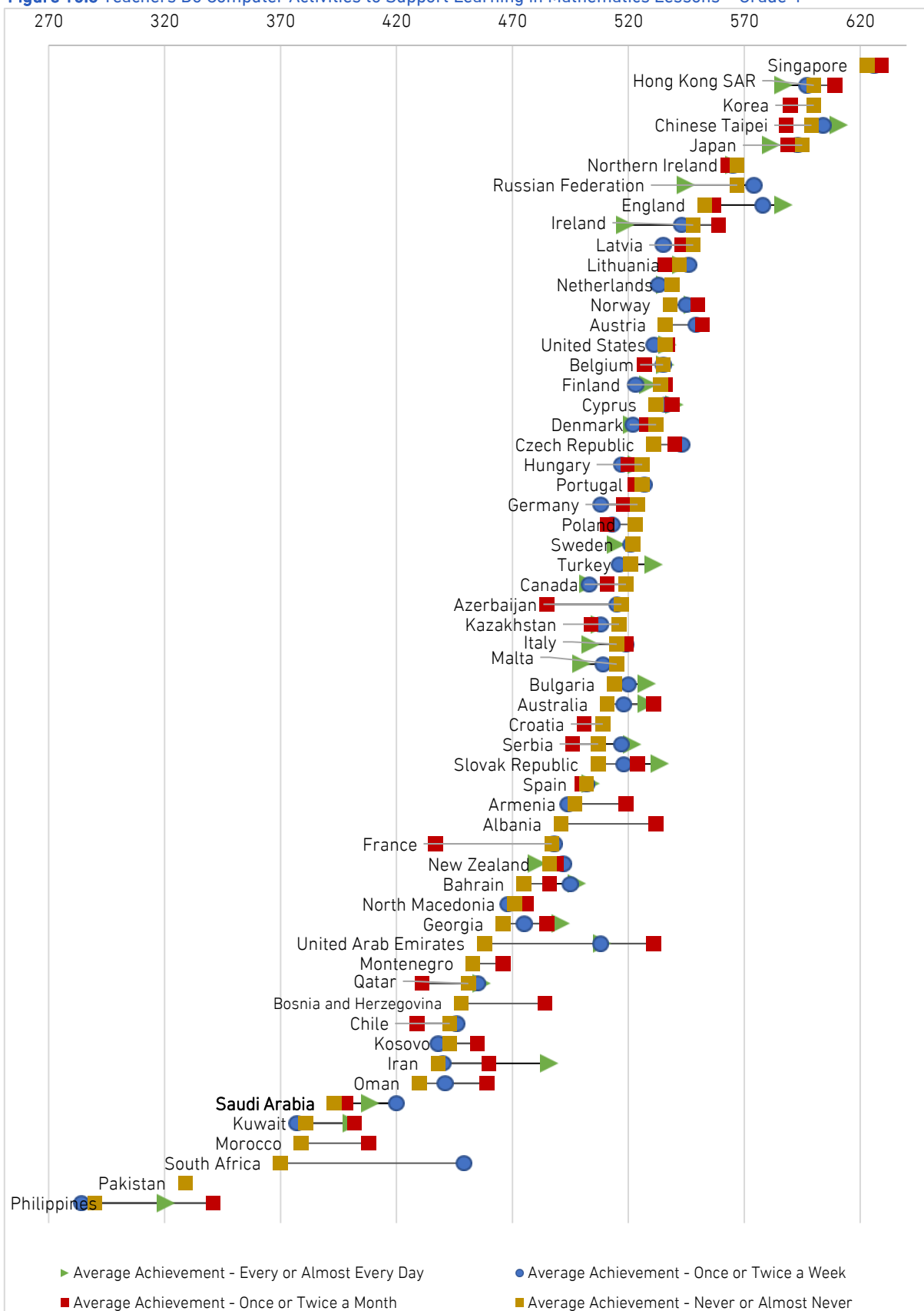
In the case of older cohorts, in the international average more than two-thirds (68%) of eighth-graders attended mathematics classes where teachers did not support learning by using computers. For science classes, this share was equal to 56%. Those numbers were even greater for Saudi Arabia (75% for Mathematics and 71% for Science).

**Table 10.5** Structure of G8 students by frequency of teachers doing computer activities to support learning, in Saudi Arabia and international average

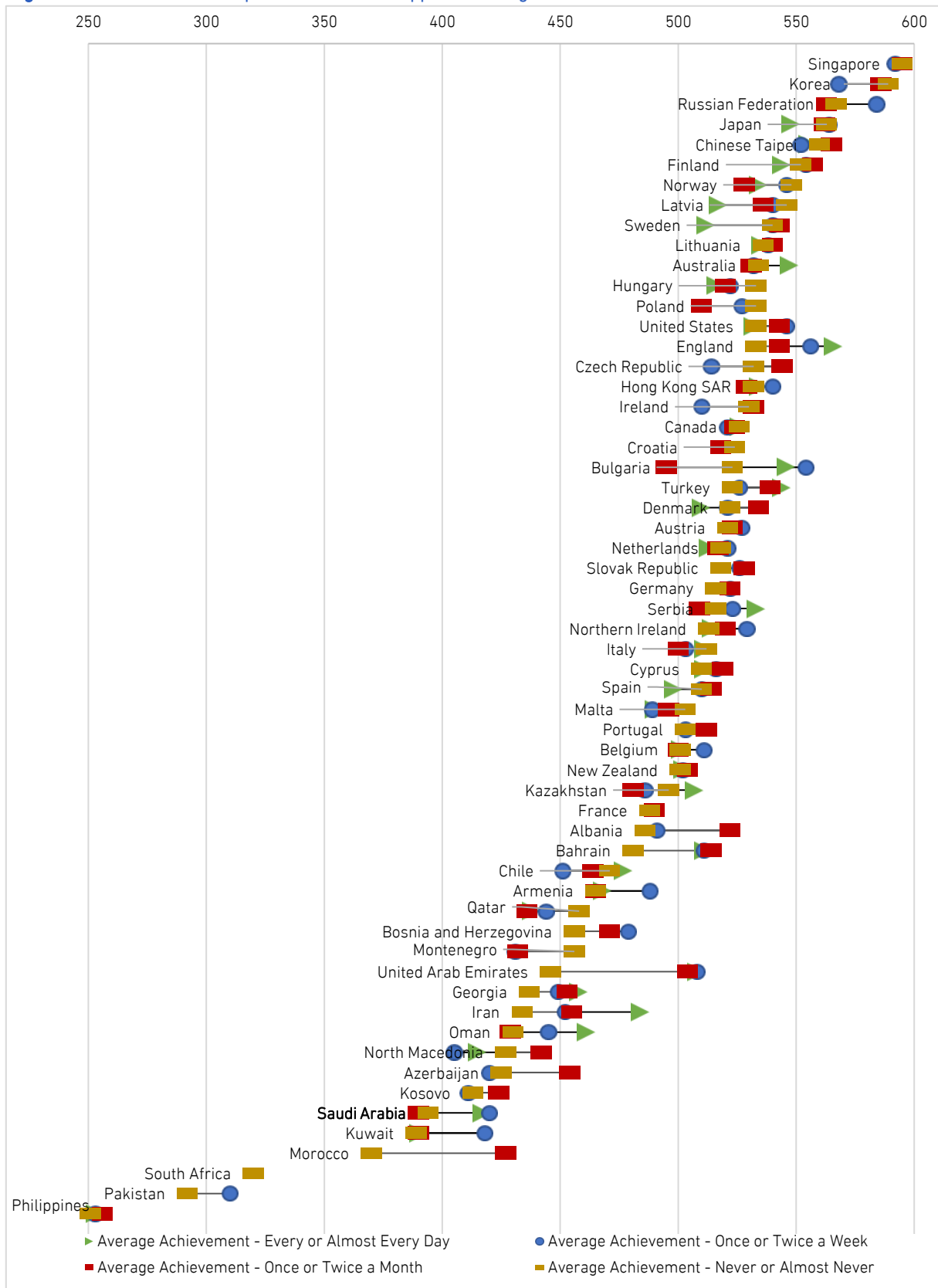
Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Every or Almost Every Day	Math-8% Science-11%	Math-413 Science-460	Math-5% Science-9%	Math-505 Science-509
Once or Twice a Week	Math-11% Science-12%	Math-408 Science-428	Math-10% Science-13%	Math-505 Science-495
Once or Twice a Month	Math-6% Science-5%	Math-374 Science-428	Math-16% Science-21%	Math-497 Science-497
Never or Almost Never	Math-75% Science-71%	Math-390 Science-428	Math-68% Science-56%	Math-487 Science-487

SOURCE: Exhibit 14.7: Teachers Do Computer Activities to Support Learning in Mathematics Lessons, and Exhibit 14.8: Teachers Do Computer Activities to Support Learning in Science Lessons. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 10.3 Teachers Do Computer Activities to Support Learning in Mathematics Lessons – Grade 4**



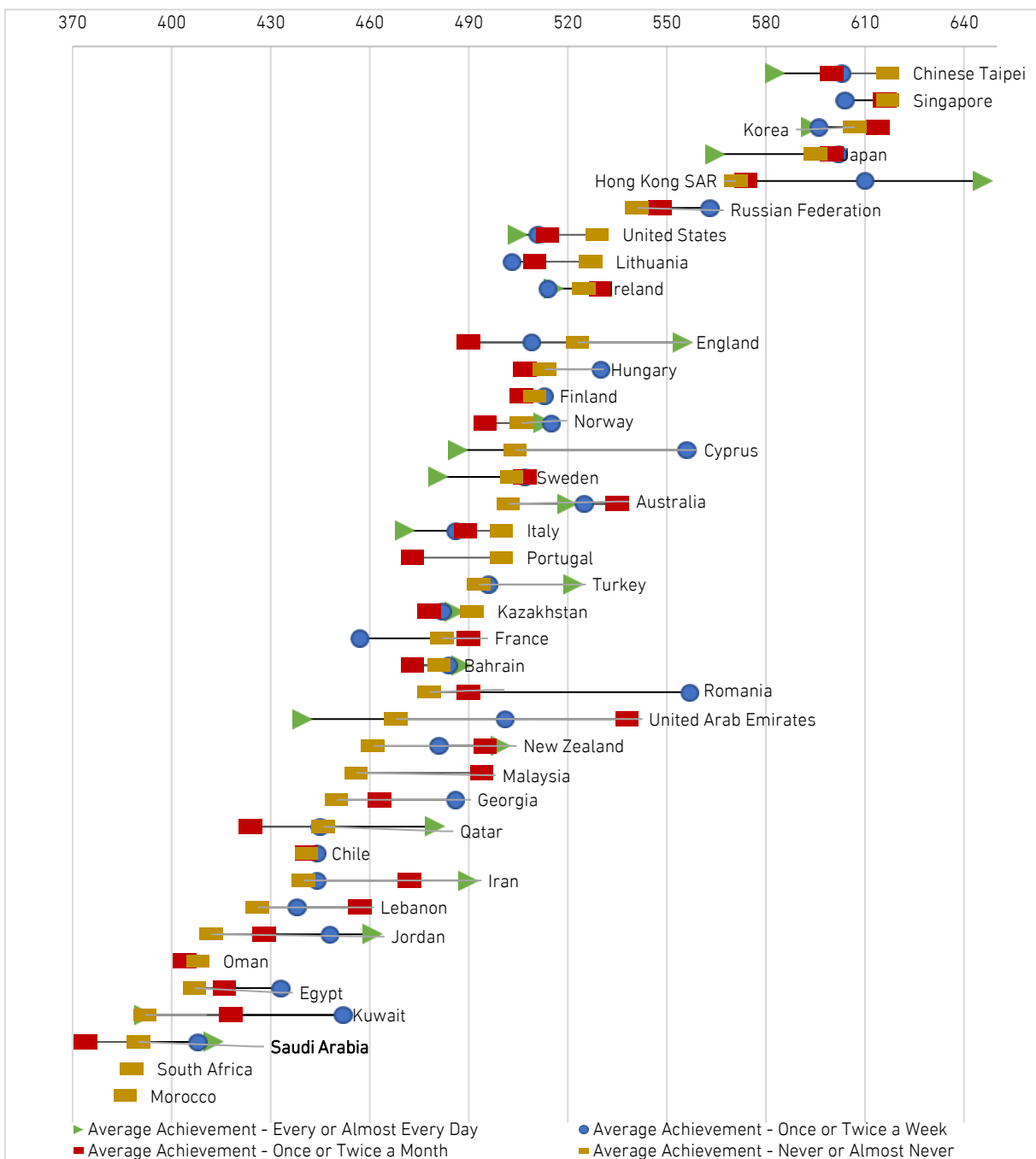
SOURCE: Exhibit 14.5: Teachers Do Computer Activities to Support Learning in Mathematics Lessons. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 10.4 Teachers Do Computer Activities to Support Learning in Science Lessons – Grade 4**

SOURCE: Exhibit 14.6: Teachers Do Computer Activities to Support Learning in Science Lessons. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

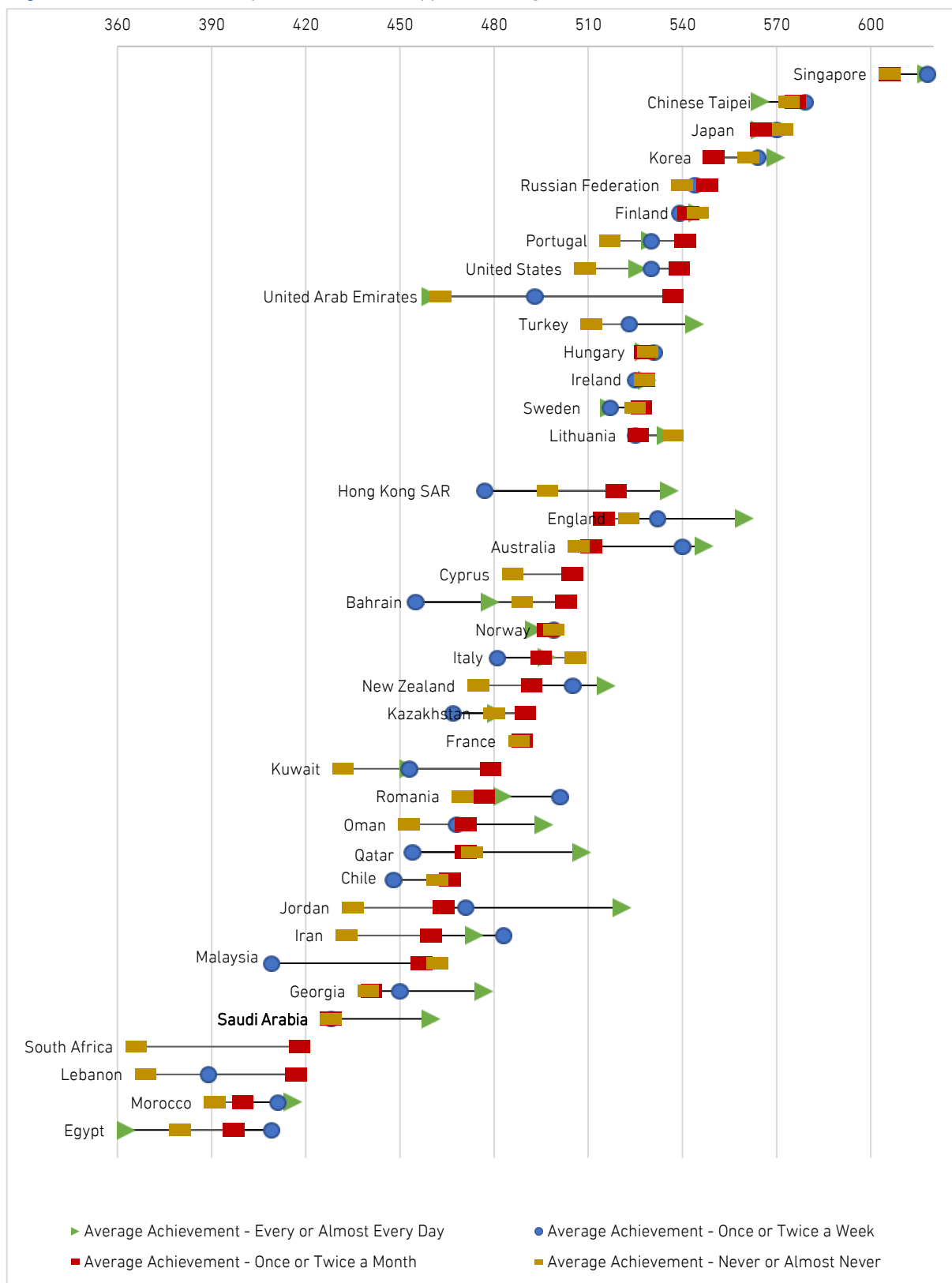
A similar pattern was noticed among the eight-graders (Figure 10.5 and Figure 10.6 ). In most of the low-performing countries (including Saudi Arabia), the lowest mathematical results were, on average achieved by students whose teachers did not, or rarely use computers during classes). However, in some of high-performing countries, too much computer activities (to support learning) is related to lower achievement.

**Figure 10.5 Teachers Do Computer Activities to Support Learning in Mathematics Lessons – Grade 8**



SOURCE: Exhibit 14.7: Teachers Do Computer Activities to Support Learning in Mathematics Lessons. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 10.6 Teachers Do Computer Activities to Support Learning in Science Lessons – Grade 8**



SOURCE: Exhibit 14.8: Teachers Do Computer Activities to Support Learning in Science Lessons. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.



### Tests Delivered on Digital Devices

The TIMSS data provide information on the use of computers to do the test in mathematics and science. Internationally, 64% and 69% of students did “never” take mathematics and science (respectively) tests on computers or tablets, while 14% to 18% did computer-based test “once or twice a year,” and 17% do so “once a month or more.” (Table 10.6) below presents the percentage distribution of fourth-graders based on the frequency of taking mathematics, and science tests on computers or tablets (according to teachers reports) in Saudi Arabia compared to the international average. In comparison to international averages, far more Saudi Arabian fourth-graders frequently participated in electronic tests.

**Table 10.6** Structure of G4 students by frequency of taking tests on computers or tablets, in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Once a Month or More	Math-38% Science-37%	Math-421 Science-418	Math-17% Science-17%	Math-502 Science-489
Once or Twice a Year	Math-9% Science-9%	Math-394 Science-394	Math-18% Science-14%	Math-504 Science-491
Never	Math-53% Science-54%	Math-381 Science-394	Math-64% Science-69%	Math-501 Science-491

SOURCE: Exhibit 14.9: Students Take Mathematics Tests on Computers or Tablets, and Exhibit 14.10: Students Take Science Tests on Computers or Tablets. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Internationally, there is no clear relation between student's average achievement score and the frequency of tests conducted on computers, or tablets. However, Saudi Arabia's fourth-graders who took the test on computers or tablets at least once a month achieved on average significantly better results.

**Table 10.7** presents the percentage distribution of eight grade students based on the frequency of taking mathematics, and science tests on computers or tablets in Saudi

Arabia compared to the international average. Exactly as for fourth-graders, far more Saudi Arabian eight-graders monthly participated in electronic tests compared to the international average. Table 10.7 below shows that there is no relation between eighth-graders' average achievement score and the frequency of tests conducted on computers or tablets. In Saudi Arabia, those students who took at least once a month test on computers or tablets achieved in science assessment, on average, significantly better results.

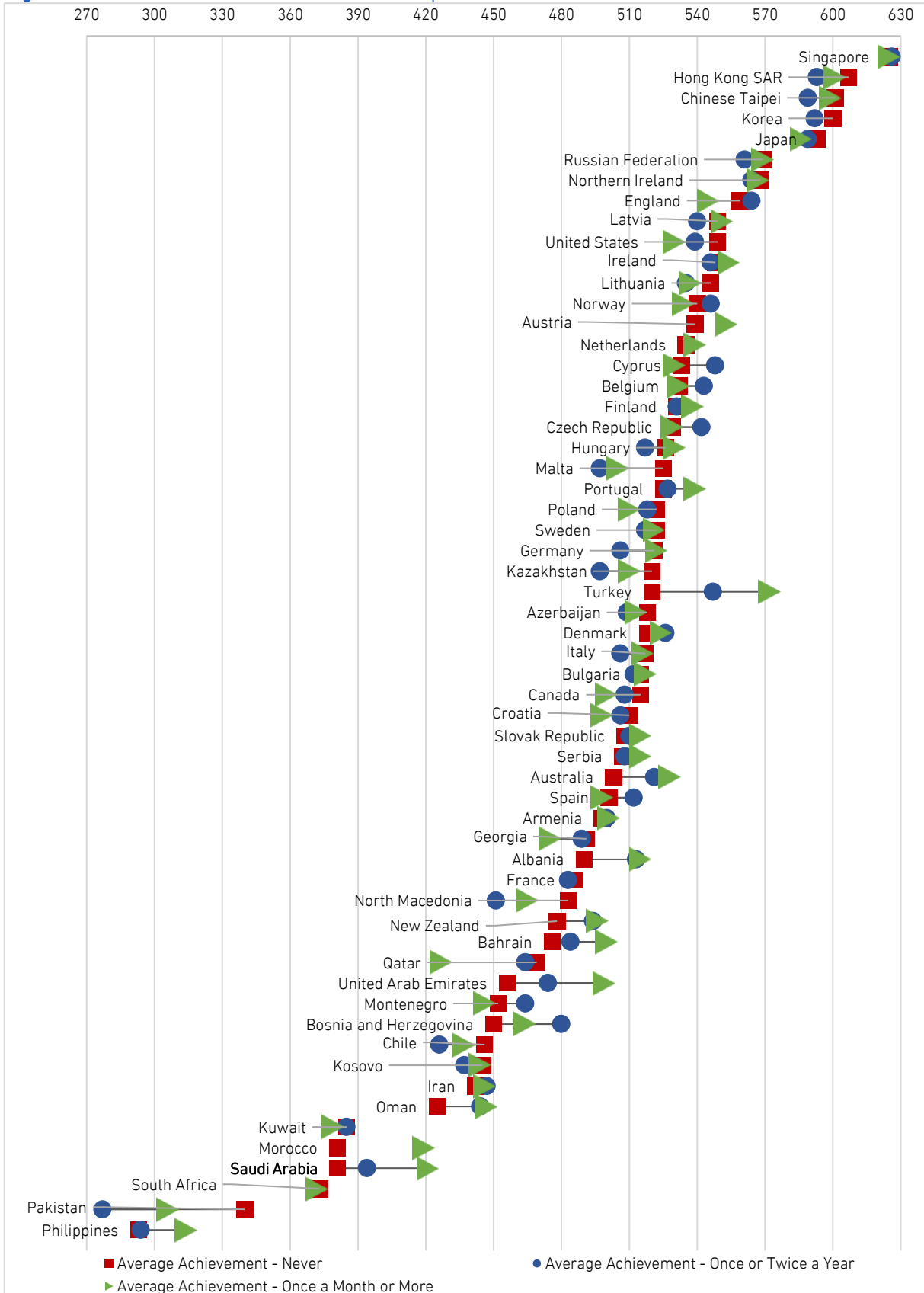
**Table 10.7** Structure of G8 students by frequency of taking tests on computers or tablets, in Saudi Arabia and international average

Category	Saudi Arabia		International Average	
	Percentage of students	Average score	Percentage of students	Average score
Once a Month or More	Math-42% Science-41%	Math-400 Science-439	Math-18% Science-20%	Math-482 Science-492
Once or Twice a Year	Math-5% Science-7%	Math-403 Science-419	Math-21% Science-20%	Math-494 Science-496
Never	Math-53% Science-52%	Math-391 Science-428	Math-61% Science-61%	Math-491 Science-491

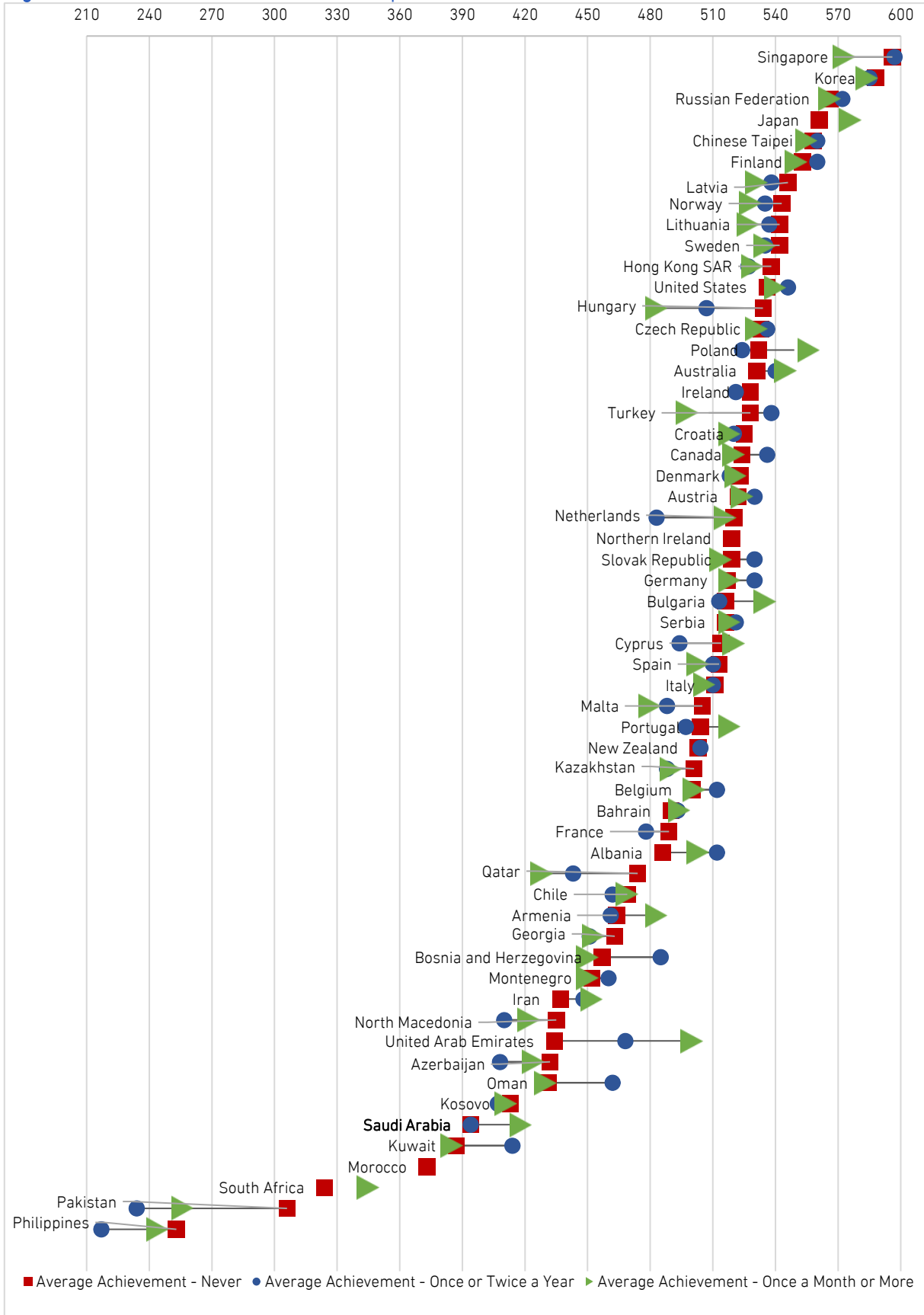
SOURCE: Exhibit 14.11: Students Take Mathematics Tests on Computers or Tablets, and Exhibit 14.12: Students Take Science Tests on Computers or Tablets. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 10.7**, and **Figure 10.8** present the average achievement of four-graders in the participating countries in the study by the frequency of taking tests on digital devices. In the majority of the countries, there is no clear correlation between the frequency of taking test on computers or tablets, and students' test results in both mathematics and science assessment. Concerning the eighth-graders, similar observations can be made (**Figure 10.9**, and **Figure 10.10**).

Figure 10.7 Students Take Mathematics Tests on Computers or Tablets – Grade 4

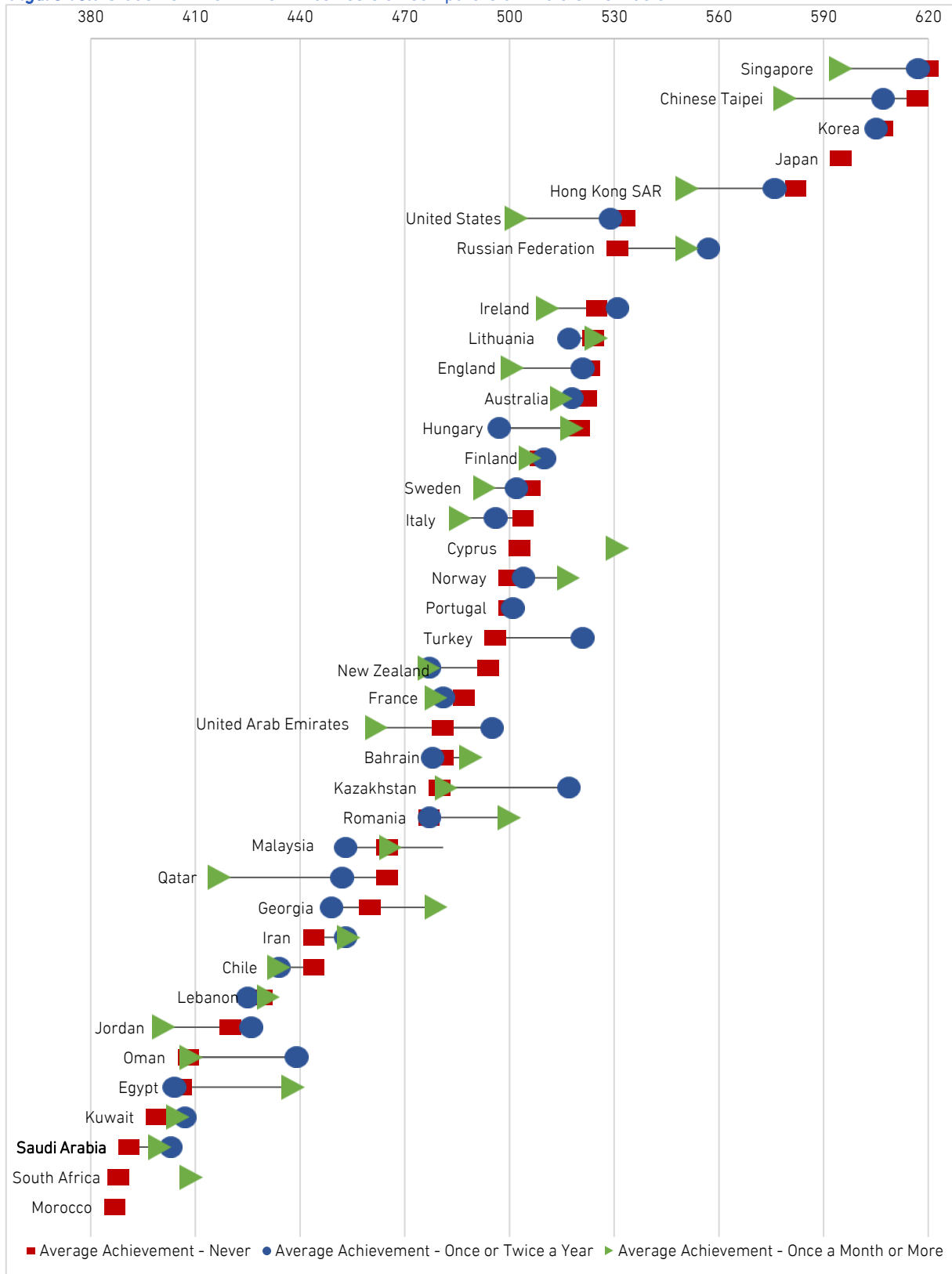


SOURCE: Exhibit 14.9: Students Take Mathematics Tests on Computers or Tablets. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

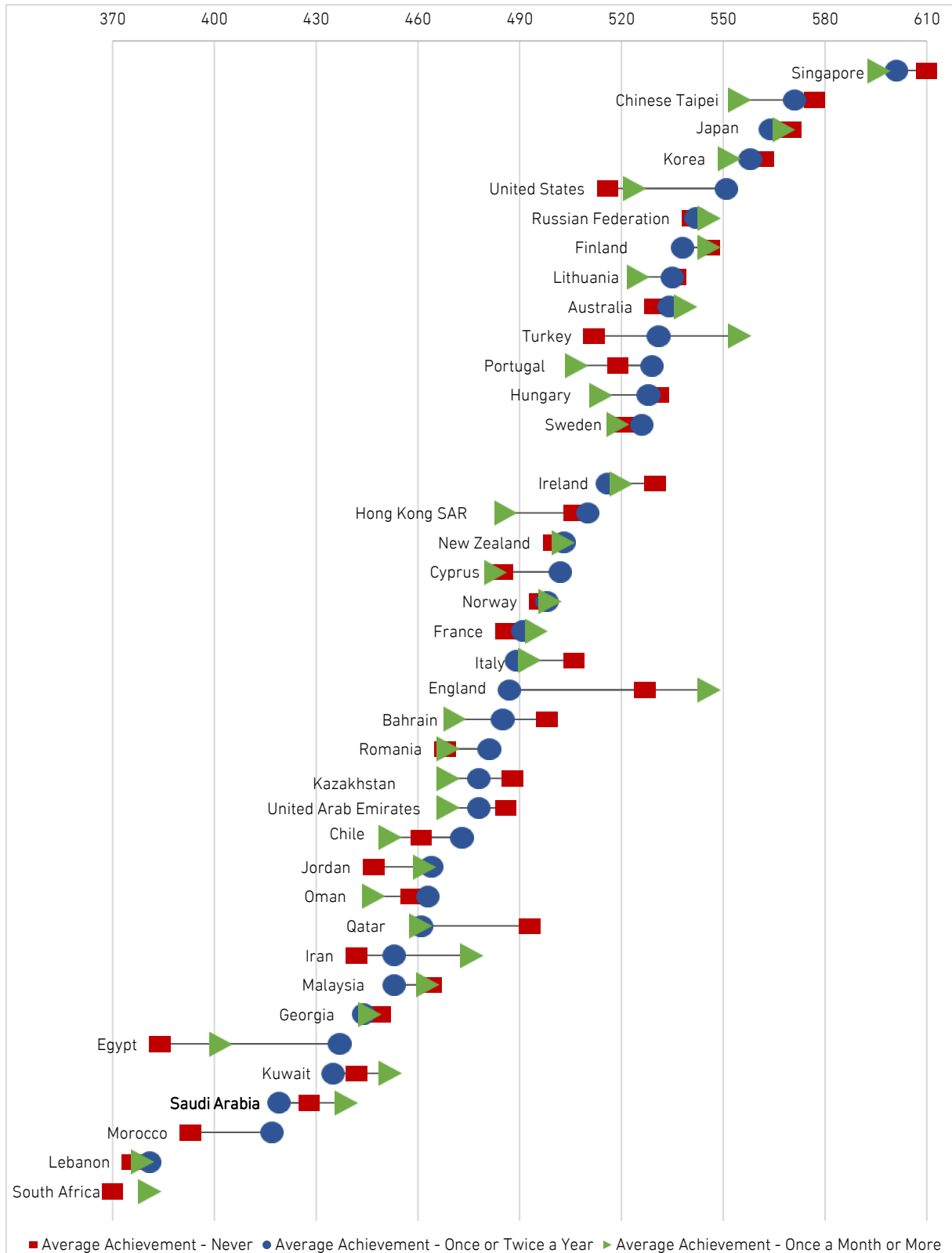
**Figure 10.8 Students Take Science Tests on Computers or Tablets – Grade 4**

SOURCE: Exhibit 14.10: Students Take Science Tests on Computers or Tablets. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 10.9 Students Take Mathematics Tests on Computers or Tablets – Grade 8



SOURCE: Exhibit 14.11: Students Take Mathematics Tests on Computers or Tablets. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

**Figure 10.10** Students Take Science Tests on Computers or Tablets– Grade 8

SOURCE: Exhibit 14.12: Students Take Science Tests on Computers or Tablets. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.



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## Chapter 11

### Curriculum and Instruction in Mathematics and Science

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## Curriculum and Instruction in Mathematics and Science

### Instructional Time in Mathematics

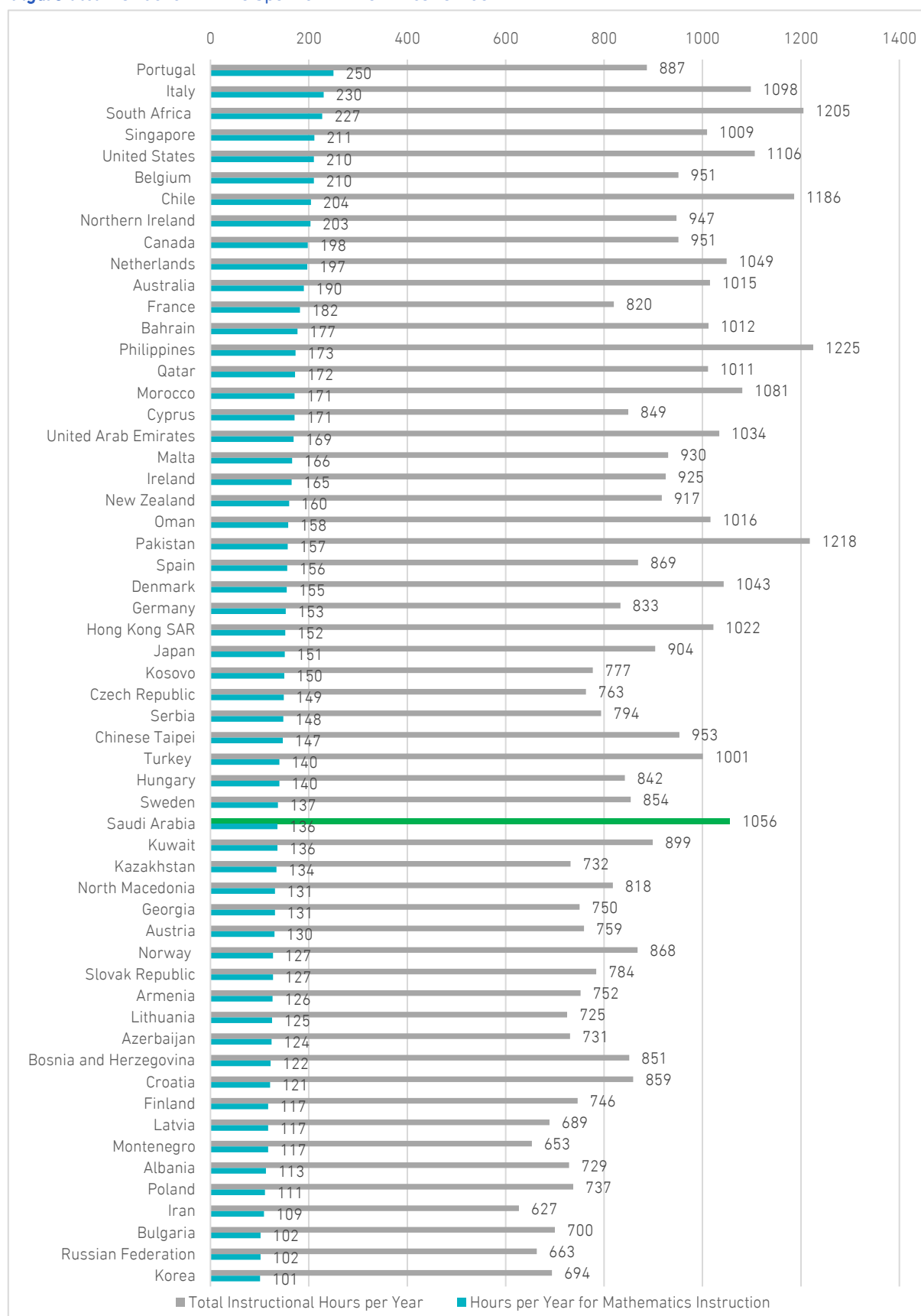
In this chapter, the data regarding instruction and curriculum in Mathematics will be discussed. Although many factors may influence the learning process, instructional time is crucial when considering students' learning. In this matter, two factors were measured:

- Total Instructional Hours Per Year (based on Principal Reports).
- Hours Per Year for Mathematics Instruction, calculated as: (Teacher Reports of Weekly Mathematics Instructional Hours) divided by (Principal Reports of School Days per Week), and multiplied by (Principal Reports of School Days per Year).

Figure 11.1 below presents variables for each of participating countries in grade four. The list of the participating countries is organized by the highest number of Hours per Year spent on Mathematics Instruction. Most time devoted to Mathematics was reported in Portugal (250 hours), Italy (230 hours), and South Africa (227 hours). On the other hand, the lowest numbers were reported in Korea (101 hours), Bulgaria (102 hours), and the Russian Federation (also 102 hours). Out of the 57 participating countries, Saudi Arabia took the 36th position (136 hours). Internationally, the fourth-graders spent around 17% of their time in school in mathematics classes (154 out of 895 hours). Saudi Arabia's fourth-graders spent, 136 out of 1056 hours in mathematics which is equivalent to around 13% of their school time (it is less than the international average by 4 p.p.).



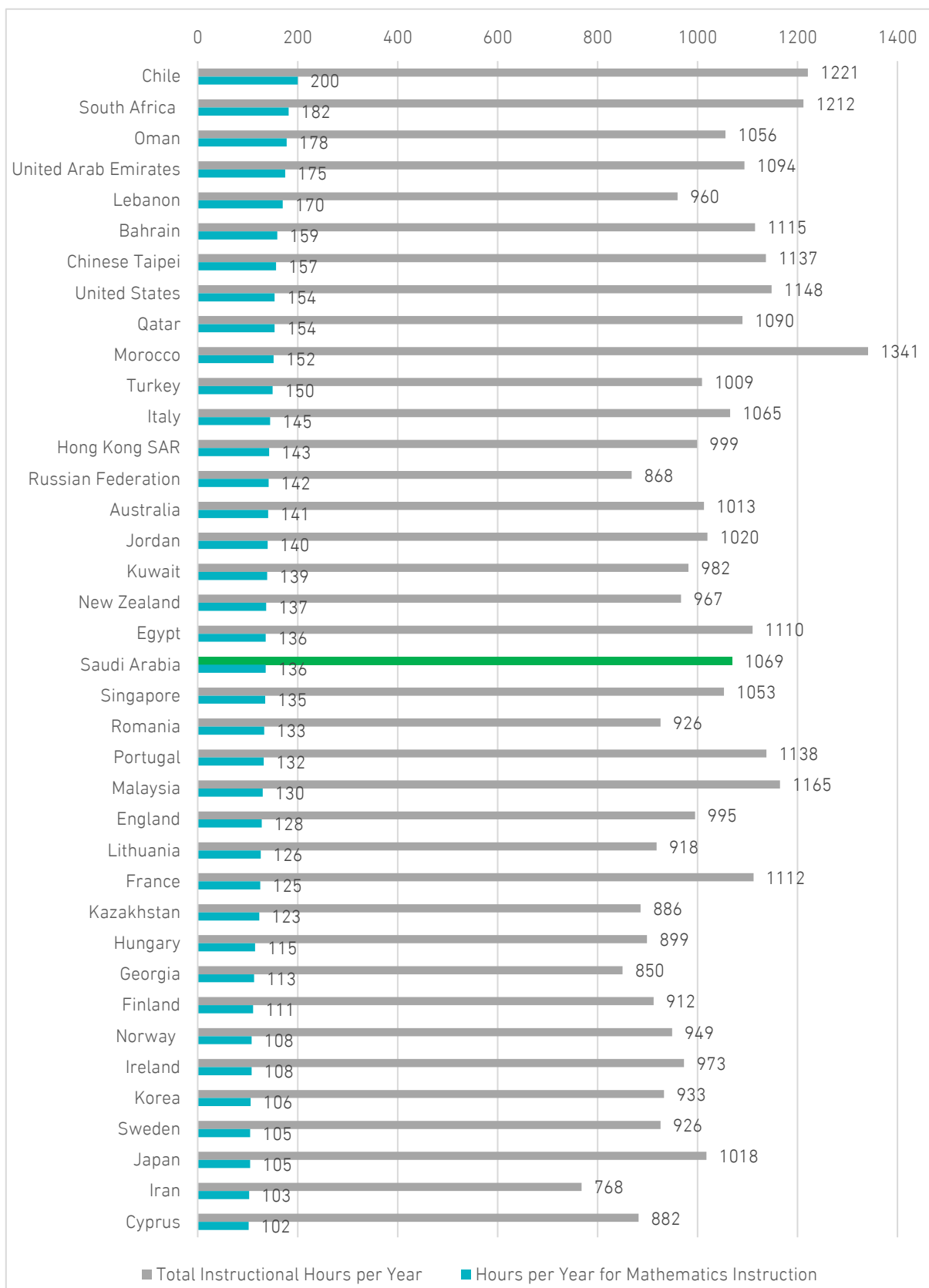
Figure 11.1 Instructional Time Spent on Mathematics- Grade 4



SOURCE: Exhibit 12.2: Instructional Time Spent on Mathematics – Grade 4. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Figure 11.2 shows Instructional Time Spent on Mathematics and Total among eighth-graders. Students from Chile (200 hours), South Africa (182 hours), and Oman (178 hours) spent the greatest amount of time in mathematics. On the other hand, the lowest numbers were observed in Cyprus (102 hours), Iran (103 hours), and Japan (105 hours). Internationally, eighth-graders spent around 13% of their time in school in mathematics classes (137 out of 1023 hours). Even though older students worldwide spent more time in school, they devote relatively less of it to mathematics. In Saudi Arabia, eighth-graders spent 136 out of 1069 hours on mathematics, this is around 13% of their school time – the same as four-graders.

Figure 11.2 Instructional Time Spent on Mathematics – Grade 8



SOURCE: Exhibit 12.3: Instructional Time Spent on Mathematics – Grade 8. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

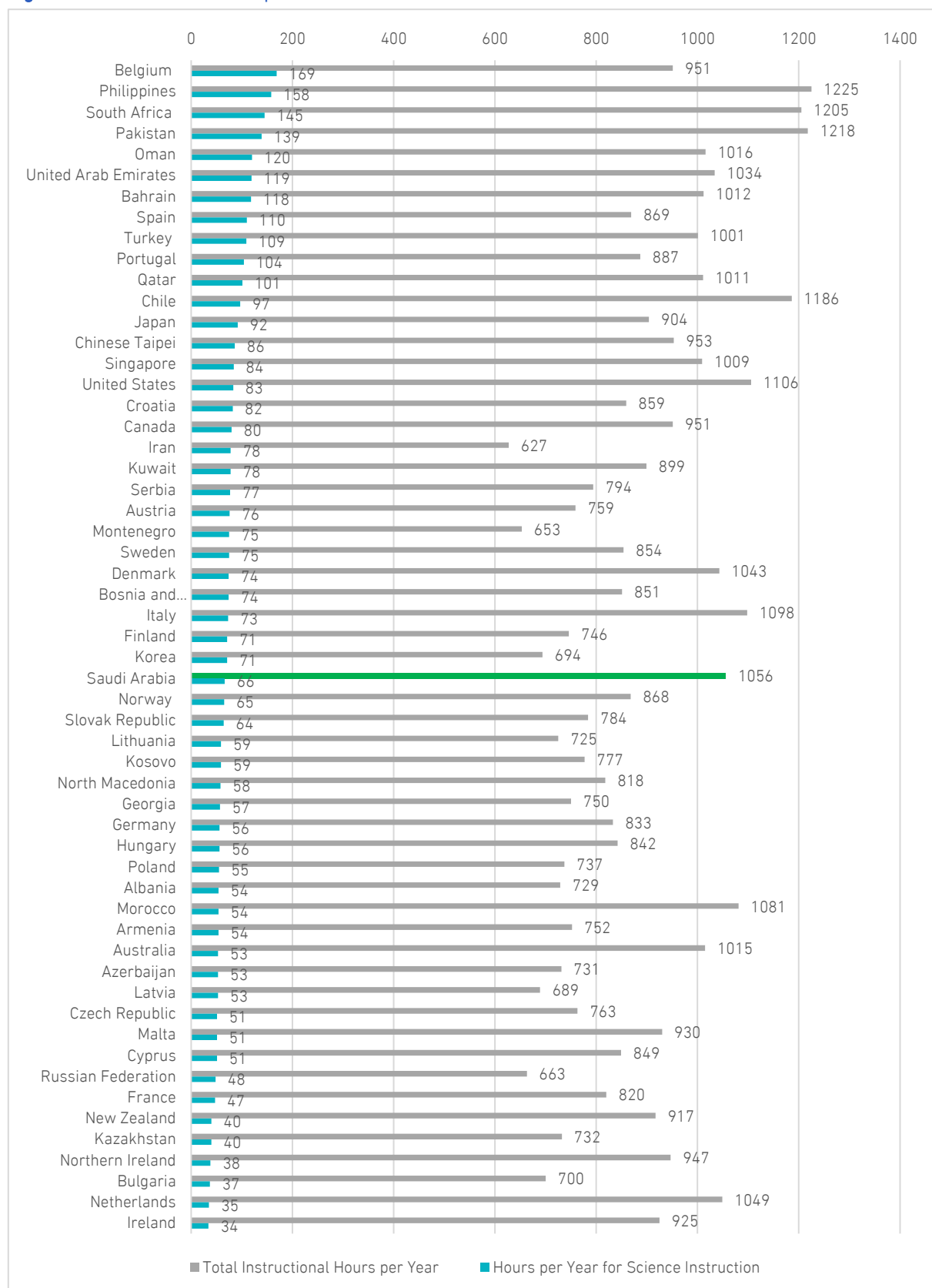
## Instructional Time in Science

In regard to Instructional Time Spent on Science, two factors were measured:

- Total Instructional Hours Per Year (based on Principal Reports).
- Hours Per Year for Science Instruction, calculated as: (Teacher Reports of Weekly Science Instructional Hours) divided by (Principal Reports of School Days per Week), and multiplied by (Principal Reports of School Days per Year).

Figure 11.3 presents a comparison between the above-mentioned variables for fourth grade assessment among all participating countries. The list of the participating countries was organized by the highest amount of time spent on science classes. This ranking starts with (Belgium – 169 hours, the Philippines – 158 hours, South Africa – 145 hours), and ends with (Ireland – 34 hours, Netherlands – 35 hours, and Bulgaria – 37 hours). Out of the 56 participating countries that have reported data in the required form, Saudi Arabia took the 30<sup>th</sup> position (66 hours). Internationally, average fourth-graders devoted around 8% of their school time to science-related activities (75 out of 895 hours), while in Saudi Arabia this share equals 6% (66 out of 1056 hours). It can be observed that Saudi Arabia's fourth-graders spent less of their school time on science, in comparison to international average.

Figure 11.3 Instructional Time Spent on Science – Grade 4

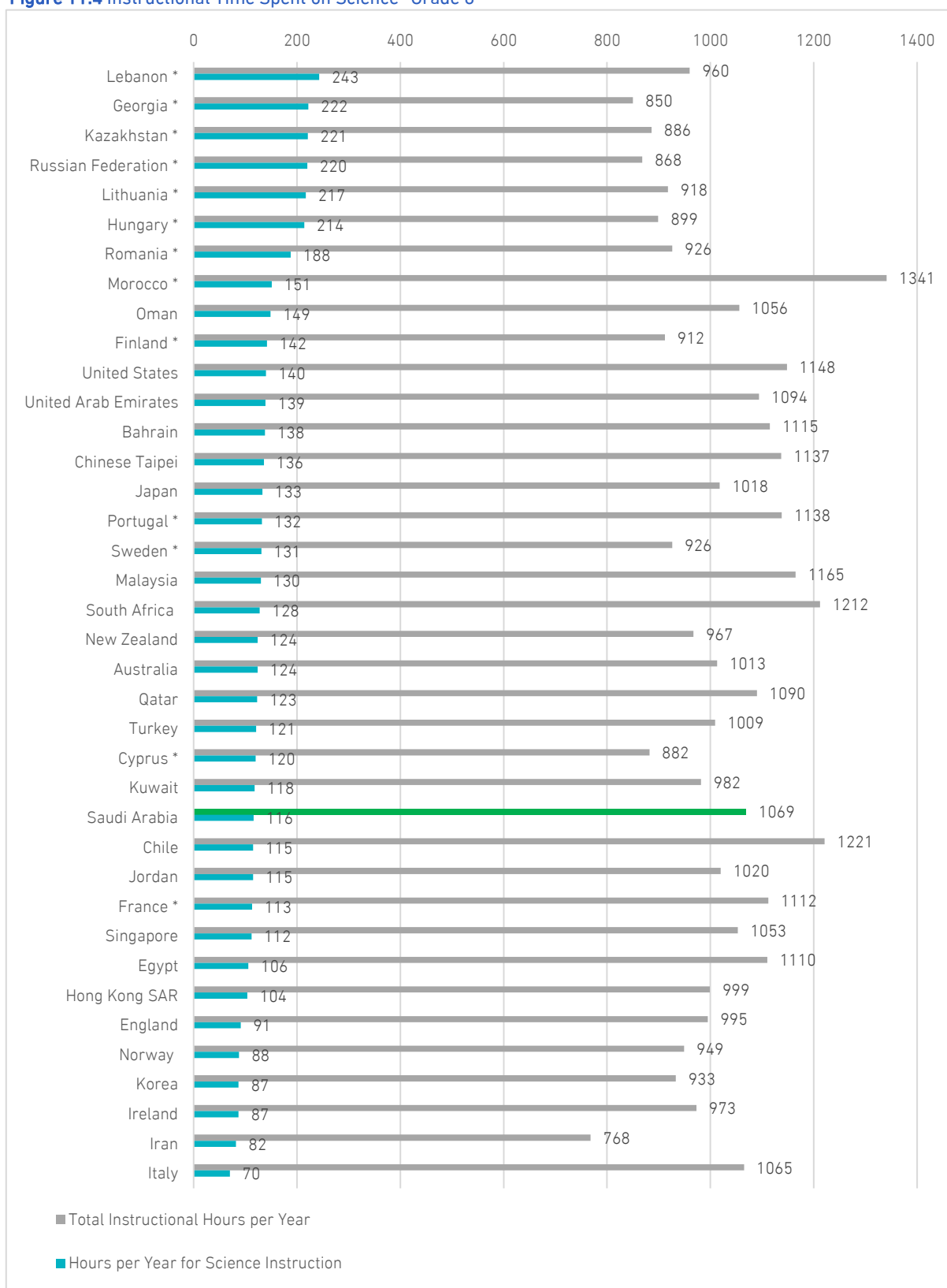


SOURCE: Exhibit 13.2: Instructional Time Spent on Science – Grade 4. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Similar data is reported for eighth-graders and presented Figure 11.4, The greatest amount of time devoted to Science was noticed in Lebanon (243 hours), Georgia (222 hours), and Kazakhstan (221 hours). However, as presented previously in the report, this does not correspond to achievement in those countries. The lowest numbers were reported in Italy (70 hours), Iran (82 hours), Ireland (87 hours), and Korea (also 87 hours). Out of the 39 participants, Saudi Arabia was placed in the 27<sup>th</sup> position.

Saudi Arabia eighth-graders devoted around 11% of their school time to science-related activities (116 out of 1069 hours). Those students spent more time on science related activities than fourth-graders. The International Average in this matter is a bit greater and equals 13% (137 out of 1023 hours

Figure 11.4 Instructional Time Spent on Science- Grade 8



SOURCE: Exhibit 13.3: Instructional Time Spent on Science – Grade 8. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Students Taught the TIMSS Mathematics Topics

Mathematics tasks included in TIMSS 2019 four-grade assessment are divided into three major domains:

- Numbers, which contains topics such as: concepts of whole numbers, including place value and ordering; adding, subtracting, multiplying, and dividing with whole numbers; concepts of multiples and factors, odd and even numbers.
- Measurement and Geometry: solving problems involving length, measuring, and estimating; problems involving mass, volume, and time; three-dimensional shapes, including relationships with their two-dimensional representations.
- Data: reading and interpreting data from tables, pictographs, bar graphs, line graphs, and pie charts; organizing and representing data to help answer questions and drawing conclusions from data displays.

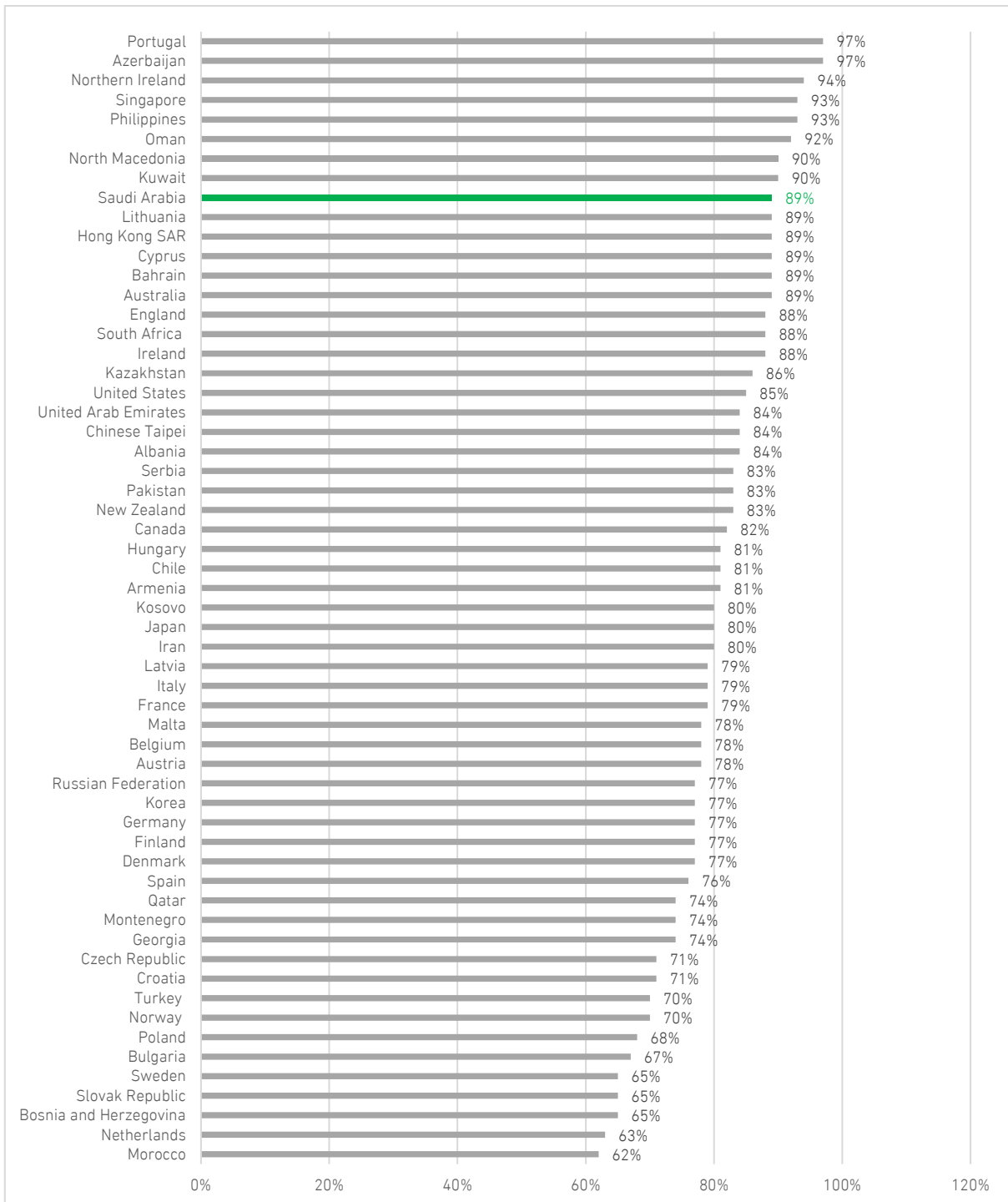
Figure 11.5 shows the percentage of fourth-graders who already have mostly discussed all mathematics assessment topics (in each of participating countries). The percentages of students who already discussed most of mathematics topics before the assessment are as follows: Azerbaijan (97%), Portugal (97%), Northern Ireland (94%), the Philippines (93%), and Singapore (93%). On the other hand, the lowest percent of such students were reported in Morocco (62%), Netherlands (63%), Sweden (65%), Slovak Republic (65%), and Bosnia and Herzegovina (65%).

Internationally, 80% of the fourth-graders have already discussed most of topics in mathematics classes (in number – 86%, in Measurement and Geometry – 76%, and in



data – 78%). In Saudi Arabia, the share of fourth-graders who have already discussed most of topics in mathematics was 89% (91% in numbers, 85% in geometry and measurement, and 91% in data). In all these fields, these numbers are significantly higher than the International Averages.

**Figure 11.5 Percentages of Students Taught mostly all the TIMSS Mathematics Topics – Grade 4**



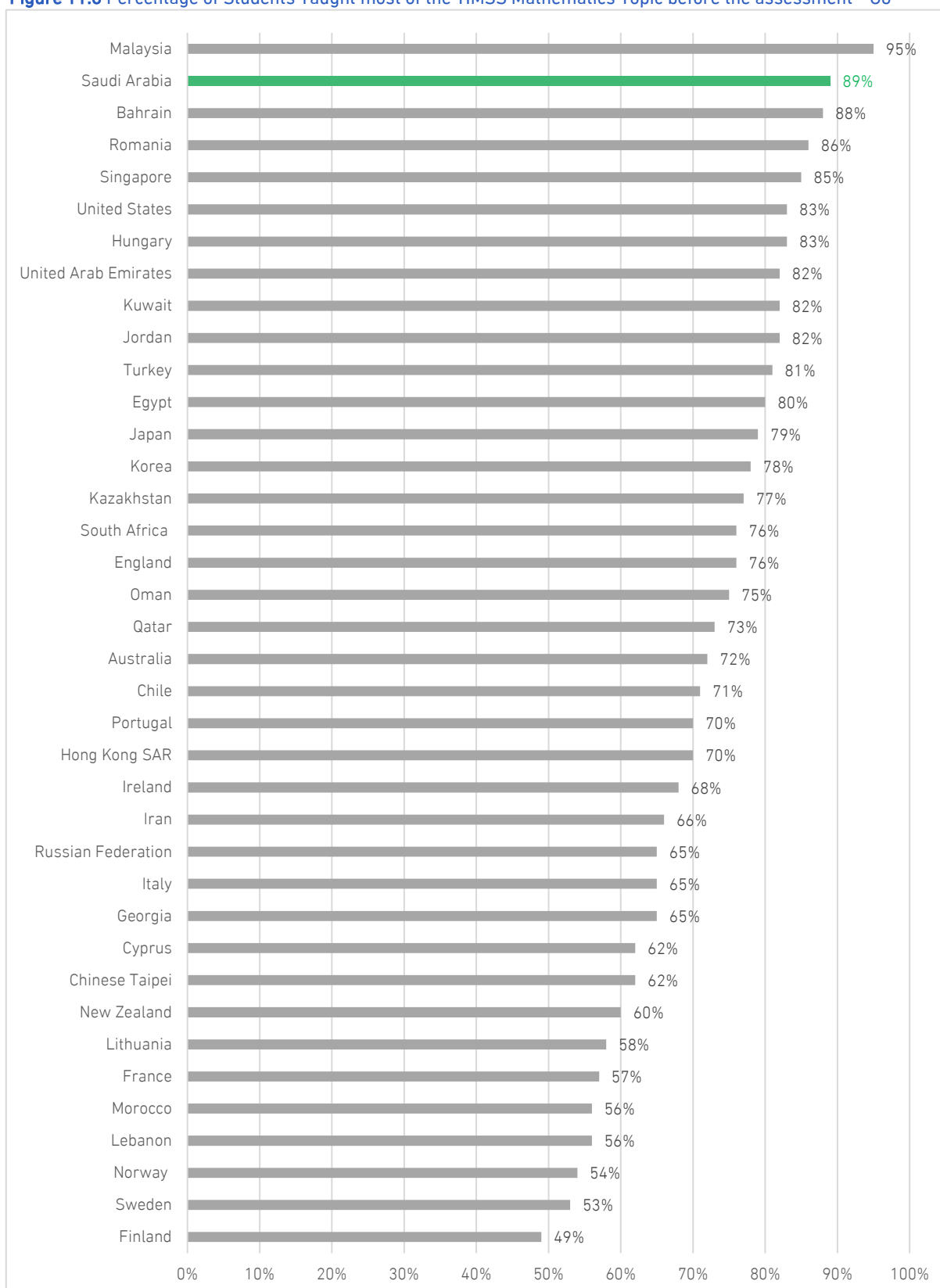
SOURCE: Exhibit 12.5: Percentages of Students Taught the TIMSS Mathematics Topics. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

Mathematics tasks included in TIMSS 2019 eight-grade assessment are divided into four different content domains.

- Number: concerning, e.g., computing with negative numbers, concepts of fractions and decimals, and solving problems involving proportions and percentages.
- Algebra: e.g., simplifying and evaluating algebraic expressions, simple linear equations, and properties of functions (slopes, intercepts, etc.).
- Geometry: e.g., geometric properties of angles, pairs of lines, and geometric shapes (triangles, quadrilaterals, and other common polygons), and solving problems involving perimeters, circumferences, and areas and congruent figures and similar triangles.
- Data and Probability: e.g., reading and interpreting data from one or more sources to solve problems (interpolating, extrapolating, drawing conclusions), identifying appropriate procedures for collecting data, and the theoretical and empirical probability of compound events.

**Figure 11.6** presents the shares of eighth-graders whose teachers have already taught them most of required topics in mathematics. Looking at the top performing countries in this ranking, the percentage of students who discussed most of the mathematics topics before the assessment in Malaysia (95%), Saudi Arabia (89%), Bahrain (88%), Romania (86%), and Singapore (85%). In Saudi Arabia, the percentage was 89% (in number – 99%, in algebra – 79%, in geometry – 96%, in data and probability – 88%), which is considerably higher than that of the international average.

**Figure 11.6 Percentage of Students Taught most of the TIMSS Mathematics Topic before the assessment - G8**



SOURCE: Exhibit 12.7: Percentages of Students Taught the TIMSS Mathematics Topics. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

## Students Taught the TIMSS Science Topics

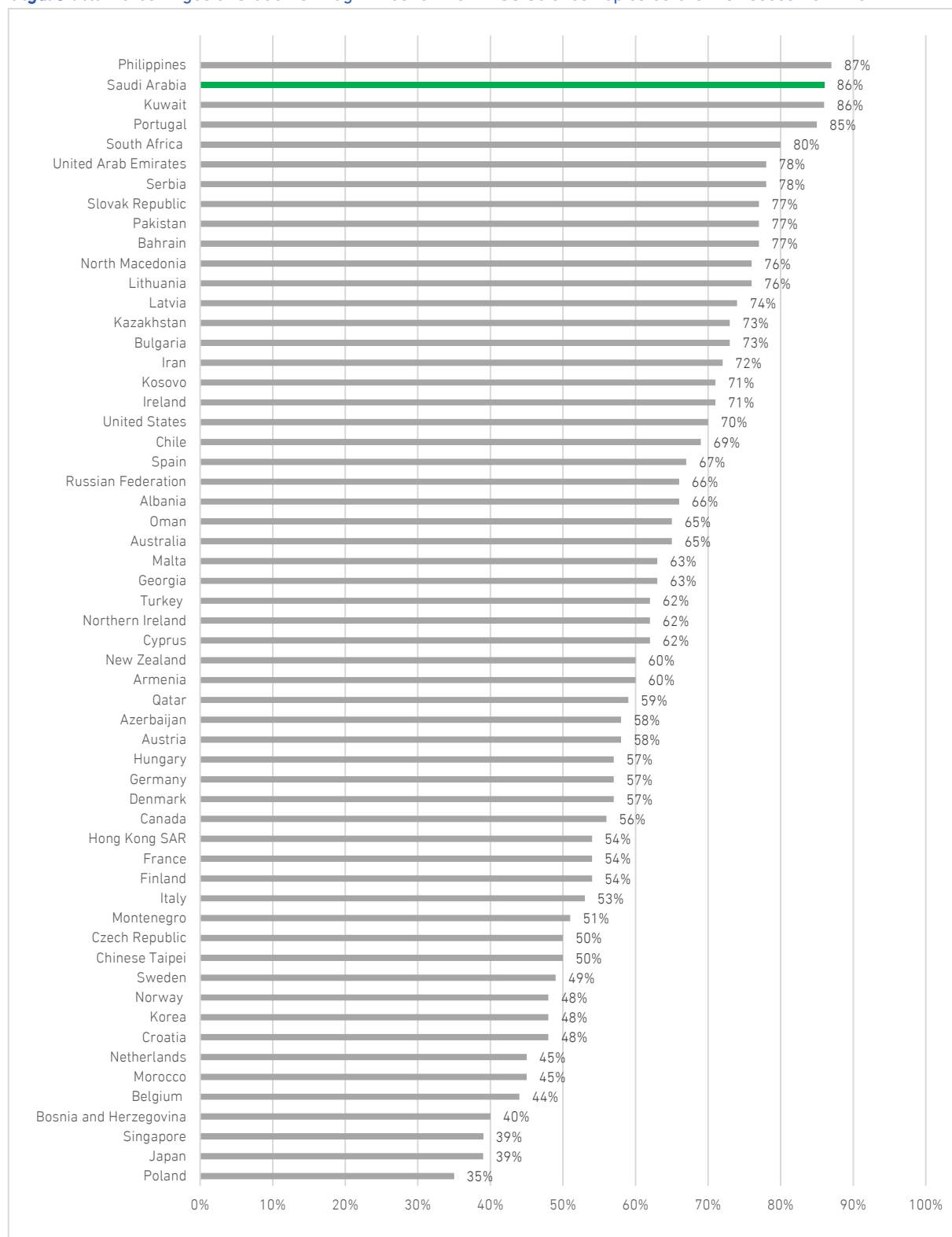
Science tasks included in TIMSS 2019 four-grade assessment are divided into three different domains:

- Life science, which contains topics such as: physical and behavioral characteristics of living things; body structures and their functions in humans, other animals, and plants; life cycles of common plants and animals; characteristics of plants and animals that are inherited; interactions between organisms and their environments; relationships in ecosystems; human health.
- Physical science: states of matter and their properties; classifying materials based on physical properties; methods for separating a mixture into its components; properties of magnets; physical, and chemical changes in everyday life; common sources, and use of energy; light and sound in everyday life; heat transfer; electricity and simple electrical circuits; forces that cause objects to move or change their motion; simple machines that help make motion easier.
- Earth science: physical makeup, and changes in Earth's surface; Earth's resources used in everyday life; fossils and what they can tell us about past conditions on Earth; weather and climate; objects in the Solar System and their movements; Earth's motion and related patterns observed on Earth.

**Figure 11.7** illustrates the shares of fourth-graders whose teachers have already taught them most of the topics required in the science assessment (in each of participating countries). The list of participants starts with the Philippines (87%), Saudi Arabia (86%), Kuwait (86%), Portugal (85%), and South Africa (80%). On the other hand, the lowest percentages were observed in Poland (35%), Japan (39%), Singapore (39%), Bosnia and Herzegovina (40%), and Belgium (44%).

Internationally, 63% of the students already covered most of the topics of fourth-grade science before TIMSS tests (in life science – 73%, in physical science – 58%, and Earth science – 60%). In comparison to mathematics assessment, less fourth grade science teachers were able to discuss the majority of required topics for the assessment.

In Saudi Arabia, 86% of the students were already taught most of topics of fourth-grade science (84% in life science, 88% in physic science, and 84% in Earth science). These values are considerably greater than those of the International Averages.

**Figure 11.7 Percentages of Students Taught most of the TIMSS Science Topics before the assessment – G4**

SOURCE: Exhibit 13.5: Percentages of Students Taught the TIMSS Mathematics Topics. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>.

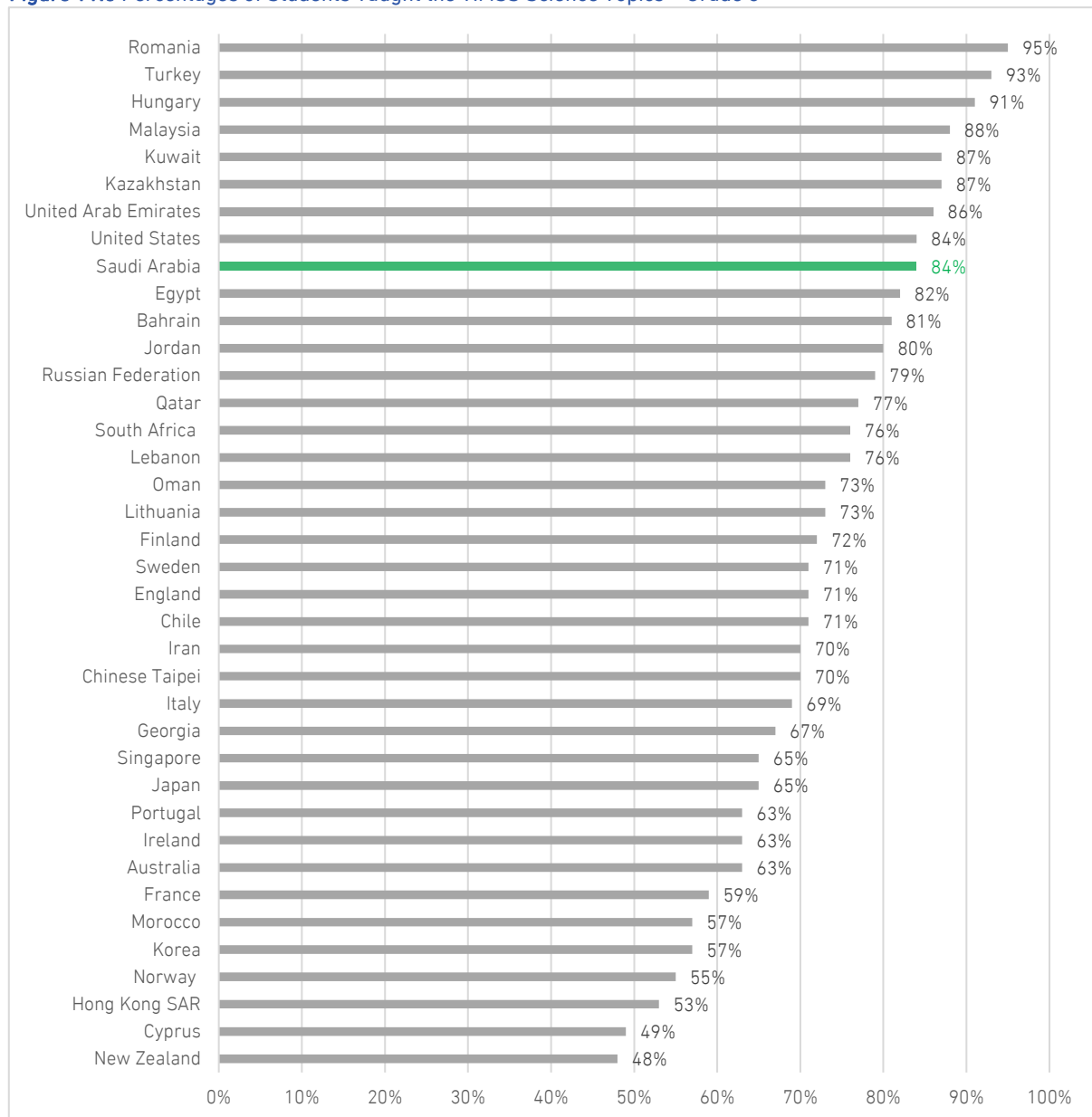
Science tasks included in TIMSS 2019 eight-grade assessment are divided into four different domains:

- **Biology:** differences among major taxonomic groups of organisms; major organs and organ systems in humans and other organisms; cells, their structure and functions, including respiration and photosynthesis as cellular processes; life cycles, sexual reproduction, and heredity; role of variation and adaptation in survival/extinction of species; interdependence of populations of organisms in an ecosystem; human health and the importance of diet, exercise, and other lifestyle choices in maintaining health.
- **Chemistry:** particulate structure, classification, and composition of matter; the periodic table as an organizing principle for the known elements; physical and chemical properties of matter; mixtures and solutions; characteristics of chemical reactions; matter and energy in chemical reactions; the role of electrons in chemical bonds.
- **Physics:** physical states and changes in matter; energy transformation and transfer; basic properties/behaviors of light, and sound; electric circuits; properties and uses of permanent magnets and electromagnets; motion and forces.
- **Earth science:** Earth's structure and physical features; Earth's processes, cycles, and history; Earth's resources, their use, and conservation; Earth in the Solar System and the universe.

Figure 11.8 presents the share of eight-grade students whose teacher taught them most of required topics for the science assessment (in each of participating

countries). The percentage of students who already discussed most of the science topics in Romania (95%), Turkey (93%), Hungary (91%), Malaysia (88%), Kuwait (87%), and Kazakhstan (also 87%). In Saudi Arabia, 84% of the students were already taught most of topics in eighth-grade science (89% in biology, 82% in chemistry, 77% in physics, and 95% in Earth science). Those number are greater in comparison to the international averages (in all science – by 12%, in biology – by 15%, in chemistry – by 8%, in physics – by 9%, and in Earth science – by 24%).

**Figure 11.8 Percentages of Students Taught the TIMSS Science Topics – Grade 8**



SOURCE: Exhibit 13.7: Instructional Time Spent on Science – Grade 8. IEA's Trends in International Mathematics and Science Study – TIMSS 2019. Downloaded from <http://timss2019.org/download>.



## Instructional Clarity in Mathematics and Science Lessons

In the TIMSS assessment, the degree of instructional clarity in mathematics lessons was measured by analyzing how many students agree with the following statements: I know what my teacher expects me to do; my teacher is easy to understand; my teacher has clear answers to my questions; my teacher is good at explaining mathematics; my teacher does a variety of things to help us learn; my teacher links new lessons to what I already know; my teacher explains a topic again when we don't understand.

The TIMSS data reveal that fourth-graders attending clearly instructed classes scored internationally on average higher than those experiencing unclear instruction. The same relation applies to Saudi Arabia where students attending clearly instructed classes achieved higher by 39, and 58 points, in comparison to respectively: fourth-graders taught in classes with moderate, and low clarity.

The same pattern is also visible for eighth-graders. Saudi Arabia's eighth-graders learning from easy to understand instruction achieved on average higher results comparing to students taught in classes with moderate clarity (by 22 points), and low clarity (by 30 points). It is worth mentioning that internationally, more older students reported a lower level of clarity in their classes in mathematics.

Also, in science assessment, students were asked to indicate a level of instructions clarity. Internationally, both fourth and eighth-graders attending clearly instructed science classes scored on average higher. Saudi Arabia fourth-graders who participated in easy to understand classes scored on average higher by 52, and 75 points more, in comparison to respectively: fourth-graders taught in classes with moderate, and low clarity. Those differences among eighth-grades are equal respectively to 22,

and 30 points. Internationally, more eighth-graders reported a lower level of clarity in their science classes (compared to fourth-graders).

However, it is worth to underline the difficulties in identifying causal inference in regard to instructional clarity. Obviously, better students understand more of the instruction, thus they indicate greater instructional clarity. The endogeneity seems to be an important issue here.

### Experiments in Science instruction

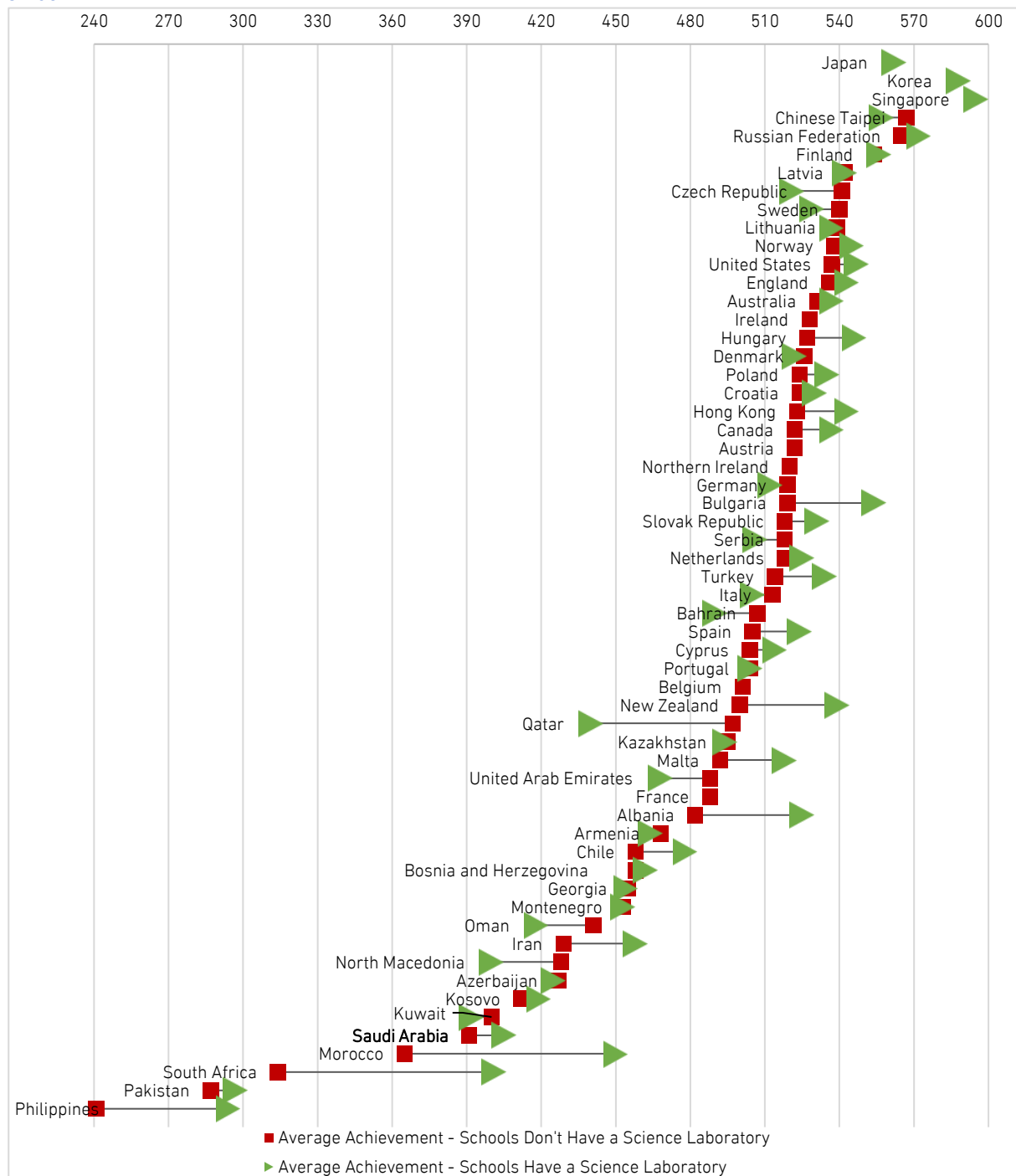
Undertaking hands-on science experiments is an important part of science instruction. Based on principals' reports, the TIMSS provides data about the school resources for science experiments, namely:

- a science laboratory
- and assistance for teachers when students are conducting experiments.

The highest shares of students with access to the labs were observed in three Asian countries: Japan (100%), Korea (99%), and Singapore (98%). In Saudi Arabia, 80% of students had access to the scientific laboratory.

**Figure 11.9** School Resources for conducting Science Experiments- Whether Schools Have a Science Laboratory- Grade 4 and **Figure 11.10** presents the fourth-graders' science achievement (in each of the participating countries), taking into account whether schools have a science laboratory. Internationally, fourth-graders that had access to this school resource, obtain on average higher results (by 10 points). This pattern was also noticed in Saudi Arabia (difference in score by 14 points). However, these results are not consistent across countries.

**Figure 11.9** School Resources for conducting Science Experiments- Whether Schools Have a Science Laboratory- Grade 4

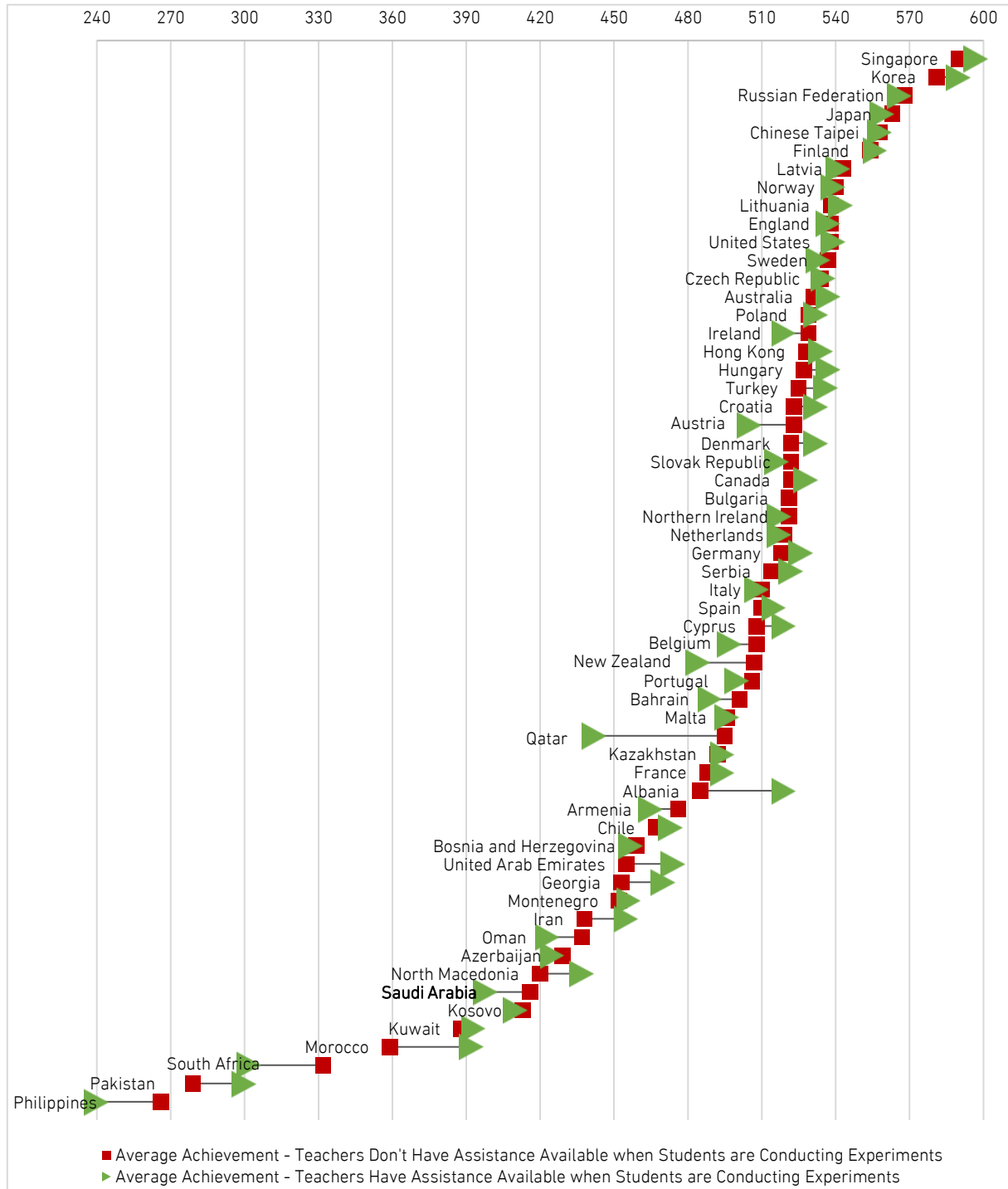


SOURCE: Exhibit 13.14: School Resources for Conducting Science Experiments. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>

Not a clear pattern was also noticed in the achievement where assistance for teachers is provided when students are conducting experiments. **Figure 11.10** data show

that in majority of the countries, teachers having assistance available when students are conducting experiments did not influence fourth-graders average achievement score.

**Figure 11.10** School Resources for Conducting Science Experiments- Whether Teachers Have Assistance Available When Students are Conducting Experiments- Grade 4



SOURCE: Exhibit 13.14: School Resources for Conducting Science Experiments. IEA's Trends in International Mathematics and Science Study - TIMSS 2019. Downloaded from <http://timss2019.org/download>

In TIMSS study, there was also an analysis of the effect of frequency of conducting experiments in science lessons on student's average achievement score. Again, there is no clear existing correlation at the International Level

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## Conclusion and Recommendations

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TIMSS (Trends in Mathematics and Science Achievement) is the international assessment of students that provides the longest track of student achievement in grades 4 and 8. It measures in a comparable way student results in mathematics and science since 1995, so the data for some countries are available already for 7 assessment cycles. For Saudi Arabia, the latest results can be compared to 2011 and 2015 assessments.

In the latest round of TIMSS assessment, data are provided for 64 countries, from which 58 countries participated in the 4<sup>th</sup> grade assessment, and 39 countries participated in the 8<sup>th</sup> grade assessment. Saudi Arabia participated in an assessment for both grades. The data were obtained from students, teachers, and school principals. The sample in Saudi Arabia was representative to the populations of 4<sup>th</sup> and 8<sup>th</sup> grade students. The sample size was larger than the average sample size across countries with 5453 students from 220 schools participating in the 4<sup>th</sup> grade assessments, and 5680 students from 209 schools participating in the 8<sup>th</sup> grade assessment.

The TIMSS 2019 National Report for Saudi Arabia provides detailed description of mathematics and science achievement in grade 4 and 8. It also discusses data describing student home environment, school composition and resources, school climate, school discipline and safety, challenges to teaching, technology access in schools, and curriculum and instruction.

Overall, the results provide a comprehensive picture of student achievement in 4<sup>th</sup> and 8<sup>th</sup> grade. Countries that have performed well in the 4<sup>th</sup> grade have also the best results in the 8<sup>th</sup> grade. It demonstrates that there are factors affecting student

achievement both in the 4<sup>th</sup> and 8<sup>th</sup> grade, but also foundations learned in early education and measured at grade 4 are crucial for further learning of mathematics and are shaping achievement of students four years later.

The results for Saudi Arabia show that many students in the 4<sup>th</sup> grade lack basic knowledge of mathematics and science. Half of students do not reach the Low International Benchmark so they do not possess even some basic mathematics knowledge expected at this age. In science, a similar share of 4<sup>th</sup> grade does not reach the Low International Benchmark showing insufficient knowledge of basic science facts. The results for 8<sup>th</sup> grade students are similar with around half of students in Saudi Arabia not being able to demonstrate basic knowledge and skills necessary to reach the Low International Benchmark.

The Low International Benchmark is reached by most students in top performing countries. In countries like Japan, only 1% of students perform below this benchmark, and 37% reach the Advanced International Benchmark marking students that excel in mathematics knowledge. In Singapore, 51% of student reach the highest benchmark. In Saudi Arabia, nearly none of the students demonstrated knowledge of mathematics at this level.

These results are alarming and indicate that too many students in Saudi Arabia do not have the basic knowledge of mathematics and science. These students will not only be unable to continue education, but their limited knowledge will do not allow them to fully participate in modern technology-rich society. Moreover, the shortage of students who excel in mathematics and science presents a challenge for future of Saudi Arabia whose goal is to develop a knowledge-driven economy. In order to achieve this goal, it is necessary for Saudi schools to improve instruction and to make sure that

students are proficient in early grades of their education showing much better knowledge and continue to develop it later on.

The TIMSS results offers a range of useful insights for those involved in reforming policy and practice of education in Saudi Arabia. The report explores how the home environment impacts early student learning. The important message here is that engagement in early education but as well as parents' involvement in early learning activities both bring positive outcomes and should be strongly encouraged. Early interventions are especially important for kids from poorer and uneducated families. For them, high-quality preschool education is the only way to acquire knowledge required to reach primary education without gaps that could be difficult to fill later on.

In schools, safety and discipline are critical factors correlated with student achievement. Students who are often bullied perform much lower. Education policy should address this problem by targeting schools with discipline and behavioral issues with effective interventions. In addition, student absenteeism is a serious issue that need to be tackled to improve learning. Too many students skip classes and school days and their performance is below those who attend school without disruptions. These problems are found in both schools for boys and girls, but are much more prevailing among boys and clustered in low-performing schools. Improving the situation in these schools, starting with behavior and limiting absenteeism, should be a priority for education policy.

The report provides also supplementary data related to technology, learning time, school climate and other important factors. It gives international perspective to results for Saudi Arabia, so policy makers and practitioners can compare state of education, student attitudes, teacher opinions, and practices to those in other countries.



The data are not enough to change education. One must act upon them to reform schools and support targeted policies to address the most important issues enlightened by results from international assessments like TIMSS and PISA. Some findings provide clear guidance on what actions are necessary. Others require a debate, but this evidence should not be buried in sand. It should be used to improve future of children in Saudi Arabia and to assure that ambitious goals stated in Vision 2030 can be reached by improving knowledge and skills of the youth.

The report provides first insights into Saudi Arabia results in TIMSS 2019 international student assessment. It will be followed by a more in-depth analysis of the results that will be released in 2021.

### Recommendations

- A national initiative should be launched to address the problem of poor performance in mathematics and science at all educational levels. It should include creative solutions (such as teaching small groups, designing a focused curriculum content, and including evaluation tasks that simulate the questions of TIMSS and PISA assessments). Such an initiative is important because mastering mathematical and scientific skills is a basic requirement for programming sciences, information technology and artificial intelligence, which major projects in Saudi Arabia such as Neom, space programs and alternative energy depend on.
- Educational research based on secondary analysis of international studies should be expanded. Such research should look into the roots of the problem of underachievement, including the analysis of the sub-fields of mathematics and science, the nature of test questions and the answers, teaching methods measured

by the study and their effectiveness, and the characteristics of the low-performing schools compared to the best-performing ones.

- A special focus should be given to underperforming students and schools by designing suitable treatment programs for them that help in improving their performances.
- It should be taken into account that improving students' academic achievement is a final outcome of different development initiatives, and thus, it requires patience as the impact of such projects and initiatives will be progressive and slow.
- The slight improvement in students' performances in TIMSS 2019 assessment reflects the importance of preparing for national and international tests, as well as preparing the educational field, parents and students for such tests. It also reflects the significance of taking external evaluation processes seriously. These results are an extension of what was observed in the Saudi Arabia's participation in PISA 2018. Therefore, they confirm the authenticity of the evaluation results, and show that they truly reflect the quality of what students learn in schools. However, in order to improve students' performances in a way that corresponds to the high status of Saudi Arabia as well as the goals of the Vision 2030, an educational reform is required, whereby priorities are identified, goals are established, and change is brought about in an effective manner.
- The risks of educational loss during the COVID-19 pandemic should be taken seriously, especially for students who are at the early stages of education (in the academic year of 2019-2020), because they are the target group in the next TIMSS assessment in 2023, as well as in PIRLS 2022. In addition to the fact, that students' performances could possibly be lower-than-expected in the upcoming international

tests, the impact of educational loss might also affect these students in later stages of education, as well as their future career and social life. Thus, such impact might have an overall effect on the social and economic development of Saudi Arabia.

- Access to high quality early childhood education programs and early education activities in general should be expanded, as Saudi Arabia does not have high preschool enrolment rates compared to the countries in the developed world. The results of TIMSS 2019 show that students who were enrolled in preschool education achieved higher scores than those who were not. The data also reveal that children who attended preschool for more years achieved better scores, especially for those who were enrolled for two years. This outcome indicates that two years of preschool education may be sufficient, at least in the short and medium terms, given the high cost of expansion in early childhood education programs. It goes without saying that the success of preschool education also depends on its quality, which emphasizes the priority of quality assurance. It is also generally agreed that the need for preschool education is more pronounced in the less socio-economic environments, where the quality of home environments and support for children's learning is low.
- Teachers and educators should focus more on constructive and formative assessments. Such assessments should be used more often to the extent that they do not interfere with children's learning. Databases should also be created, in order to ensure tracking students' performances in school. Moreover, while teachers and schools should be supported through educational supervision, it is necessary to shift the roles of supervisors from merely monitoring and evaluating to more professional support and guidance for teachers. In addition, given the crisis of COVID-19 pandemic and the shift to distance learning through electronic platforms, it is imperative to take

advantage of electronic sources of knowledge that have become more available during this crisis.

- TIMSS 2019 databases should be benefited from by analyzing the number of annual learning hours spent in Saudi Arabia compared to the time spent in the countries with good performance, as well as the ratios of hours devoted to mathematics and science. Curriculum contents should also be analyzed to examine its relation to the assessment content and cognitive domains (knowing, applying and reasoning) in TIMSS 2019. The curriculum in Saudi Arabia should be reviewed on this basis, taking into account the extensive evidence from international evaluation studies, which demonstrates that the depth of the curriculum is better than its length. Thus, the depth of learning and acquiring skills should be prioritized regardless of the length of the content.
- It is widely acknowledged that teachers are the cornerstone and the most influential element of the quality of education. Having mentioned that, it should be noted that the teacher preparation policy in Saudi Arabia needs to be improved, and it is already in the process of being improved by the Ministry of Education. In this regard, it is necessary to emphasize the importance of selecting teachers who have great cognitive abilities, ensuring that teachers are highly knowledgeable about their specializations. These teachers then should be subject to a practical training program with guidance support during the application, before they apply to obtain a professional license. There is no doubt that the teacher preparation policy and the design of applied programs for pre-service teacher training are one of the most important priorities, and therefore, should be taken care of in universities. The teaching profession in Saudi Arabia is in high demand, as it is an attractive profession

for graduates, and this should facilitate improving teacher preparation programs in the country.

- Professional development programs for teachers should be highly increased, especially for primary school teachers. However, it should be emphasized that these programs should be of an applied nature and supervised by educational supervisors. Teachers should be visited in their classrooms as well as in schools and should be directly supported and given advice in relation to teaching methods, evaluating students, and enhancing the learning of students with poor performance, to name but a few of the challenges facing teachers in classrooms.



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