Trends in International Mathematics and Science Study (TIMSS) International Data Explorer Help Guide

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TIMSS International Data Explorer Help Guide

I. Background on the Trends in International Mathematics and Science Study (TIMSS), TIMSS Advanced, and the TIMSS International Data Explorer

The TIMSS International Data Explorer (IDE) is a web-based application for accessing Trends in International Mathematics and Science Study (TIMSS) data supported by the U.S. National Center for Education Statistics (NCES). Developed and implemented at the international level by the International Association for the Evaluation of Educational Achievement (IEA), TIMSS is an international comparative study of the mathematics and science achievement of students.

The TIMSS IDE includes data from both TIMSS and TIMSS Advanced, the latter of which assesses the advanced mathematics and physics knowledge and skills of students in their final year of secondary school (12th grade in the United States) who were taking or had taken courses in advanced mathematics and physics.

1. What is TIMSS?

TIMSS, which was first administered in 1995, is used to measure the mathematics and science knowledge and skills of fourth- and eighth-graders over time. Since 1995, TIMSS has been administered in 1999, 2003, 2007, 2011, 2015, and most recently in 2019. TIMSS is designed to align broadly with mathematics and science curricula in the participating countries and education systems. Therefore, the results suggest the degree to which students have learned mathematics and science concepts and skills likely to have been taught in school. TIMSS also collects background information on students, teachers, and schools in order to allow cross-national comparisons of educational contexts that may be related to student achievement. The 2019 assessment was administered in a total of 64 education systems alongside 8 benchmarking participants. TIMSS 2019, 2015, 2011, 2007, 2003, 1999, and 1995 results are all available through the IDE.

TIMSS 2019 marked the beginning of the transition to a computer-based assessment by introducing a computerized version of TIMSS called eTIMSS. The eighth assessment cycle of TIMSS, which will be conducted in 2023, will provide 28 years of trend data and complete the transition to eTIMSS.

In TIMSS, an overall mathematics scale and an overall science scale are used to report achievement for each grade in each year. The overall scales can be used for trend analyses across years. Subscales in both mathematics and science are used to report student performance in various topic areas.

2. What is TIMSS Advanced?

In addition to TIMSS, the IEA also administered the TIMSS Advanced assessment in 2015, which is used to measure the advanced mathematics and physics achievement of students in their final year of high school (12th grade in the U.S.) who are taking or have taken advanced courses. TIMSS Advanced was administered previously, in 1995 and in 2008, and most recently in 2015. The United States participated in the 1995 and 2015 administrations. Like TIMSS, TIMSS Advanced is designed to align broadly with curricula in the participating education systems and, therefore, to reflect students' school-based learning of advanced mathematics and physics. TIMSS Advanced also collects information about educational contexts (such as schools and teachers) that may be related to advanced students' achievement. The 2015 assessment was administered in a total of 9 education systems, and only 2015 data are currently available in the IDE.

In TIMSS Advanced, an overall advanced mathematics scale and an overall physics scale are used to report achievement at the end of high school. Subscales in both advanced mathematics and physics are used to report student performance in various topic areas.

3. What aspects of mathematics achievement can I explore in TIMSS and TIMSS Advanced?

Overall mathematics scale, grade 4— The TIMSS mathematics achievement scale for grade 4 summarizes student performance on test items designed to measure understanding of content in number, geometric shapes and measures, and data display, as well as a range of processes within the knowing, applying, and reasoning cognitive domains.

Mathematics content domains, grade 4—In grade 4, there are subscales for three content domains in 2019, 2015, 2011 and 2007, five content domains in 2003, and four content domains in 1995:

- **Number (2019, 2015, 2011, 2007), fractions and number (2003)—**The *number* content domain includes understanding of computing with whole numbers of reasonable size, fractions as the basis for many calculations, comparisons of familiar fractions and decimals, the concept of variables in simple equations, and initial understandings of relationships between quantities.
- **Geometric shapes and measures (2019, 2015, 2011, 2007, 2003, 1995)**—The *geometric shapes and measures* content domain includes identifying properties and characteristics of lines, angles, and a variety of geometric figures, including two- and three-dimensional shapes, describe and draw a variety of geometric figures, analyze geometric relationships and use these relationships to solve problems, use instruments and tools to measure physical attributes such as length, angle, area, and volume, and use simple formulas to calculate areas and perimeters of squares and rectangles.
- **Data display (2019, 2015, 2011, 2007)—**The *data display* content domain includes reading and recognizing various forms of data analysis, organizing and representing the

data in graphs and charts that address the questions that prompted the data collection, comparing characteristics of data and drawing conclusions based on data displays.

- **Patterns and relationships (2003)**—The *patterns and relationships* content domain includes understanding patterns, simple equations, and the idea of functions as they apply to pairs of numbers.
- **Data and probability (2003, 1995)**—The *data and probability* content domain includes understanding simple data-gathering, data representation and interpretation.
- **Measurement (2003)**—The *measurement* content domain includes the understanding of attributes and units and the use of basic instruments and formulas for measurement of area, length, volume, weight, and time.
- **Fractions and proportions (1995)—**The *fractions and proportions* content domain includes recognizing the pictorial representation of common fractions and decimal fractions as well as the relationships between common and decimal fractions.
- **Whole numbers (1995)—**The *whole numbers* content domain includes understanding place value, ordering and comparing numbers, and solving single- as well as multistep problems involving the operations of addition, subtraction, and multiplication.

Overall mathematics scale, grade 8—The TIMSS mathematics achievement scale for grade 8 summarizes student performance on test items designed to measure understanding of content in number, algebra, geometry, and data and chance, as well as a range of processes within the knowing, applying, and reasoning cognitive domains.

Mathematics content domains, grade 8—In grade 8 there are subscales for four content domains in 2019, 2015, 2011 and 2007 and five content domains in 2003, 1999, and 1995:

- **Number (2019, 2015, 2011, 2007), fractions and number (2003, 1999, 1995)—**The *number* content domain includes demonstrating proficiency with more complex whole number concepts and procedures as well as extending mathematical understanding of rational numbers, computing with fractions and decimals, computing with integers through various models, understanding various representations of rational numbers and recognizing the distinctions among interpretations of rational numbers, construct relations among them and reason with them.
- **Algebra (2019, 2015, 2011, 2007, 2003, 1999, 1995)—**The *algebra* content domain includes solving real-world problems using algebraic models and explain relationships involving algebraic concepts, given a formula for two quantities, if one quantity is known, the other can be found, using linear equations for constant rates and quadratic expressions to study motion, and using functions to understanding what will happen to a variable over time.
- **Geometry (2019, 2015, 2011, 2007, 2003, 1999, 1995)—**The *geometry* content domain includes analyzing the properties and characteristics of a variety of two- and three-

dimensional geometric figures, understanding geometric measurement, and solving problems and providing explanations based on geometric relationships.

- **Data and chance (2019, 2015, 2011, 2007), data and probability (2003, 1999, 1995)**—The *data* content domain includes reading and extracting the important meaning from a variety of visual displays, being familiar with the statistics underlying data distributions and how these relate to the shape of data graphs, understanding how the creators of charts and graphics can misinterpret the truth, and having an initial grasp of some concepts related to probability.
- **Measurement (2003, 1999, 1995)**—The *measurement* content domain includes the use of instruments and tools to measure physical attributes, conversions, and application of formulas for measuring rate, surface area, etc.

Overall advanced mathematics scale, end of high school—The TIMSS Advanced mathematics achievement scale for students at the end of high school who have taken or are taking advanced courses summarizes student performance on test items designed to measure understanding of content in algebra, calculus, and geometry, as well as a range of processes within the knowing, applying, and reasoning cognitive domains.

Advanced mathematics content domains, end of high school—In advanced mathematics at the end of high school there are subscales for three content domains in 2015:

- **Algebra (2015)—**The *algebra* content domain includes operating with and evaluating a variety of algebraic expressions, working with arithmetic and geometric series, equations and inequalities, and systems of equations and inequalities to solve problems. In addition, this content area also includes interpreting, relating, and generating various representations and properties of functions.
- **Calculus (2015)**—The calculus content domain includes understanding limits and finding the limit of a function, differentiation, and integration of a range of functions, and using these skills in solving problems.
- **Geometry (2015)**—The geometry content domain includes using the properties of geometric figures to solve problems in two and three dimensions, solving problems with coordinate geometry in two dimensions, and vectors. In addition, this content area includes triangle trigonometry and trigonometric functions.

Mathematics (and advanced mathematics) cognitive domains—There are subscales for three cognitive domains in both grades 4 and 8, as well as in advanced mathematics at the end of high school, but the balance of testing time differs, reflecting the difference in age and experience of students at the different grade levels. These subscales are shown in the IDE for 2019, 2015, 2011, 2007, and 2003 for grade 4 and grade 8, and for 2015 for advanced mathematics at the end of high school.

- **Knowing—**The *knowing* cognitive domain includes applying mathematics, reasonsing about mathematical situations, familiarity with mathematical concepts, and fluency in mathematical skills.
- **Applying—**The *applying* cognitive domain focuses on the application of mathematics in a range of contexts, and applying mathematical knowledge of facts, skills, and procedures or understanding of mathematical concepts to create representations.
- **Reasoning—**The *reasoning* cognitive domain goes beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multistep problems including intuitive and deductive reasoning based on patterns and regularities that can be used to arrive at solutions to problems set in novel or unfamiliar situations.

4. What aspects of science achievement can I explore in TIMSS and TIMSS Advanced?

Overall science scale, grade 4—The TIMSS science achievement scale for grade 4 summarizes student performance on test items designed to measure understanding of content in the life, physical, and Earth sciences, as well as a range of processes within the knowing, applying, and reasoning cognitive domains.

Science content domains, grade 4—In grade 4 there are subscales for three content domains in 2019, 2015, 2011, 2007, 2003, and 1995:

- **Environmental Awareness (2019)—**The *environmental awareness* subscale includes items related to the environment from two TIMSS 2019 science content domains at each grade: Earth science and life science at fourth grade, and Earth science and biology at eighth grade.
- **Life science (2019, 2015, 2011, 2007, 2003, 1995)—**The *life science* content domain includes understanding of how organisms function, and fundamental concepts in reproduction, heredity, and human health.
- **Physical Science (2019, 2015, 2011, 2007, 2003, 1995)—**The *physical science* content domain includes an understanding of physical states of matter, common changes in the state and form of matter, common forms and sources of energy and their practical uses, and an understanding of light, sound, electricity, and magnetism. Also included is an understanding of forces and motion.
- **Earth science (2019, 2015, 2011, 2007, 2003, 1995)—**The *Earth science* content domain is concerned with the study of Earth and its structure and physical characteristics, and about the use of Earth's most important resources. An understanding of Earth's processes, the time frame in which processes occur and the Earth's place in the solar system are also included.

Overall science scale, grade 8—The TIMSS overall science achievement scale for grade 8 summarizes student performance on test items designed to measure understanding of content in

the biological, chemical, physical, and Earth sciences, as well as a range of processes within the knowing, applying, and reasoning cognitive domains.

***Science content domains, grade 8*—**In grade 8 there are subscales for four content domains in 2019, 2015, 2011, 2007, and 1995; five content domains in 2003; and six content domains in 1999:

- **Environmental Awareness (2019)—** The *environmental awareness* subscale includes items related to the environment from two TIMSS 2019 science content domains at each grade: Earth science and life science at fourth grade, and Earth science and biology at eighth grade.
- **Biology (2019, 2015, 2011, 2007)—**The *biology* content domain emphasizes students' understanding of how structure relates to function in organisms and how organisms respond physiologically to changes in environmental conditions, build an understanding of cell structure and function and photosynthesis and cellular respiration, the concepts of adaptation and natural selection, interactions in an ecosystem, and developing a science-based understanding of human health.
- **Chemistry (2019, 2015, 2011, 2007, 2003, 1999, 1995)—**The *chemistry* content domain assesses students' understanding of distinguishing between physical and chemical properties of matter and understanding the properties of mixtures and solutions and acids and bases.
- **Physics (2019, 2015, 2011, 2007, 2003, 1999, 1995)—**The *physics* content domain assesses students' understandings of changes in state and how states of matter is related to distance between particles, different forms of energy, energy conservation, concepts of heat and temperature, light and sound, electrical conductivity, currents in circuits, forces and motion, simple machines, pressure and density, and qualitative changes in motion based on the forces acting.
- **Earth science (2019, 2015, 2011, 2007, 2003, 1999, 1995)—**The *Earth science* content domain is concerned with the study of Earth and its structure and physical features, soils and the atmosphere, geological processes, the water cycle, patterns of weather and climate, and conservation of resources.
- **Life science (2003, 1999, 1995)—**The *life science* content domain assesses understandings of the nature and function of living organisms, the relationships between them, and their interaction with the environment.
- **Environmental science (2003, 1999)**—The *environmental science* content domain emphasizes students' understanding of limiting resources and the impact of science and technology on the use and conservation of these resources.
- **Nature science (1999)**—The *nature science* content domain includes the nature of scientific knowledge, the scientific enterprise, interactions of science, technology, mathematics, and society, and the tools and process used in conducting investigations.

Overall physics scale, end of high school—The TIMSS Advanced physics achievement scale for students at the end of high school summarizes student performance on test items designed to measure understanding of content in mechanics and thermodynamics, electricity and magnetism, and wave phenomena and atomic/nuclear physics, as well as a range of processes within the knowing, applying, and reasoning cognitive domains.

Physics content domains, end of high school—In physics at the end of high school there are subscales for three content domains in 2015:

- **Mechanics and Thermodynamics (2015)—**The *mechanics and thermodynamics* content domain includes kinematics, Newton's three laws of motion (dynamics), law of gravitation, conservation of certain physical quantities such as energy and momentum, mechanisms of heat transfer and how properties of matter change with temperature.
- **Electricity and Magnetism (2015)—**The *electricity and magnetism* content domain includes the relationship between electricity and magnetism, the interaction of charged particles with magnetic fields, the production of magnetic fields from current-carrying wires, and induction.
- **Wave Phenomena and Atomic/Nuclear Physics (2015)—**The *wave phenomena and atomic/nuclear physics* content domain includes mechanical wave phenomena, electromagnetic radiation, as well as refraction, interference, and diffraction.

Science (and physics) cognitive domains—There are subscales for three cognitive domains in both grades 4 and 8, as well as in physics at the end of high school, but the balance of testing time differs, reflecting the difference in age and experience of students at the different grade levels. These subscales are shown in the IDE for 2019, 2015, 2011, 2007, and 2003 for grade 4 and grade 8, and for 2015 for physics at the end of high school.

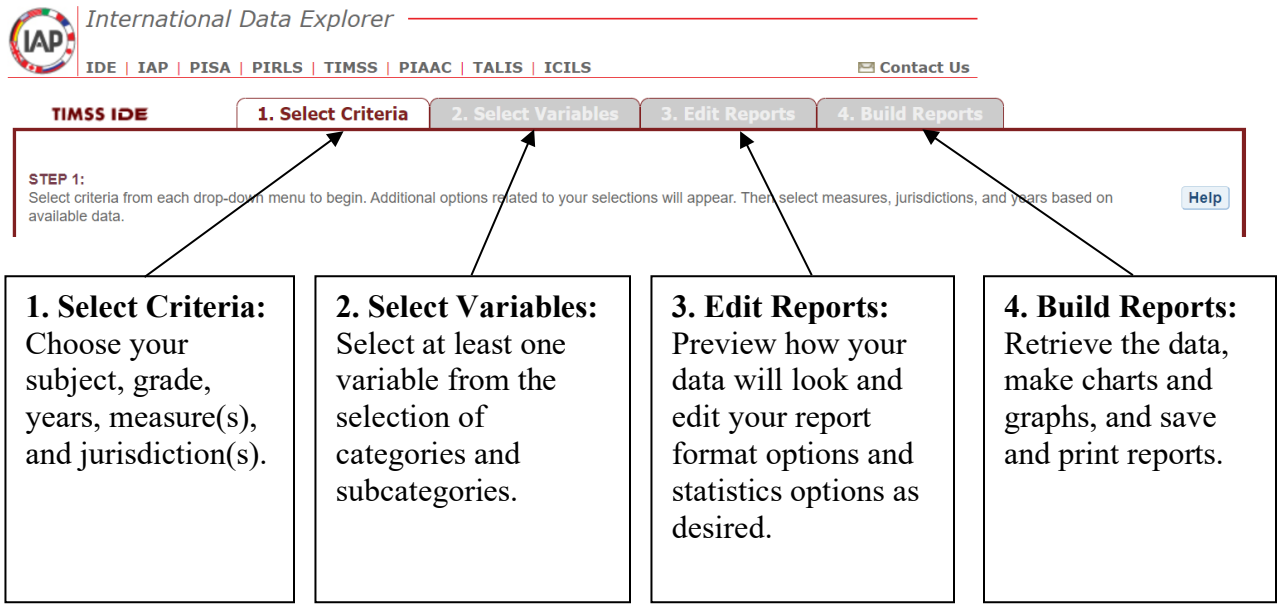
- **Knowing—**The *knowing* cognitive domain covers the facts, procedures, concepts, and equipment that students need to know.
- **Applying—**The *applying* cognitive domain focuses on the ability of students to apply knowledge and conceptual understanding to solve problems or answer questions likely to be familiar in the teaching and learning of science.
- **Reasoning—**The *reasoning* cognitive domain goes beyond the solution of routine problems and requires students to engage in reasoning that encompasses unfamiliar situations, complex contexts, and multistep problems.

For more information on the TIMSS mathematics and science domains from the 2019 TIMSS assessment, see Mullis, I.V.S. & Martin, M.O. (Eds.). (2017). *TIMSS 2019 Assessment Frameworks.* Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College. For further information on the TIMSS mathematics and science domains from previous years, visit timssandpirls.bc.edu.

II. General Overview

There are four general steps for exploring TIMSS and TIMSS Advanced data using the TIMSS International Data Explorer (IDE) (see exhibit 1). Each step is described in more detail starting on page 12.

Exhibit 1. What you will see in the IDE environment and what each step entails



III. Computer Requirements for the International Data Explorer (IDE)

- Screen resolution should be 1024 x 768 pixels or higher.
- Browsers: Google Chrome, Apple Safari, Internet Explorer (IE) version 10 or higher, FireFox 3.0 or higher.
- Enable JavaScript and pop-ups in your browser.
- The TIMSS IDE requires Flash version 9.0.115 or higher (download Adobe Flash Player at http://get.adobe.com/flashplayer/).
- Exports of files to Microsoft Office can be opened with Office 2003 or later.
- Exports of files to PDF can be read with Adobe Acrobat Reader.
- Screen reader software should be JAWS 8.0 or higher.

If you encounter an error, please send us the details through the **Contact Us** button (located in the upper-right portion of the screen on each page of the IDE website). When writing, include your browser version and operating system version, and as many other details as possible. Be sure to provide an e-mail address so that we can contact you.

IV. Steps to Explore Data

To create your own custom tables, charts, graphs, and maps, follow these steps when using the TIMSS International Data Explorer (IDE).

1. Select criteria
2. Select variables
3. Edit reports
4. Build reports

Each of these steps is discussed in detail throughout the remainder of this guide, beginning with the selection of criteria.

1. Select Criteria

1.A. Overview

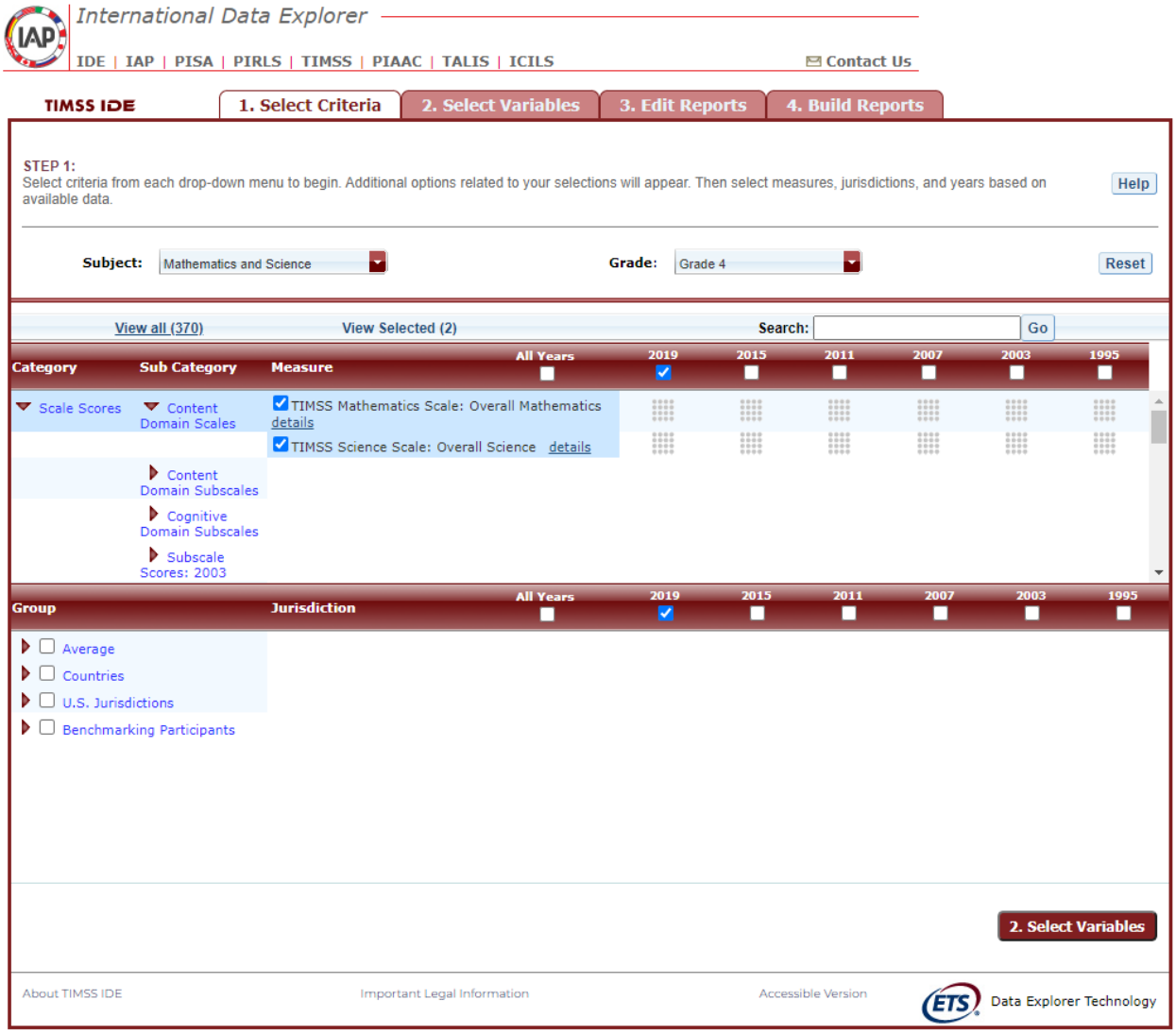
Your data query in the IDE begins on the **Select Criteria** screen (see exhibit 2).

Choose one **Subject**, one **Grade**, and one or more **Measures**, **Years,** and **Jurisdictions** for the data you wish to view or compare.

Use the **Reset** button, located in the upper-right portion of the screen (just below the **Help** button), to cancel your selections and begin again.

Click on a red sideways-facing arrow (►) to open up a category and click on a red downward-facing arrow (▼) to close a category.

Exhibit 2. Selecting criteria



1.B. Choose Subject

Under **Subject**, you have the choice of **Mathematics and Science**, **TIMSS Advanced: Advanced Mathematics**, or **TIMSS Advanced: Physics**.

1.C. Choose Grade

Under **Grade**, choose **Grade 4**, **Grade 8**, or **End of High School**. Once a grade is chosen, the screen resets and you can select **Year**(s), **Measure**(s), and **Jurisdiction**(s).

1.D. Choose Year

At the top of the **Measure** and **Jurisdiction** sections, you have the choice of selecting 2019, 2015, 2011, 2007, 2003, 1999, and/or 1995 by checking the appropriate box. To include data from all years, check the "All Years" box to the left of the individual years. Mathematics and science data are available for 2019, 2015, 2011, 2007, 2003, 1999, and 1995. In 1999, no data for grade 4 were collected in mathematics or science. Advanced mathematics and physics data are available for 2015 only.

1.E. Choose Measure

After choosing a subject, you can choose between the overall scale and/or any of the subject's subscales. The overall scale and subscales can be used for trend analyses across years where applicable.

In addition, there are a number of continuous variables other than scale scores that you may choose as a measure of analysis. These variables fall under different categories, such as "Student and Family Characteristics" and "Teacher Background Characteristics, Formal Education, and Training" and include variables such as age, teaching experience, and class size.

1.F. Choose Jurisdiction

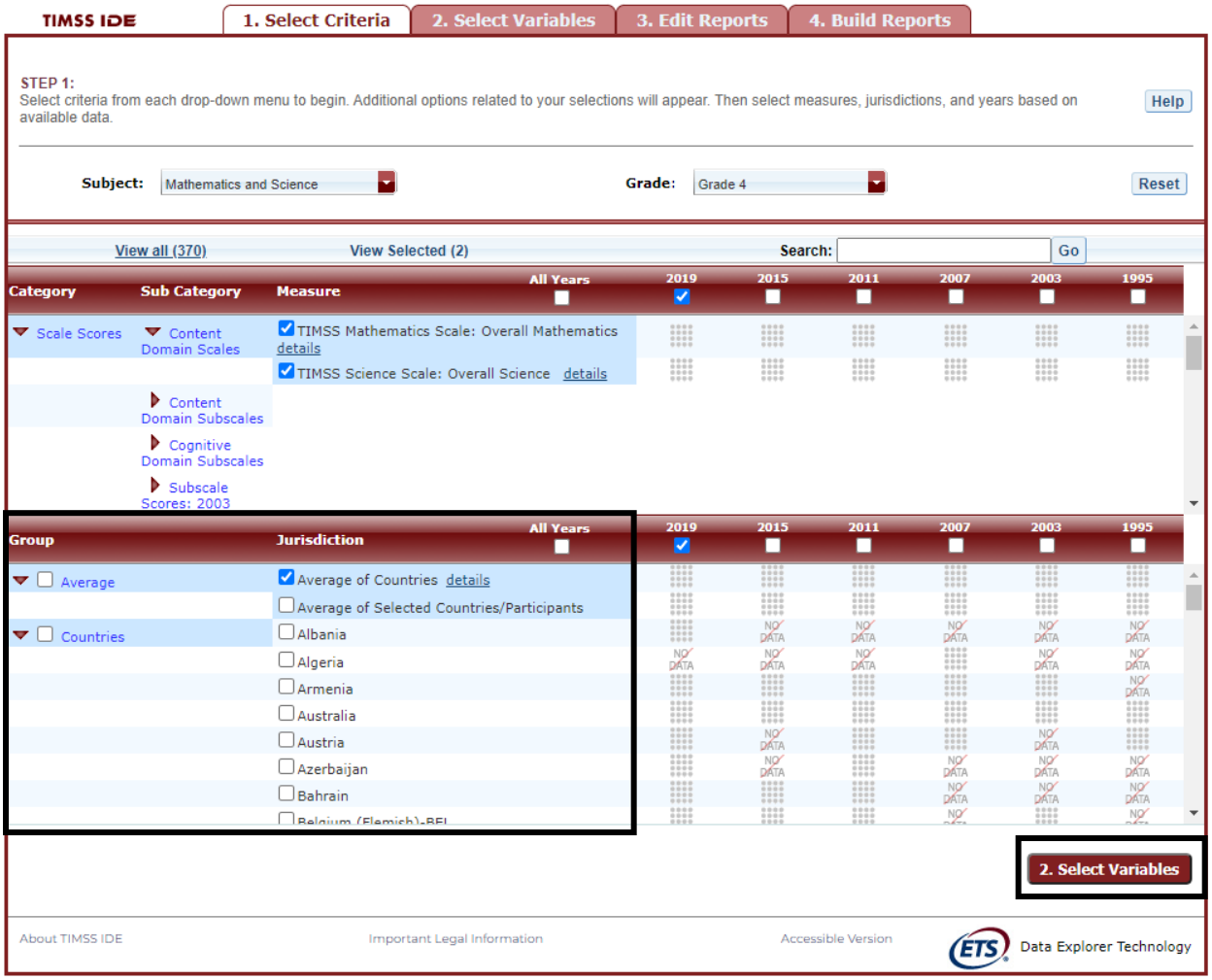
With your **Measure**(s) and **Year**(s) selected, next choose at least one **Jurisdiction**.

Jurisdictions are found under the following groups: **Countries**, **U.S. Jurisdictions**, and **Benchmarking Participants.** There is also a group category called **Average,** with options to display the **Average of Countries** and the **Average of Selected Countries/Participants. Average of Countries** displays the average statistic for all available jurisdictions under the "**Countries**" group, except when "**All students**" is selected at step 2, in which case **Average of Countries** displays the TIMSS scale centerpoint of 500.

The general procedures for selecting one or more jurisdictions are as follows:

1. To open or close jurisdictions, click on the arrow. Jurisdictions in the group are open and can be selected when the red arrow points down (see exhibit 3).
2. Click the checkboxes next to the specific jurisdictions that you are interested in, or uncheck those jurisdictions that you wish to deselect. If you click the checkbox next to the group name (e.g., "Countries"), you will select all the jurisdictions within that group. If desired, uncheck the group name to deselect all.
3. If you want to close a group (e.g., close the list of countries in order to readily see the benchmarking participants), click the red arrow next to the group name. The closed group's arrow points to the right. Be advised that closing the group will not deselect your choices.

Exhibit 3. Choosing jurisdictions



To continue in the IDE, click the **Select Variables** button at the bottom right of the page or the tab at the top of the page to go to the next screen (see exhibit 3).

2. Select Variables

2.A. Overview

Step 2, **Select Variables,** can only be accessed after choosing criteria at step 1, **Select Criteria**.

To continue your data query and edit a report, you must choose at least one variable on this screen. You can browse for variables using the **Category** and **Sub Category** lists or by using the **Search** function (see exhibit 4). You can return to this screen to change variable selections at any time.

Exhibit 4. Selecting variables overview

2.B. Search Using Category and Sub Category Lists

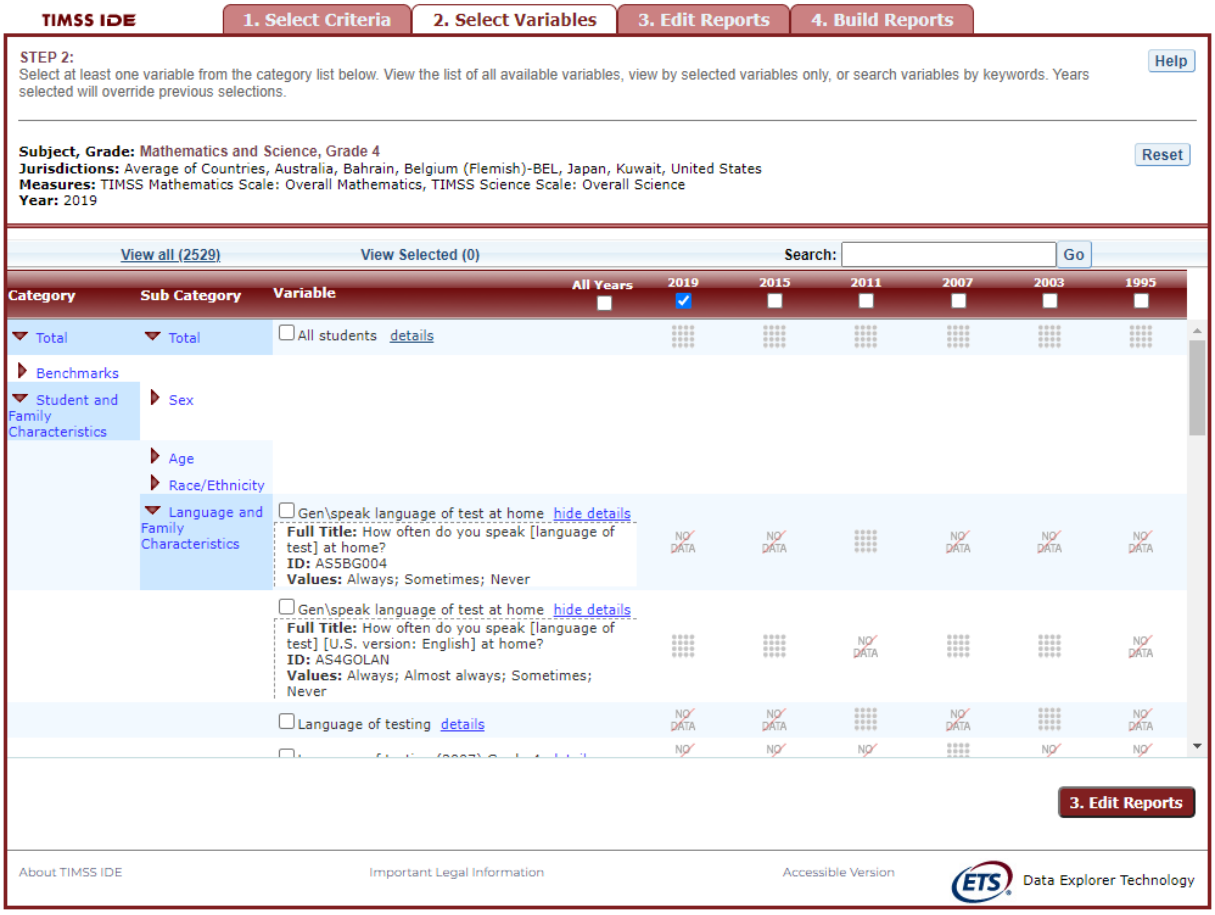
On the **Select Variables** screen, choose at least one variable for your report. One way to do this is to search for variables using the **Category** and **Sub Category** lists. If you don't wish to choose from any of the specified categories and subcategories, select **All students** in the **Total** category.

The variables shown are tied to the criteria you selected at step 1 (**Subject, Grade, Jurisdiction, Measure,** and **Year**), which are indicated at the top of the screen. To change any of these criteria, return to step 1, **Select Criteria**.

To browse for variables, get details about them, select them, and view them:

1. Click the red arrows to open and close categories and subcategories of variables (see exhibit 5).
2. Click **details** or **hide details** to show or hide the full title of a given variable, the TIMSS ID, and the values (i.e., value labels). Note that some variables have the same or similar short titles, but comparing details will show you how they differ. See the example in exhibit 5 below, which shows two variables titled **Gen\speak language of test at home**. "Gen" refers to variables that are general cross-subject variables. The differences between these two variables are described in the details.
3. Click the checkbox next to a variable to select it for your analysis/report. You will see the count increase next to **View Selected**.
4. Click the **View Selected** tab to see the variables you have chosen. To return to the full list of variables by category, click the **View all** tab.
5. Remember to select the year for which you wish to build a report and make sure that data are available for your chosen year and variables.
6. Searching variables is an option from the **Search** box. See Section 2.C Search Function for more details about this function.

Exhibit 5. Select variables using category and sub category lists



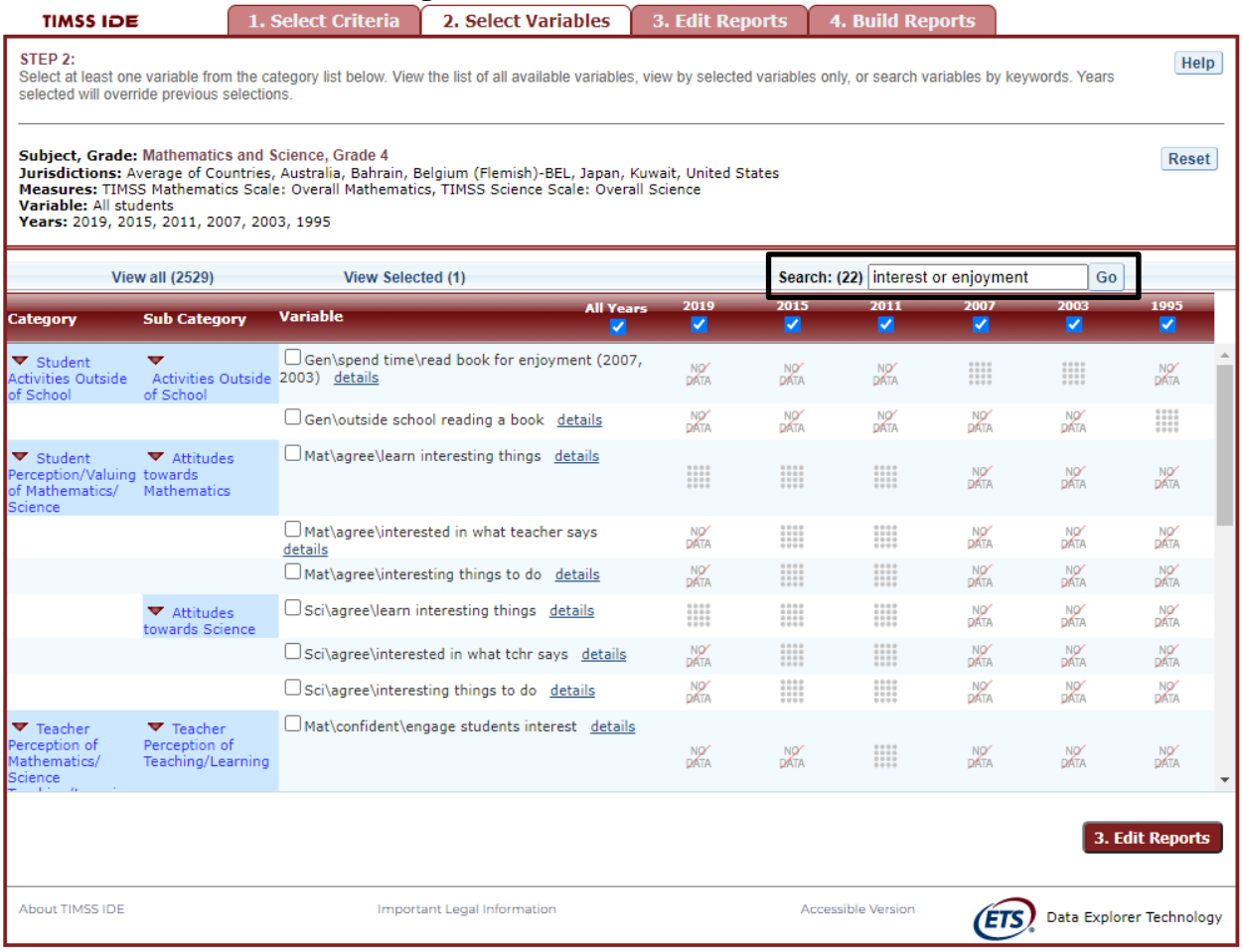
When you have selected the variable(s) you want to include, continue by clicking the **Edit Reports** button at the bottom of the page or the tab at the top of the page to go to the next screen.

2.C. Search Function

The second way to search for variables is to use the **Search** function on the **Select Variables** screen.

Type a term in the **Search** box and click **Go** (or hit "Enter" on your keyboard) to find variables by keywords in the question and/or details for the variable (see exhibit 6). If you use multiple keywords, "and" is assumed. You can narrow your search by using "or," "not," or "and not." The search function operates on an exact phrase if it is contained in quotes. The variable(s) that include the search term(s) in the question or its details will be listed.

Exhibit 6. Select variables using the search function



When you have selected the variable(s) you want to include, continue by clicking the **Edit Reports** button at the bottom of the page or the tab at the top of the page to go to the next screen.

3. Edit Reports

3.A. Overview

You can access step 3, **Edit Reports,** after choosing criteria at step 1, **Select Criteria**, and choosing variables at step 2, **Select Variables**. The IDE will automatically build reports based on your selections from steps 1 and 2. However, at step 3, the **Edit Reports** phase, you may modify your selections for each report.

At this step, you can

- preview and edit the layout of your reports;
- copy reports or create new reports based on the variables selected;
- change formatting options, such as number of decimal places to display, for all reports (these may also be changed in individual reports, but format options can overwrite previous edits);
- change statistics options, such as averages, for all reports (these may also be changed in individual reports, but statistics options can overwrite previous edits);
- select reports to be built into tables and charts at step 4, **Build Reports**; and
- delete reports.

Using your chosen criteria, the IDE will return a separate data report for each variable you have chosen. If you have selected two or three variables (not counting **All students**), you will also see a cross-tabulated report for these variables. If you have chosen four or more variables, you will get tables for each variable, but you will not get the cross-tabulation. If your selected criteria include more than one measure (e.g., overall science scale and one or more science subscales or continuous variables), a separate set of data reports will be generated for each measure (see exhibit 7).

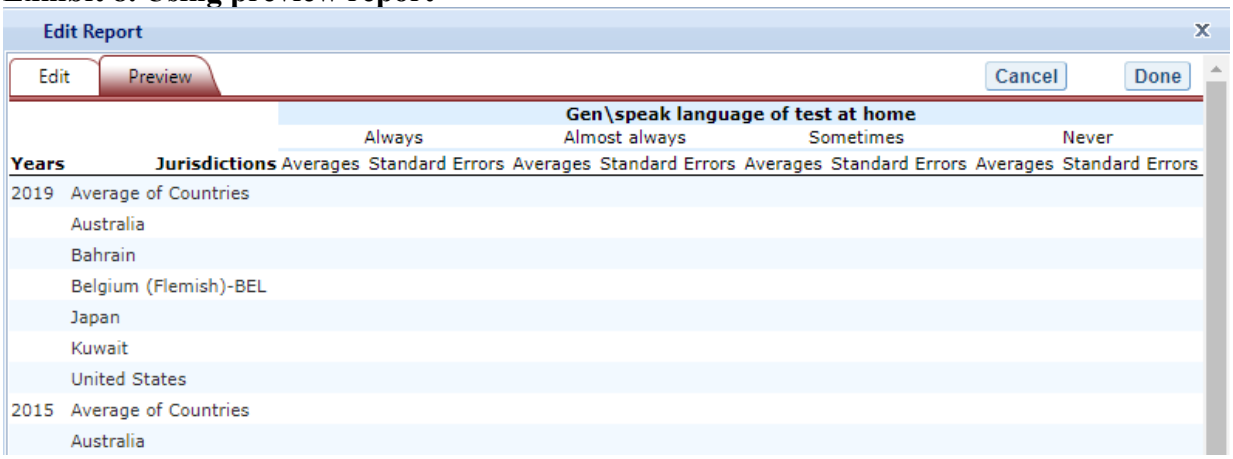
Exhibit 7. Edit reports overview

The **Edit Reports** step shows detailed information on the layout of your reports. The **Report** column indicates the report, or cross-tabulation report, number based on the variable(s) chosen during the criteria selection. Under the **All** tab, reports may be chosen for the report-building phase, either by selecting **All** or selecting individual reports. The **Action** column gives you the option to **Preview**, **Edit**, **Delete**, or **Copy** the report. The **Measure** column shows which measure the report will portray. The **Variable** column indicates the variable(s) included in the report. The **Year** column shows which years you have selected for comparison. The **Jurisdiction** column shows the countries and subnational education systems selected for comparison, and the **Statistic** column provides the type of statistic output that will be generated in the report-building phase.

3.B. Preview Report

Select **Preview,** in the **Action** column (see exhibit 7), to see how your report will be laid out. The preview will not provide actual data, but will show how the data will be arranged in rows and columns (see exhibit 8). You can select **Preview** at any time to see how your changes will affect the report's final layout.

Exhibit 8. Using preview report



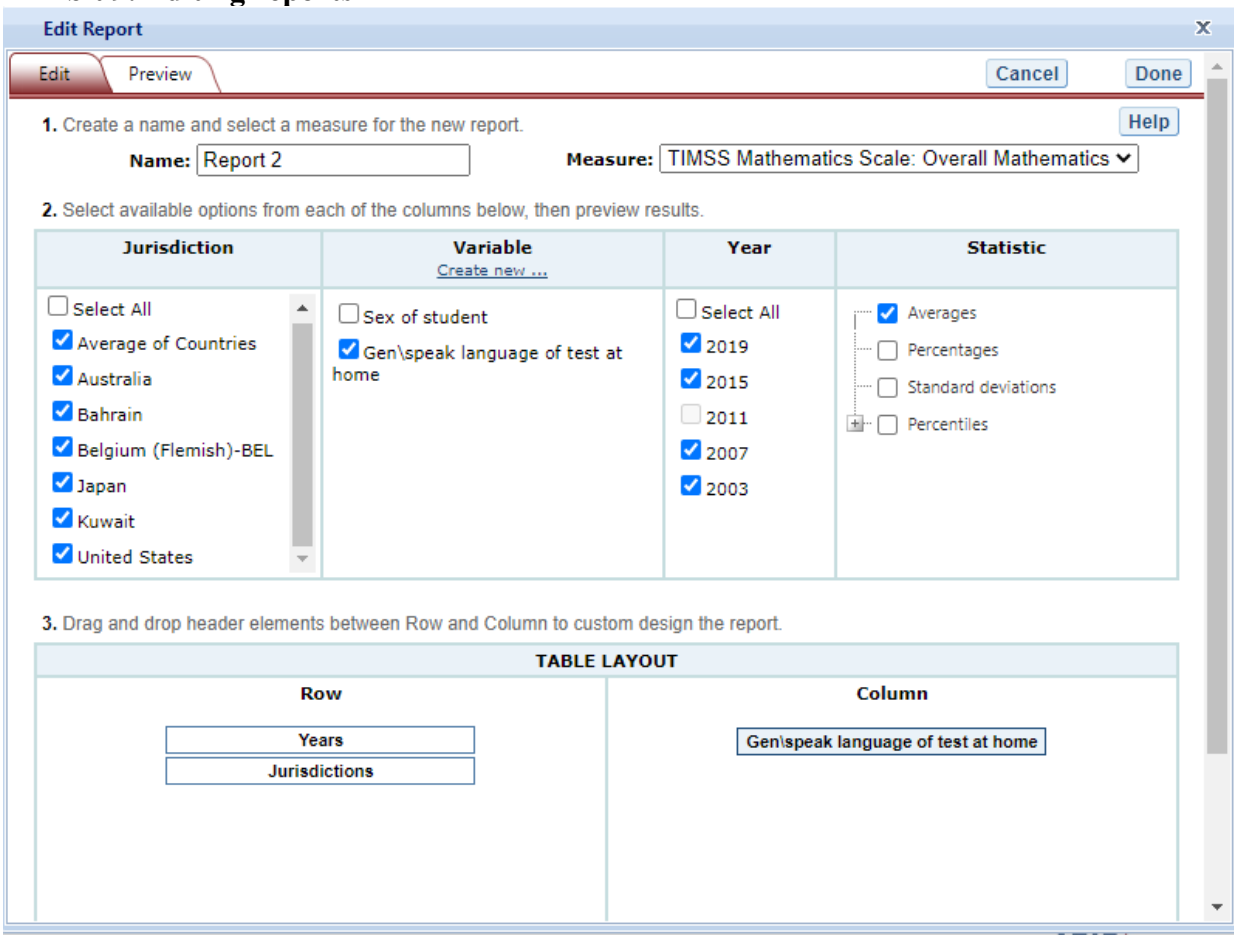
3.C. Edit Report

To edit the report, select the **Edit** command, in the **Action** column (see exhibit 7). (Another way to edit a report is to select the **Edit** tab when you are previewing a report.) The following can be done using the edit function (see exhibit 9):

1. Name your report. You have the option of giving each report a distinctive name, up to a limit of 50 characters, using only letters, numbers, spaces, underscores, and hyphens. (Otherwise, by default, the report is named Report 1, Report 2, etc., or Cross-Tabulated Report 1, Cross-Tabulated Report 2, etc.)
2. Select a measure. You can choose a measure if more than one was slected at step 1.

3. Select which jurisdictions, variables, years (if applicable), and statistics to include (out of the selections previously made at steps 1 and 2). You can select up to two statistics options from the following: averages, percentages, standard deviations, and percentiles. (For further information, see Section 3.G. Statistics Options.)
4. To create a new variable while editing a report, click on **Create New…** under the **Variable** heading. Section 3.D below explains the process for creating a new variable.
5. Change the table layout by dragging elements to determine which items will appear in rows and which will appear in columns. Some of the arrangements will not be permissible, but a pop-up alert will explain this.

Exhibit 9. Editing reports



To save changes, make sure to select **Done** in the upper-right portion of the screen before closing the **Edit Report** window.

3.D. Create New Variables

To create a new variable, select **Edit,** in the **Action** column, and select **Create new…** under **Variable** (see exhibit 9 above). The new variable is created by collapsing values for an existing variable. The steps are as follows:

1. Click **Create new...** under the **Variable** heading.
2. Select the variable for which you wish to collapse values.
3. Select the values you want to collapse by checking the boxes to the left of the values. In the example below (see exhibit 10a), "Always" and "Almost always" are checked
4. Create a name for the new value, and press **Create**. The collapsed values will appear in gray to indicate that they have already been used.
5. Repeat steps 3 and 4 to collapse other values if applicable. In the example below (see exhibit 10b), "Sometimes" and "Never" will be collapsed into "Sometimes or Never". Note that it is also possible to leave "Sometimes" and "Never" uncollapsed, thus skipping step 5.
6. Press **Done** when the screen has refreshed.
7. The new variable will appear in the **Variable** list in the **Edit Report** window, designated as "collapsed."
8. Check the box next to the new variable to view it in the report. You can click **Preview** to see how the table will be laid out before retrieving data.

Exhibit 10a. Creating new variables

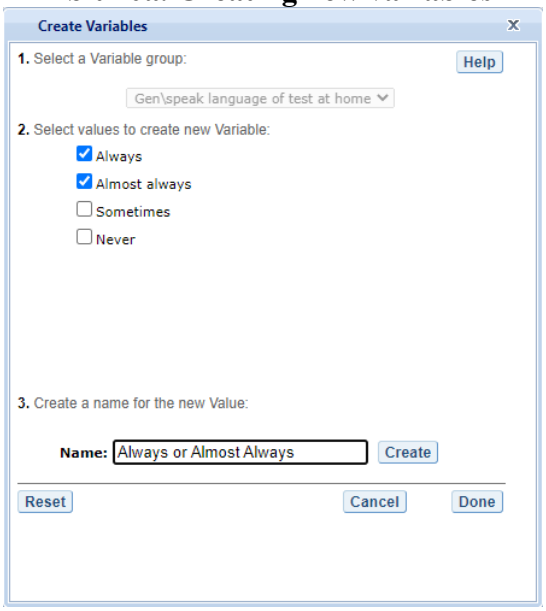


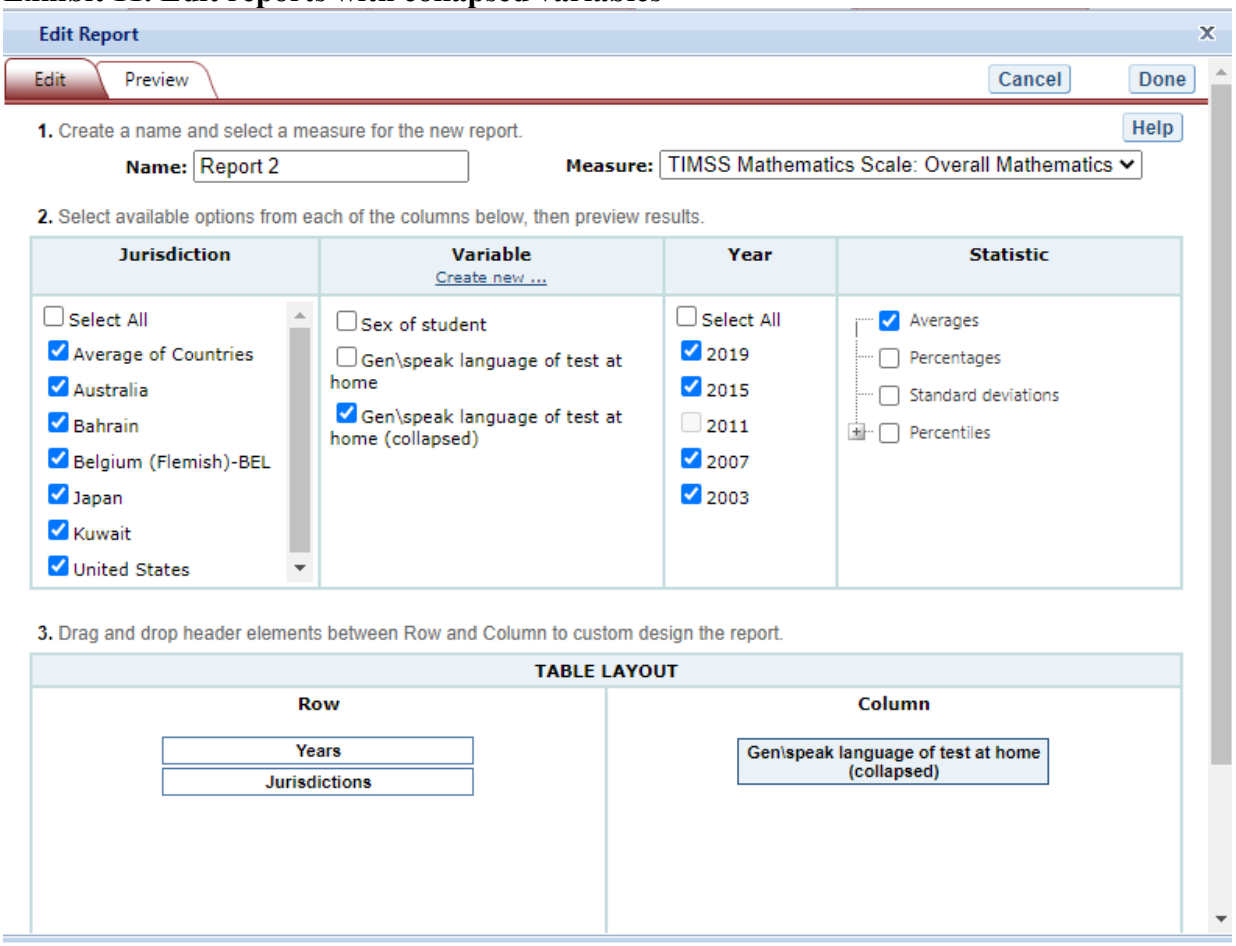
Exhibit 10b. Creating new variables

A new variable that you create is applicable only to a specific report; it does not apply to the other reports listed on the **Edit Reports** screen. For example, if you selected multiple measures of science literacy for analysis, then you would need to create the new variable for each measure, or create a copy of the report and edit it accordingly. To do the latter, click on **Copy** report on the **Edit Reports** screen (copied reports appear at the end of the list of reports) and then, for the new copy, click on **Edit** (using the above example, you can change the measure and give the report a new name).

You can repeat the process and combine different values of a variable to create additional new variables. Using the **Create New Report** function, you can create a new report for each new variable that you create. (For further information, see section 3.E. Create New Report.)

If you selected two or three variables from which to create new variables, you can repeat the process for each of them. Using the **Create New Report** or **Edit Report** function, these collapsed variables will be listed and available for cross-tabulation (see exhibit 11). If you have chosen four or more variables (not counting **All Students**), you won't get the cross-tabulation. You can click **Preview** to see how the table will be laid out before retrieving data.

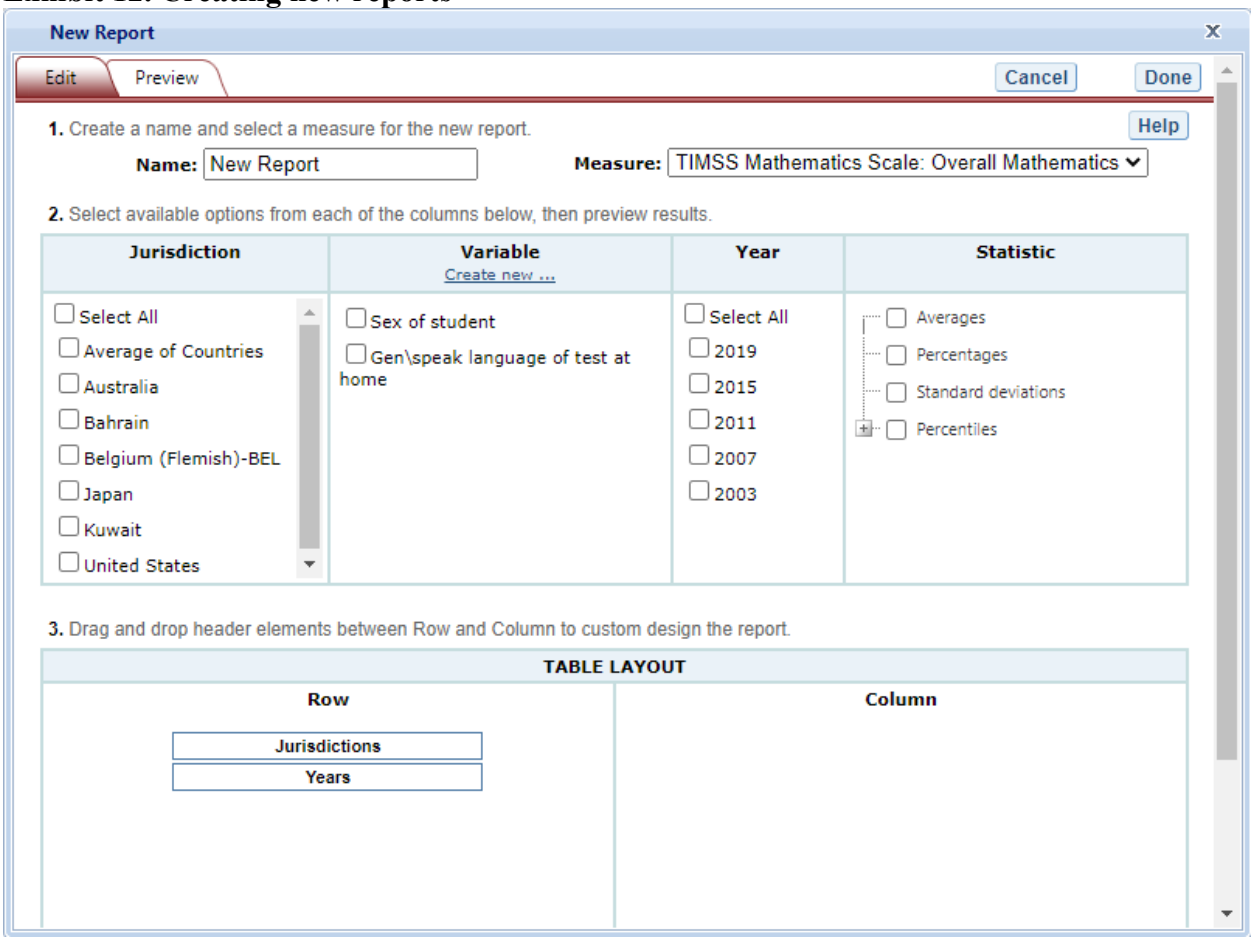
Exhibit 11. Edit reports with collapsed variables



3.E. Create New Report

From the main **Edit Reports** screen, clicking on **Create New Report** brings up the same options as **Edit Report**, but with no checkboxes marked and without any new variables you may have created. Thus, **Create New Report** provides a clean slate for your selections from the first two steps, **Select Criteria** and **Select Variables** (see exhibit 12). Each new report you create will appear at the end of the list of reports. If you do not give the report a specific name, it will be called "New Report."

Exhibit 12. Creating new reports



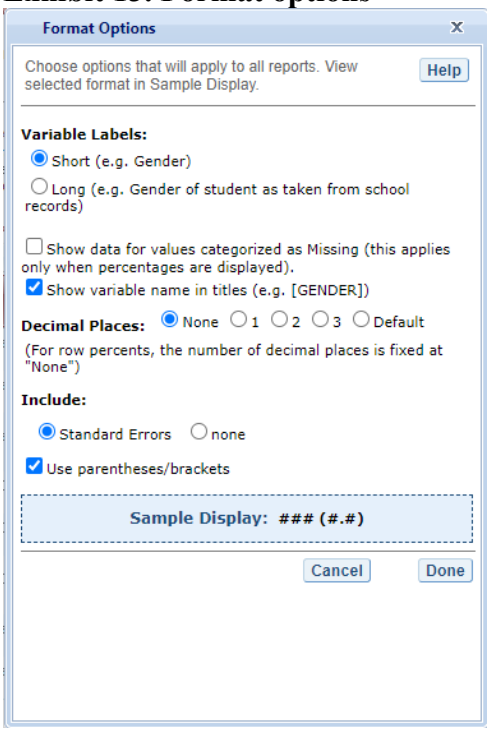
3.F. Format Options

From the main **Edit Reports** screen, clicking on **Format Options** will allow you to make formatting changes applicable to all the reports listed. The following formatting options are available using this function (see exhibit 13):

1. **Variable Labels** gives you the option to display a more detailed description of the variables selected in a query (**Long**) than the default label (**Short**). For variables from questionnaires, the full text of the question is displayed when **Long** is selected. Be advised that the length of the extra detail may sometimes interfere with table formatting.
2. **Show data for values categorized as Missing** will include the percentage of students in the total sample or in a reporting group for whom membership in a particular response category is unknown because no response was given by the students, their teacher, or their school. The percentage of "missing" will be shown in the right-most table column. Missing data are available only for queries that involve percentages as the statistic type. Unless you check this option, the default is for missing responses not to be included in the percentage distribution shown.

3. **Decimal Places** allows you to specify the level of precision for a particular statistic. Depending on the value range of the dependent variable (for example, the dependent variable "TIMSS Mathematics Scale: Overall Mathematics" ranges from 0 to 1000; the dependent variable "Students like learning mathematics scale [AS5BG071]" ranges from 4 to 13), the default decimal places for a report could be from zero to three. Also, standard errors will be shown to one more decimal place than is shown for a particular statistic. For example, if you request that average scores be displayed to one decimal place (by default, the average scores are displayed as whole numbers), the corresponding standard errors will be displayed to two decimal places. If you export to Excel, you will be able to increase the number of decimal places in most cases. Note that only integer-level precision is allowed for percentages; that is, the number of decimal places is fixed at "none" for percentages and the corresponding standard errors are shown to one decimal place.
4. **Include** gives you the option of showing standard errors. By default, standard errors are shown inside parentheses, but you have the option of choosing to show them without parentheses. You can preview the effects of your selection in the **Sample Display** area (see the blue-shaded box at the bottom of exhibit 13).

Exhibit 13. Format options



Be advised that the choices you make in the **Format Options** window will apply to all reports and cannot be changed for individual reports. Use the **Reset** button, located in the upper-right portion of the main **Edit Reports** screen (just below the **Help** button), to restore the **Format Options** to the default settings (although caution is advised, as this will also delete any new reports that you have created).

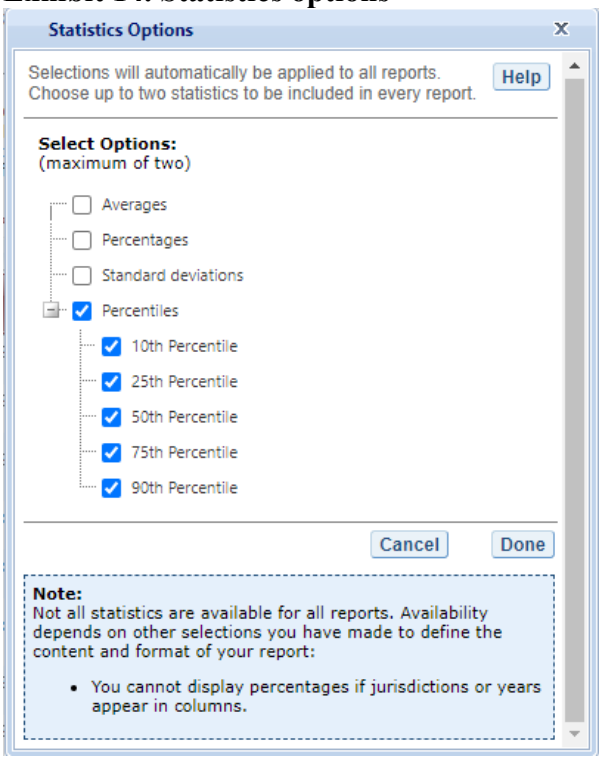
3.G. Statistics Options

Available only from the main **Edit Reports** screen, clicking on **Statistics Options** allows you to designate up to two statistics. The selections you make are applicable to all the reports listed, although you can also change the statistics for an individual report when you edit it. (For further information, see Section 3.C. Edit Report.)

The following statistics options are available (see exhibit 14):

1. **Averages.** This statistic provides the average value for a selected continuous variable or score (i.e., overall score or subscale score). For the TIMSS assessment, student performance is reported on scales that range from 0 to 1,000. By default, the standard errors of the scores are shown in parentheses.
2. **Percentages.** This statistic shows the percentage of students as a row percentage. For example, if the first column lists countries, then each country will display its own percentage distribution across its row. By default, percentage distributions do not include missing data. For information on how to show data for values categorized as missing, see Section 3.F. Format Options.
3. **Standard deviations.** The standard deviation is a measure of how widely or narrowly dispersed scores are for a particular variable. Under general normality assumptions, 95 percent of the scores are within two standard deviations of the mean. For example, if the average score of a variable is 500 and the standard deviation is 100, it means that 95 percent of the scores in this variable fall between 300 and 700. The standard deviation is the square root of the variance.
4. **Percentiles.** This statistic shows the threshold (or cutpoint) score for the following:
    - 10^{th} percentile—the bottom 10 percent of students
    - 25^{th} percentile—the bottom quarter of students
    - 50^{th} percentile—the median (half the students scored below the cutpoint and half scored above it)
    - 75^{th} percentile—the top quarter of students
    - 90^{th} percentile—the top 10 percent of students

Exhibit 14. Statistics options



As previously noted, the selections you make in **Statistics Options** will be applied automatically to all reports, although you can change the statistics for an individual report when you edit it. Be advised that if you use **Statistics Options** after editing the statistics in one or more of your individual reports, the statistics options selected will overwrite your previously edited selections. If you wish to use the same criteria and variables in a report with a different selection of statistics, consider using the **Create New Report** function to generate a new report with different statistics. (For further information, see Section 3.E. Create New Report.) You can also make a copy of an individual report.

You can use the **Reset** button, located in the upper-right portion of the main **Edit Reports** screen (just below the **Help** button), to restore the **Statistics Options** to the default setting, which is averages for all reports (this will also delete any new reports that you created).

Not all statistics are available for all reports. Their availability depends on other selections you have made to define the content and format of your report:

- Percentages will not display if jurisdictions or years appear in columns.
- If benchmarks are selected in the variable section, only average scores and percentages will be displayed.

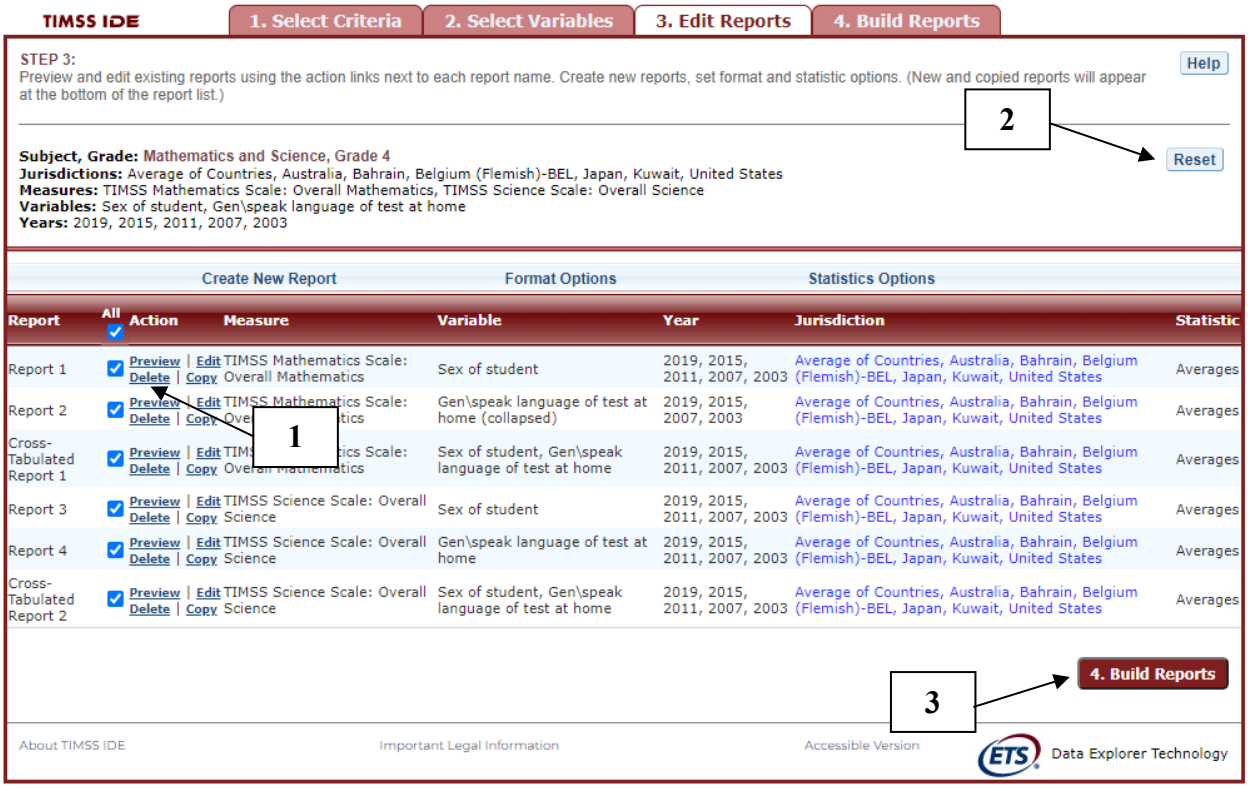
Please note that results obtained from the IDE might not always match those published by the International Association for the Evaluation of Educational Achievement (IEA). This is due to the use of different reporting standards, such as suppression rules related to sample size, and suppression due to response rates. In addition, results published by the IEA using teacher data

make use of all available teacher data for any one student, whereas results obtained from the IDE make use of only one teacher per student. In other words, in IEA published data, when a student has more than one teacher, the individual student weight is distributed evenly across all responding teachers of that student. In the IDE, under the same circumstances, the response of a single teacher is selected at random and assigned to the student. While the results are expected to be the same, there is some small variation due to the random selection of the teacher response. This affects results for teacher data, calculated for 4th and 8th graders, and is only noticeable in cases where students have multiple teachers.

3.H. Select Reports to Build

As you edit your reports, you can give them distinct names (up to 50 characters) to differentiate them, as well as make changes to the jurisdictions and variables previously selected, the statistics, and the layout of the rows and columns. (For further information, see section 3.C. Edit Report.) You may make copies of reports with these changes. In order to proceed to step 4, **Build Reports**, each report for which you want to retrieve data should be previewed using the **Preview** function. To decrease processing time as you move to step 4, you can uncheck any reports for which you do not wish to retrieve data. By default, all reports are checked. To uncheck one or more reports, you can either uncheck the reports individually or click on the **All** box. (Doing the latter will uncheck all of the reports and allow you to check only those for which you wish to retrieve data.) In the example that follows (see exhibit 15), data will be retrieved for all reports.

Exhibit 15. Selecting reports to build



If you wish to delete a report from the list of reports, click **Delete** (see 1 above) in the **Action** column. Use the **Reset** button (see 2 above), located in the upper-right portion of the screen (just below the **Help** button), to restore the deleted reports (although caution is advised, as this will also delete any new reports that you created and restore the **Format Options** and **Statistics Options** to the default settings).

To continue to the last step in the IDE, click the **Build Reports** button at the bottom of the page (see 3 above) or the tab at the top of the page to go to the next screen.

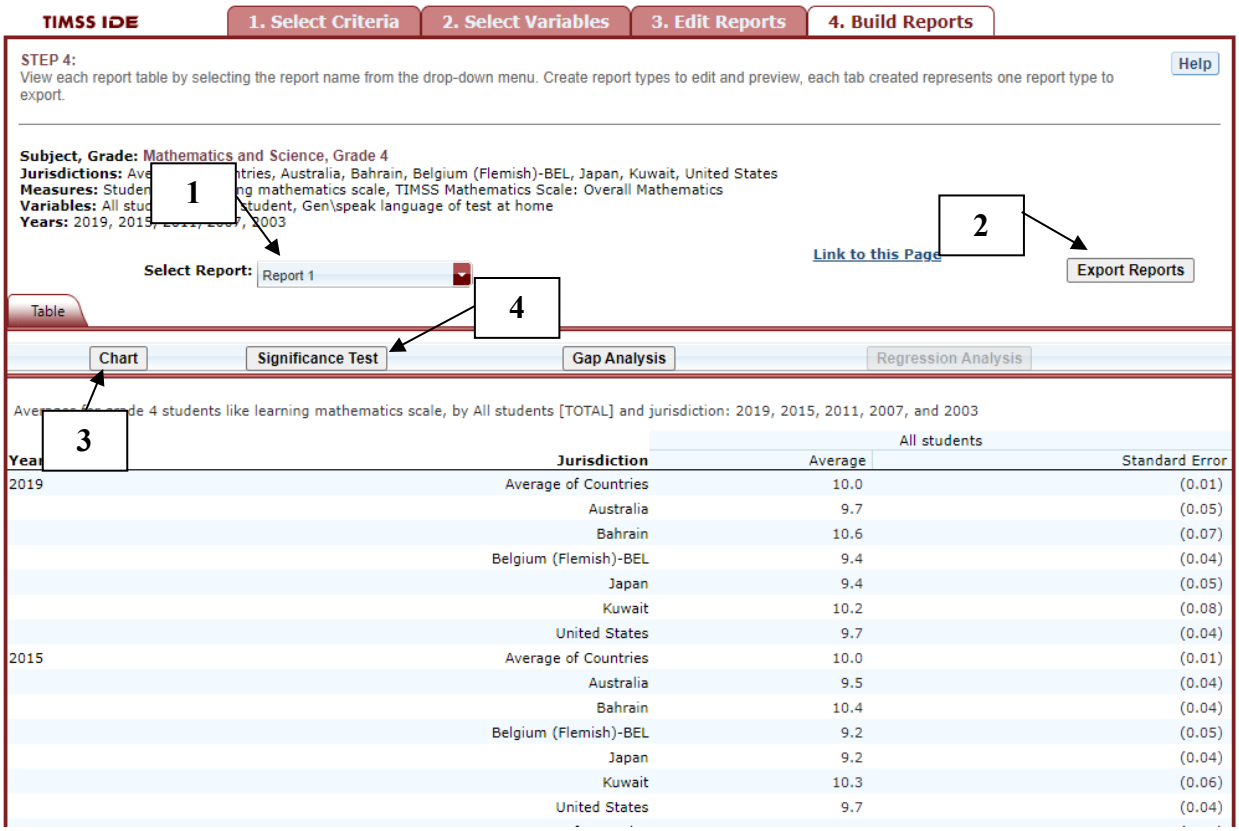
4. Build Reports

4.A. Overview

You can access step 4, **Build Reports**, after choosing criteria at step 1, **Select Criteria**, in which case the default report built will provide data for just averages and for the **All Students** variable. After step 1, you may also go on to steps 2 and 3, where you can select additional variables and edit reports, before moving on to **Build Reports**. In **Build Reports**, you can do the following:

1. Generate a data table for each report, as shown in the **Select Report** drop-down feature (see 1 in exhibit 16). By default, all reports are checked, although you can uncheck any reports for which you do not wish to retrieve data. (For further information, see section 3.H. Select Reports to Build.)
2. Export and save data tables into various formats using the **Export Reports** button (see 2 in exhibit 16). The output formats include HTML (print-friendly), Microsoft Excel, Microsoft Word, and Adobe PDF.
3. Select the **Chart** tab (see 3 in exhibit 16) to create and customize charts for each report and save them for export in the above formats.
4. Select the **Significance Test** tab (see 4 in exhibit 16) to run a significance test on your results, customize it, and export it.

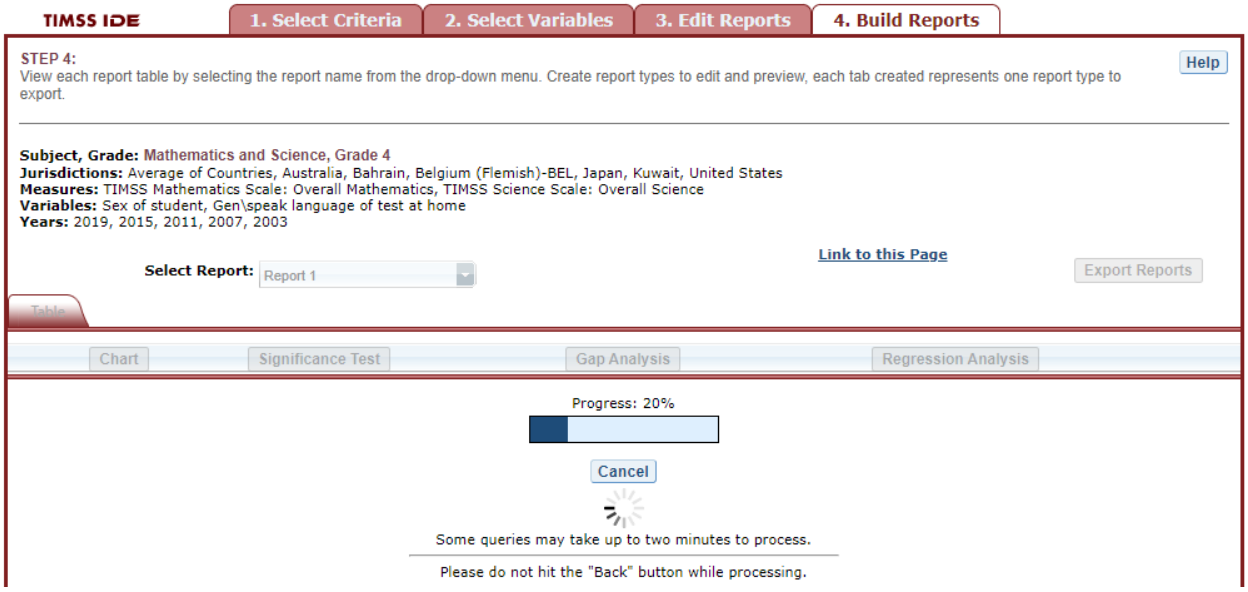
Exhibit 16. Building reports overview



4.B. View Reports as Data Tables

Some reports will take longer than others to process, so please do not hit the "Back" button on your browser once you click on **Build Reports** (see exhibit 17). Your table will appear once the processing is complete. To select a different table to view, go to the **Select Report** drop-down menu (see 1 in exhibit 16) and choose the table of interest. To change the formatting or statistics options of a table or to generate a table from a report not included in your selection, return to step 3, **Edit Reports**.

Exhibit 17. Processing data

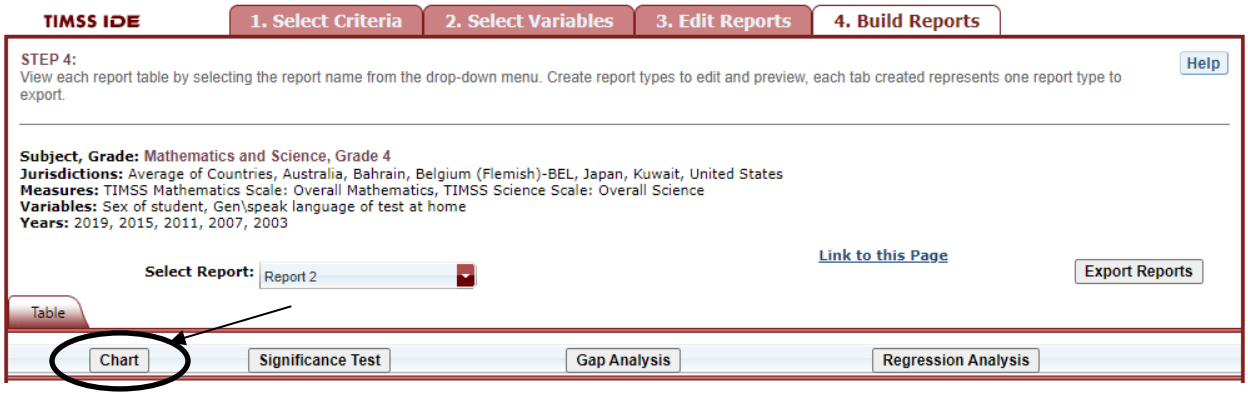


4.C. Charts

To create a chart, go to **Select Report** on the **Build Reports** screen to choose the report of interest from the drop-down menu, and then click the **Chart** link (see exhibit 18).

You will be able to create many types of charts and customize them. Section 4.E. Create Charts—Chart Options provides a summary of the available features and how they can be customized.

Exhibit 18. Viewing reports as charts



4.D. Create Charts—Chart Options

When you click **Chart,** your screen will present data options pertaining to **Jurisdiction, Year,** and **Statistic** (see exhibit 19). Only the statistics option(s) used to report data in the previous step will be presented, and only one statistics option can be selected at a time. For example,

Percentiles will appear as the only data option to build the chart if the table created in the previous step is reporting data with only percentiles selected as the statistics option.

Below, you can select **Bar Chart, Column Chart,** or **Line Chart** (see exhibit 20). If all of the percentiles are chosen as the statistics option, you also have the option of selecting a **Percentile Chart**.

After selecting a chart type, change any data dimensions from the drop-down menus for **Bar**, **Column**, or **Line Values** and **Values Grouped by**. Any new variables that you created at step 3, **Edit Reports**, will be available for selection, but only if you selected the variables (by clicking the checkbox next to them) and pressed **Done** after you edited the report.

Once you are finished with the Chart Options, click the **Create Chart** button in the lower-right corner of the screen.

Exhibit 19. Data options for charts

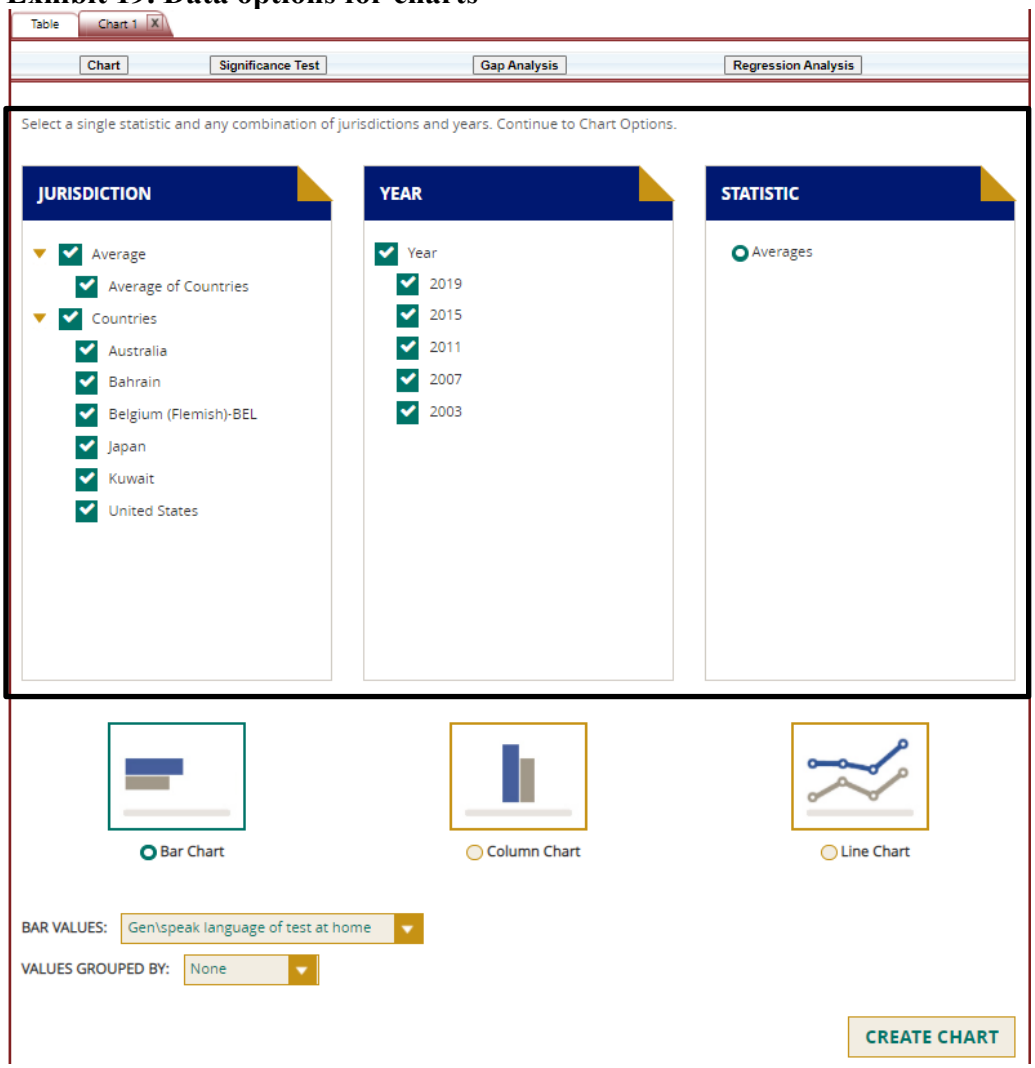
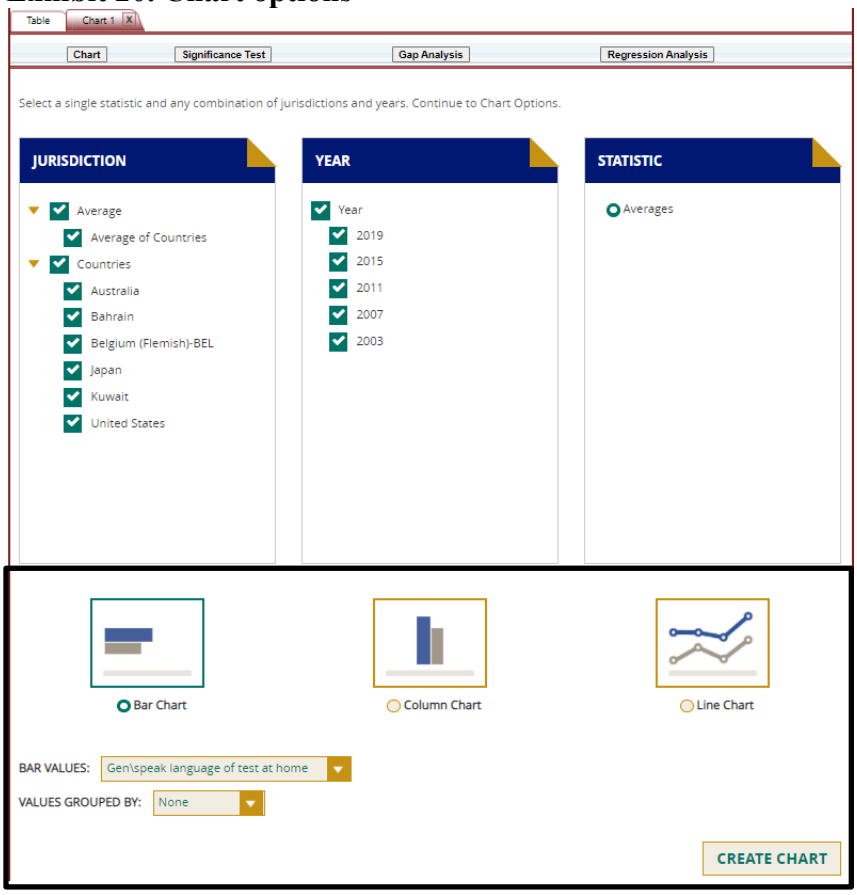
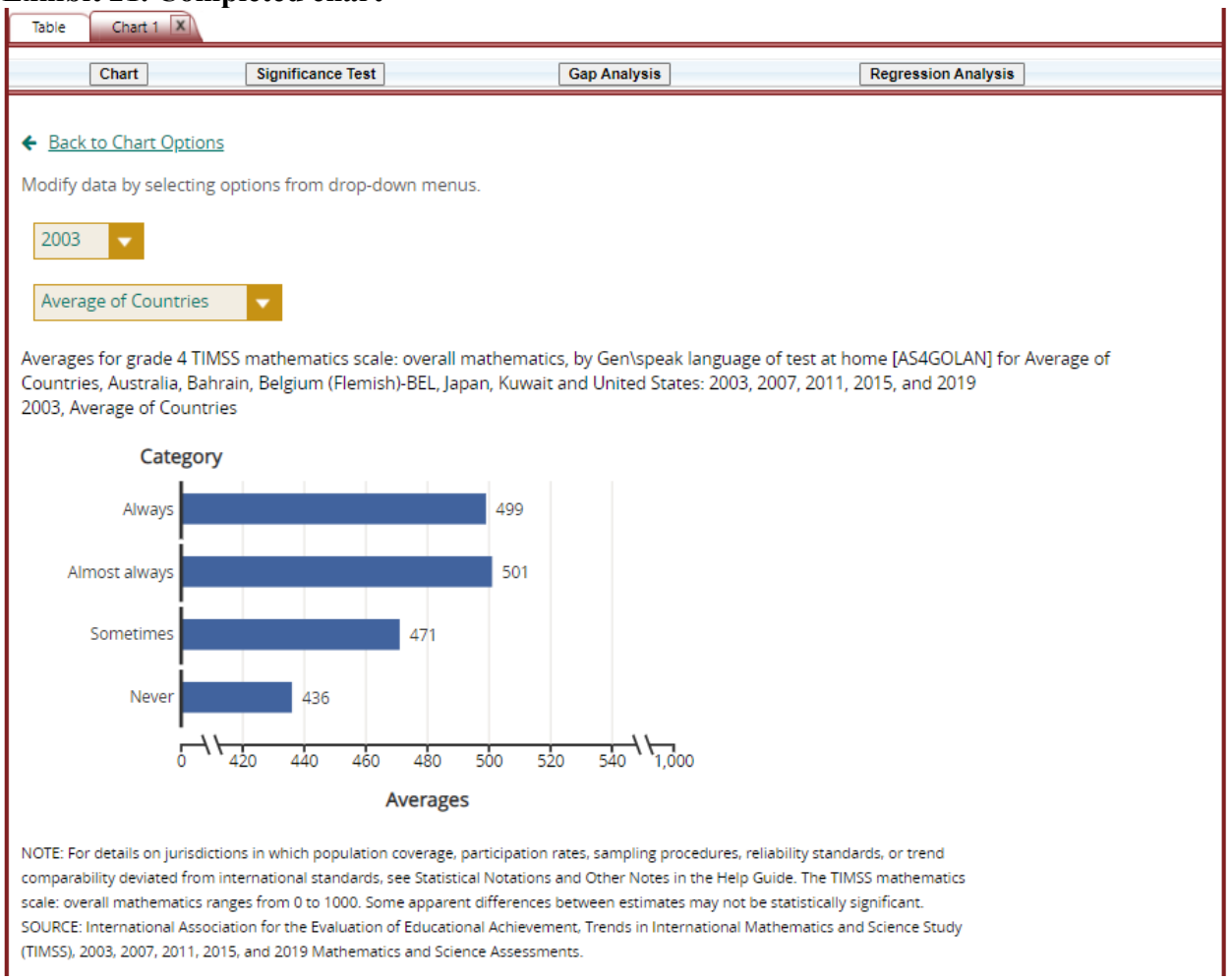


Exhibit 20. Chart options



Clicking **Create Chart** takes you to the exportable version of the chart (see exhibit 21). You can subsequently click **"Back to Chart Options"** (located in the upper-left corner, below **Chart**) to make more changes.

Exhibit 21. Completed chart



To make an additional chart from the same report or table, click the **Chart** link on the **Build Reports** screen. If you don't start the chart process again by clicking the **Chart** link, the new chart will overwrite the previous one.

If you wish to make charts from other reports, select another report in the **Select Report** drop-down list. (If other reports were not checked in step 3, **Edit Reports**, go back to step 3 and check the ones you want. Then, when you advance to step 4, **Build Reports**, the reports will appear in the **Select Report** drop-down list.) If you need to create new reports, go back to step 1, **Select Criteria**, and/or step 2, **Select Variables**. Remember to export any completed charts you want to save by using the **Export Reports** function before leaving the **Build Reports** screen. (For further information, see Section 4.H. Export Reports.)

4.E. Significance Tests

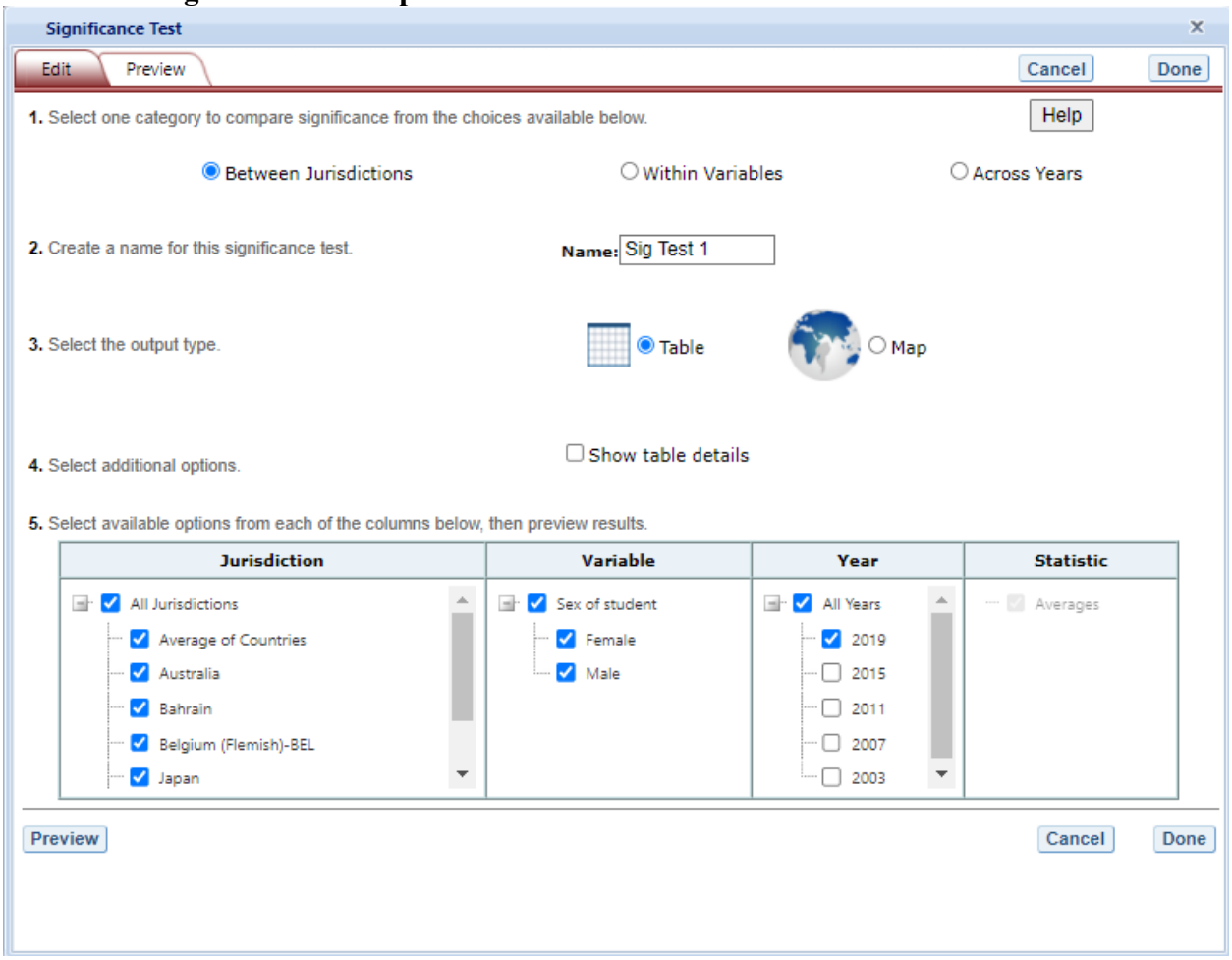
Tests for statistical significance indicate whether observed differences between estimates are likely to have occurred because of sampling error or chance. "Significance" here does not imply any judgment about absolute magnitude or educational relevance. It refers only to the statistical nature of the difference and whether that difference likely reflects a true difference in the population.

With your report of interest selected, click the **Significance Test** link, which is located to the right of the **Chart** link (see exhibit 16 and 21). You first need to decide which variable you want to test and the criterion by which you want to test it (i.e., between jurisdictions, within variables, or across years). You will compare or look across the variable's range of values, so it must have more than one value. You can look across jurisdictions for a variable (that is, compare between two or more jurisdictions) or you can look across the values within a variable for a single jurisdiction. For example, with the variable shown in exhibit 22, you could choose to compare scores of female students between countries and subnational education systems, or you could choose to compare scores of female students and male students.

The general steps for running significance tests are as follows (see exhibit 22):

1. In the **Significance Test** window, select either **Between Jurisdictions**, **Within Variables**, or **Across Years**. Then, select the appropriate jurisdiction(s), variable(s), year(s), and statistic(s). For **Between Jurisdictions**, select at least two jurisdictions. For **Within Variables**, select at least two variable values. For **Across Years**, more than one year needs to be selected.
2. You can enter a **Name** limited to 25 characters, using only letters, numbers, spaces, underscores, and hyphens (otherwise, by default, the test is named "Sig Test 1").
3. Select the output type as either **Table** or **Map**. The table option will show the significance test results as a matrix. The map option will show the significance test results on a world map, highlighting countries and subnational education systems that have been selected. The map output is only available when **Between Jurisdictions** is selected in the first step.
4. Additional options allow you to select **Show table details** to display the estimates and standard errors for the table cells. If you selected a map, this option is not applicable, as the map will automatically show score details.
5. Click the **Preview** tab located in the upper-left corner, or the **Preview** button located in the bottom-left corner.
6. Click the **Edit** tab in the upper-left corner of the screen if you wish to go back and make changes to the selections you made for running the significance tests.
7. Click the **Done** button in the upper- or lower-right corner of the screen to run the significance tests.

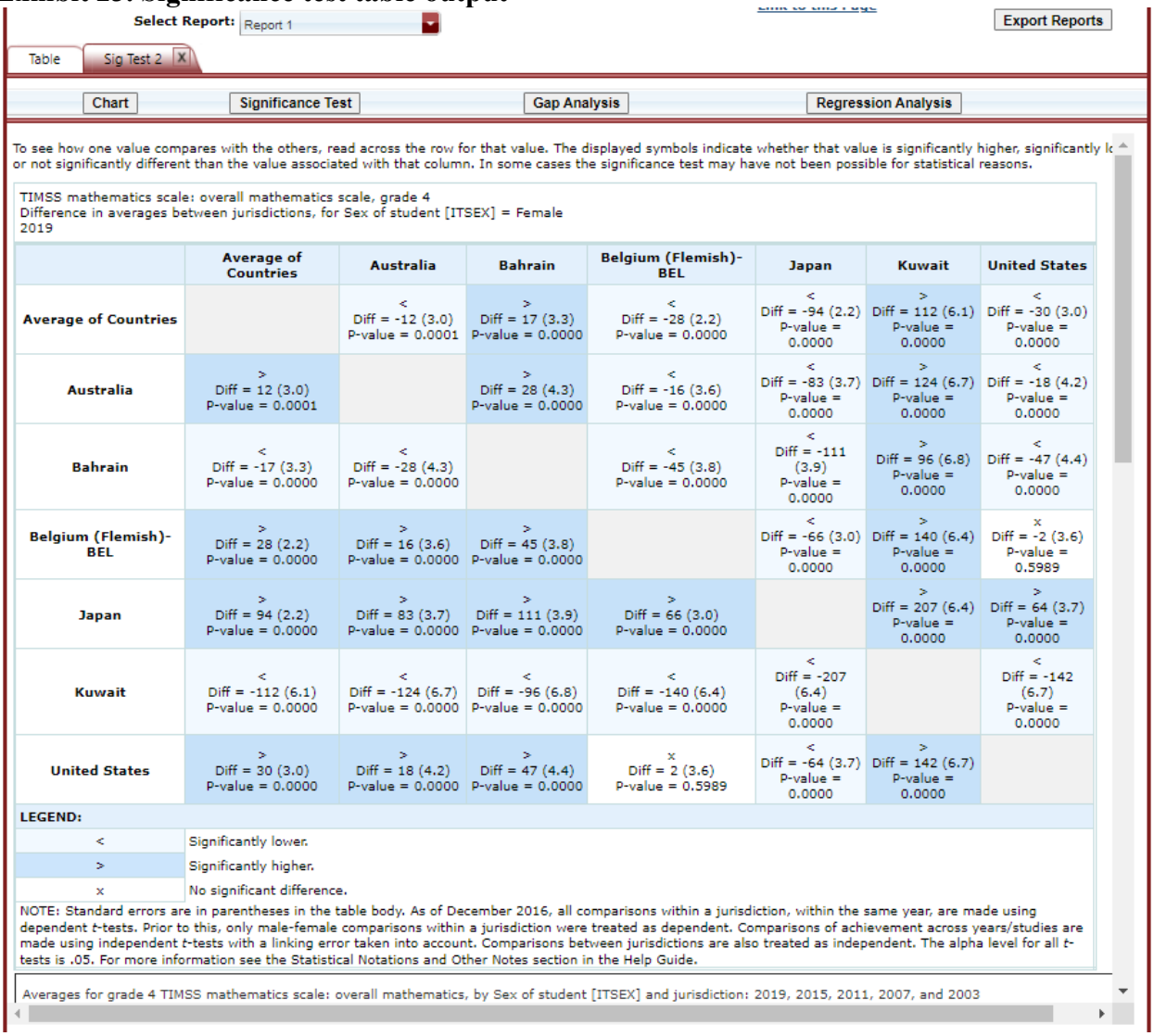
Exhibit 22. Significance test options



When the table option is selected, you will get a significance test matrix in which you will see the differences and *p* values. Using the symbols shown in the legend of the matrix, an indication is also provided of whether one estimate is significantly lower or higher than another estimate or whether there is no significant difference (see exhibit 23).

The alpha level to establish significance for all comparisons is .05. All comparisons within a jurisdiction, within the same year, are made using dependent samples *t*-tests. Comparisons between jurisdictions, and comparisons between years, even for the same jurisdiction, are made using independent samples *t*-tests. The TIMSS IDE also uses independent samples *t*-tests, between a country and a subnational entity that is participating as a benchmarking entity (for instance, in order to compare scores between the United States and Massachusetts or Minnesota, since they each are an independent sample).

Exhibit 23. Significance test table output



Select Report: Report 1 — Export Reports

Table | Sig Test 2

Chart | Significance Test | Gap Analysis | Regression Analysis

To see how one value compares with the others, read across the row for that value. The displayed symbols indicate whether that value is significantly higher, significantly lo or not significantly different than the value associated with that column. In some cases the significance test may have not been possible for statistical reasons.

TIMSS mathematics scale: overall mathematics scale, grade 4
Difference in averages between jurisdictions, for Sex of student [ITSEX] = Female
2019

	Average of Countries	Australia	Bahrain	Belgium (Flemish)-BEL	Japan	Kuwait	United States
Average of Countries		< Diff = -12 (3.0) P-value = 0.0001	> Diff = 17 (3.3) P-value = 0.0000	< Diff = -28 (2.2) P-value = 0.0000	< Diff = -94 (2.2) P-value = 0.0000	> Diff = 112 (6.1) P-value = 0.0000	< Diff = -30 (3.0) P-value = 0.0000
Australia	> Diff = 12 (3.0) P-value = 0.0001		> Diff = 28 (4.3) P-value = 0.0000	< Diff = -16 (3.6) P-value = 0.0000	< Diff = -83 (3.7) P-value = 0.0000	> Diff = 124 (6.7) P-value = 0.0000	< Diff = -18 (4.2) P-value = 0.0000
Bahrain	< Diff = -17 (3.3) P-value = 0.0000	< Diff = -28 (4.3) P-value = 0.0000		< Diff = -45 (3.8) P-value = 0.0000	< Diff = -111 (3.9) P-value = 0.0000	> Diff = 96 (6.8) P-value = 0.0000	< Diff = -47 (4.4) P-value = 0.0000
Belgium (Flemish)-BEL	> Diff = 28 (2.2) P-value = 0.0000	> Diff = 16 (3.6) P-value = 0.0000	> Diff = 45 (3.8) P-value = 0.0000		< Diff = -66 (3.0) P-value = 0.0000	> Diff = 140 (6.4) P-value = 0.0000	x Diff = -2 (3.6) P-value = 0.5989
Japan	> Diff = 94 (2.2) P-value = 0.0000	> Diff = 83 (3.7) P-value = 0.0000	> Diff = 111 (3.9) P-value = 0.0000	> Diff = 66 (3.0) P-value = 0.0000		> Diff = 207 (6.4) P-value = 0.0000	> Diff = 64 (3.7) P-value = 0.0000
Kuwait	< Diff = -112 (6.1) P-value = 0.0000	< Diff = -124 (6.7) P-value = 0.0000	< Diff = -96 (6.8) P-value = 0.0000	< Diff = -140 (6.4) P-value = 0.0000	< Diff = -207 (6.4) P-value = 0.0000		< Diff = -142 (6.7) P-value = 0.0000
United States	> Diff = 30 (3.0) P-value = 0.0000	> Diff = 18 (4.2) P-value = 0.0000	> Diff = 47 (4.4) P-value = 0.0000	x Diff = 2 (3.6) P-value = 0.5989	< Diff = -64 (3.7) P-value = 0.0000	> Diff = 142 (6.7) P-value = 0.0000	

LEGEND:

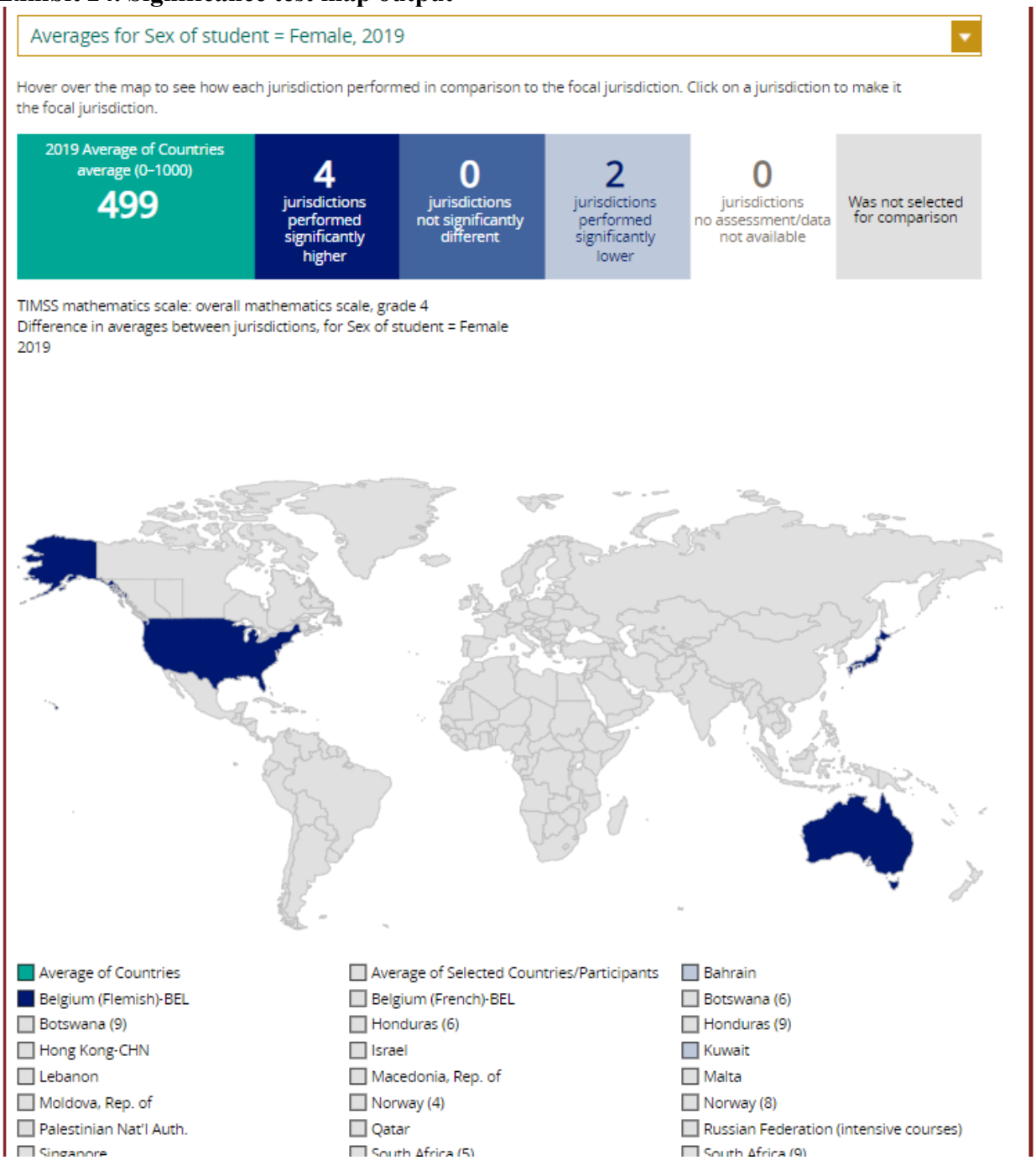
<	Significantly lower.
>	Significantly higher.
x	No significant difference.

NOTE: Standard errors are in parentheses in the table body. As of December 2016, all comparisons within a jurisdiction, within the same year, are made using dependent *t*-tests. Prior to this, only male-female comparisons within a jurisdiction were treated as dependent. Comparisons of achievement across years/studies are made using independent *t*-tests with a linking error taken into account. Comparisons between jurisdictions are also treated as independent. The alpha level for all *t*-tests is .05. For more information see the Statistical Notations and Other Notes section in the Help Guide.

Averages for grade 4 TIMSS mathematics scale: overall mathematics, by Sex of student [ITSEX] and jurisdiction: 2019, 2015, 2011, 2007, and 2003

When the **map option** is selected, a global map is shown with the countries and subnational education systems that were previously selected shaded (see exhibit 24). The focal jurisdiction is shaded in green, with all other countries compared to it. The other countries are shaded in colors that indicate whether they are higher, lower, or not significantly different from the focal jurisdiction on whatever measure has been selected. (Note that grey is the default color for countries not selected for comparison.) When you hover over a country, a text bubble pops up indicating the point estimates for that country and the focal jurisdiction. At any point, you may choose a different focal jurisdiction by clicking on another country.

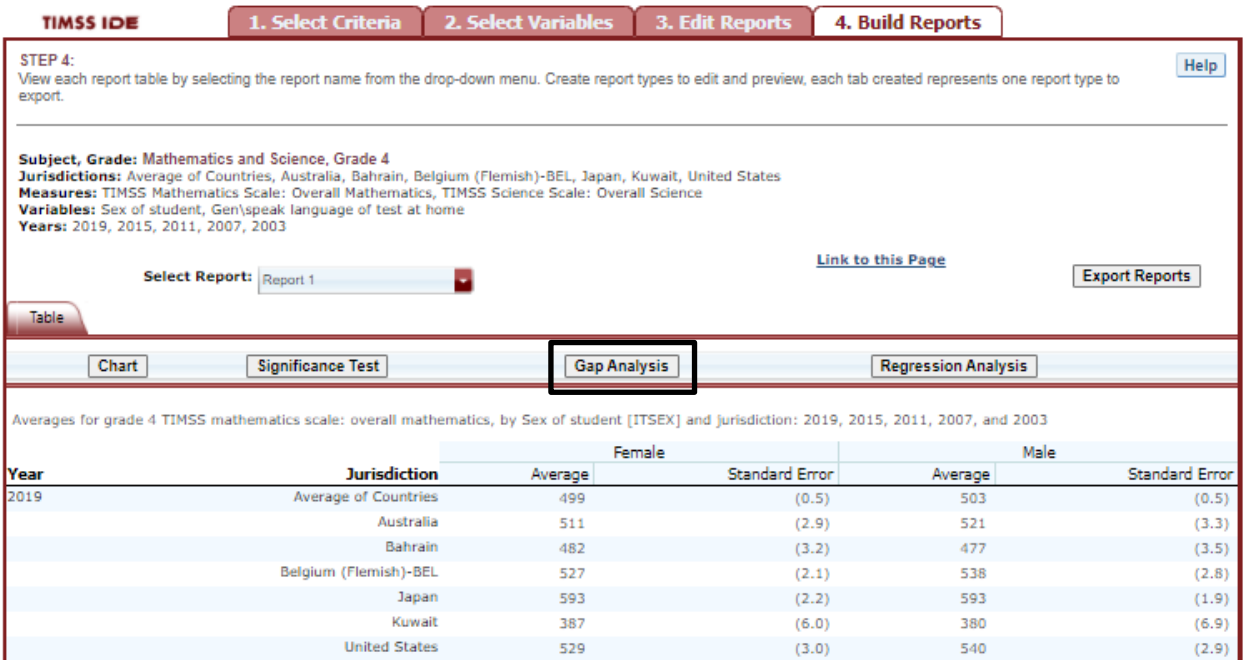
Exhibit 24. Significance test map output



4.F. Gap Analysis

Gap Analysis is included in the IDE to compare differences in gaps shown in a map, table, or chart. These gap differences can be compared between jurisdictions and/or across years.

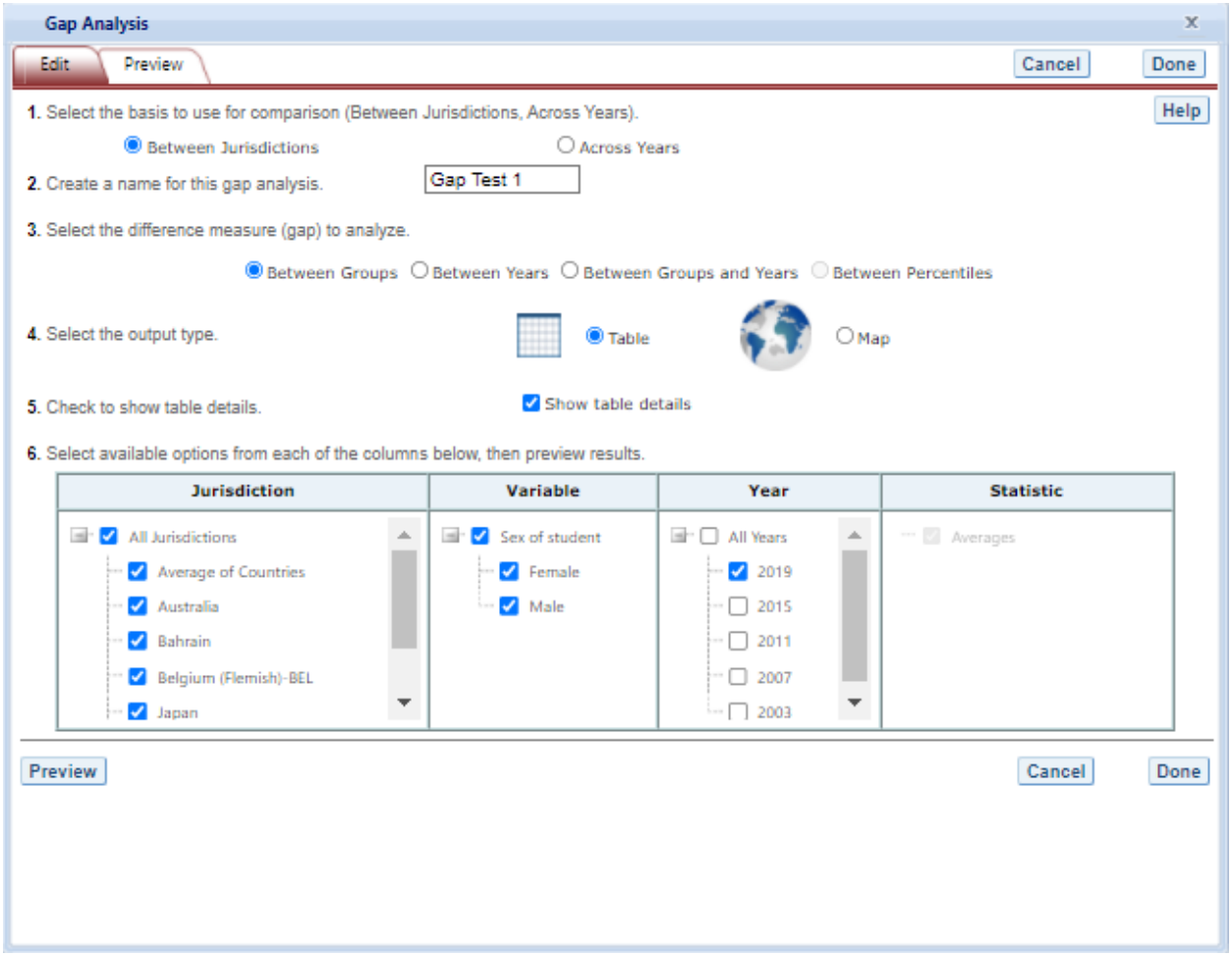
Exhibit 25. Gap analysis link selection



With your report of interest selected, click on the **Gap Analysis** link, which is located to the right of the **Significance Test** link (see exhibit 25). You will need to decide which variable you would like to test (e.g., gender) and the criterion by which you want to test it (i.e., between jurisdictions or across years). The difference measure, or gap, can be viewed between groups, between years, between groups and years, or between percentiles within the selected variable. For example, if you compute average mathematics scores for two countries at two time points for males and females, you can:

- at one time point, compare the male-female gap in one country to the male-female gap in another country;
- compare the male-female gap at two time points within a country;
- compare the difference between the male-female gap at two time points in one country to the difference between the male-female gap at two time points in another country; or
- compare the gap for females at two time points in one country to the gap for females at two time points in another country.

Exhibit 26. Gap analysis options



The steps for running a gap analysis are similar to those for conducting a statistical significance test (see exhibit 26). Thus, to run a gap analysis, follow the instructions under section **4.E. Significance Tests**, noting the following differences:

1. The **Gap Analysis** link should be selected, not the **Significance Test** link.
2. The gap analysis does not have a **Within Variables** option for analysis; the options are **Between Jurisdictions** and **Across Years.**
3. The difference measure (gap) of analysis must be selected from the following: **Between Groups, Between Years, Between Groups and Years,** and **Between Percentiles** (if variables are selected for which a difference measure is not feasible, the difference measure option will not appear as available in the Gap Analysis menu).

The gap analysis output is presented in a format similar to that of the significance test output, with one difference: the difference estimate shown in the output is the difference between the gaps selected for analysis. Note that you will still see the significance of these differences just like in a significance test. For example, exhibit 27 shows cross-national differences between male-female score gaps among 8th grade students.

The gap analysis function computes and statistically tests differences between score, percentage, or percentile gaps. All gap comparisons are made using independent samples *t*-tests with an alpha level of 0.05. Note that the reference group for the gaps is kept constant during the analysis, as opposed to taking the absolute value of the gaps. Therefore, the gap analysis tests whether the magnitude of the gaps differ from each other only when the gaps go in the same direction (e.g., comparing a 5-point gender gap favoring females in one country with a 15-point gender gap favoring females in another country).

Exhibit 27. Gap analysis output

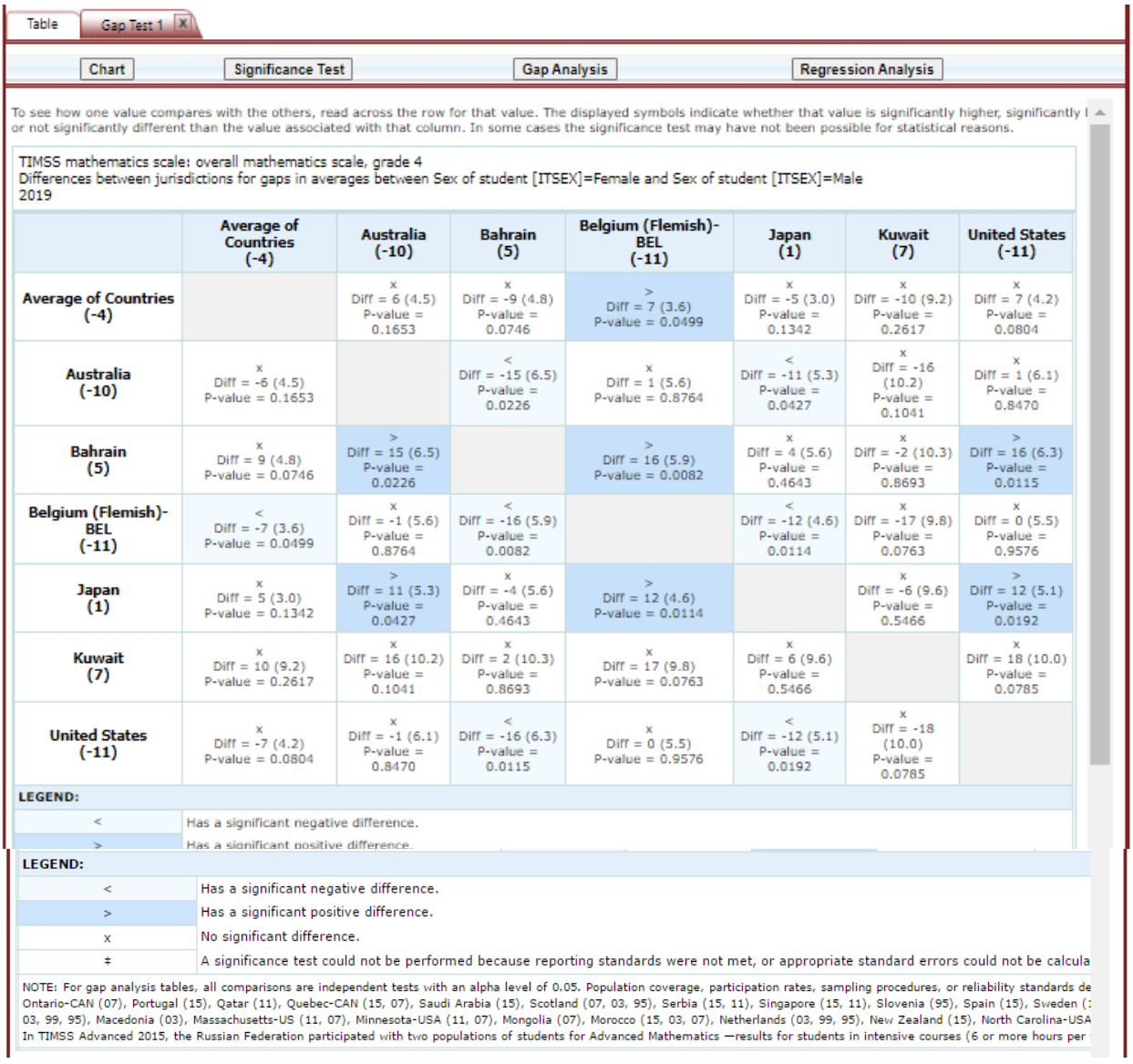


Table | Gap Test 1

Chart | Significance Test | Gap Analysis | Regression Analysis

To see how one value compares with the others, read across the row for that value. The displayed symbols indicate whether that value is significantly higher, significantly l or not significantly different than the value associated with that column. In some cases the significance test may have not been possible for statistical reasons.

TIMSS mathematics scale: overall mathematics scale, grade 4
Differences between jurisdictions for gaps in averages between Sex of student [ITSEX]=Female and Sex of student [ITSEX]=Male
2019

	Average of Countries (-4)	Australia (-10)	Bahrain (5)	Belgium (Flemish)-BEL (-11)	Japan (1)	Kuwait (7)	United States (-11)
Average of Countries (-4)		x Diff = 6 (4.5) P-value = 0.1653	x Diff = -9 (4.8) P-value = 0.0746	> Diff = 7 (3.6) P-value = 0.0499	x Diff = -5 (3.0) P-value = 0.1342	x Diff = -10 (9.2) P-value = 0.2617	x Diff = 7 (4.2) P-value = 0.0804
Australia (-10)	x Diff = -6 (4.5) P-value = 0.1653		< Diff = -15 (6.5) P-value = 0.0226	x Diff = 1 (5.6) P-value = 0.8764	< Diff = -11 (5.3) P-value = 0.0427	x Diff = -16 (10.2) P-value = 0.1041	x Diff = 1 (6.1) P-value = 0.8470
Bahrain (5)	x Diff = 9 (4.8) P-value = 0.0746	> Diff = 15 (6.5) P-value = 0.0226		> Diff = 16 (5.9) P-value = 0.0082	x Diff = 4 (5.6) P-value = 0.4643	x Diff = -2 (10.3) P-value = 0.8693	> Diff = 16 (6.3) P-value = 0.0115
Belgium (Flemish)-BEL (-11)	< Diff = -7 (3.6) P-value = 0.0499	x Diff = -1 (5.6) P-value = 0.8764	< Diff = -16 (5.9) P-value = 0.0082		< Diff = -12 (4.6) P-value = 0.0114	x Diff = -17 (9.8) P-value = 0.0763	x Diff = 0 (5.5) P-value = 0.9576
Japan (1)	x Diff = 5 (3.0) P-value = 0.1342	> Diff = 11 (5.3) P-value = 0.0427	x Diff = -4 (5.6) P-value = 0.4643	> Diff = 12 (4.6) P-value = 0.0114		x Diff = -6 (9.6) P-value = 0.5466	> Diff = 12 (5.1) P-value = 0.0192
Kuwait (7)	x Diff = 10 (9.2) P-value = 0.2617	x Diff = 16 (10.2) P-value = 0.1041	x Diff = 2 (10.3) P-value = 0.8693	x Diff = 17 (9.8) P-value = 0.0763	x Diff = 6 (9.6) P-value = 0.5466		x Diff = 18 (10.0) P-value = 0.0785
United States (-11)	x Diff = -7 (4.2) P-value = 0.0804	x Diff = -1 (6.1) P-value = 0.8470	< Diff = -16 (6.3) P-value = 0.0115	x Diff = 0 (5.5) P-value = 0.9576	< Diff = -12 (5.1) P-value = 0.0192	x Diff = -18 (10.0) P-value = 0.0785	

LEGEND:

<	Has a significant negative difference.
>	Has a significant positive difference.

LEGEND:

<	Has a significant negative difference.
>	Has a significant positive difference.
x	No significant difference.
‡	A significance test could not be performed because reporting standards were not met, or appropriate standard errors could not be calcula

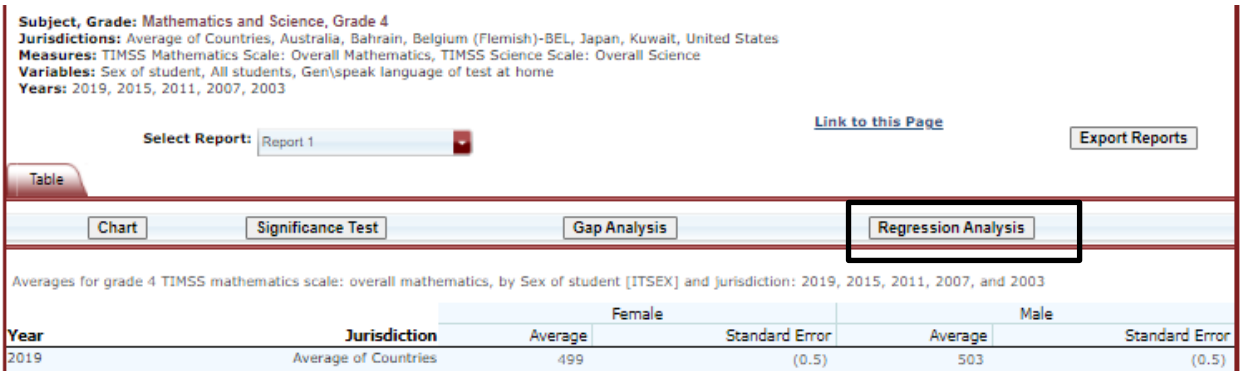
NOTE: For gap analysis tables, all comparisons are independent tests with an alpha level of 0.05. Population coverage, participation rates, sampling procedures, or reliability standards de Ontario-CAN (07), Portugal (15), Qatar (11), Quebec-CAN (15, 07), Saudi Arabia (15), Scotland (07, 03, 95), Serbia (15, 11), Singapore (15, 11), Slovenia (95), Spain (15), Sweden (: 03, 99, 95), Macedonia (03), Massachusetts-US (11, 07), Minnesota-USA (11, 07), Mongolia (07), Morocco (15, 03, 07), Netherlands (03, 99, 95), New Zealand (15), North Carolina-USA In TIMSS Advanced 2015, the Russian Federation participated with two populations of students for Advanced Mathematics —results for students in intensive courses (6 or more hours per

Note that a gap analysis across years cannot be combined with the Between Years or Between Groups and Years difference measures, so you will select the difference measure Between Groups, or, if you have selected percentiles as one of your statistics, you may choose Between Percentiles.

4.G. Regression Analysis

Regression Analysis is included in the IDE to test for the relationship between one or more independent variables with a dependent variable, with the independent variables controlling for each other. The type of analysis performed in this feature of the IDE is referred to as linear regression, with the dependent variable being a continuous variable selected at step 1.

Exhibit 28. Regression analysis link selection

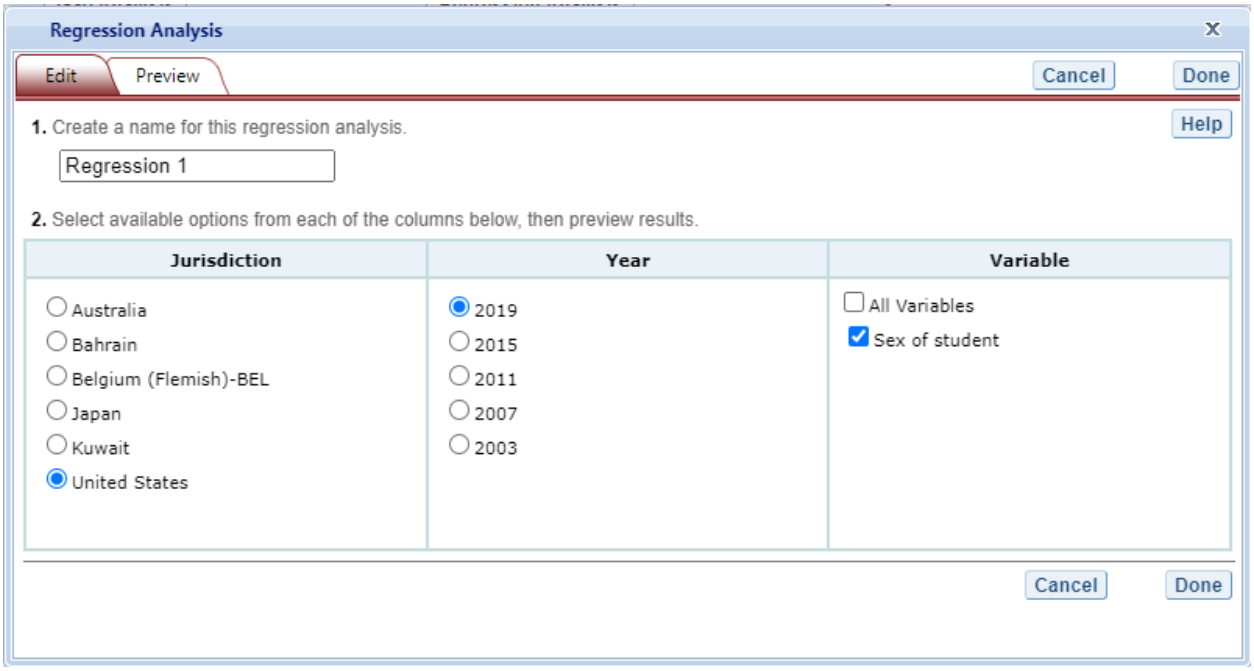


A regression analysis can be performed based on the selections that were made to build your table in the IDE by selecting the **Regression Analysis** button above the table (see Exhibit 28). The **Measure**, or continuous variable, that you selected in Step 1 and that is displayed in your table will automatically become your dependent variable for the regression analysis (in Exhibit 28 this is "TIMSS Mathematics Scale: Overall Mathematics"). Please note that continuous variables cannot be used as independent variables. The variables that you selected in Step 2 and that are displayed in your table will become your independent variable options for the regression analysis (in Exhibit 28 this is "Sex of student").

The general steps for running a regression analysis are as follows (see exhibit 29):

1. In the **Regression Analysis** pop-up window, you can enter a **Name** limited to 25 characters, using only letters, numbers, spaces, underscores, and hyphens (otherwise, by default, the test will be named "Regression 1").
2. Select the appropriate jurisdiction, year, and variable(s) for analysis. Please note that you may only choose one jurisdiction and year at a time, but you may choose up to 3 independent variables to be in your report. In order to use up to 3 variables, you must have already created and selected a cross-tabulated report (by selecting 3 variables in Step 2, **Select Variables**).
3. Click the **Preview** tab located in the upper-left corner to view the table format into which your output will be populated. In the Preview tab, an "X" denotes where the output will display.
4. Click the **Edit** tab in the upper-left corner of the screen if you wish to go back and make changes to the selections you made for running the analysis.
5. Click the **Done** button in the upper- or lower-right corner of the screen to run the regression analysis.

Exhibit 29. Regression analysis options



After you have clicked **Done**, your regression analysis output will load onto the screen (see exhibit 30). A 0-1 contrast coding is used to code the independent variable, where the first subgroup of the independent variable is the reference group. Using dummy-coded variables in a linear regression is useful for comparing each subgroup against a reference group. For example, in exhibit 30, if the subgroup "Female" is the reference group for the independent variable **Sex of student [ITSEX]**, the IDE creates a "Male" dummy variable (1 for respondents who answered "Male", 0 otherwise). Reference group "Female" is excluded from the regression analysis.

Exhibit 30. Regression analysis output

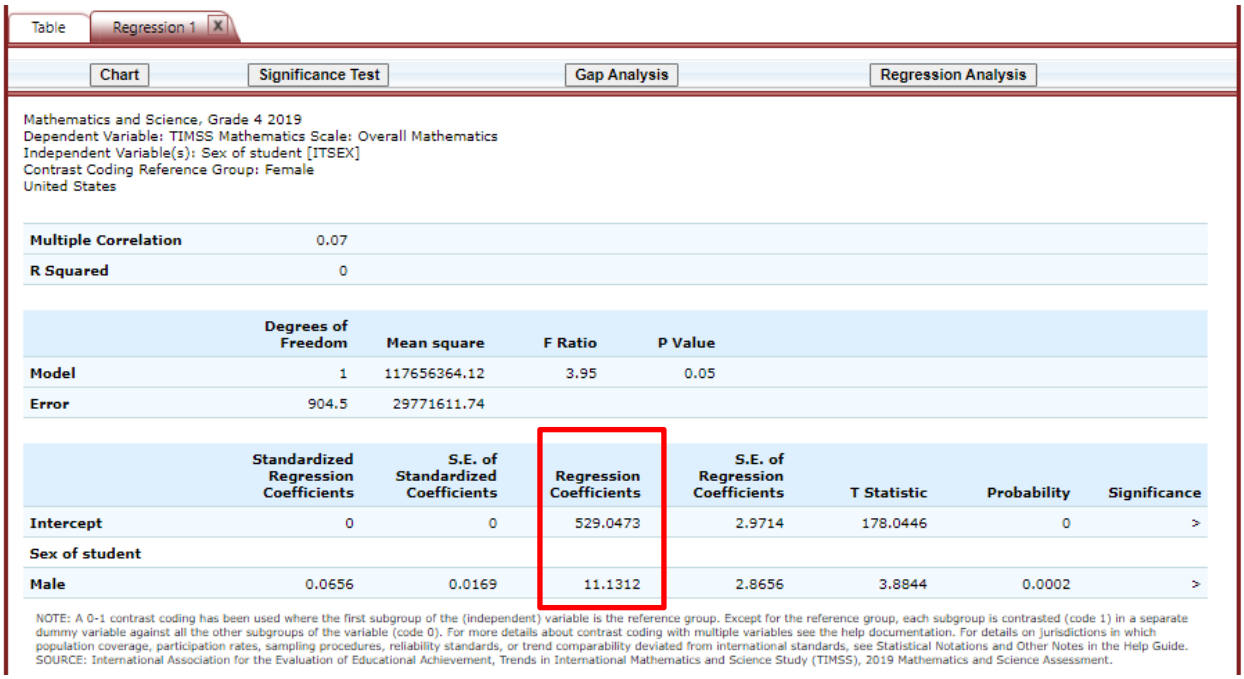


Table | Regression 1

Chart | Significance Test | Gap Analysis | Regression Analysis

Mathematics and Science, Grade 4 2019
Dependent Variable: TIMSS Mathematics Scale: Overall Mathematics
Independent Variable(s): Sex of student [ITSEX]
Contrast Coding Reference Group: Female
United States

Multiple Correlation	0.07
R Squared	0

	Degrees of Freedom	Mean square	F Ratio	P Value
Model	1	117656364.12	3.95	0.05
Error	904.5	29771611.74		

	Standardized Regression Coefficients	S.E. of Standardized Coefficients	Regression Coefficients	S.E. of Regression Coefficients	T Statistic	Probability	Significance
Intercept	0	0	529.0473	2.9714	178.0446	0	>
Sex of student							
Male	0.0656	0.0169	11.1312	2.8656	3.8844	0.0002	>

NOTE: A 0-1 contrast coding has been used where the first subgroup of the (independent) variable is the reference group. Except for the reference group, each subgroup is contrasted (code 1) in a separate dummy variable against all the other subgroups of the variable (code 0). For more details about contrast coding with multiple variables see the help documentation. For details on jurisdictions in which population coverage, participation rates, sampling procedures, reliability standards, or trend comparability deviated from international standards, see Statistical Notations and Other Notes in the Help Guide.
SOURCE: International Association for the Evaluation of Educational Achievement, Trends in International Mathematics and Science Study (TIMSS), 2019 Mathematics and Science Assessment.

Using the output from exhibit 30 you can compare the average mathematics achievement of 8th grade students who are female to the average mathematics achievement of 8th grade students who are female. When a single dummy-coded variable is used in a regression, the *intercept* is the mean of the reference group (e.g., 529.0473), and the *regression coefficient* is the difference between the mean of the reference group and the group identified (coded 1) with the dummy-coded variable (e.g., 11.1312 for students who are Male). Since the regression coefficients are presented with a standard error and a *t* value, these can be used to test whether a difference between means is statistically significant. Under the Significance column in the output you will see 3 possible signs: 1) < signifies a significant negative difference, 2) > signifies a significant positive difference, and 3) x signifies the difference is not statistically significant.

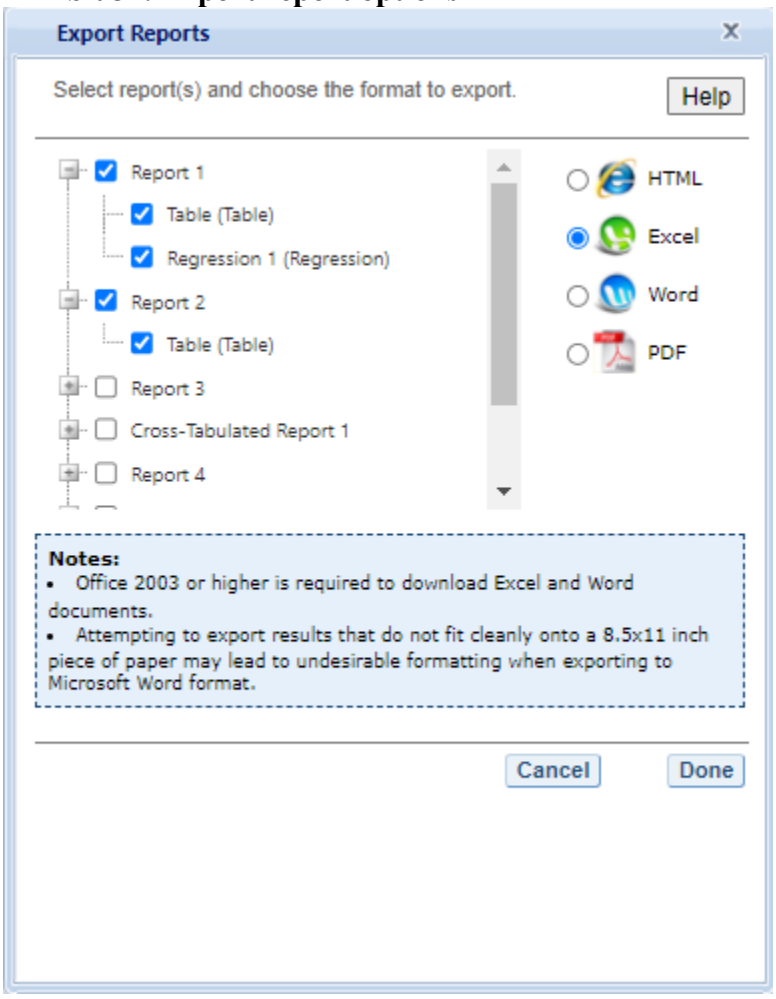
4.H. Export Reports

Click on the **Export Reports** button located on the right side of the **Build Reports** screen to save or print your tables, charts, and significance tests. The report names that appear in the **Export Reports** window are those that were checked off at step 3, **Edit Reports**.

Check the files you want to export, and select one of the file formats: **HTML** (print-friendly), **Excel, Word,** or **PDF** (see exhibit 31). All reports that you select at the same time will be exported in one file. In the Excel format, you will be able to increase the visible decimal places visible wherever more precision is available. Because there are many different operating systems in use, you may get an error message with Excel or one of the other formats. Usually, this will not affect your ability to export, so please wait for the software "errors" to resolve.

Charts or maps for each report will only be available on the **Export Reports** menu if you saved them by clicking **Done** when you finished each one. If a chart or map that you wish to save or print is grayed out (not available for selection), cancel the **Export Reports** tool, go back to your chart or map, and be sure to click **Done** on the last screen. After that, it will be available for export.

Exhibit 31. Export report options



V. TIMSS International Data Explorer (IDE) Definitions

This section describes the kinds of criteria and variables that are used to form data queries, as well as the kinds of data that are available and the statistical methods used to assess them.

These topics include the following:

- Criteria
  - Subject
  - Grade
  - Years
  - Measures
  - Jurisdictions
- Variables
- Statistics options
  - Averages
  - Percentages
  - Standard deviations
  - Percentiles
- Cross-tabulations
- Statistical notations and other notes
- Index Variables

1. Criteria

Each data query must include at least one selection from four criteria choices: subject, grade, measure(s), and jurisdiction(s). Shown below is an outline of these selection criteria followed by a brief description.

1. Subject:
   - Mathematics and Science
   - TIMSS Advanced: Advanced Mathematics
   - TIMSS Advanced: Physics
2. Grade:
   - Grade 4
   - Grade 8
   - End of High School
3. Years
   - 2019
   - 2015
   - 2011
   - 2007
   - 2003
   - 1999
   - 1995

4. Measure:
    - TIMSS scale scores
        - Mathematics: Grade 4
            - Overall scale
            - Subscales
        - Mathematics: Grade 8
            - Overall scale
            - Subscales
        - Science: Grade 4
            - Overall scale
            - Subscales
        - Science: Grade 8
            - Overall scale
            - Subscales
        - TIMSS Advanced: Advanced Mathematics: End of High School
            - Overall scale
            - Subscales
        - TIMSS Advanced: Physics: End of High School
            - Overall scale
            - Subscales
    - Student and Family Characteristics
    - Student Computer Use
    - Student Activities Outside of School
    - Student Perception/Valuing of Mathematics/Science
    - Teacher Background Characteristics, Formal Education, and Training
    - Teacher Perception of Mathematics/Science Teaching/Learning
    - Teacher Preparation and Collaboration
    - Teacher Activities Outside of School (when Mathematics and Science is selected)
    - Classroom Characteristics
    - Classroom Instruction
    - Role of Homework (Teacher)
    - School Characteristics
    - School Resources
    - Home Involvement (School)
    - School Climate and Safety

5. Jurisdiction:
    - Average of Countries
    - Average of the Selected Countries/Participants
    - Countries
    - U.S. Jurisdiction (when Mathematics and Science is selected)
    - Benchmarking Participants (when Mathematics and Science is selected)

Subject & Grade

TIMSS is a study of mathematics and science, and those are the subjects that can be selected. The Mathematics and Science subject can only be selected with either Grade 4 or Grade 8 options. TIMSS Advanced is a study of advanced mathematics and physics, and those are the subjects that can be selected. The TIMSS Advanced: Advanced Mathematics and the TIMSS Advanced: Physics options can only be selected with the End of High School grade option.

Measures

TIMSS focuses on overall mathematics and science knowledge, but within these broad categories a variety of subscales are available each year, including the environmental awareness subscale introduced in TIMSS 2019. Subscales are constituent parts of the composite subject scale for an assessment, and are specified by the assessment framework for that year. The weighted average of these is the basis for the mathematics and science composite scales, as described in the TIMSS and TIMSS Advanced frameworks.

Subscales are based on fewer observations than the composite scales and, as a result, may have larger standard errors.

In addition, there are a number of continuous variables other than scale and subscale scores that you may choose as a measure of analysis. These variables fall under different categories, such as Student and Family Characteristics and School Characteristics, and include variables such as age, teaching experience, and class size.

Jurisdictions & Years

Note that some country counts overlap because some countries participated at both the fourth- and eighth-grade levels. Also, benchmarking participants are currently available in the IDE for 2019, 2015, 2011, 2007, and 2003. So they are only listed below for those years.

In 2019, a total of 64 education systems participated in TIMSS at the 4th grade, while 46 systems participated at the 8th grade. Most of these education systems are member countries of the International Association for the Evaluation of Educational Achievement (IEA), the group that sponsors TIMSS internationally; a small number at each grade are nonmember subnational entities that joined TIMSS 2019 as “benchmarking participants”.

In 2015, there were 49 countries and subnational education systems, as well as 6 benchmarking participants that participated in TIMSS at the fourth-grade level. At the eighth-grade level, 38 countries and subnational education systems participated along with 6 benchmarking participants. Nine countries participated in TIMSS Advanced at the end of high school. Also, for TIMSS 2015, countries where students were expected to find the TIMSS assessments too difficult for their fourth- or eighth-grade students were given the option to assess students at a higher grade. Accordingly, one country (South Africa) administered the fourth grade assessment

to fifth grade students and two countries (Bostwana and South Africa) administered the eighth grade assessment to ninth grade students.

All off-grade participants (i.e., countries that tested students at grades other than four and eight) have the tested grade in parentheses within the IDE system. For example, South Africa's label is "South Africa (5)" and "South Africa (9)".

In 2015, Norway chose to assess fifth and ninth grades to obtain better comparisons with Sweden and Finland, but also collected benchmark data at fourth and eighth grades to maintain trend with previous TIMSS cycles. In 2019, Norway continued assessing at the fifth and ninth grade level and did not test grades four and eight.

Additionally, for TIMSS 2015, 7 countries and 1 benchmarking education system participated in the Numeracy assessment (newly developed TIMSS Numeracy assessment, a less difficult version of the fourth grade mathematics assessment), including Bahrain, Indonesia, Iran, Kuwait, Jordan, Morocco, and South Africa as well as Buenos Aires. Each of these participants gave the fourth-grade assessments in mathematics and science as well as the Numeracy assessment, except for Jordan and South Africa, which each participated exclusively in Numeracy.

In 2011, there were 52 countries and subnational education systems, as well as 7 benchmarking participantsthat participated in TIMSS at the fourth-grade level. At the eighth-grade level, 45 countries and subnational education systems participated along with 14 benchmarking participants. Also, for TIMSS 2011, countries where students were expected to find the TIMSS assessments too difficult for their fourth- or eighth-grade students were given the option to assess students at a higher grade. Accordingly, three countries administered the fourth grade assessment to their sixth grade students and the eighth grade assessment to their ninth grade students.

In 2007, there were 37 countries and subnational education systems, as well as 7 benchmarking participantsthat participated in TIMSS at the fourth-grade level. At the eighth-grade level, 50 countries and subnational education systems participated along with 7 benchmarking participants.

In 2003, there were 25 countries and subnational education systems, as well as 3 benchmarking participantsthat participated in TIMSS at the fourth-grade level. At the eighth-grade level, 48 countries and subnational education systems participated along with 4 benchmarking participants.

In 1999, there were 38 countries and subnational education systems that participated in TIMSS at the eighth-grade level. Fourth-grade students were not assessed in TIMSS 1999.

In 1995, there were 29 countries and subnational education systems that participated in TIMSS at the fourth-grade level. At the eighth-grade level, 46 countries and subnational education systems participated.

All listed jurisdictions can be selected for any analyses. However, the IDE contains a few U.S.-specific background variables (e.g., race/ethnicity) that, when selected, will not yield information for any non-U.S. jurisdictions.

2. Variables

In the TIMSS IDE, questions from three types of questionnaires (student, teacher, and school) as well as variables that are derived from background information are organized into categories that have shared characteristics and can be selected as a group when examining and generating tables.

Content category and subcategory titles may overlap, but specific variables appear only once in a subcategory. Use **Search** in the **Select Variables** step to locate variables.

Benchmarks

In addition to average scale scores, achievement results for TIMSS and TIMSS Advanced are reported using benchmarks. The benchmarks are internationally set levels based on collective judgments about what students should know and be able to do relative to the body of content reflected in each subject-area assessment. Using score cutpoints, the average scale scores are divided into four international benchmarks for TIMSS (*low*, *intermediate*, *high*, and *advanced*) and three international benchmarks for TIMSS Advanced (*intermediate*, *high*, and *advanced*).

TIMSS benchmark data for grades 4 and 8 are presented in a discrete format. This "discrete" format presents the percentage of students performing at each international benchmark: *at low*, *at intermediate*, *at high*, and *at advanced*, with an additional category created for those students scoring below the *low* benchmark (*below low*). (Note that there is simply too little information to know what students scoring below the *low* benchmark can actually do.)

TIMSS Advanced benchmark data are presented in a discrete format. This "discrete" format presents the percentage of students performing at each international benchmark: *at intermediate*, *at high*, and *at advanced*, with an additional category created for those students scoring below the *intermediate* benchmark (*below intermediate*). Please note that the TIMSS assessment is not designed to assess students scoring below the *intermediate* benchmark.

The following tables contain descriptions of the competencies displayed by students categorized at each benchmark in the 2019 TIMSS and 2015 TIMSS Advanced international assessments. Competencies are described separately for grade 4 mathematics, grade 8 mathematics, grade 4 science, grade 8 science, advanced mathematics at the end of high school, and physics at the end of high school. The table also displays score cutpoints for each benchmark.

Table 1. Description of TIMSS international benchmarks, fourth-grade mathematics: 2019

Benchmark	Cutpoint	Grade 4 mathematics skills and strategies
Low	**400**	• Have some basic mathematical knowledge. • Add, subtract, multiply, and divide one- and two-digit whole numbers. • Solve simple word problems. • Have some knowledge of simple fractions and common geometric shapes. • Read and complete simple bar graphs and tables.
Intermediate	**475**	• Apply basic mathematical knowledge in simple situations. • Compute with three- and four-digit whole numbers in a variety of situations. • Have some understanding of decimals and fractions. • Identify and draw shapes with simple properties. • Read, label, and interpret information in graphs and tables.
High	**550**	• Apply conceptual understanding to solve problems. • Apply conceptual understanding of whole numbers to solve two-step word problems. • Show understanding of the number line, multiples, factors, and rounding numbers, and operations with fractions and decimals. • Solve simple measurement problems. • Demonstrate understanding of geometric properties of shapes and angles. • Interpret and use data in tables and a variety of graphs to solve problems
Advanced	**625**	• Apply their understanding and knowledge in a variety of relatively complex situations and explain their reasoning. • Solve a variety of multistep word problems involving whole numbers and show an understanding of fractions and decimals. • Apply knowledge of two- and three-dimensional shapes in a variety of situations. • Interpret and represent data to solve multistep problems.

NOTE: Information about the procedures used to set the international benchmarks is available in *Methods and Procedures in TIMSS 2019*.
SOURCE: Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D.L., & Fishbein, B. (2020). TIMSS 2019 International Results in Mathematics and Science. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Table 2. Description of TIMSS international benchmarks, eighth-grade mathematics: 2019

Benchmark	Cutpoint	Grade 8 mathematics skills and strategies
Low	**400**	• Have some knowledge of whole numbers and basic graphs.
Intermediate	**475**	• Apply basic mathematical knowledge in a variety of situations. • Solve problems involving whole numbers, negative numbers, fractions, decimals, and ratios. • Have some basic knowledge about properties of two-dimensional shapes. • Read and interpret data in graphs and have some rudimentary knowledge of probability.
High	**550**	• Apply their understanding and knowledge in a variety of relatively complex situations. • Solve problems with fractions, decimals, ratios, and proportions. • Show basic procedural knowledge related to algebraic expressions and equations. • Solve a variety of problems with angles, including problems involving triangles, parallel lines, rectangles, and congruent and similar figures. • Interpret data in a variety of graphs and solve simple problems involving outcomes and probabilities.
Advanced	**625**	• Apply and reason in a variety of problem situations, solve linear equations, and make generalizations. • Solve a variety of fraction, proportion, and percent problems and justify their conclusions. • Understand linear functions and algebraic expressions. • Use their knowledge of geometric figures to solve a wide range of problems involving angles, area, and surface area. • Calculate means and medians, and understand how changing data points can impact the mean. • Interpret a wide variety of data displays to draw and justify conclusions, and solve multistep problems. • Solve problems involving expected values.

NOTE: Information about the procedures used to set the international benchmarks is available in *Methods and Procedures in TIMSS 2019*.
SOURCE: Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D.L., & Fishbein, B. (2020). TIMSS 2019 International Results in Mathematics and Science. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Table 3. Description of TIMSS international benchmarks, fourth-grade science: 2019

Benchmark	Cutpoint	Grade 4 science skills and strategies
Low	**400**	• Show limited understanding of scientific concepts and limited knowledge of foundational science facts.
Intermediate	**475**	• Show knowledge and understanding of some aspects of science. • Demonstrate some basic knowledge of plants and animals. • Demonstrate knowledge about some properties of matter and some facts related to electricity, and can apply elementary knowledge of forces and motion. • Show some understanding of Earth's physical characteristics.
High	**550**	• Communicate and apply knowledge of life, physical, and Earth sciences. • Communicate knowledge of characteristics of plants, animals, and their life cycles, and apply knowledge of ecosystems and of humans' and organisms' interactions with their environment. • Demonstrate knowledge of states and properties of matter and of energy transfer in practical contexts, and show some understanding of forces and motion. • Know various facts about the Earth's physical characteristics and show basic understanding of the Earth-Moon-Sun system.
Advanced	**625**	• Communicate their understanding of life, physical, and Earth sciences and demonstrate some knowledge of the process of scientific inquiry. • Demonstrate knowledge of characteristics and life processes of a variety of organisms. • Can communicate understanding of relationships in ecosystems and interactions between organisms and their environment. • Communicate understanding of properties and states of matter and physical and chemical changes. • Communicate understanding of Earth's physical characteristics, processes, and history and show knowledge of Earth's revolution and rotation.

NOTE: Information about the procedures used to set the international benchmarks is available in *Methods and Procedures in TIMSS 2019*.
SOURCE: Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D.L., & Fishbein, B. (2020). TIMSS 2019 International Results in Mathematics and Science. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Table 4. Description of TIMSS international benchmarks, eighth-grade science: 2019

Benchmark	Cutpoint	Grade 8 science skills and strategies
Low	**400**	• Show limited understanding of scientific principles and concepts and limited knowledge of science facts.
Intermediate	**475**	• Show and apply some knowledge of biology and the physical sciences. Students demonstrate some knowledge of characteristics of animals and apply knowledge of ecosystems. • Show some knowledge of the properties of matter, chemical changes, and a few physics concepts.
High	**550**	• Apply understanding of concepts from biology, chemistry, physics, and Earth science. • Apply knowledge of the characteristics of groups of animals, life processes in humans, cells and their functions, genetic inheritance, ecosystems, and nutrition. • Show some knowledge and understanding of the composition and properties of matter and chemical reactions. • Apply basic knowledge of energy transformation and transfer, electrical circuits, properties of magnets, light, sound, and forces. • Apply knowledge of Earth's physical features, processes, cycles, and history, and show some understanding of Earth's resources and their use.
Advanced	**625**	• Communicate understanding of concepts related to biology, chemistry, physics, and Earth science in a variety of contexts. • Classify animals into taxonomic groups. • Apply knowledge of cell structures and their functions. • Show some understanding of diversity, adaptation, and natural selection. • Recognize the interdependence of populations of organisms in an ecosystem. • Demonstrate knowledge of the composition of matter and the periodic table of the elements. • Use physical properties of matter to sort, classify, and compare substances and materials. • Recognize evidence that a chemical reaction has occurred. • Communicate understanding of particle spacing and motion in different physical states. • Apply knowledge of energy transfer and electrical circuits, can relate the properties of light and sound to

		common phenomena, and demonstrate understanding of forces in everyday contexts. • Communicate understanding of Earth's structure, physical features, and processes. • Demonstrate knowledge of the Earth's resources and their conservation.

NOTE: Information about the procedures used to set the international benchmarks is available in *Methods and Procedures in TIMSS 2019*.
SOURCE: Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D.L., & Fishbein, B. (2020). TIMSS 2019 International Results in Mathematics and Science. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Table 5. Description of TIMSS Advanced Mathematics international benchmarks, twelfth-grade: 2015

Benchmark	Cutpoint	Grade 12 advanced mathematics skills and strategies
Intermediate	**475**	• Demonstrate basic knowledge of concepts and procedures in algebra, calculus, and geometry to solve routine problems. • Apply and transform a formula to solve a word problem. • Determine a term in a geometric sequence and analyze a proposed solution of a simple logarithmic equation. Recognize a graph of the absolute value of a function and identify and evaluate composite functions. • Make connections between the sign of the derivative and the graph of a function. • Use knowledge of basic properties of geometric figures and the Pythagorean theorem to solve problems. Add and subtract vectors in coordinate form.
High	**550**	• Apply a broad range of mathematical concepts and procedures in algebra, calculus, geometry, and trigonometry to analyze and solve multistep problems set in routine and non-routine contexts. • Analyze and solve algebra problems, including problems set in a practical context. Solve problems requiring interpretation of information related to functions and graphs of functions. • Determine a sum of an arithmetic sequence and solve quadratic and other inequalities. Simplify logarithmic expressions and multiply complex numbers. • Have a basic understanding of continuity and differentiability. Analyze equations of functions and graphs of functions. Relate the graphs of functions to graphs and signs of their first and second derivatives. Show some conceptual understanding of definite integrals. • Use trigonometric properties to solve a variety of problems involving trigonometric functions and

		geometric figures. Use the Cartesian plane to solve problems, identify a vector perpendicular to a given vector, and prove that a quadrilateral given in the coordinate system is a parallelogram.
Advanced	**625**	• Demonstrate thorough understanding of concepts, mastery of procedures, and mathematical reasoning skills. Solve problems in complex contexts in algebra, calculus, geometry, and trigonometry. • Reason with functions to solve pure mathematical problems. Demonstrate facility with complex numbers and permutations and can find sums of algebraic and infinite geometric series. In calculus, demonstrate thorough understanding of continuity and differentiability. Solve problems about optimization in different contexts and justify their solutions. Use definite integrals to calculate the area between the curves. • Use geometric reasoning to solve complex problems. Use properties of vectors to express relationships among vectors. Use trigonometric properties including the sine and cosine rules to solve non-routine problems about geometric figures.

SOURCE: Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M. (2016). TIMSS Advanced 2015 International Results in Advanced Mathematics and Physics. Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/advanced/.

Table 6. Description of TIMSS Advanced Physics international benchmarks, end of high school: 2015

Benchmark	Cutpoint	Grade 12 physics skills and strategies
Intermediate	**475**	• Demonstrate some basic knowledge of the physics underlying a range of phenomena. • Use knowledge of forces and motion to solve problems, apply knowledge of heat and temperature to energy transfers, and of conservations laws to everyday and abstract contexts. • Show knowledge of electric fields, point charges, and electromagnetic induction. Apply knowledge of phenomena related to mechanical and electromagnetic waves and knowledge of atomic and nuclear physics to solve problems. • Interpret information in diagrams and graphs to solve problems, calculate a variety of physical quantities in a range of contexts, and evaluate statements to identify explanations for physical phenomena.

High	**550**	• Apply basic laws of physics in solving problems in a variety of situations. • Apply knowledge of forces and motion, communicate understanding of the laws of conservation of energy and momentum, and apply knowledge of heat and temperature to solve problems. • Apply knowledge of Ohm's Law and Joule's Law to electric circuits, solve problems involving charged particles in electric and magnetic fields, and apply knowledge of magnetic fields and electromagnetic induction to solve problems. Show understanding of phenomena related to electromagnetic waves and knowledge of nuclear reactions. • Interpret information in complex diagrams and graphs depicting abstract concepts, derive formulas and provide calculations of a variety of physical quantities in a range of contexts, evaluate explanations for physical phenomena, and provide brief explanations to communicate scientific knowledge.
Advanced	**625**	• Communicate understanding of laws of physics to solve problems in practical and abstract contexts. • Apply knowledge of the motion of objects in freefall, of heat and temperature, and of electrical circuits and electrical fields. • Communicate understanding of magnetic fields and of phenomena related to mechanical and electromagnetic waves, and demonstrate understanding of atomic and nuclear physics. • Design experimental procedures and interpret results, synthesize information in complex diagrams and graphs depicting abstract physics concepts to solve problems, provide multistep calculations of a variety of physical quantities in a range of contexts, draw conclusions about physical phenomena, and provide explanations to communicate scientific knowledge.

SOURCE: Mullis, I.V.S., Martin, M.O., Foy, P., and Hooper, M. (2016). TIMSS Advanced 2015 International Results in Advanced Mathematics and Physics. Retrieved from http://timssandpirls.bc.edu/timss2015/international-results/advanced/.

3. Statistics Options

The IDE reports TIMSS data with several statistics options:

- Averages
- Percentages
- Standard deviations
- Percentiles

Averages

This statistic provides the average value for a selected continuous variable or overall score for the combined scale (e.g., TIMSS Mathematics Scale: Overall Mathematics) or score for one of the subscales corresponding to the subject chosen (e.g., TIMSS Mathematics Scale: Algebra).

For the TIMSS and TIMSS Advanced assessment, student performance is reported on scales that range from 0 to 1,000, with the TIMSS scale centerpoint fixed at 500 and a standard deviation of 100.

Scale scores can show the standard error and are often accompanied by data showing percentages and standard deviations.

TIMSS scales are produced using item response theory (IRT) to estimate average scores for mathematics, science, advanced mathematics, and physics for each jurisdiction. IRT identifies patterns of response and uses statistical models to predict the probability of answering an item correctly as a function of students' proficiency in answering other questions. That is, student responses to the assessment questions are analyzed to determine the percentage of students responding correctly to each multiple-choice question and the percentage of students achieving in each of the score categories for constructed-response questions.

The TIMSS achievement scale was established in 1995 based on the combined achievement distribution of all countries that participated in TIMSS 1995. To provide a point of reference for country comparisons, the scale centerpoint of 500 was located at the mean of the combined achievement distribution. The units of the scale were chosen so that 100 scale score points corresponded to the standard deviation of the distribution. In the IDE, Average of Countries shows the TIMSS scale centerpoint when "All students" is selected at Step 2 as the independent variable.

Percentages

This statistic shows the percentage of students as a row percentage. For example, if the first column lists countries, then each country will display its own percentage distribution across its row. By default, percentage distributions do not include missing data, although there is an option to include them.

Standard deviations

The standard deviation is a measure of how widely or narrowly dispersed scores are for a particular dataset. Under general normality assumptions, 95 percent of the scores are within two standard deviations of the mean. For example, if the average score of a dataset is 500 and the standard deviation is 100, it means that 95 percent of the scores in this dataset fall between 300 and 700. The standard deviation is the square root of the variance.

Percentiles

This statistic shows the threshold (or cutpoint) score for the following:

- 10th percentile—the bottom 10 percent of students
- 25th percentile—the bottom quarter of students
- 50th percentile—the median (half the students scored below the cutpoint and half scored above it)
- 75th percentile—the top quarter of students
- 90th percentile—the top 10 percent of students

4. Cross-tabulations

Cross-tabulation is a method of combining separate variables into a single table. Normally, each variable has its own table. If you have selected two or three variables (not counting **All students**) and when you go to the **Edit Reports** step, you will automatically get one table for each variable (including one for **All students**); at the end of that list, you will get one cross-tabulation for the two or three variables selected.

If you have chosen four or more variables (not counting **All students**), you will get tables for each variable, but you won't get the cross-tabulation.

Be advised that if you go back to add another variable without subtracting one to keep the total under four, you will lose any edits you might have made to the cross-tabulation.

5. Statistical Notations and Other Notes

Statistical notations and other notes are found at the end of a data table, as applicable to that table:

- — Not available.
- † Not applicable. (For instance, the standard error for the statistic cannot be reported because the statistic does not meet reporting standards.)
- # The statistic rounds to zero.
- ‡ Reporting standards not met. (For instance, the sample size is insufficient to permit a reliable estimate.)

- NOTE: A general note pertains to any special characteristics of the data in the table. Population coverage, participation rates, sampling procedures, reliability standards, and trend comparability issues are addressed here. See details below.
- SOURCE: Source information is listed for all TIMSS and TIMSS Advanced data and should be cited when data are used in a publication or presentation.

Population coverage, participation rates, sampling procedures, or reliability standards deviated from international standards in the following jurisdictions (years in parentheses):

Grade 4:

Abu Dhabi-UAE (15)
Alberta-CAN (11, 07)
Australia (03, 95)
Austria (95)
Azerbaijan (11)
Bahrain (15)
Belgium (Flemish)-BEL (19, 15)
British Columbia-CAN (07)
Canada (19, 15)
Croatia (11)
Denmark (19, 15, 11, 07)
Dubai-UAE (19, 07)
England-GBR (19, 03, 95)
Florida-USA (15, 11)
Georgia (19, 15, 11, 07)
Hong Kong-CHN (19, 15, 11, 03)
Hungary (95)
Israel (95)
Italy (15)
Kazakhstan (19, 11, 07)
Kosovo (19)
Kuwait (15, 11, 95)
Latvia (19, 07, 95)
Lithuania (19, 15, 11, 07, 03)
Massachusetts-USA (07)
Minnesota-USA (07)
Mongolia (07)
Morocco (19, 15)
Netherlands (19, 15, 11, 07, 03, 95)
New Zealand (19)
North Carolina-USA (11)
Northern Ireland-GBR (19, 15, 11)
Norway (19, 11)
Ontario-CAN (19, 07)
Pakistan (19)
Philippines (19)
Portugal (19, 15)
Qatar (11)
Quebec-CAN (15, 07)
Russian Federation (19)
Saudi Arabia (19, 15)
Scotland-GBR (07, 03, 95)
Serbia (19, 15, 11)
Singapore (19, 15, 11)
Slovak Republic (19)
Slovenia (95)
South Africa (19)
Spain (15)
Sweden (15)
Thailand (95)
Turkey (19)
United States (19, 15, 11, 07, 03)

Grade 8:

Abu Dhabi-UAE (19)
Alabama-US (11)
Alberta-CAN (11)
Australia (95)
Austria (95)
Belgium (Flemish)-BEL (99, 95)
Belgium (French)-BEL (95)
British Columbia-CAN (07)
Buenos Aires-ARG (15)
California-USA (11)
Canada (15)
Chile (19, 15)
Colombia (95)
Colorado-USA (11)
Greece (95)
Georgia (19, 15, 11, 07)
Germany (95)
Honduras-Grade 9 (11)
Hong Kong-CHN (19, 07, 03, 99)
Indiana-USA (11)
Indonesia (03)
Iran, Islamic Rep. of (15)
Israel (19, 15, 11, 07, 03, 99, 95)
Italy (15)
Jordan (19, 15)
Kazakhstan (19)
Kuwait (19, 15, 95)
Latvia (99, 95)
New Zealand (19, 15)
North Carolina-USA (11)
Norway (19)
Oman (19, 15)
Ontario-CAN (11, 07)
Qatar (19, 15)
Quebec-CAN (19, 15, 07)
Romania (95)
Russian Federation (19, 11)
Saudi Arabia (19, 15)
Scotland-GBR (07, 03, 95)
Serbia (07, 03)
Singapore (19, 15, 11)
Slovenia (95)

Connecticut-USA (11)	Lithuania (15, 11, 07, 03, 99, 95)	South Africa (19)
Denmark (95)	Macedonia (03)	Sweden (19)
Dubai-UAE (19, 07)	Massachusetts-USA (11, 07)	Switzerland (95)
Egypt (19, 15)	Minnesota-USA (11, 07)	Thailand (95)
England-GBR (11, 07, 03, 99, 95)	Mongolia (07)	United States (19, 15, 11, 07, 03, 95)
Florida-USA (15, 11)	Morocco (19, 15, 03, 07)	Western Cape-ZAF (19)
Gauteng-ZAF (19)	Netherlands (03, 99, 95)	

TIMSS Advanced:

Lebanon (15)	Portugal (15)	United States (15)

Jurisdictions with a number after their name (for instance, Norway (5) and Norway (9)) have participated with a grade different than most other jurisdictions. The number in parentheses indicate the grade.

TIMSS Advanced assesses the advanced mathematics and physics knowledge and skills of students in their final year of secondary school who were taking or had taken courses in advanced mathematics and physics; the percentage of the age cohort enrolled in these courses and considered eligible for the TIMSS Advanced study varied across participating jurisdictions (ranging from 2% to 34% in 2015, and was 11% in the United States for advanced mathematics and 5% for physics).

In TIMSS Advanced 2015, the Russian Federation participated with two populations of students for Advanced Mathematics —results for students in intensive courses (6 or more hours per week) are reported separately from the results for other students from the Russian Federation taking courses that involve 4.5 hours per week.

In 2015, Armenia tested the same cohort of students as other countries, but later in the assessment year.

Data from these jurisdictions have issues that interfere with proper trend analysis: Armenia, Australia, Botswana, Canada, Finland, Indonesia, Israel, Italy, Kazakhstan, Kuwait, Latvia, Morocco, Norway, Philippines, Poland, Qatar, Saudi Arabia, Slovenia, South Africa, Syrian Arab Republic, Thailand, Turkey, and Yemen. For more details on trends with 2019 data, see Appendix A in the IEA TIMSS 2019 International Reports, which lists all countries with previous years of data not comparable for measuring trends to 2019, primarily due to countries improving translations or increasing population coverage.

See the IEA TIMSS 2015 International Reports, IEA TIMSS 2011 International Reports, the IEA TIMSS 2007 International Reports, and the IEA TIMSS 2003 International Reports for further information on specific trend issues in previous years.

Because of national-level changes in the starting age/date of school, 1999 data for Australia and Slovenia cannot be compared to 2003 data. Because of changes in the population tested, 1995

data for Israel, Italy, New Zealand, and South Africa and 1999 data for Morocco cannot be used for trend analyses. Because only Latvian-speaking schools were included in 1995 and 1999 data for Latvia, 1995 and 1999 data cannot be compared to 2003, 2007, and 2011 data. Data for Kuwait, Indonesia, Saudi Arabia, Morocco, and Turkey cannot be used for trend analyses because comparable data across years are not available.

The Syrian Arab Republic participated in TIMSS 2003 at the 8th grade and Yemen participated in TIMSS 2003 at the 4th grade, but because the characteristics of their sample are not completely known, they were shown in an appendix in the TIMSS 2003 International Report and their 2003 data are excluded from the IDE.

South Africa and Bulgaria participated in TIMSS 1995 at the 8th grade, but due to problems with their background data, their 1995 data are excluded from the IDE.

Linking teacher data

Results shown in the TIMSS IDE may differ slightly from those in the International Association for the Evaluation of Educational Achievement (IEA) TIMSS International Reports because of a slightly different procedure used in linking teacher data to the students. For Grade 4 and Grade 8, some students (mostly for Grade 8) may be assigned more than one science or mathematics teacher. Each teacher is asked to complete the teacher questionnaire, and the IEA TIMSS International Reports present results that are based on averaged data for these teachers. For the TIMSS IDE, if a student has more than one teacher for each subject, a student is linked to data from a single teacher for mathematics and science. The teacher is chosen randomly from the group of teachers (mathematics or science) who answered the questionnaire for each student.

Statistical comparisons

The alpha level to establish significance for all comparisons is .05. All comparisons within a jurisdiction, within the same year, are made using dependent samples *t*-tests. Comparisons between jurisdictions, and comparisons between years, even for the same jurisdiction, are made using independent samples *t*-tests. The TIMSS IDE also uses independent samples *t*-tests, between a country and a subnational entity that is participating as a benchmarking entity (for instance, in order to compare scores between the United States and Massachusetts or Minnesota, since they each are an independent sample).

Data suppression

Data suppression may be handled slightly differently in the TIMSS IDE and the IEA TIMSS International Reports. For the IDE, the Rule of 62 is applied to suppress data to avoid reporting results for groups about which little of interest could be said due to lack of power. The Rule of 62 is borrowed from the IDE's counterpart, the National Assessment of Educational Progress (NAEP) Data Explorer (NDE). This rule states that statistics for a group are suppressed if they are based on less than 62 cases. Statistics are: means, standard errors, standard deviations and a set of percentiles. The rule serves to assure a minimum power requirement to detect moderate differences at a nominal significance level (0.05). The minimum power is 0.80 and the moderate

effect size is 0.5 standard deviation units. A design effect of 2 is assumed to derive an appropriate complex sample standard deviation.

For information on creating and interpreting the TIMSS 2019 context questionnaire scales, see Methods and Procedures: TIMSS 2019 Technical Report.

6. Index Variables

In addition to scale scores representing performance in various subjects, TIMSS and TIMSS Advanced use indices derived from the student, teacher, and school questionnaires to contextualize results or estimate trends that account for demographic changes over time.

Information on indices for each year of administration can be found in the chapters referenced in the summary table below.

Study Name	Study Year	Links
TIMSS	2019	https://timss2019.org/international-database/downloads/T19_UG_Supp3-derived-context-variables.pdf
TIMSS	2015	http://timssandpirls.bc.edu/timss2015/international-database/downloads/T15_UG_Supplement3.pdf
TIMSS	2011	https://timssandpirls.bc.edu/timss2011/downloads/T11_UG_Supplement3.pdf
TIMSS	2007	https://timssandpirls.bc.edu/TIMSS2007/PDF/T07_UserGuide_Supp3.zip
TIMSS	2003	https://timssandpirls.bc.edu/timss2003i/PDF/t03_ug_s3.pdf
TIMSS	1999	https://timssandpirls.bc.edu/timss1999i/data/bm2_supplement3.pdf
TIMSS	1995	https://timssandpirls.bc.edu/timss1995i/database/UG1_Sup4.pdf
TIMSS Advanced	2015	https://timssandpirls.bc.edu/timss2015/advanced-international-database/downloads/TA15_UG_Supplement3.pdf
TIMSS Advanced	1995	https://timssandpirls.bc.edu/timss1995i/database/UG3_Sup3.pdf