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19 country/jurisdiction case
study

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DIRECTORATE FOR EDUCATION AND SKILLS

**When Practice Meets Policy in Mathematics Education: A 19
Country/Jurisdiction Case Study**

OECD Education Working Paper No. 268

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The OECD countries and jurisdictions participating in the study included: Australia, Estonia, Greece, Hungary, Israel, Korea, Latvia, Lithuania, the Netherlands, New Zealand, Norway, Portugal, Sweden. The OECD partner countries and economies participating in the study included: Argentina, Hong Kong (China), Kazakhstan. Additionally, for the following countries/economies, data were provided by independent researchers: Japan, Chinese Taipei, and the United States.

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Abstract

The OECD Future of Education and Skills 2030 (E2030) project's overall goal is that of looking to the future in terms of how school curricula should evolve given the technological advances and other changes that societies are now facing. Towards that end, the E2030 project centres on the idea that education needs to equip students with the knowledge, skills, attitudes and values they need to become active, responsible and engaged citizens.

Mathematics is considered a highly relevant subject for achieving the above stated goals, as such it requires further and more detailed analysis. As a result, it has been chosen as one of the E2030 project's subject-specific analyses.¹ The project has been named the Mathematics Curriculum Document Analysis (MCDA) study as per the request of participating countries. This working paper presents the findings of the MCDA study, which involves participants from 19 countries and jurisdictions.

¹ OECD countries and jurisdictions participating in the E2030 project: Australia, Belgium, Canada (British Columbia, Manitoba, Quebec, Saskatchewan), Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovenia, Spain, Sweden, United Kingdom (Scotland, Wales), United States; OECD partner countries and economies participating in the E2030 project: Argentina, China (People's Republic of), Costa Rica, Hong Kong (China), Indonesia, Kazakhstan, Lebanon, Russia, Saudi Arabia, Singapore, South Africa, United Arab Emirates, Viet Nam.

1. Introduction

The world in which we now live has become increasingly complicated, not just in terms of artificial intelligence (AI), computers, robotics and other forms of technology, but in terms of the ways in which we acquire the knowledge we need to live, work and respond to the complicated issues that now confront the world's population. Pandemics rage, economies plunge, and the occurrence of floods, hurricanes, tornadoes, and earthquakes increase exponentially in conjunction with climate change. Understanding these issues not only requires literacy in the sense of being able to comprehend what you read, but also requires *mathematics* literacy, such that a person is able to comprehend the necessary information that increasingly is numerical in nature and is often presented in graphical or tabular form. Such data include a background surrounding the following mathematics topics: fractions, rates, ratios, percentages and proportionality, which need to be interpreted correctly to understand the given issue.

Nothing illustrates the need for such mathematics literacy more than the current COVID-19 pandemic. Data are presented daily with respect to the number of cases, the number of hospitalisations, the number of deaths, and the number of vaccinations for different countries, regions and cities. People look to see how their region compares to others or use it to make decisions about whether to get vaccinated, when to wear a mask, or where to travel. To effectively use this information, a person must understand what the denominator of the percentage is in order to make reasoned comparisons among issues involving quantities, medicines, areas, deaths, etc.

Mathematics literacy includes knowledge of statistical procedures and statistical reasoning (based primarily on probability) that is increasingly more important in making informed decisions related to both the world of work as well as to personal decisions about health, family finances, schooling options, and filing tax returns, but also societal issues such as climate change, inflation rates, income tax policies and country budgets. For example, those who refuse to get vaccinated because they believe it is dangerous due to possible side-effects often fail to take into account that not getting the vaccination is not free of risk either. The more thoughtful response would be for the person to compare the probability of each. It is this type of statistical reasoning – a key component of mathematics literacy – that must be provided to all children by their schooling no matter their socio-economic status.

Mathematics education must continue to provide all children with the formal ideas, concepts, algorithms and procedures that define formal mathematics, but also focus on providing students opportunities to experience quantitative reasoning (including mathematics, statistics, geometric, and algorithmic reasoning) in the solution of real-world applications. Perhaps then, we would no longer hear our children say, “Why do I have to learn math? I’m never going to use it!”

2. Research questions

The OECD Future of Education and Skills 2030 (E2030) project's overall goal is that of looking to the future in terms of how school curricula should evolve given the technological advances and other changes that societies now are expected to face. Towards that end, the E2030 project centres on the idea that education needs to equip students with the knowledge, skills, attitudes and values they need to become active, responsible and engaged citizens.

Some 25 years ago, as a part of the Trends in International Mathematics and Science Study (TIMSS) 1995 project, a special curriculum study was conducted that coded over 40 countries' national curricula standards over grades 1-12 (Schmidt et al., 2001^[1]; Schmidt et al., 1997^[2]). Reports of that work characterised what topics were covered at particular grades as well as important characteristics of the curricula of the top-performing countries on the TIMSS assessment – such as focus, rigor, and coherence (Schmidt, Wang and McKnight, 2005^[3]). The study also included a very thorough and detailed document analysis of 4th and 8th grade mathematics textbooks (Schmidt et al., 1997^[2]).

Building on that opportunity, the first research question for the MCDA study is: how much and in what ways has the mathematics curriculum changed in terms of its coverage of formal mathematics over the first 8 grades of schooling. Clearly, technology has impacted the mathematics curriculum with the advent of high-powered computers and calculators. On one hand, the part of formal mathematics that is the basis for school mathematics has not changed. On the other hand, the inclusion or exclusion of particular topics or the amount of time allocated to those topics as indicated by the number of grades in which they are covered might have changed. In addition, other topics not covered in the past could have been added to the mathematics curriculum.

As the TIMSS-95 curriculum study showed, there were distinctive differences among countries in terms of their coverage of mathematics especially over the first eight grades which in most countries includes primary- and lower-secondary schooling. It is to these additions, deletions, and differences among countries that the first data collection is designed to address. Simply put the research question is – has the timing, focus and organisation of school mathematics changed over the last 25 years?

A related but second research question centres on the inclusion of topics that were not typically taught in the mathematics curriculum some 25 years ago. One example is the inclusion of formal statistics which other than defining mean, median and mode and various data displays, was not typically covered 25 years ago. There are several other topics such as non-linear models, measuring irregular geometric shapes, algorithmic reasoning, and human perspectives on the history of mathematics that fall into the same category. The research question is: to what extent and in what grades have these topics been added to curricula in the early part of the 21st century?

The third research question and the one most central to this working paper concerns the extent to which issues related to the development of mathematics literacy are now being included in countries' and jurisdiction's national curriculum standards and in the textbooks used by the teachers. The research question becomes – to what extent quantitative reasoning (including mathematics, statistical, algorithmic, and geometric reasoning), higher-order real-world applications, and 21st century competencies (knowledge, skills, attitudes and values) related to mathematics literacy have been added to the 19 countries' and jurisdiction's national standards and textbooks. Put another way, to what extent have these countries started to shift their mathematics curriculum toward real-world applications involving personal and societal issues given the increasing amount of information relative to these issues that are often presented in a data-oriented format. The purpose of this research is to provide an answer to the proverbial student question rephrased as follows, “am I ever going to use mathematics outside of school.”

The fourth research question centres on the 8th grade mathematics textbooks used by the 19 countries and jurisdictions. In mathematics, as shown originally in the TIMSS 95 study (Schmidt et al., 1997^[2]; Valverde et al., 2002^[4]), most mathematics classes around the world use textbooks as the medium for providing the exercises that students need to do in order to learn mathematics. Each country selected the most typically used textbook for analysis (four countries selected two). We focused on the exercises contained in the textbook as these are what provide the relevant opportunities to learn both formal mathematics and mathematics literacy. We categorised the exercises as to the nature of the opportunity provided. It was with those data that we used to examine the research question: to what extent do the 19 countries and jurisdictions provide teachers with textbooks that provide opportunities to learn both the formal topics of mathematics as well as those aspects related to mathematics literacy?

The fifth research question examines the degree of consistency between the emphasis found in the national/jurisdictional curriculum standards and that found in the textbooks used by each country/jurisdiction. Such a lack of consistency would likely have a negative effect on student learning. Finally, the last question centres on the curriculum decision making as done in the TIMSS-95 study (Schmidt et al., 2001^[1]). In other words, who makes what decisions? It examines the strength and breadth of curriculum decision making and whether countries vary in their patterns of making curricular decisions across 14 areas of the curriculum.

3. Methods

Document analysis procedures, developed originally in the TIMSS-95 study were used to code the national curriculum standards and at least one 8th grade mathematics textbook from the 19 countries and jurisdictions. The mathematics framework used in the current coding for formal mathematics was based on the TIMSS-95 framework but included both newly emerging mathematics topics as well as aspects related to the development of mathematics literacy.

The formal part of the framework adds topics that were not typically taught 25 years ago such as those related to statistics, non-linear models, computational methods, and irregular geometric shapes. Three dimensions were added to the framework characterising mathematics literacy: quantitative reasoning including mathematics, statistics, geometric, and algorithmic reasoning, higher-order real-world applications, and 21st century competencies (see **Annex A** for the Mathematics Curriculum Document Analysis (MCDA) Framework).

Representatives with mathematics backgrounds from each country were selected to do the coding of both the national standards documents in place in 2019 and at least one 8th grade textbook. Each country selected a commonly used textbook to be analysed (some countries chose two such commonly used textbooks). The training took place over five days in 2019 with the first two days consisting of training and testing to a criterion reflecting a high level of accuracy and interrater reliability. On days 3, 4 and 5 of the work sessions the coders, using the mathematics framework, first coded their curriculum standards as to the coverage of the formal mathematics content specified in the framework. The coding identified for each topic in the framework the grade or grades in which that topic was to be covered as specified in the standards. The coders were instructed to conduct “low-inference” coding by which we meant that the coders were not to use their own opinions or other information they might have as to whether or not the topics were covered at particular grades. They were to base their coding solely on the actual words used in the documents – in other words strictly a literal interpretation of the actual words used in the curriculum standards. This same principle was applied to the coding of the textbooks.

For the textbooks, parts of the same mathematics framework were used but the methodology was different. The first task for the coders was to go through the textbook, page-by-page counting the number of exercises included in each chapter or section of the textbook (depending on the country’s specific organisational textbook structure). The exercises were then coded as either computational or word problems. Any exercise that simply required a computation or the application of procedures or algorithms was coded as computational (including the solving of simple linear equations). Following the identification of the exercises as being computational, they were then further classified into two categories: straightforward computation or higher-order math-world applications. The country representatives also further sorted the word problems into two categories: simple word problems or higher-order real-world applications.

The coders were again instructed to strictly follow the following definitions of the two higher-order designations and to not read more into the exercises than was literally included in the exercise. Each definition is followed by several examples of that specific type of higher-order application (see Figures 1 – 6 below).

Higher-order real-world applications

Problems presented in a realistic, authentic, real-world context that require more than identifying the mathematics needed to arrive at an acceptable solution. The problem needs to simulate the real world in its messy, complex way requiring the student to conceptualise, organise, and extract the relevant information before formulating a mathematical equation representing the problem and then finding the correct answer. In fact, the latter may well be the least challenging and the least important in terms of the development of mathematics literacy.

Figure 1. Example of a real-world application exercise

The following article appeared on the website of *The Courier*.

Support to cut speed limits on country roads

NEW road safety research shows strong support for lower speed limits on country roads. The Monash University study of 4100 drivers showed the majority thought a speed limit of 100km/h for country roads was too high.

Seventy-five per cent believed there should be a reduction in speed limits on country roads from 100km/h to 90km/h and 92 percent considered a limit of 80km/h appropriate for gravel roads.

Only 14 percent of drivers said the 50km/h speed limit for local residential roads was too high.

However, there was some discrepancy between the views of city and country drivers to lower speed limits.

More than 80 percent of city drivers backed a 90km/h limit for country roads compared to 61.8

percent of country drivers. While 93.2 percent of city drivers and 88.5 percent of country drivers supported the 80km/h limit for gravel roads.

Senior research fellow, Dr. Bruce Corben of Monash University Accident Resource Centre said the difference in opinion could reflect a desire by country drivers to save travel time and greater familiarity with the roads.

He said lowering the speed limit was a way of reducing road trauma at a low cost.

"I think governments have been reluctant to move in that direction because there is a perception that the community is opposed to it."

"With these results is an opportunity to re-think what's the appropriate limit for rural roads."

Cathy Morris, *The Courier*, 01/04/2010

a) The article does not state the number of country and city drivers who were surveyed. Does this make a difference to any interpretation of the percentages stated?

b) The corresponding article in Victoria's *Herald Sun* indicated that 1217 of the drivers surveyed were Victorians. Do you think this is an unbiased or a biased survey? Give reasons for your answer.

c) If this survey was to be conducted Australia-wide, how could you ensure that each state and territory had a fair representation?

d) Further research at the website of the Monash University Accident Research Centre, the authors of the report, gave the following additional information: Victoria contributed 1217 (29.7%) of the respondents, South Australia 1175 (28.6%), West Australia 1135 (27.7%) and Tasmania 573 (14%) and the survey was web-based with individuals on existing data bases sent an invitation to participate in the survey. Does this additional information change your opinion about the survey in any way? Why or why not? Give a detailed answer to this question.

Source:(Pearson Australia, 2014_[5]), *Pearson Mathematics Student Book 8*, (1st edition)

Figure 2. Example of a real-world application exercise

To celebrate, Glenda invited 9 of her friends to go to lunch. The itemized total bill is \$800. All ten guests had a different main entrée and some type of drink. Four guests had a dessert and two other guests had appetizers. Suggest alternative ways the bill could be divided and explain your reasoning and the assumptions you made for each alternative.

Source: Adapted from (Pearson Australia, 2014_[5]), *Pearson Mathematics Student Book 8*, (1st edition)

Figure 3. Example of a real-world application exercise

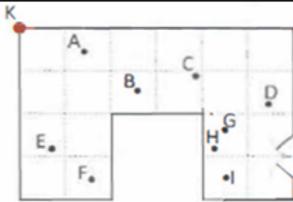
	Rate	0-4 Years Old	4-8 Years Old	8-14 Years Old
Hungarian Hotel	7500 Forint	Free	50% Reduction in regular rate	70% Reduction in regular rate
Austrian Hotel	30 Euro	Free	40% Reduction in regular rate	75% Reduction in regular rate

The five-person Gardener family goes skiing in Austria. They're getting ready together with dad, mom, 4.5-year-old Geri, 9-year-old Ama and 11-year-old Dia. The ski slope has already been selected and ski passes were paid in advance via the Internet because it was cheaper. Now they're looking for a place to stay. One option is to stay in Hungary and drive 100 km a day (50 km to the ski slope and then back to the hotel). The other possibility is to stay in an Austrian hotel next to the ski slope. Prices are included in the table:

- Convert Austrian prices in Euros into Forints. (Check the internet for how many Forints you can convert to Euros!)
- Calculate the one night's hotel stay for a family of 5 people.
- How much does it cost to go 100km a day if the car consumes 7.6 litres of petrol per 100km. (Check current gasoline prices!)
- Calculate how much a 5-day, 4-night stay would cost the Gardener family in Hungary and Austria. Add the extra petrol cost to the accommodation in Hungary.
- How much would this tour cost your family per night?

Source:(Eszterhazy Karoly University, 2018^[6]), *Matematika 8*.

Figure 4. Example of a real-world application exercise



A store owner upgrades their security system and decided to add one more security camera. The camera is able to rotate in any direction 360 degrees. The camera was mounted at point K. In the plan, points are marked by buyers.

- Which buyers are not visible to the surveillance camera? Make an appropriate drawing to justify your answer.
- The store owner claims that the camera is capable of tracking 85% of the store's area. Is this statement true?
- Compare the solutions. What questions did you have when looking for a solution? The shop owner began to wonder if placing the camera anywhere else on the wall would make it possible to see a larger area of the store.
- Propose your offer to your classmates and tell them your thought process to get this solution. What mathematical strategies did you use?
- Where would you place the camera if you wanted to reduce theft? Explain your reasoning.

Source: (France, Lace and and Slokenberga, 2017^[7]). *Matematika 8 Klasei*, Lielvārds.

Higher-order math-world applications

Problems are situated only within mathematics (not the real world) but require the student to conceptualise, organise, extract the relevant information, and develop a logical approach before finding a solution. A good example is a geometric proof where the goal is to formally construct a deductive proof using the relevant information and then develop a logical approach to solving the

problem. One key aspect of such solutions is the recognition of relevant theorems and axioms and how they can be combined logically in a proof.

Figure 5. Example of a math-world application exercise

Show that $\left(\frac{1}{x}\right)^m = \frac{1}{x^m}$ is implied by $\left(\frac{x}{y}\right)^n = \frac{x^n}{y^n}$ when $m > 0$, and explain why $\left(\frac{1}{x}\right)^m = \frac{1}{x^m}$ continues to hold even when $m = 0$.

Source: (Great Minds, 2015^[8]) Eureka Math! Grade 8 Modules 1 and 2 (Student Edition).

Figure 6. Example of a math-world application exercise

A coin is tossed, and a die is rolled.

- 1) Use a two-way table to define the sample space.
- 2) From the table, determine the probability of obtaining:
 - a) a tail,
 - b) a tail and a multiple of 3,
 - c) a head and number less than 4,
 - d) a tail and a head.
- 3) Use set theory and the associated formal probability theorems in solving each of the above.

Source: Author's own work

Figure 7. Example of a math-world application exercise

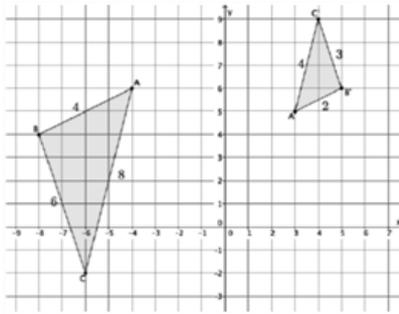
Prove statements a) and b) with algebraic expressions.

- a) If we add a number divisible by 10 to a number divisible by 15, the sum is always divisible by 5.
- b) If we take a number divisible by 18 from a number divisible by 27, the difference is divisible by 9.

Source: (Eszterhazy Karoly University, 2018^[6]), Matematika 8

Figure 8. Example of a math-world application exercise

The goal is to show that if $\triangle ABC$ is similar to $\triangle A'B'C'$, then $\triangle A'B'C'$ is similar to $\triangle ABC$.
Symbolically, if $\triangle ABC \sim \triangle A'B'C'$, then $\triangle A'B'C' \sim \triangle ABC$.



a) First, determine whether or not $\triangle ABC$ is in fact similar to $\triangle A'B'C'$. (If it isn't, then no further work needs to be done.) Use a protractor to verify that the corresponding angles are congruent and that the ratios of the corresponding sides are equal to some scale factor.

b) Describe the sequence of dilation followed by a congruence that proves $\triangle ABC \sim \triangle A'B'C'$

c) Describe the sequence of dilation followed by a congruence that proves $\triangle A'B'C' \sim \triangle ABC$.

d) Is it true that $\triangle ABC \sim \triangle A'B'C'$ and $\triangle A'B'C' \sim \triangle ABC$? Why do you think this is so?

Source: (Great Minds, 2015^[9]), Eureka Math! Grade 8 Modules 3,4, and 5 (Student Edition).

In both the real-world and the math-world applications, the designation of higher-order has a similar meaning. In the case of the real-world as specified above, it demands the use of quantitative reasoning and having to not only think through which of the information provided is relevant, but also how to set up the problem mathematically. The actual mathematics computation is perhaps the least important element of the exercise.

Higher-order real-world applications (HoRw) do not come with only the relevant information and the specific required numbers you need in order to find the solution as is typical with word problems. HoRw applications come from a messier context in which there may be multiple numbers, multiple facets defining the situation, and even multiple solutions to the problem. Part of the task associated with the exercise is to discern what is relevant and what is not and how to formulate the problem in mathematical terms thus leading to the solution.

Similarly in the higher-order math-world applications (HoMw) a student must actually reason their way through multiple steps to figure out what mathematics to put together in order to find the solution to the stated problem. These are the types of items that demand at least one of the four types of reasoning: mathematics, statistics, geometric, or algorithmic.

The higher-order real-world exercises were subjected to one additional coding to assure consistency in comparisons across countries. The set of higher-order items that were identified by the country coders were further classified as to whether they met the definition of higher-order by two of the researchers themselves – both of whom have degrees in mathematics and statistics.

Both the national curriculum standards and the exercises identified as higher-order real-world applications were coded with respect to the three dimensions related to mathematics literacy – in other words the standards and the higher-order exercises were both coded as to whether they included quantitative reasoning and 21st century competencies. The curriculum standards were additionally coded as to whether and to what extent they included higher-order real-world applications. In the case of the 21st century competencies, seven were identified which we hypothesised were likely to be related to the mathematics curriculum (see Table 1).

In the case of the national curriculum standards, each of these three framework dimensions were not only coded so as to indicate their presence in the standards, but also for the degree of emphasis that

they received. The size of the emphasis code also reflected the degree to which each of the three framework dimensions were formally integrated with specific mathematics topics and specific grade levels. If the whole mathematics section of the national curriculum standards only mentioned a framework dimension once it would produce the lowest score (1), the only lower score (0) indicates there was no mention of the framework dimension at all.

Table 1. 21st Century Competencies Related to Mathematics Education

21st Century Competencies	Definitions
Communication	Communication requires individuals to be both knowledgeable in the mathematics substance involved in the communication as well as being knowledgeable about the audience for the communication and how best to craft the mathematics substance of the communication for the targeted audience.
Creativity	Creativity is defined as the ability to approach problems or situations with fresh perspectives resulting in seemingly unorthodox solutions. Creative thinking is the process through which one develops novel ideas, approaches or information (Mumford, Medeiros and Partlow, 2012 ^[10]). Creativity has been central to the evolution of the discipline of mathematics, as innovations in the rules and methods have brought us from its origins to the present-day practice of the discipline. From complex mathematics problems to higher-order real-world applications, creativity becomes essential.
Critical thinking	Critical thinking is defined as questioning and evaluating ideas and solutions (OECD, 2016 ^[11]). Critical thinking is a higher-order cognitive skill and includes inductive and deductive reasoning, making correct analyses, inferences and evaluations (Facione, Giancarlo and Facione, 1995 ^[12] ; Liu, Frankel and Roohr, 2014 ^[13]). Mathematics requires critical thinking when individuals must draw on knowledge, logic and plausible reasoning to make sense of and form a response or solution to a problem.
Information use	Information use in mathematics increasingly demands digital literate students. They must have the knowledge, understanding, skills and dispositions to use digital devices effectively and appropriately in both the world of mathematics, but especially in higher-order real-world applications.
Reflection	Reflection is the ability to take a critical stance before deciding, choosing and acting, such as, by stepping back from the assumed, known, apparent, and accepted, comparing a given situation from other, different perspectives, and looking beyond the immediate situation to the long-term and indirect effects of one's decisions and actions. Mathematics problems calling for reasoning and argument benefit from reflection.
Resistance/ resilience	Resilience is the disposition required to maintain effort or interest in an activity in the face of difficulties encountered, the length of time or steps involved or when opposed by someone or something. Resilience is the process of adapting well in the face of adversity, trauma, threats or significant sources of stress (American Psychological Association, 2017 ^[14]).
Systems thinking	Systems thinking is the ability to think about a system as a whole, rather than only considering the parts individually (Sternan, 2000 ^[15]). The student is able to situate the mathematics problem or the real-world application in a well-defined context and articulate the relationships among the various variables defining the mathematics problem or the higher-order real-world application.

What created a larger emphasis code for a framework dimension was a more frequent mention of it and even more so the number of times the framework dimension was integrated with a specific mathematics topic in a particular grade. In short, the more frequently the framework topic is mentioned in connection with specific topics in specific grades, the larger the measure of emphasis.

The same basic approach was taken with textbooks. The coding procedure described above classified the exercises as higher-order applications or not. Those identified as higher-order real-world applications were further coded as to the type of quantitative reasoning required and for the inclusion of any of the seven 21st century competencies identified in Table 1.

The figures and graphics outlined in the following section present in detail data indicating the formal mathematics content and the three additional dimensions related to mathematics literacy as they occurred in both the countries' national curriculum standards document and in a lower-secondary

textbook. Those data reflect decisions made by the country with respect to what it is that schools should teach in mathematics. The final question we address is who makes the various decisions related to curriculum. To address this question, we developed a form that lists 4 major areas of curriculum including: the goals of the system, the content to be included in the instruction, the instructional methods used in the teaching of mathematics, and development of the framework and assessment items both within the classroom and for the country as a whole. Each of these four categories, had between two and five sub-areas identified.

The country representative was asked for each of the 14 aspects of curriculum, to identify the amount of influence each of five loci had on that particular decision. The five loci represented different levels of the system with correspondingly different actors. These included: the national centre (often referred to as the Ministry of Education or Secretary of Education), the regional school office in charge of the curriculum, the school headmaster or principal or other school-level official in charge of the curriculum, a formal committee of the teachers chosen for the activity, and finally the individual teacher his or herself.

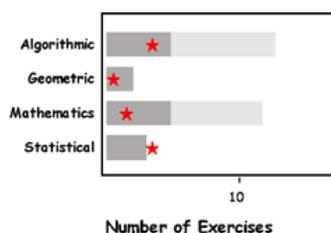
For each curriculum area and locus of control, the country representative was asked to indicate the degree of influence that the particular office or individual had. They responded on a four-point scale indicating: no formal control; advice and recommendation; constrain or veto/modify recommendation; and final authority or approval.

We have chosen to present the results of the analyses as country reports. We present the data graphically to make them more accessible to those outside of the area of mathematics such as education leaders, government authorities, and policy analysts. The next section of this report provides details regarding each of the figures in the report and illustrates the interpretation that goes with each of the graphics found throughout the report.

4. Information Relative to the Various Graphics and Tables Presented throughout the Results Section

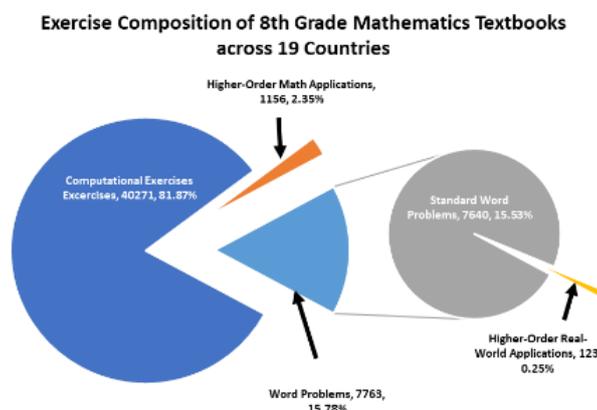
4.1. Guide to the Mathematics Curriculum Analysis Displays

Figures 1-4 and 7-8



Notes: The light grey bars show the Range for each of the seven sets of variables. Figure 1 includes the number of topics covered at each grade level. Figures 2-4 indicate the intensity of effort in the standards associated with reasoning and 21st century competencies. Figures 2-4 include and represent all grades. Figures 7-8 show the number of Higher-Order Real-World textbook exercises that were classified as reasoning and 21st century competencies. The dark grey bars show the Inter-Quartile Range (25th percentile-75 percentile) found within the number of textbook exercises across the 19 countries and jurisdictions. The stars show the number of higher-Order Real World exercises that are presented in each country's/jurisdiction's textbook with the specific type of Quantitative Reasoning and the specific Competencies. For Figure 1, the counts for each grade are defined in terms of the MCDA Mathematics Framework.

Figures 5-6. Textbook composition



Notes: Figure 6 shows the results of the classification of all of the exercises found in a country’s/jurisdiction’s eighth-grade mathematics textbook. Figure 5 is the classification of the said exercises cumulatively across the 19 participating countries’/jurisdiction’s textbooks. For countries/jurisdictions that analysed two textbooks, they are included in Figure 5 (and 6) as an average, not separately (but each textbook is also reported separately at the end of the individual country/jurisdiction report) in that way Figure 5 represents the distribution of type of exercises with country/jurisdiction as the unit of analysis. The classification includes three categories which sum to 100%: Computational Exercises, Higher-Order Math Applications, and Word Problems. The additional pie shows the two types of problems – Standard Word and Higher Order Real World – that make up Word Problems.

Figure 9. Roles played in curriculum decision making at five education levels

Decision Role:	Locus of Curriculum Decisions			
	National	Regional	School	Teachers Collectively / Teachers Individually
no formal role (0)				
Advice & recommendations (1)				
Consult, with/without recommendations (2)				
Final authority or approval (3)				
Goals for Pupils				
By overall system completion				
For intermediate stages				
For differentiated program types				
To be reached in a given grade				
To apply for a specific school				
Content of Instruction				
Course (grade level) offerings				
Student course assignment rules				
Course content (syllabi)				
Auxiliary content outside of syllabi				
Methods of instruction				
Textbook selection				
Instructional methods/techniques				
Examinations				
Content of examinations				
Examination performance standards				
School Examination standards				

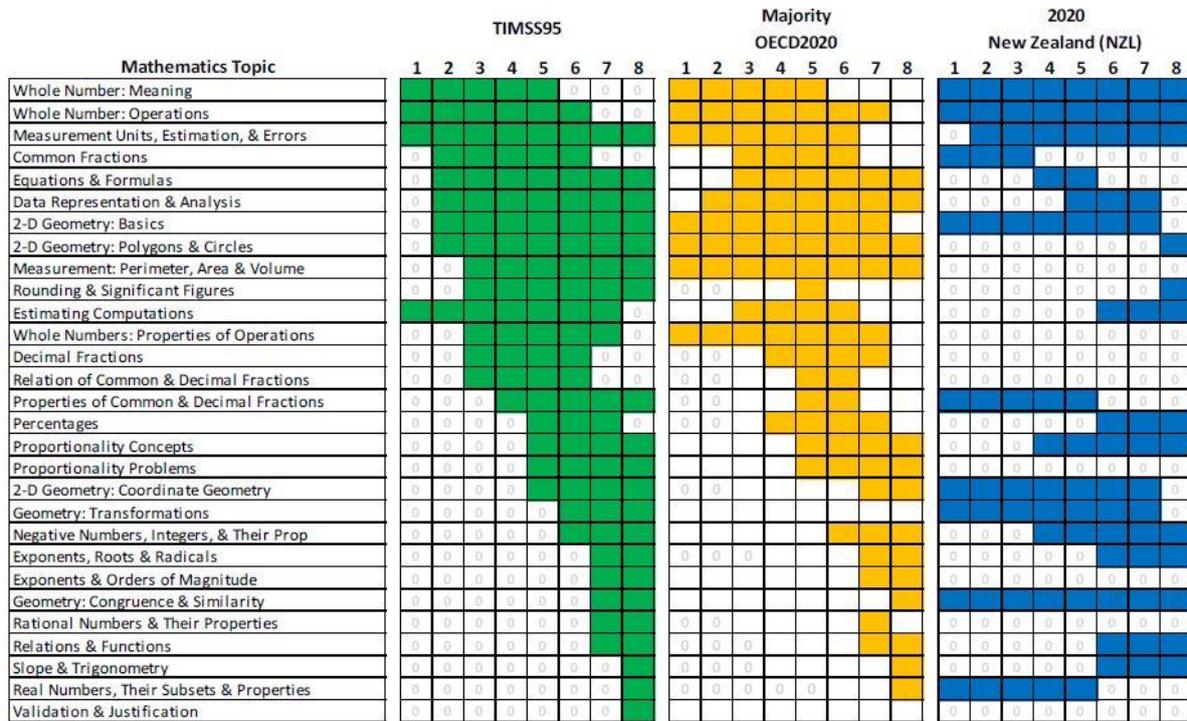
Notes: Country/jurisdiction curriculum decision making involves individuals from different levels of the educational system (the five levels, e.g. national, define the columns in the above figure) having different levels of responsibility as a part of the general decision-making process. The four different types of responsibilities are included in the key at the top of the display and are numbered from 0 (no responsibility) to 3 (final authority/approval). Curriculum decisions involve multiple facets such as content, examinations, etc. We have identified 13 subcategories of the four facets which define the rows of the above figure. Each country/jurisdiction was asked to choose the type of responsibility that each level of the education system has for each facet.

Figures 10 and 11. Average influence of each educational level on four general curriculum facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for Pupils	60%	0%	87%	87%	87%
Content of Instruction	25%	0%	100%	100%	100%
Methods of instruction	0%	0%	100%	100%	100%
Examinations	100%	0%	22%	22%	22%

Notes: Transforming the four levels of responsibility as defined in Figure 9 to their numerical equivalent (i.e., no formal role is coded as 0, final authority/approval is coded as 3, we then calculated for each combination of education level and the four broad curriculum facets. The results are displayed in Figure 10. The average over all 19 countries and jurisdictions is presented in Figure 11.

Figure 12. Comparing the patterns of topic coverage over 25 years



Notes: The above juxtaposed three figures characterise topic coverage for each of grades 1-8. The rows represent the set of topics typically covered world-wide in mathematics while the columns indicate grade level. The green cells indicate coverage by two-thirds of the top achieving countries in TIMSS-95 – termed TIMSS A+ (Schmidt, Wang and McKnight, 2005^[3]). Orange cells indicate coverage by a simple majority of the 19 countries and jurisdictions in the OECD2020 study (10 or more). Blue cells indicate specific country/jurisdiction coverage (Figure 12).

Figure 13. Moving into the future: Coverage of topics defining a new literacy

	TIMSS95								Majority OECD2020								2020 New Zealand (NZL)									
Binary Arithmetic &/or Other Number Bases	0	0	0	0	0	0	0	0	0	0	0	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0
Computational Thinking: Algorithmic Mathematics	0	0	0	0	0	0	0	0	2	2	2	3	2	1	2	3	0	0	0	0	0	0	0	0	0	
Computer Coding (including both formal and inform	0	0	0	0	0	0	0	0	0	0	0	1	2	2	3	3	0	0	0	0	0	0	0	0	0	
Vectors and Matrices	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0	0	0	0	0	0	0	
Geometric approximation for irregular shapes	0	0	0	0	0	0	0	0	0	0	0	1	1	4	4	5	0	0	0	0	0	0	0	0	0	
Trigonometric equations and identities	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	0	0	0	0	0	0	0	0	0	
Other Equations and Inequalities (quadratics, poly	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	14	0	0	0	0	0	0	0	0	0	
Exponential Functions	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	6	0	0	0	0	0	0	0	0	0	
Other non-Linear Functions	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	12	0	0	0	0	0	0	0	0	0	
Linear, non-Linear, and Exponential for modeling gr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	8	0	0	0	0	0	0	0	0	0	
Definition of discrete probability and related theor	0	0	0	0	0	0	0	0	2	2	3	4	5	6	9	9	0	0	0	0	0	0	0	0	0	
Conditional probability and Independent Events	0	0	0	0	0	0	0	0	0	0	0	1	0	1	3	4	0	0	0	0	0	0	0	0	0	
Discrete and continuous random variables and the	0	0	0	0	0	0	0	0	0	0	0	1	1	1	2	2	0	0	0	0	0	0	0	0	0	
Inferential Statistical Topics	0	0	0	0	0	0	0	0	1	1	1	2	3	3	7	7	0	0	0	0	0	0	0	0	0	
Populations and their parameters	0	0	0	0	0	0	0	0	0	0	0	1	1	1	3	5	0	0	0	0	0	0	0	0	0	
Sampling from the Population/Random Sampling	0	0	0	0	0	0	0	0	1	1	1	1	1	1	3	5	0	0	0	0	0	0	0	0	0	
Estimation of parameters (e.g., mean, variance)	0	0	0	0	0	0	0	0	0	0	0	1	2	2	5	3	0	0	0	0	0	0	0	0	0	
Definition of Correlation Coefficient	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	
Relationship among categorical variables (Cor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
Relationship involving continuous variables (f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
Historical Perspectives	0	0	0	0	0	0	0	0	1	1	2	2	2	2	3	3	0	0	0	0	0	0	0	0	0	
Sampling distributions, standard errors, Confidence intervals, Hypothesis testing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Relationship involving categorical and continuous variables (ANOVA)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Notes: Like Figure 12, the rows define a set of topics and the columns grades 1-8. What is different in this table is that these are mathematics topics that have not been commonly covered across the world in grades 1-8. These topics were identified by consultants coming from four major sectors of the world’s economy: financial, medical, communications, and high-tech manufacturing, as well as mathematicians and mathematics teachers. The three juxtaposed figures correspond to those in Figure 12. The difference is that a colored cell indicates at least one country/jurisdiction intends to cover that topic at that grade. The third set of data included represents, as in Figure 12, the results for a specific country/jurisdiction. In that case, the colored cell means that the country/jurisdiction intended coverage of that topic at that grade. The absence of green cells indicates no coverage of any of these topics in TIMSS95. For the OECD2020 results the orange-colored cell together with the imbedded numbers indicate the number of countries and jurisdictions (of 19) currently covering the topic.

5. Results: Country/jurisdiction reports

This section contains the individual reports for each of the 19 countries/jurisdictions in the study. See Table 2 below for the specific page numbers for each country/jurisdiction.

Table 2. Country/jurisdiction reports

Country/jurisdiction	Page numbers
OECD	
Australia	19-26
Estonia	27-30
Greece	31-34
Hungary	35-38
Israel	39-42
Japan	43-46
Korea	47-50
Latvia	51-56
Lithuania	57-60
Netherlands	61-64
New Zealand	65-68
Norway	69-76
Portugal	77-80
Sweden	81-84
United States	85-90
Partner	
Argentina	91-94
Chinese Taipei	95-100
Hong Kong (China)	101-106
Kazakhstan	107-110

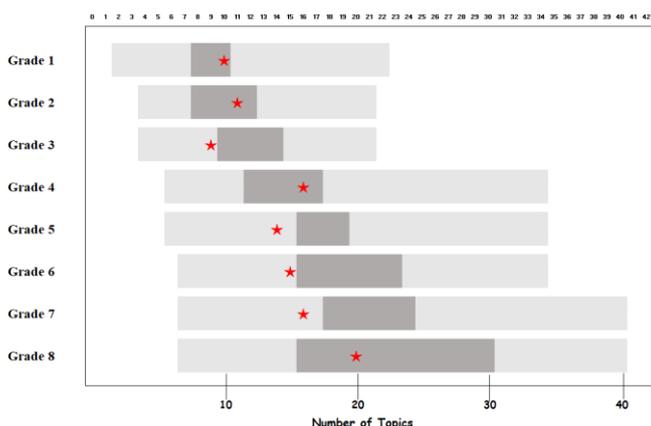
Australia

Curriculum Standards

Index

- Page 1 portrays the composition of the country's/ jurisdiction's curriculum standards.
- Page 2 portrays the composition of a representative 8th grade mathematics textbook.
- Page 3 portrays the curriculum decision making authority within the educational system.
- Page 4 portrays the mathematics topic coverage of the country's/jurisdiction's curriculum standards across grades 1-8 in comparison to the 1995 TIMSS A+ benchmark curriculum.

Figure 1. Number of Topics to be Covered at each Grade



Notes for Figure 1:

- Light Grey bars show the range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
- Dark Grey bars show the Inter-Quartile Range (25th to 75th Percentile) found within the broader range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
- The stars show the number of topics that the country/ jurisdiction intended to cover at each of the grades.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

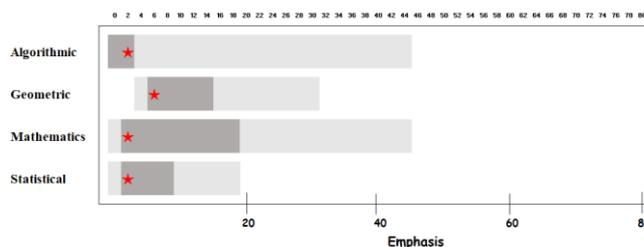


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

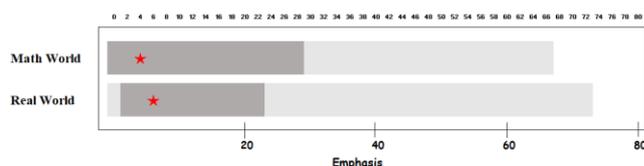
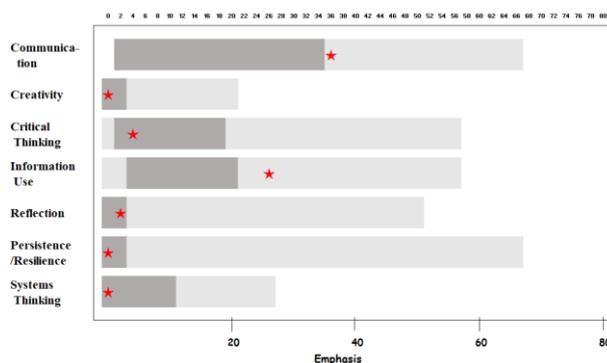


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

- The structure of these figures is the same as described in the note for Figure 1.
- The variable represented in each of these figures is a measure of the intensity/emphasis that the curriculum standards for each of the countries/jurisdictions placed on each of these three dimensions of mathematics literacy.
- The measure is defined with 0 indicating no mention of the dimension and 1-75 indicating the degree of emphasis (see methods section of the introduction to the country/jurisdiction reports).

8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

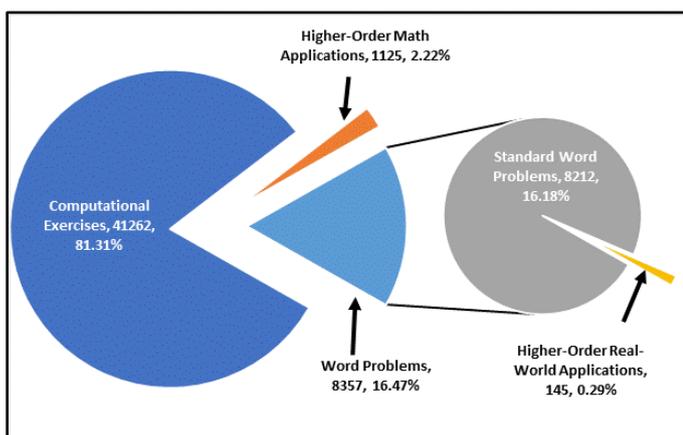
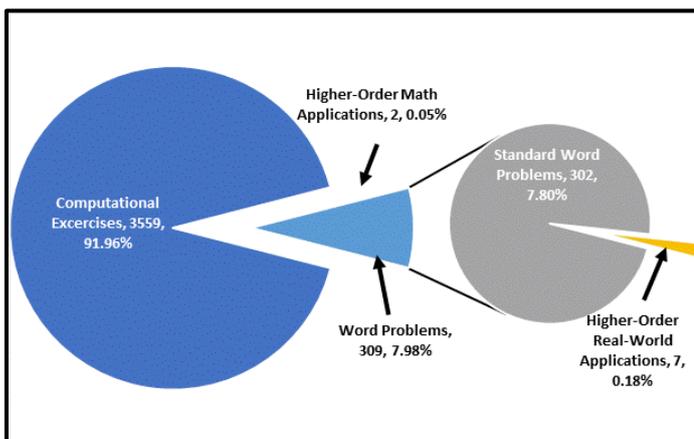


Figure 6. Country/Jurisdiction Textbook



Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

- The Blue pie diagram shows the total number of different types of exercises.
- The Grey pie diagram shows the number of standard word problems (an expansion of the light-blue wedge).
- The Orange wedge represents the number of Higher-Order Math-World applications.
- The Yellow wedge represents the number of Higher-Order Real-World applications.
- For countries/jurisdictions that coded 2 textbooks, the average number of exercises of the two textbooks was used in Figures 5, 6, 7 and 8.

Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

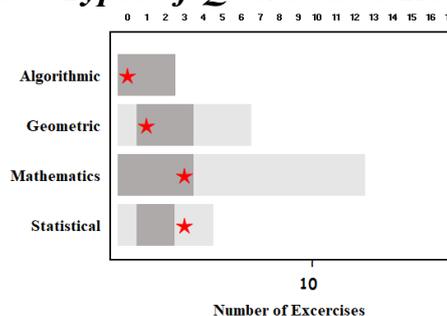
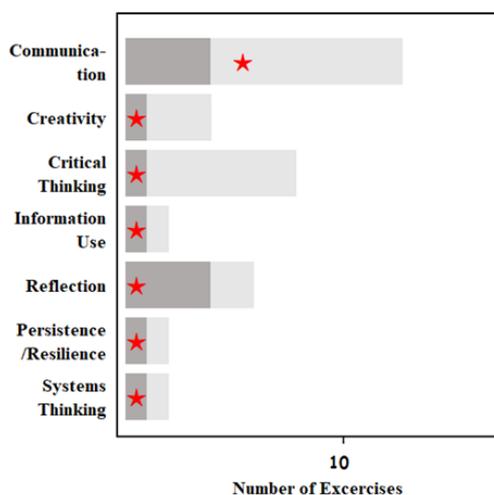


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

- Light Grey bars show the range for the number of Higher-Order Real-World application exercises of each type for each country/jurisdiction.
- Dark Grey bars show the Inter-Quartile Range (25th to 75th percentile).
- Special case: in cases where the majority of the country's/jurisdiction's values were 0, the light grey bar encompasses the dark grey bar.
- The stars show the number of Higher-Order Real-World application exercises of each type that are included.

Notes for Figures 9 & 10 (next page):

- The Australian Curriculum, Assessment and Reporting Authority (ACARA) is responsible for the development and monitoring of the national curriculum and the National Assessment Program. This includes the National Assessment Program – Literacy and Numeracy (NAPLAN) which is an annual assessment for all Australian students in Years 3, 5, 7 and 9 and three-yearly NAP sample assessments in science literacy, civics and citizenship, and ICT literacy for selected groups of students in Years 6 and 10. Jurisdictions, systems and schools are responsible for the implementation of the Australian Curriculum and determine how student learning is assessed and reported.

Curriculum Decision Making

	0	1	2	3
Decision role	No formal role	Advice & recommendations	Constrain, veto or modify recommendations	Final authority or approval
	□	▬□	▬▬▬	▬▬▬▬

Figure 9. Who Makes What Decisions?

		Locus of Curriculum Decisions				
		National	Regional	School	Teachers Collectively	Teachers Individually
Goals for Pupils						
A	By overall system completion	▬□	▬□	▬▬▬	▬▬▬	▬▬▬
B	For intermediate stages	▬□	▬□	▬▬▬	▬▬▬	▬▬▬
C	For differentiated programme types	▬□	▬▬▬	▬▬▬▬	▬▬▬	▬▬▬
D	To be reached in a given grade	□	▬▬▬	▬▬▬▬	▬▬▬	▬▬▬
E	To apply for a specific school	□	□	▬▬▬▬	□	□
Content of Instruction						
F	Course (grade level) offerings	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬
G	Auxiliary content outside of syllabi	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬
H	Student course assignment rules	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬	▬▬▬▬
I	Course content (syllabi)	▬□	▬□	▬▬▬▬	▬▬▬▬	▬▬▬▬
Methods of instruction						
J	Textbook selection	□	□	▬▬▬▬	▬▬▬▬	▬▬▬▬
K	Instructional methods/techniques	□	▬□	▬▬▬▬	▬□	▬▬▬▬
Examinations						
L	Content of examinations	▬▬▬▬	▬▬▬	▬▬▬▬	▬▬▬▬	▬□
M	Examination performance standards	▬▬▬▬	▬▬▬▬	□	□	□
N	School Examination standards	▬□	▬□	▬▬▬▬	▬▬▬▬	▬□

Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	20%	40%	87%	53%	53%
Content of instruction	83%	83%	67%	67%	67%
Methods (including textbooks)	0%	17%	83%	67%	67%
Examinations	78%	56%	56%	44%	22%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. Note. The facet Methods of Instruction includes textbook selection as well.

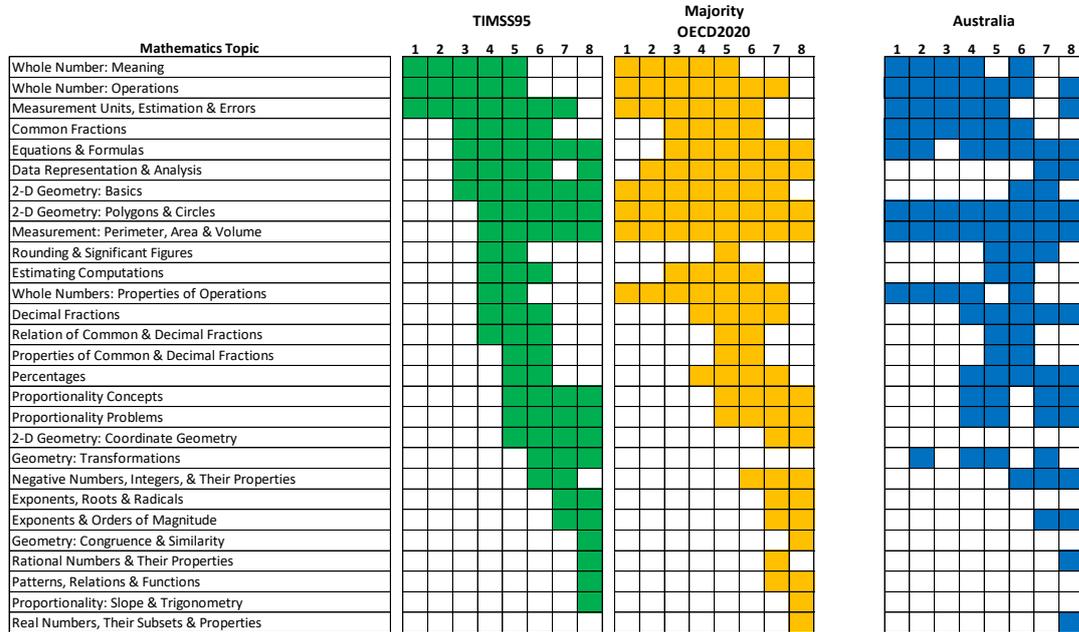
Figure 11. Relative Importance Averaged Across All 19 Countries/Jurisdictions

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	52%	24%	40%	29%	33%
Content of instruction	46%	19%	43%	42%	53%
Methods (including textbooks)	28%	18%	55%	50%	74%
Examinations	55%	16%	30%	40%	41%

Note for Figures 9, 10 & 11. In the above figures looking across rows tells who has what role while looking down the columns especially in Figures 10 and 11, indicates over which facets each locus has the most influence. We acknowledge David E. Wiley’s contribution to the study of curriculum decision making.

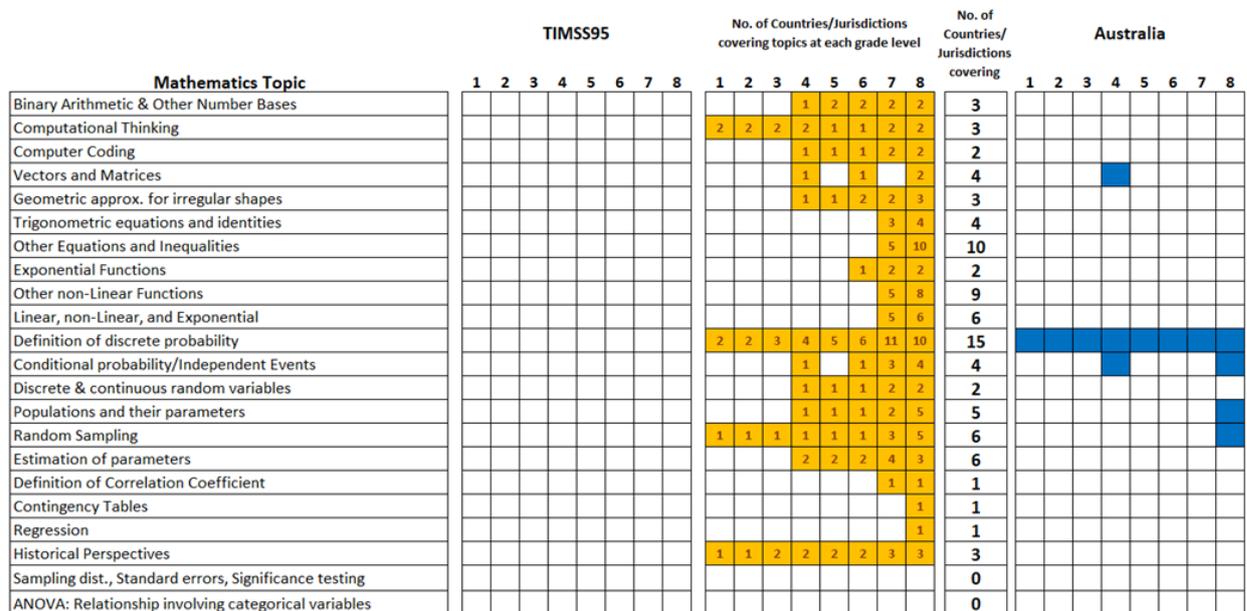
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

Figure 13. Moving into the Future: Current Coverage of Topics Defining a New Literacy



Note. Orange cells indicate the number of countries that cover that topic at that grade level. The accompanying column indicates the number of countries/jurisdictions that included that topic at any grade level; Blue cells indicate specific country/jurisdiction coverage. The absence of green cells indicates the lack of coverage of those topics in TIMSS95.

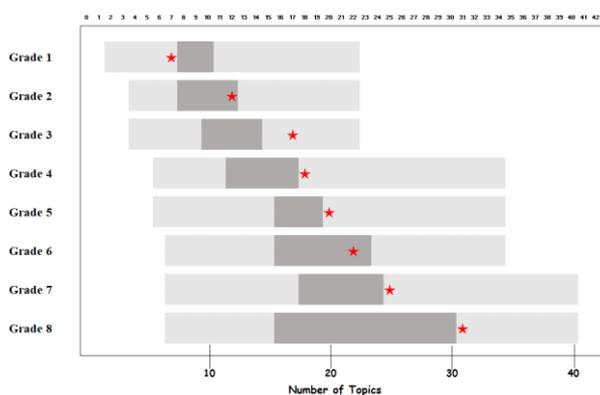
Australia

Revised curriculum standards*

Index

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Figure 1. Number of Topics to be Covered at each Grade



Notes for Figure 1:

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- The stars show the number of topics that the country/ jurisdiction intended to cover at each of the grades.

Note regarding curriculum standards:

- *The Australian Revised Curriculum Standards are the ones categorised on this page (page 1) and page 4 of this report. They are formally entitled “Australian Curriculum Standards - Consultation version 2021” and were available during a 10 week open public consultation period from April to July 2021. Further refinements have been made to the curriculum following analysis of the consultation feedback. The final revisions are awaiting ministerial endorsement. When endorsed, it will become known as Australian Curriculum (version 9).

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

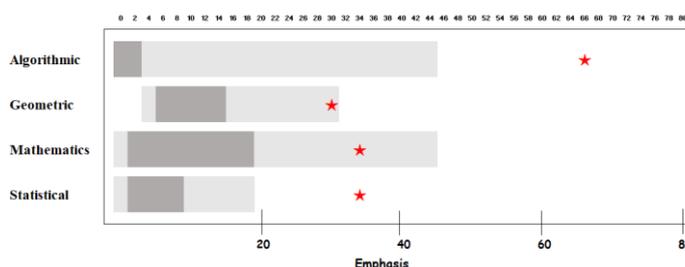


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

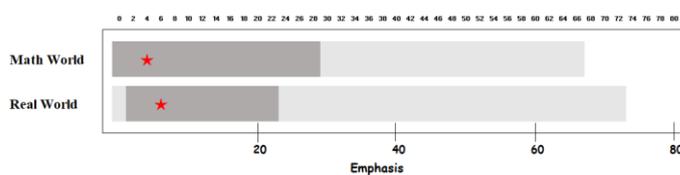
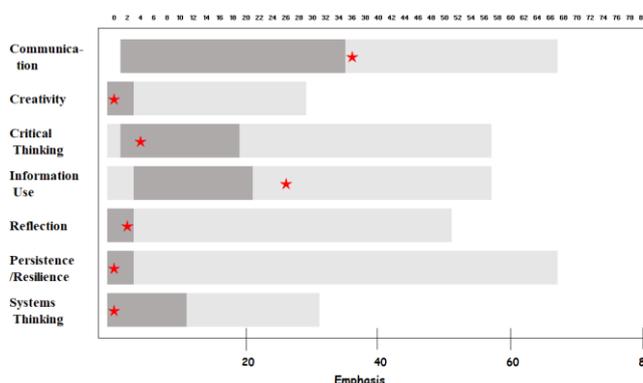


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Notes for Figures 2-4:

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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

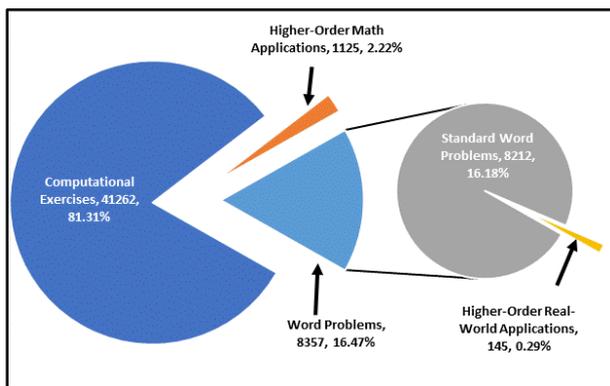
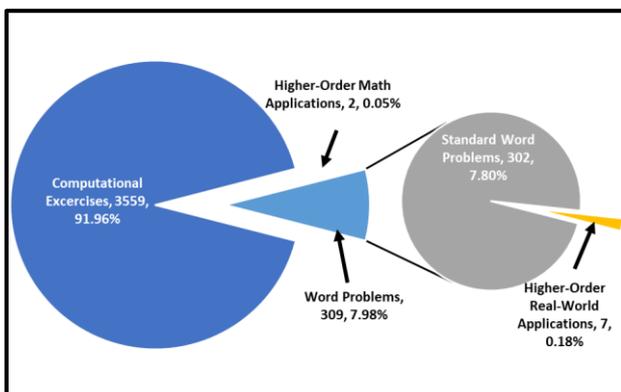


Figure 6. Country/Jurisdiction Textbook



Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

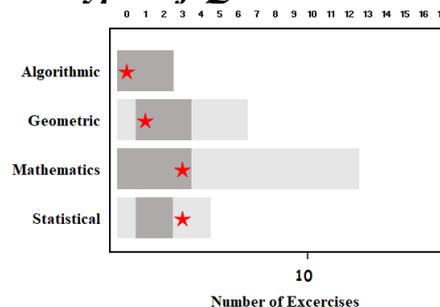
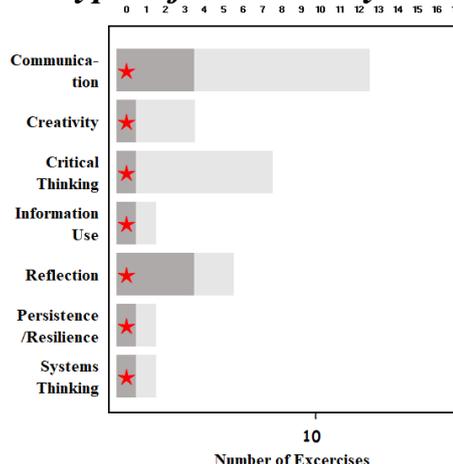


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

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C	For differentiated programme types					
D	To be reached in a given grade					
E	To apply for a specific school					
Content of Instruction						
F	Course (grade level) offerings					
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H	Course content (syllabi)					
I	Auxiliary content outside of syllabi					
Methods of instruction						
J	Textbook selection					
K	Instructional methods/techniques					
Examinations						
L	Content of examinations					
M	Examination performance standards					
N	School Examination standards					

Figure 10. Country/Jurisd: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	20%	40%	87%	53%	53%
Content of instruction	83%	83%	67%	67%	67%
Methods (including textbooks)	0%	17%	83%	67%	67%
Examinations	78%	56%	56%	44%	22%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

Figure 11. Relative Importance Averaged Across All 19 Countries/Jurisdictions

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	52%	24%	40%	29%	33%
Content of instruction	46%	19%	43%	42%	53%
Methods (including textbooks)	28%	18%	55%	50%	74%
Examinations	55%	16%	30%	40%	41%

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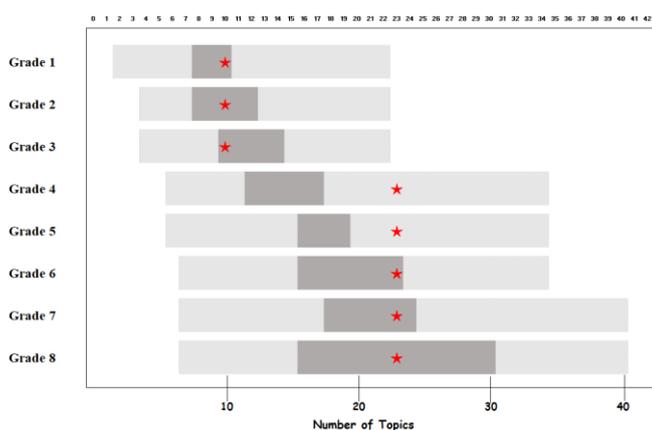
Estonia

Curriculum Standards

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Figure 1. Number of Topics to be Covered at each Grade



Notes for Figure 1:

- Light Grey bars show the range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
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- The stars show the number of topics that the country/ jurisdiction intended to cover at each of the grades.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

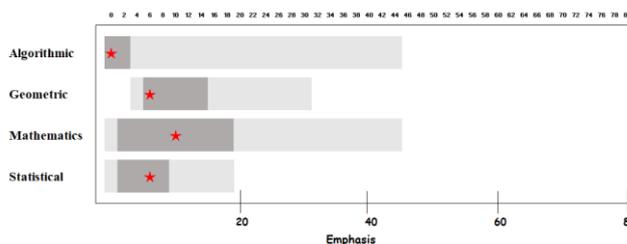


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

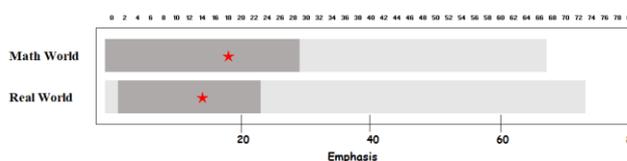
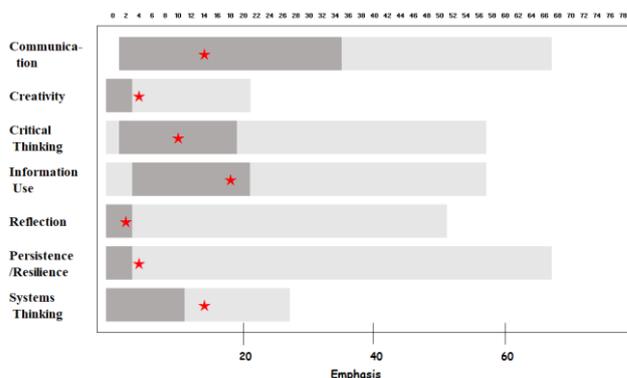


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

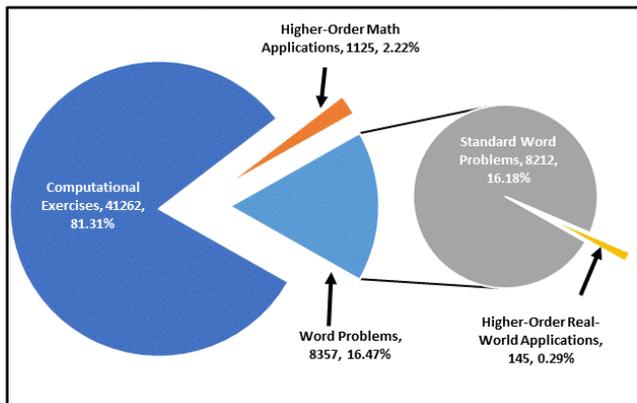
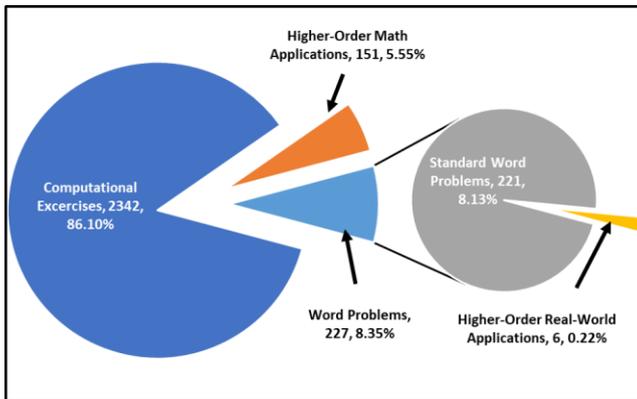


Figure 6. Country/Jurisdiction Textbook



Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

- The Blue pie diagram shows the total number of different types of exercises.
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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

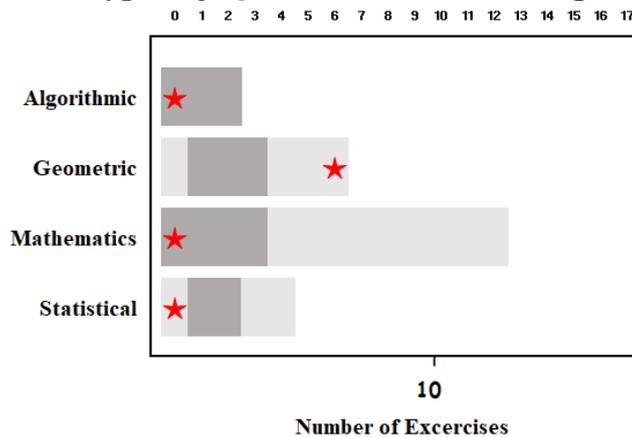
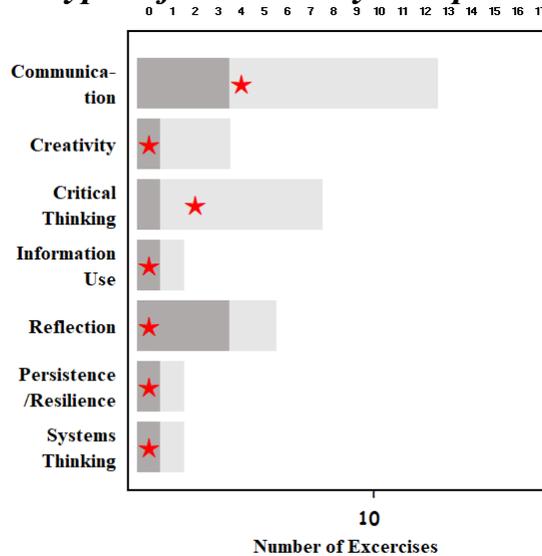


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- The stars show the number of Higher-Order Real-World application exercises of each type that are included.

Curriculum Decision Making

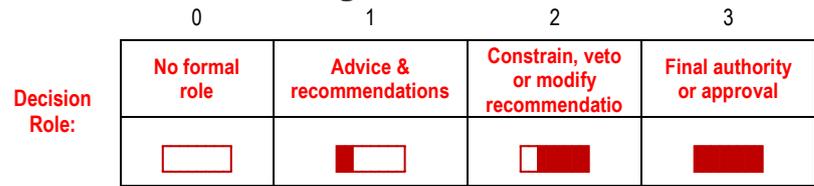


Figure 9. Who Makes What Decisions?

		National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils						
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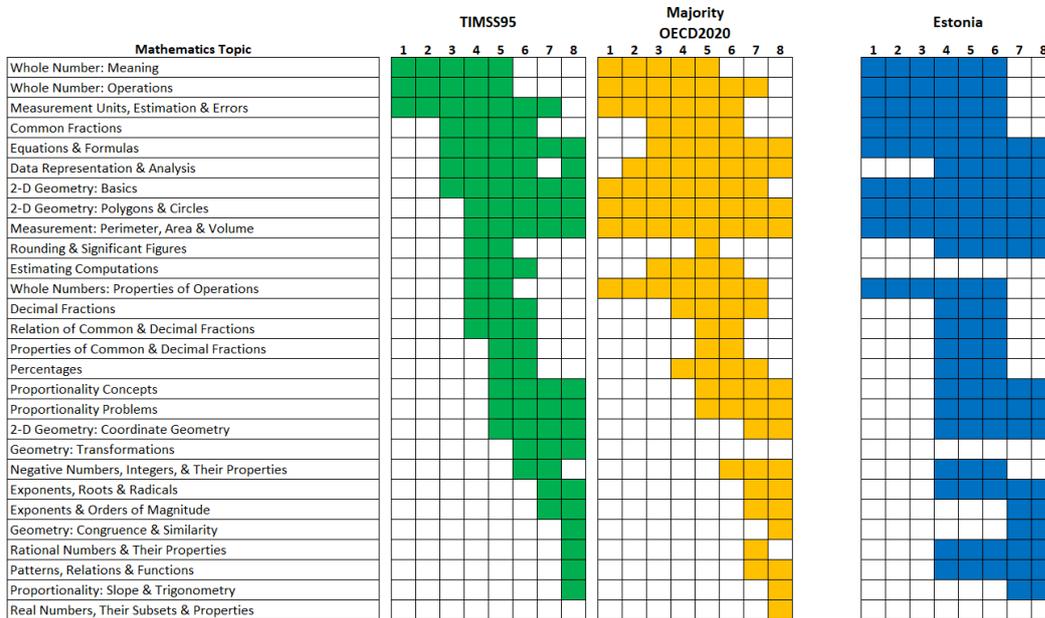
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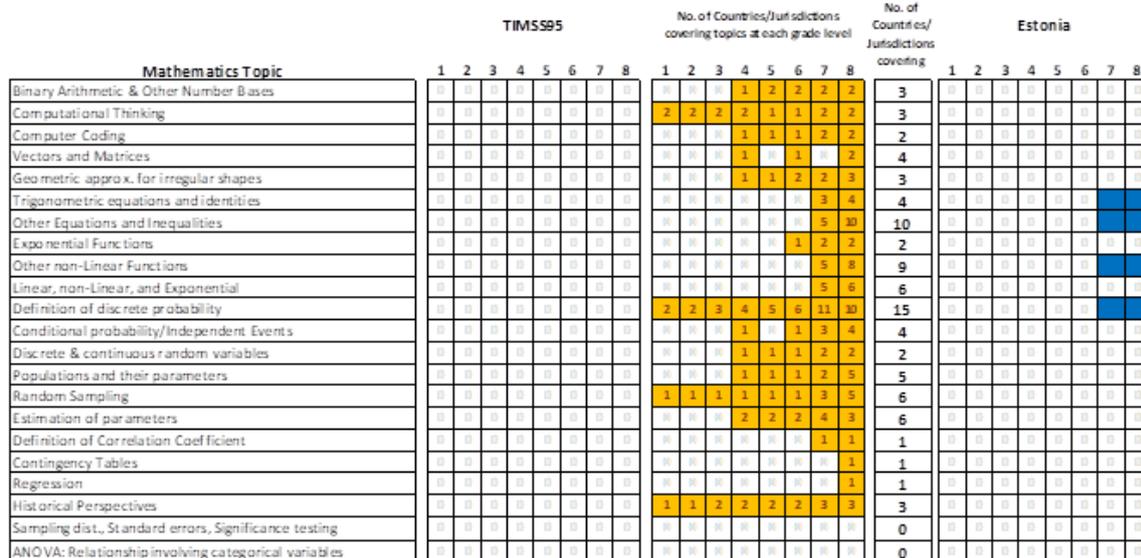
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

Figure 13. Moving into the Future: Current Coverage of Topics Defining a New Literacy



Note. Orange cells indicate the number of countries that cover that topic at that grade level. The accompanying column indicates the number of countries/jurisdictions that included that topic at any grade level; Blue cells indicate specific country/jurisdiction coverage. The absence of green cells indicates the lack of coverage of those topics in TIMSS95.

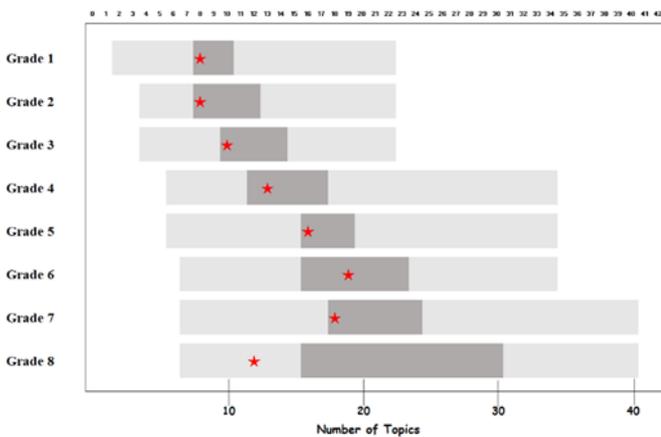
Greece

Curriculum Standards

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Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

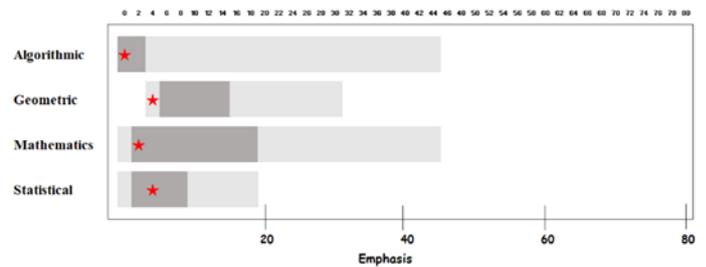


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

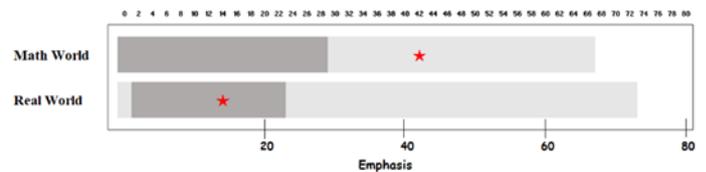
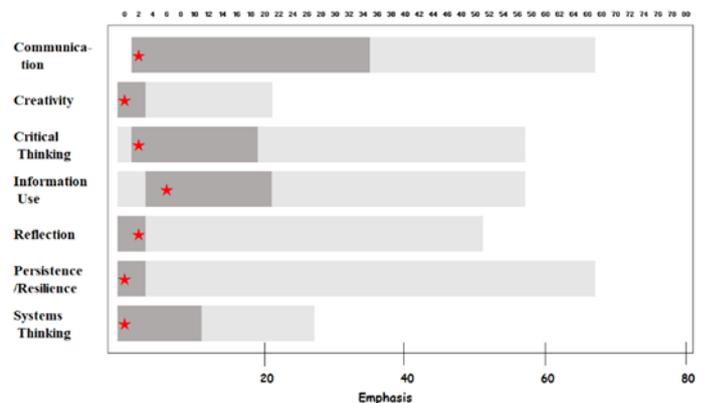


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

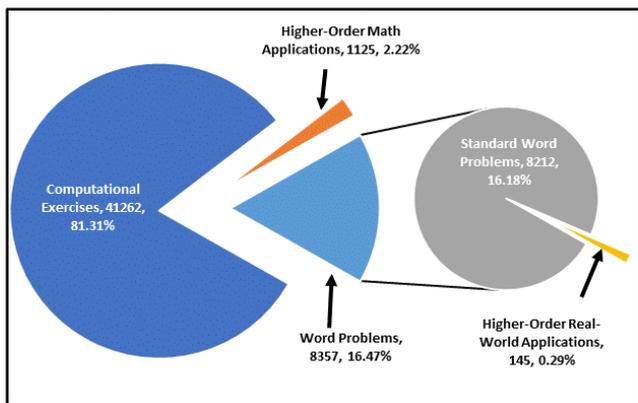
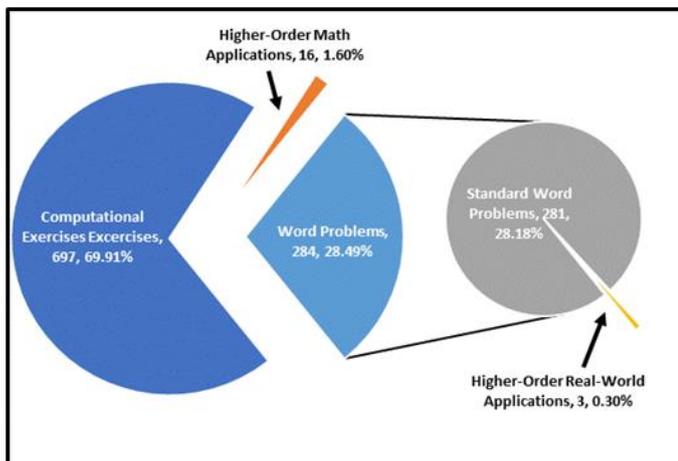


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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

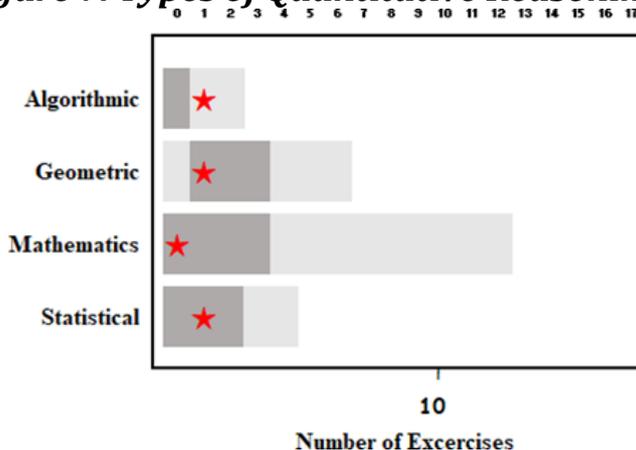
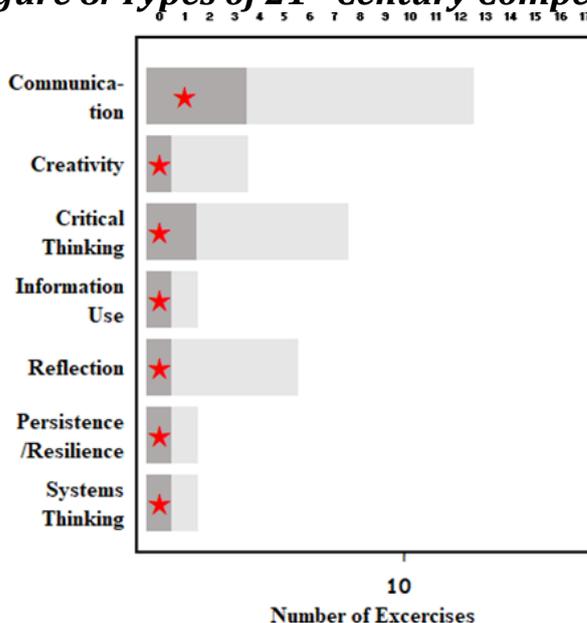


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	0	1	2	3
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Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	100%	0%	0%	0%	0%
Content of instruction	83%	0%	0%	0%	25%
Methods (including textbooks)	67%	0%	0%	17%	50%
Examinations	67%	0%	0%	67%	44%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

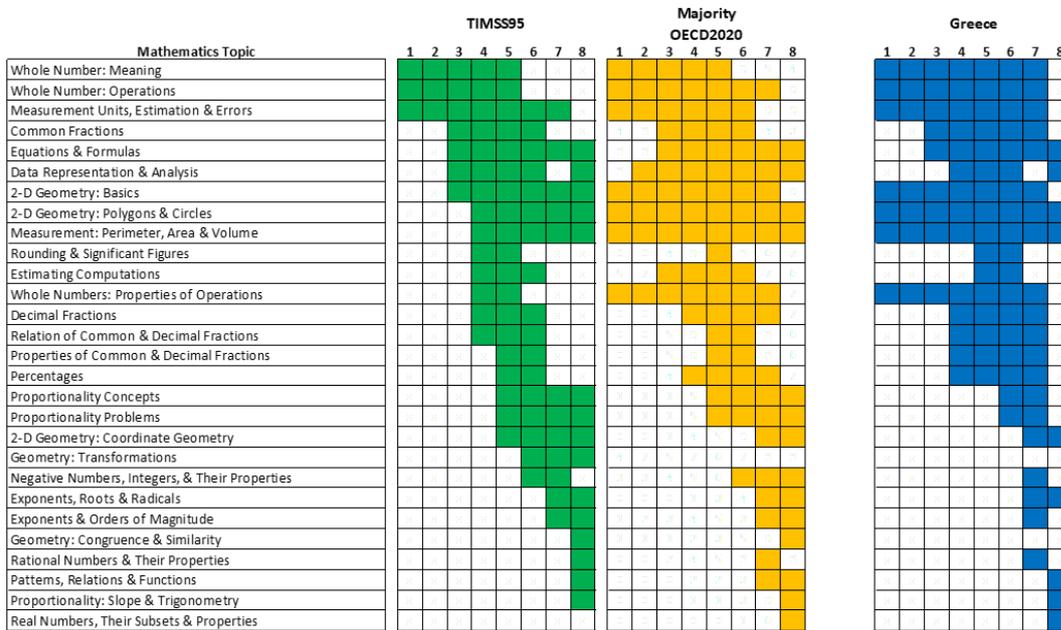
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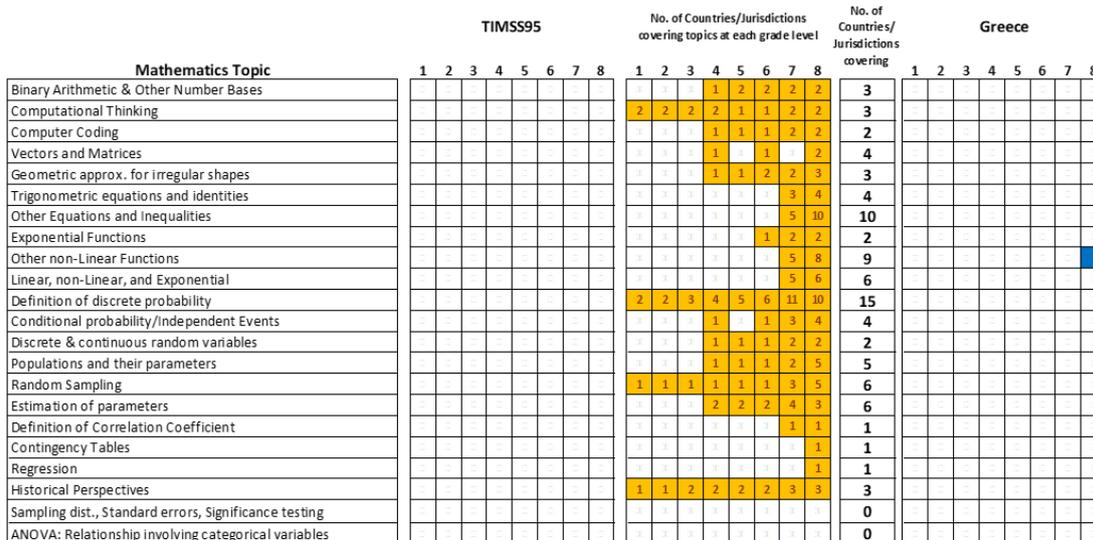
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

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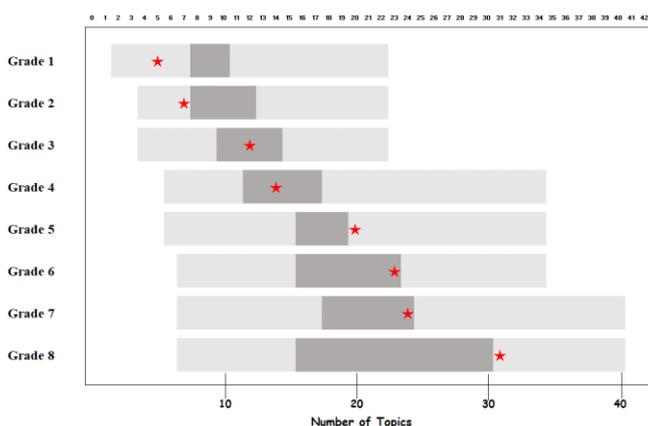
Hungary

Curriculum Standards

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Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

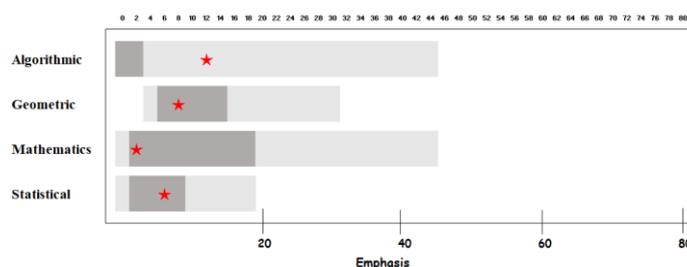


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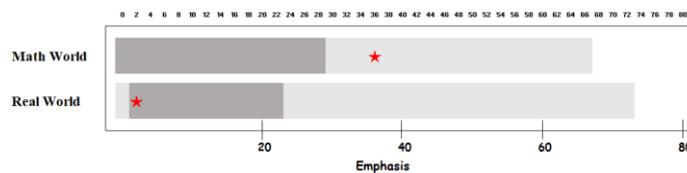
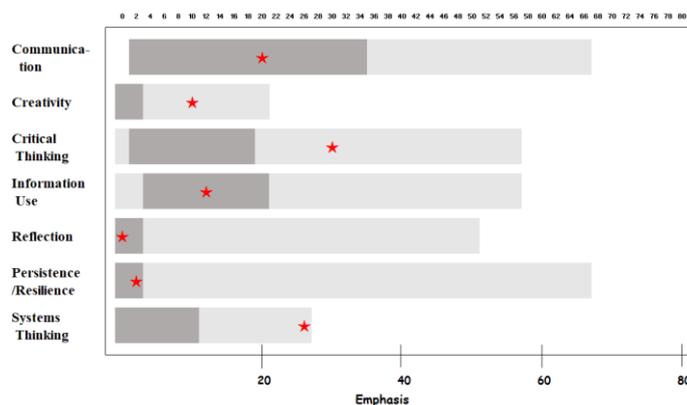


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8th Grade Textbook Exercises

Textbook Exercise Composition

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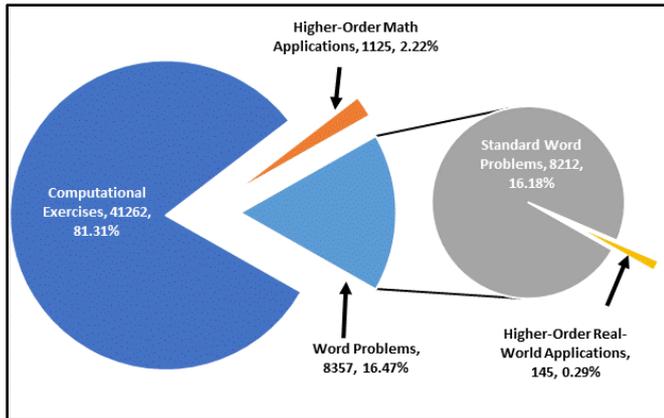
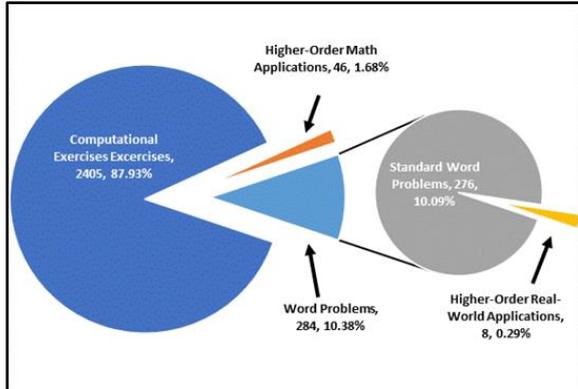


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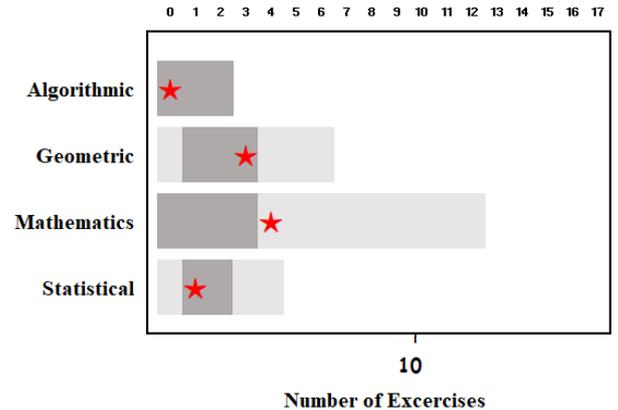
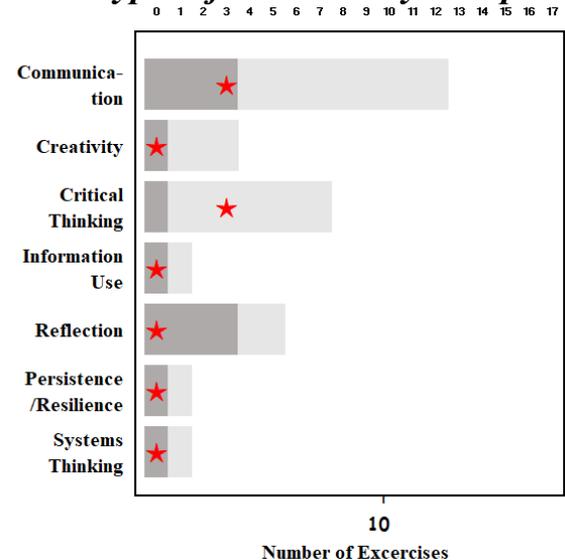


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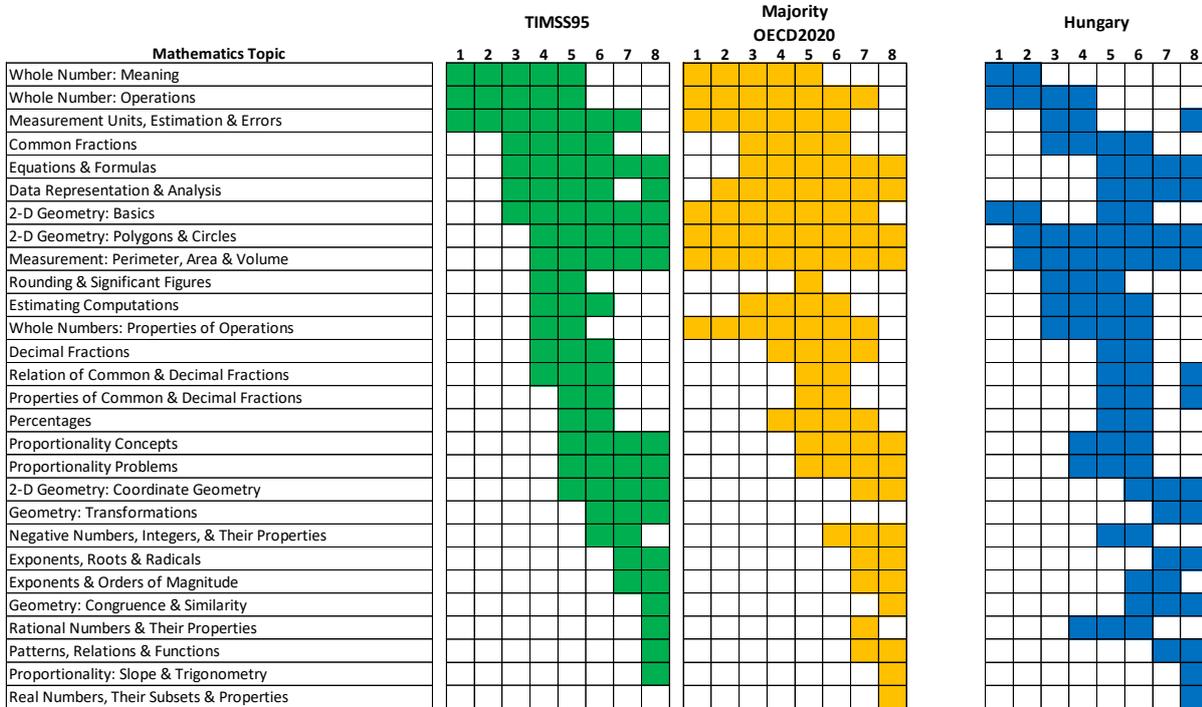
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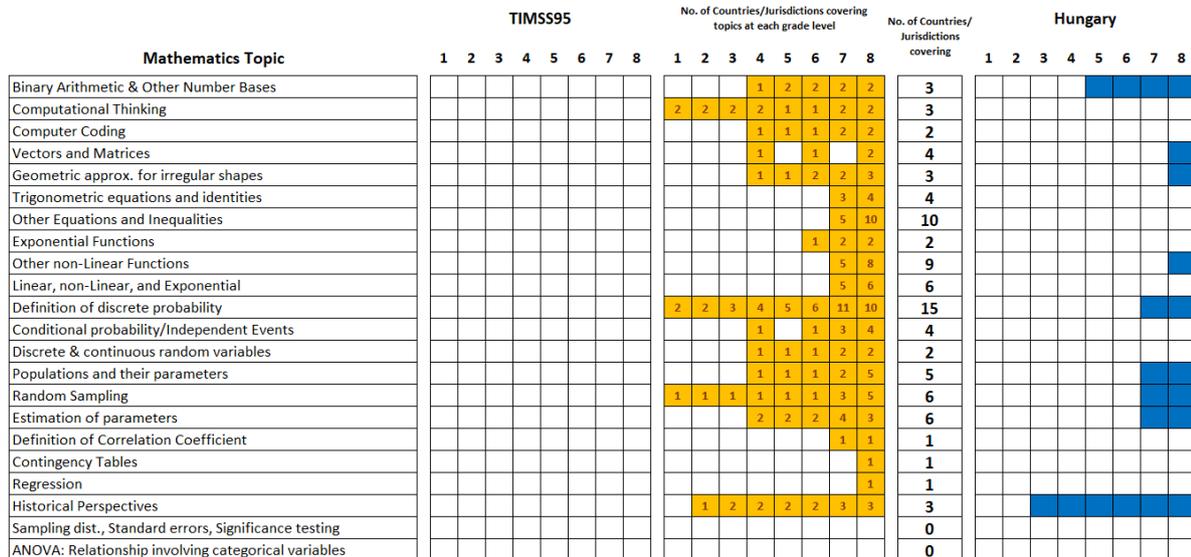
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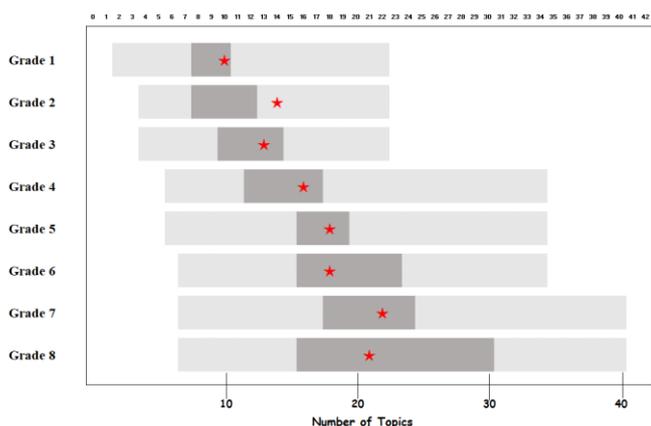
Israel

Curriculum Standards

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- The stars show the number of topics that the country/ jurisdiction intended to cover at each of the grades.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

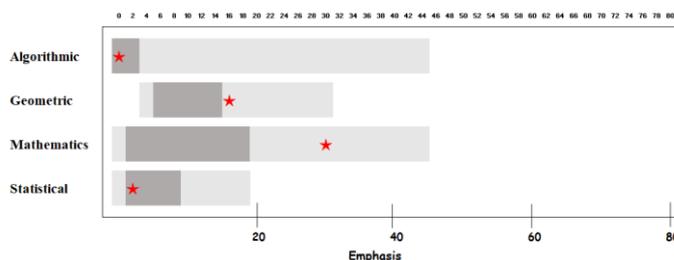


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

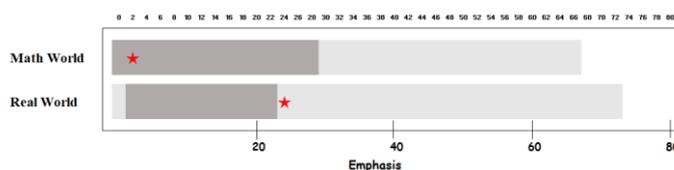
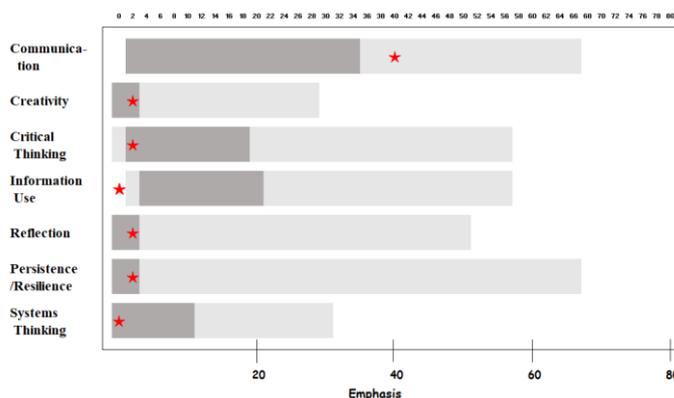


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

- The structure of these figures is the same as described in the note for Figure 1.
- The variable represented in each of these figures is a measure of the intensity/emphasis that the curriculum standards for each of the countries/jurisdictions placed on each of these three dimensions of mathematics literacy.
- The measure is defined with 0 indicating no mention of the dimension and 1-75 indicating the degree of emphasis (see methods section of the introduction to the country/jurisdiction reports).

8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

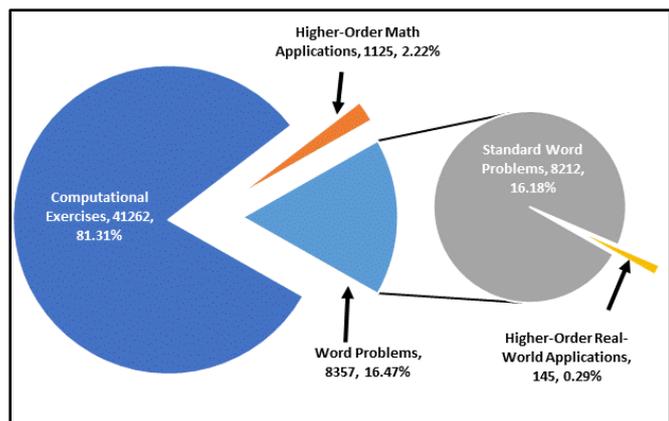
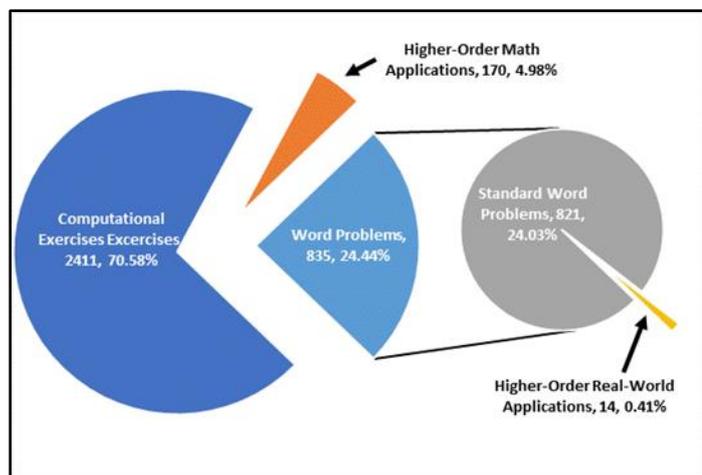


Figure 6. Country/Jurisdiction Textbook



Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

- The Blue pie diagram shows the total number of different types of exercises.
- The Grey pie diagram shows the number of standard word problems (an expansion of the light-blue wedge).
- The Orange wedge represents the number of Higher-Order Math-World applications.
- The Yellow wedge represents the number of Higher-Order Real-World applications.
- For countries/jurisdictions that coded 2 textbooks, the average number of exercises of the two textbooks was used in Figures 5, 6, 7 and 8.

Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

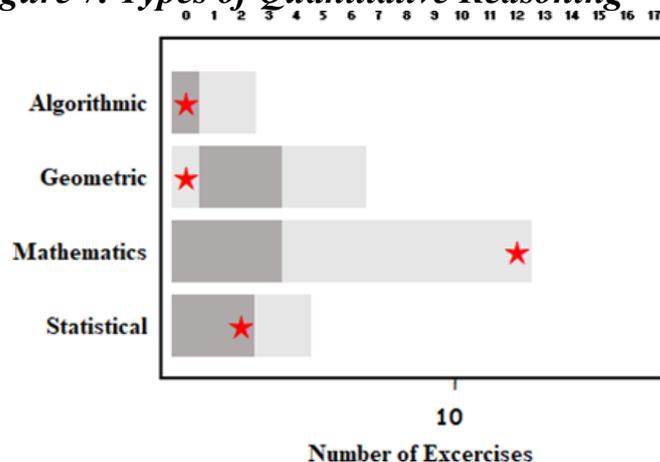
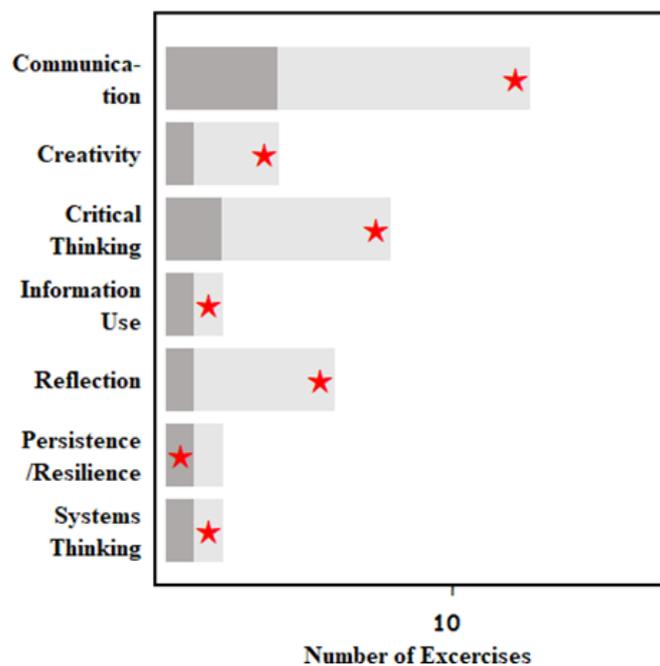


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

- Light Grey bars show the range for the number of Higher-Order Real-World application exercises of each type for each country/jurisdiction.
- Dark Grey bars show the Inter-Quartile Range (25th to 75th percentile).
- Special case: in cases where the majority of the country's/jurisdiction's values were 0, the light grey bar encompasses the dark grey bar.
- The stars show the number of Higher-Order Real-World application exercises of each type that are included.

Curriculum Decision Making



Figure 9. Who Makes What Decisions?

		National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils						
A	By overall system completion					
B	For intermediate stages					
C	For differentiated programme types					
D	To be reached in a given grade					
E	To apply for a specific school					
Content of Instruction						
F	Course (grade level) offerings					
G	Student course assignment rules					
H	Course content (syllabi)					
I	Auxiliary content outside of syllabi					
Methods of instruction						
J	Textbook selection					
K	Instructional methods/techniques					
Examinations						
L	Content of examinations					
M	Examination performance standards					
N	School Examination standards					

Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	100%	0%	0%	0%	0%
Content of instruction	92%	17%	25%	0%	25%
Methods (including textbooks)	50%	17%	83%	83%	50%
Examinations	56%	22%	67%	67%	67%

Notes. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

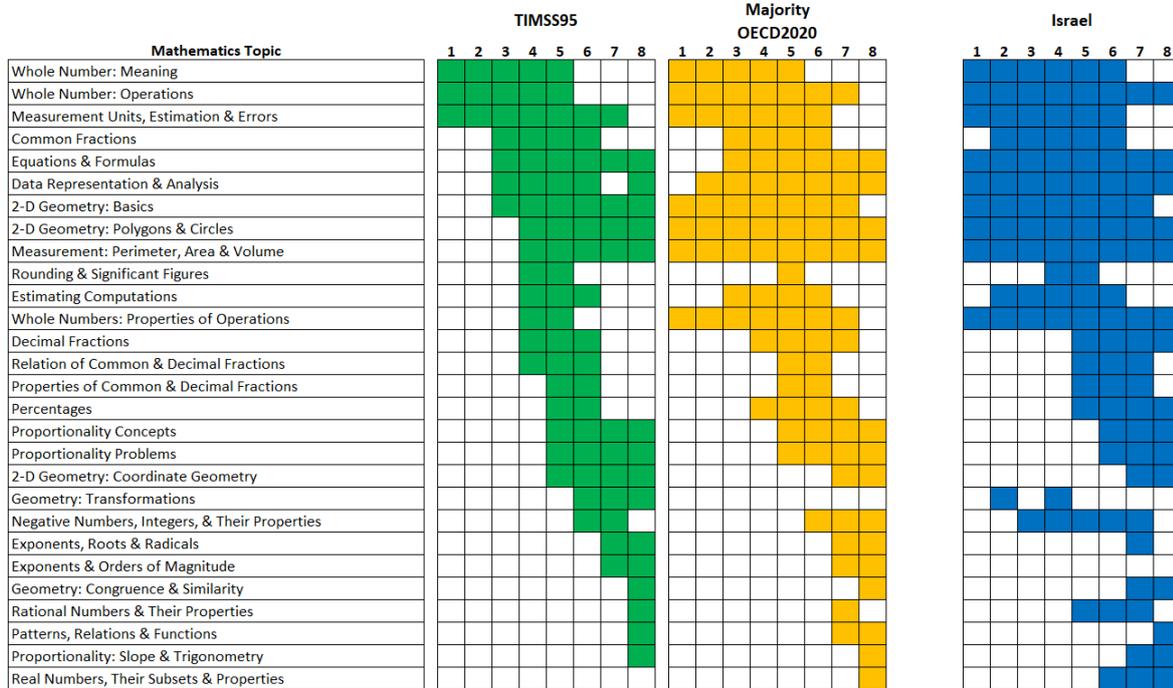
Figure 11. Relative Importance Averaged Across All 19 Countries/Jurisdictions

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	52%	24%	40%	29%	33%
Content of instruction	46%	19%	43%	42%	53%
Methods (including textbooks)	28%	18%	55%	50%	74%
Examinations	55%	16%	30%	40%	41%

Notes for Figures 9, 10 & 11. In the above figures looking across rows tells who has what role while looking down the columns especially in Figures 10 and 11, indicates over which facets each locus has the most influence. We acknowledge David E. Wiley's contribution to the study of curriculum decision making.

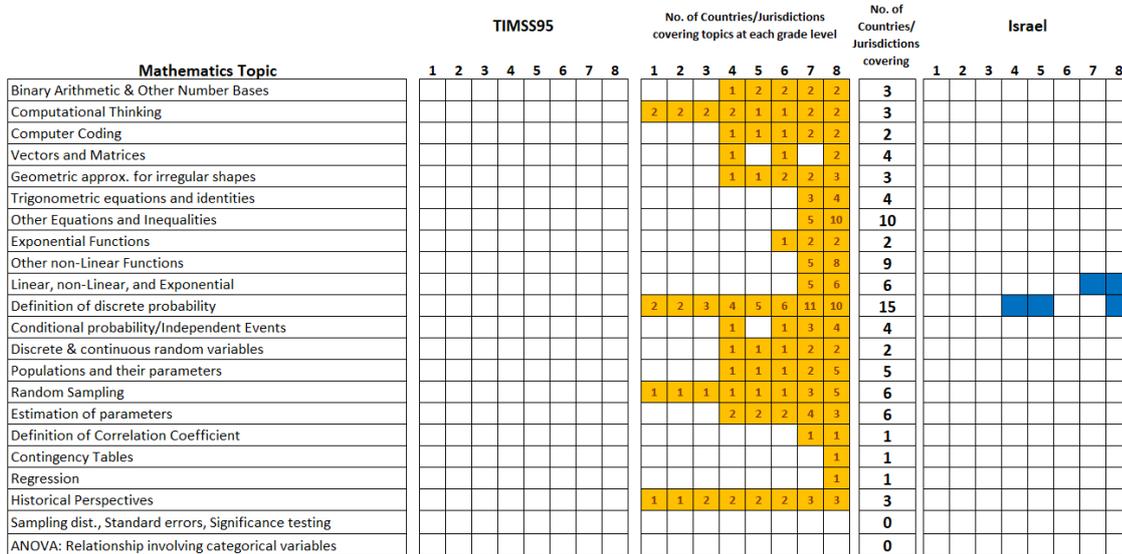
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

Figure 13. Moving into the Future: Current Coverage of Topics Defining a New Literacy



Note. Orange cells indicate the number of countries that cover that topic at that grade level. The accompanying column indicates the number of countries/jurisdictions that included that topic at any grade level; Blue cells indicate specific country/jurisdiction coverage. The absence of green cells indicates the lack of coverage of those topics in TIMSS95.

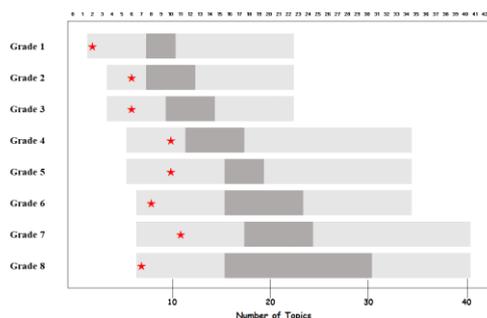
Japan

Curriculum Standards

Index

- Page 1 portrays the composition of the country's/ jurisdiction's curriculum standards.
- Page 2 portrays the composition of a representative 8th grade mathematics textbook.
- Page 3 portrays the curriculum decision-making authority within the educational system.
- Page 4 portrays the mathematics topic coverage of the country's/jurisdiction's curriculum standards across grades 1-8 in comparison to the 1995 TIMSS A+ benchmark curriculum.

Figure 1. Number of Topics to be Covered at each Grade



Notes for Figure 1:

- Light Grey bars show the range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
- Dark Grey bars show the Inter-Quartile Range (25th to 75th Percentile) found within the broader range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
- The stars show the number of topics that the country/ jurisdiction intended to cover at each of the grades.
- The numbers presented in Figure 1 are based on data from the coding of the MCDA Framework and as a result are not associated with changes made to Figure 12.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

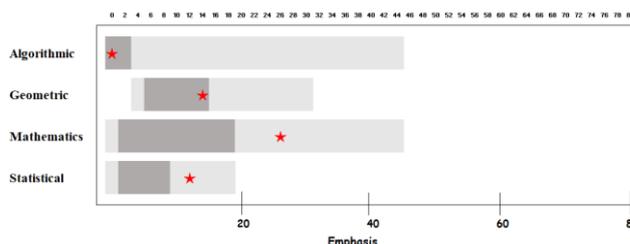


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

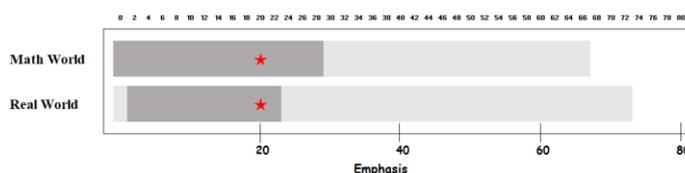
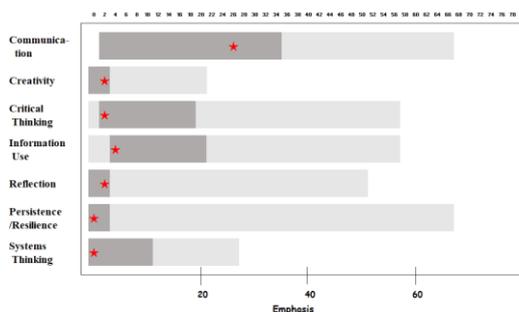


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

- The structure of these figures is the same as described in the note for Figure 1.
- The variable represented in each of these figures is a measure of the intensity/emphasis that the curriculum standards for each of the countries/jurisdictions placed on each of these three dimensions of mathematics literacy.
- The measure is defined with 0 indicating no mention of the dimension and 1-75 indicating the degree of emphasis (see methods section of the introduction to the country/jurisdiction reports).

8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

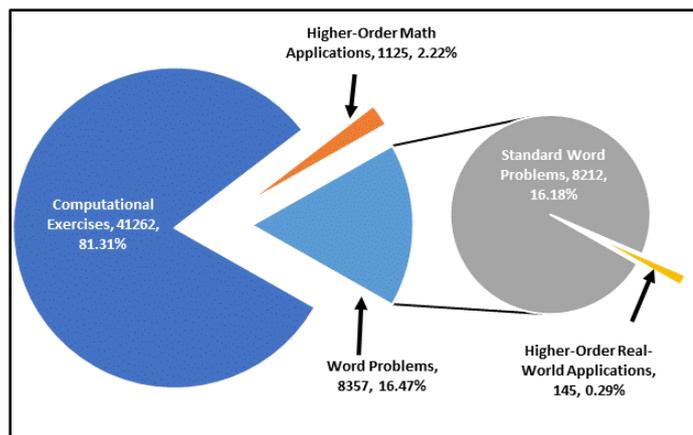
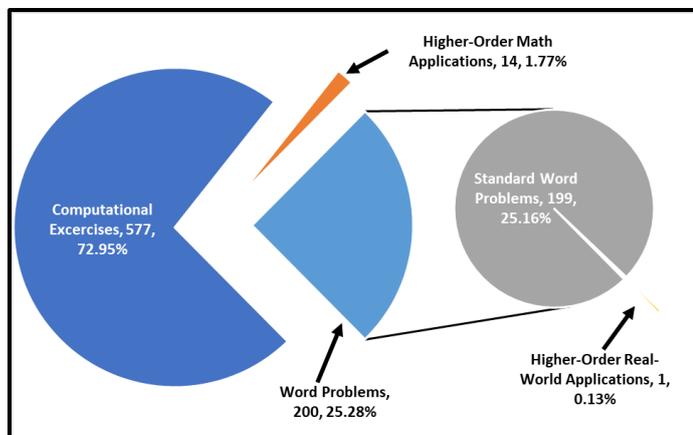


Figure 6. Country/Jurisdiction Textbook



Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

- The Blue pie diagram shows the total number of different types of exercises.
- The Grey pie diagram shows the number of standard word problems (an expansion of the light-blue wedge).
- The Orange wedge represents the number of Higher-Order Math-World applications.
- The Yellow wedge represents the number of Higher-Order Real-World applications.
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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

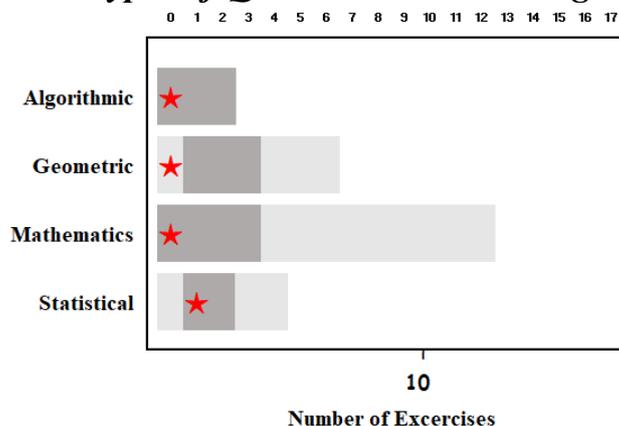
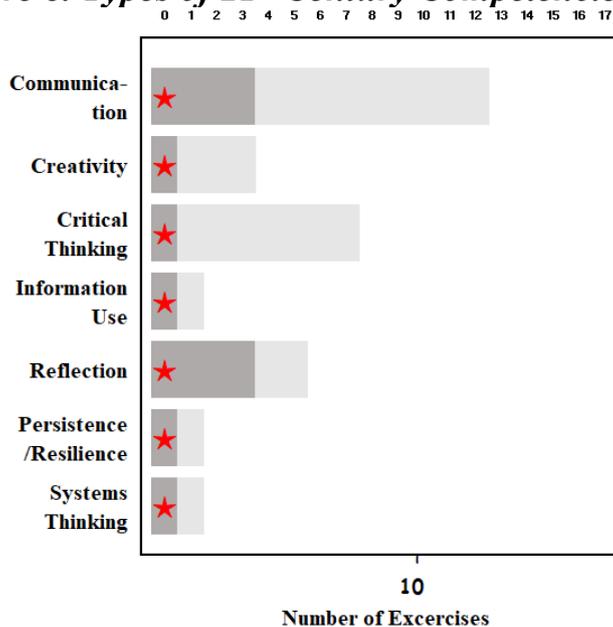


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

- Light Grey bars show the range for the number of Higher-Order Real-World application exercises of each type for each country/jurisdiction.
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- The stars show the number of Higher-Order Real-World application exercises of each type that are included.

Curriculum Decision Making

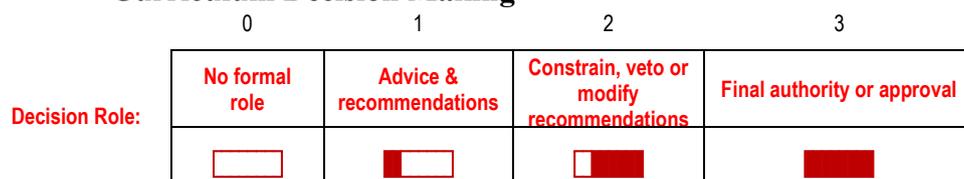


Figure 9. Who Makes What Decisions?

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Goals for pupils						
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E	To apply for a specific school					
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F	Course (grade level) offerings					
G	Student course assignment rules					
H	Course content (syllabi)					
I	Auxiliary content outside of syllabi					
Methods of instruction						
J	Textbook selection					
K	Instructional methods/techniques					
Examinations						
L	Content of examinations					
M	Examination performance standards					
N	School Examination					

Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	80%	33%	33%	0%	0%
Content of instruction	67%	50%	100%	67%	67%
Methods (including textbooks)	67%	67%	33%	33%	50%
Examinations	33%	33%	44%	44%	67%

Notes: The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

Figure 11. Relative Importance Averaged Across All 19 Countries/Jurisdictions

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	52%	24%	40%	29%	33%
Content of instruction	46%	19%	43%	42%	53%
Methods (including textbooks)	28%	18%	55%	50%	74%
Examinations	55%	16%	30%	40%	41%

Note for Figures 9, 10 & 11. In the above figures looking across rows tells who has what role while looking down the columns especially in Figures 10 and 11, indicates over which facets each locus has the most influence. Given Japan's Ministry of Education's request for changes in Figure 9, Figure 11 does not include their revised data. We acknowledge David E. Wiley's contribution to the study of curriculum decision making.

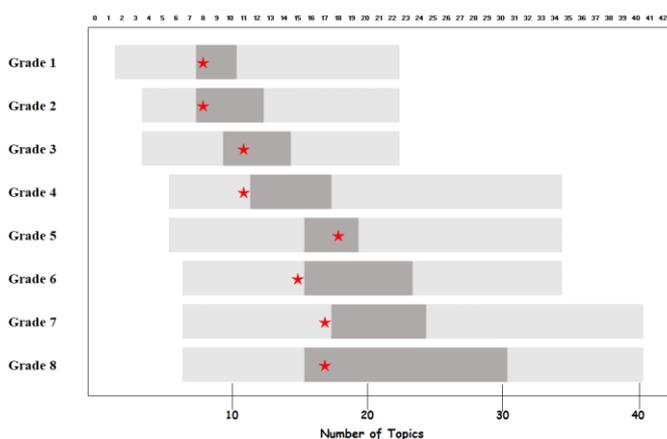
Korea

Curriculum Standards

Index

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- Page 4 portrays the mathematics topic coverage of the country's/jurisdiction's curriculum standards across grades 1-8 in comparison to the 1995 TIMSS A+ benchmark curriculum.

Figure 1. Number of Topics to be Covered at each Grade



Notes for Figure 1:

- Light Grey bars show the range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
- Dark Grey bars show the Inter-Quartile Range (25th to 75th Percentile) found within the broader range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
- The stars show the number of topics that the country/ jurisdiction intended to cover at each of the grades.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

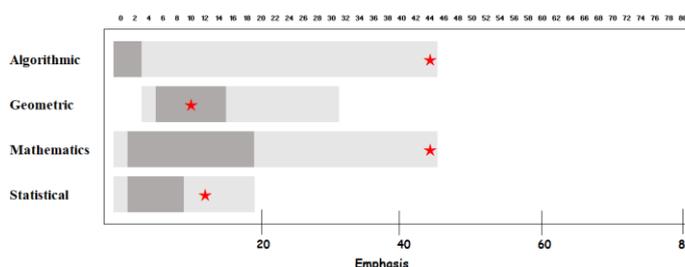


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

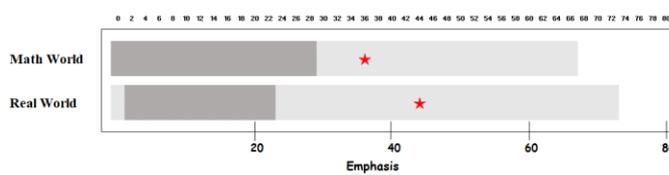
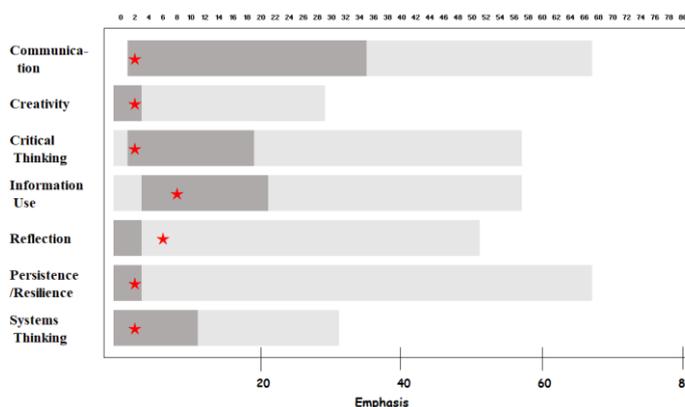


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

- The structure of these figures is the same as described in the note for Figure 1.
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- The measure is defined with 0 indicating no mention of the dimension and 1-75 indicating the degree of emphasis (see methods section of the introduction to the country/jurisdiction reports).

8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

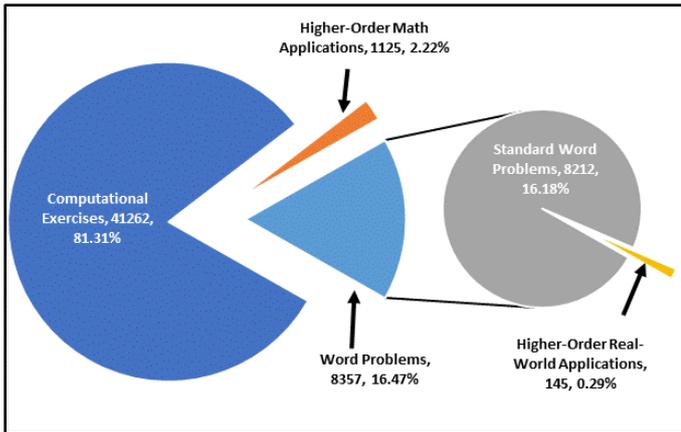
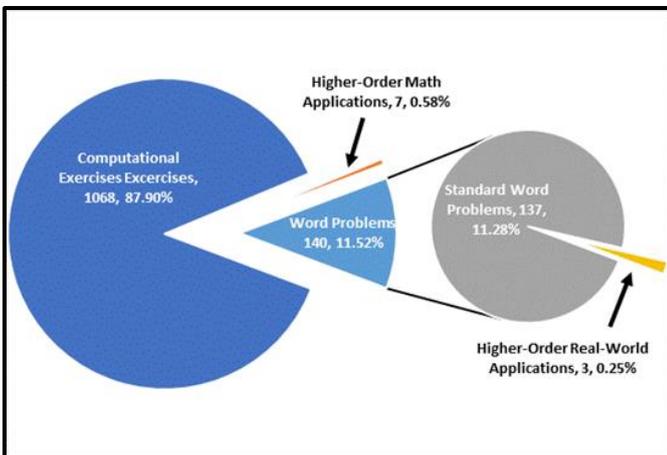


Figure 6. Country/Jurisdiction Textbook



Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

- The Blue pie diagram shows the total number of different types of exercises.
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- For countries/jurisdictions that coded 2 textbooks, the average number of exercises of the two textbooks was used in Figures 5, 6, 7 and 8.

Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

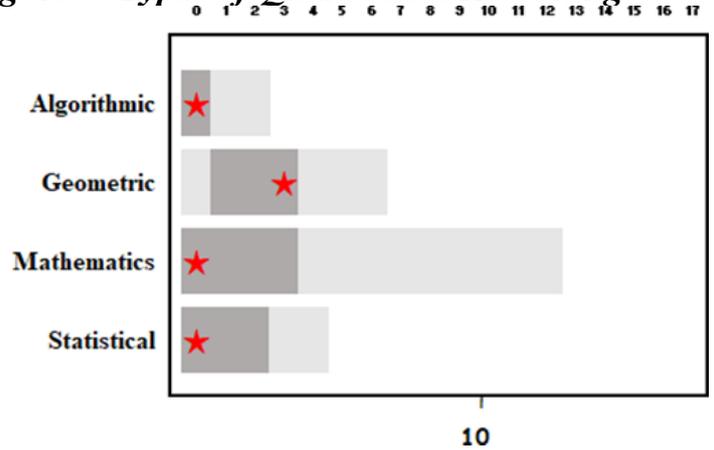
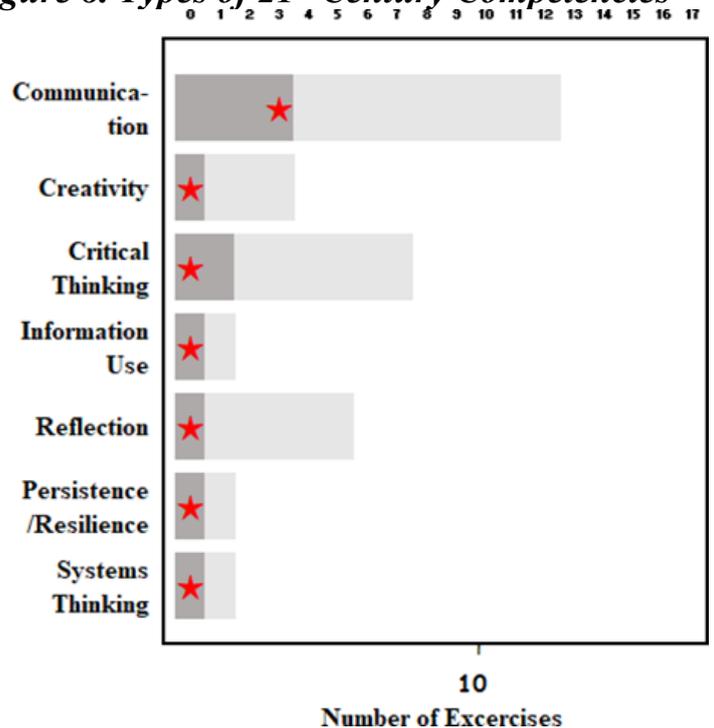


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

- Light Grey bars show the range for the number of Higher-Order Real-World application exercises of each type for each country/jurisdiction.
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- The stars show the number of Higher-Order Real-World application exercises of each type that are included.

Curriculum Decision Making

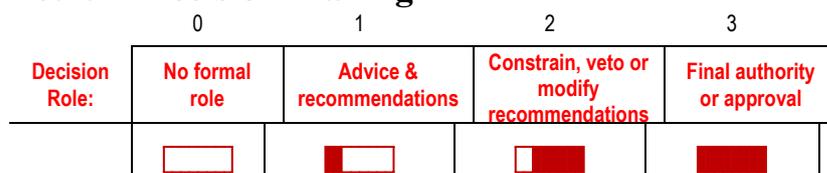


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K	Instructional methods/techniques					
Examinations						
L	Content of examinations					
M	Examination performance standards					
N	School Examination standards					

Figure 10. Country/Jurisd: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	13%	67%	67%	53%	53%
Content of instruction	42%	50%	58%	67%	67%
Methods (including textbooks)	17%	17%	67%	100%	100%
Examinations	11%	33%	78%	78%	78%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

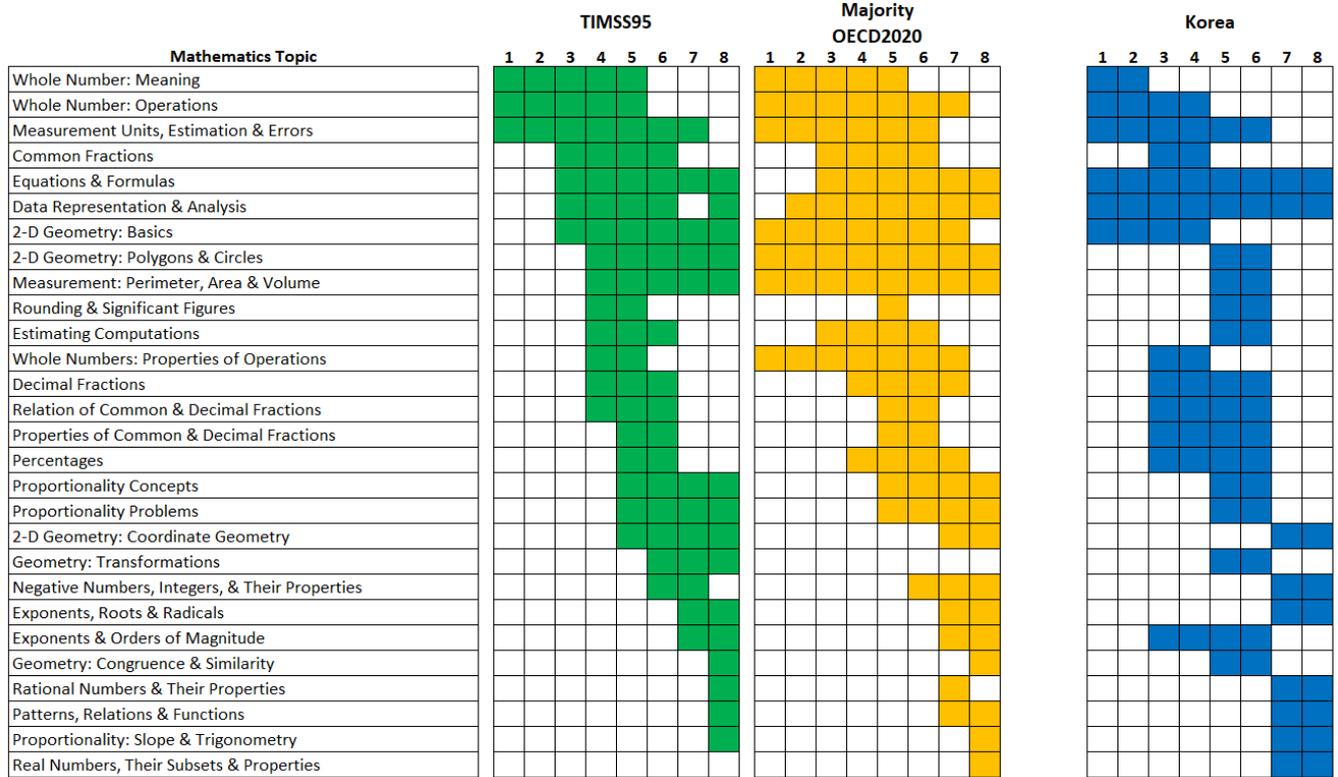
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Methods (including textbooks)	28%	18%	55%	50%	74%
Examinations	55%	16%	30%	40%	41%

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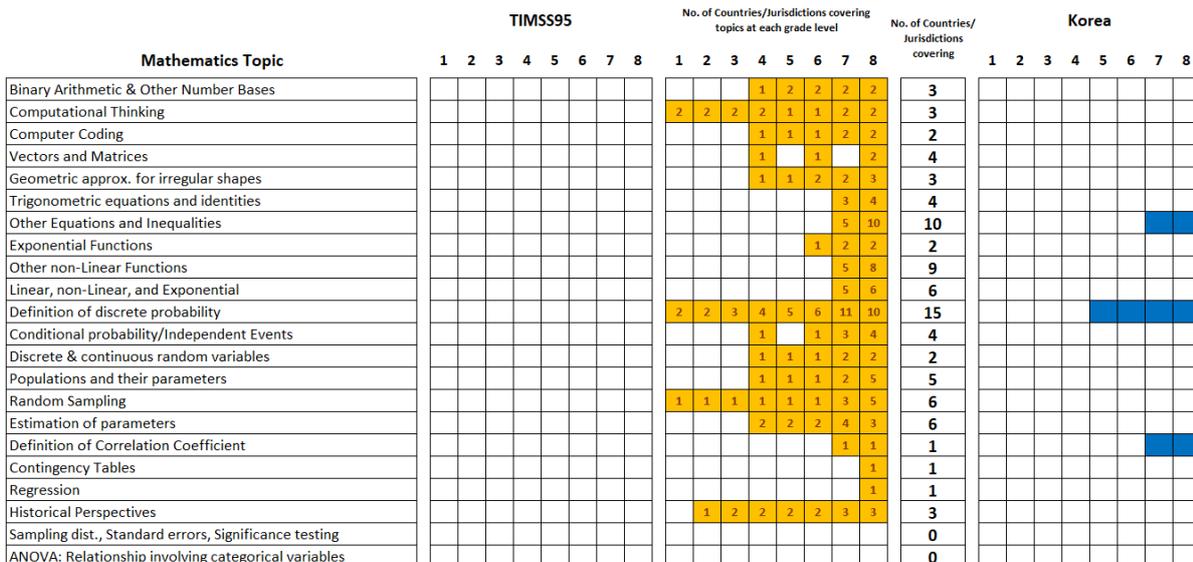
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

Figure 13. Moving into the Future: Current Coverage of Topics Defining a New Literacy



Note. Orange cells indicate the number of countries that cover that topic at that grade level. The accompanying column indicates the number of countries/jurisdictions that included that topic at any grade level; Blue cells indicate specific country/jurisdiction coverage. The absence of green cells indicates the lack of coverage of those topics in TIMSS95.

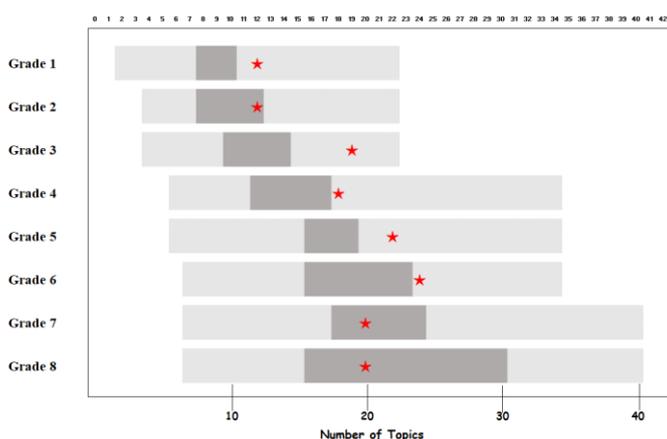
Latvia

Curriculum Standards

Index

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- Light Grey bars show the range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
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Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

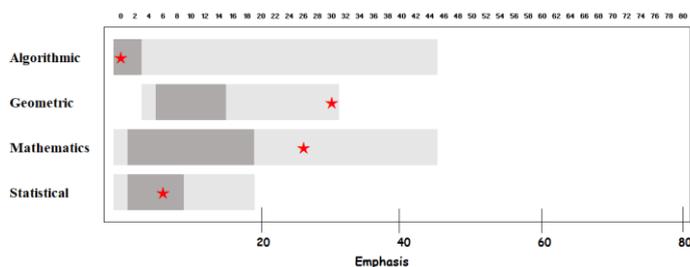


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

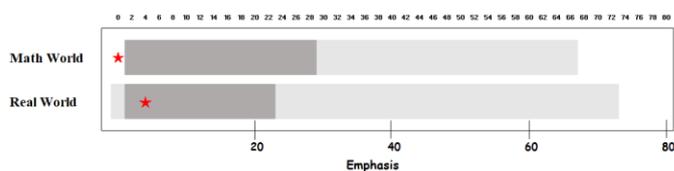
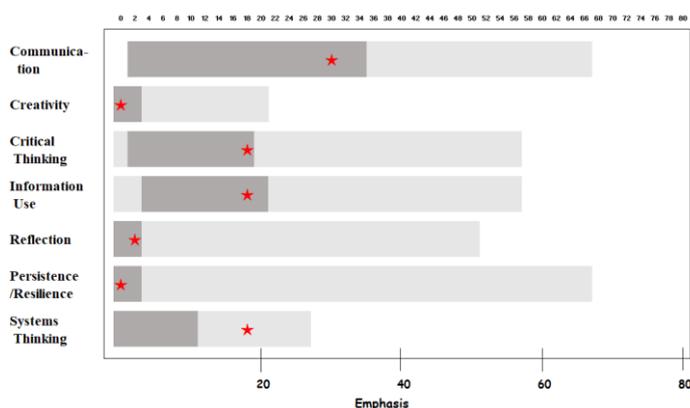


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

- The structure of these figures is the same as described in the note for Figure 1.
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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

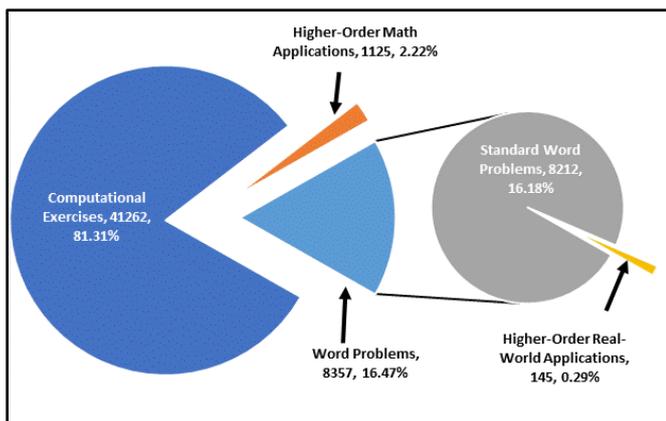
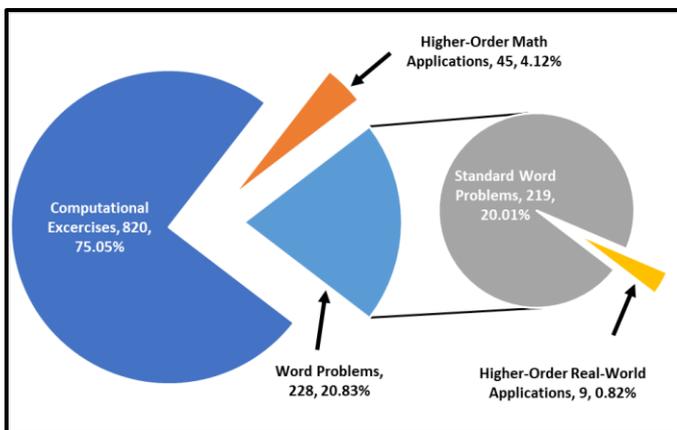


Figure 6. Country/Jurisdiction Textbook



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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

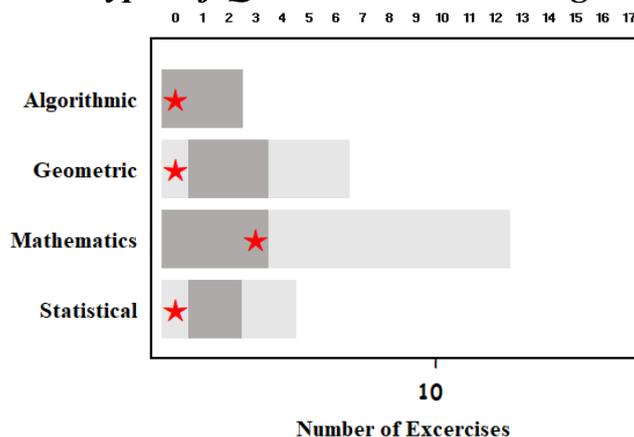
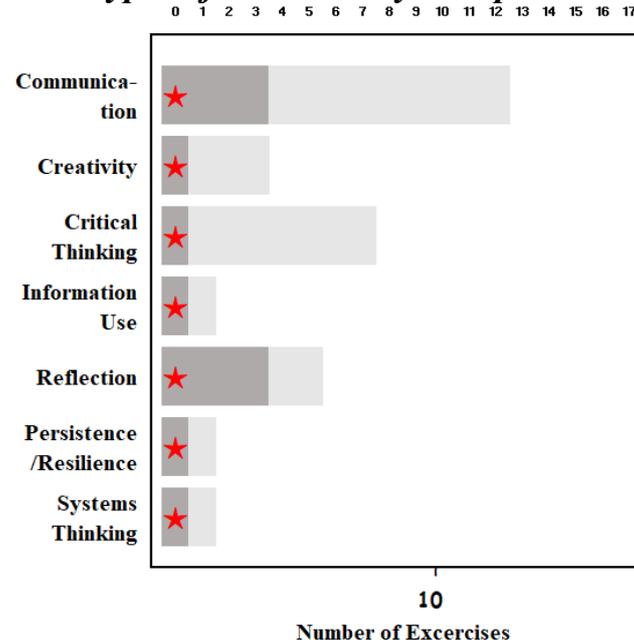


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

- Light Grey bars show the range for the number of Higher-Order Real-World application exercises of each type for each country/jurisdiction.
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- The stars show the number of Higher-Order Real-World application exercises of each type that are included.

Curriculum Decision Making

	0	1	2	3
Decision Role:	No formal role	Advice & recommendations	Constrain, veto or modify recommendations	Final authority or approval

Figure 9. Who Makes What Decisions?

		National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils						
A	By overall system completion					
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I	Auxiliary content outside of syllabi					
Methods of instruction						
J	Textbook selection					
K	Instructional methods/techniques					
Examinations						
L	Content of examinations					
M	Examination performance standards					
N	School Examination standards					

Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	60%	67%	87%	67%	67%
Content of instruction	25%	0%	75%	67%	100%
Methods (including textbooks)	17%	0%	67%	67%	83%
Examinations	78%	0%	11%	33%	33%

Notes The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

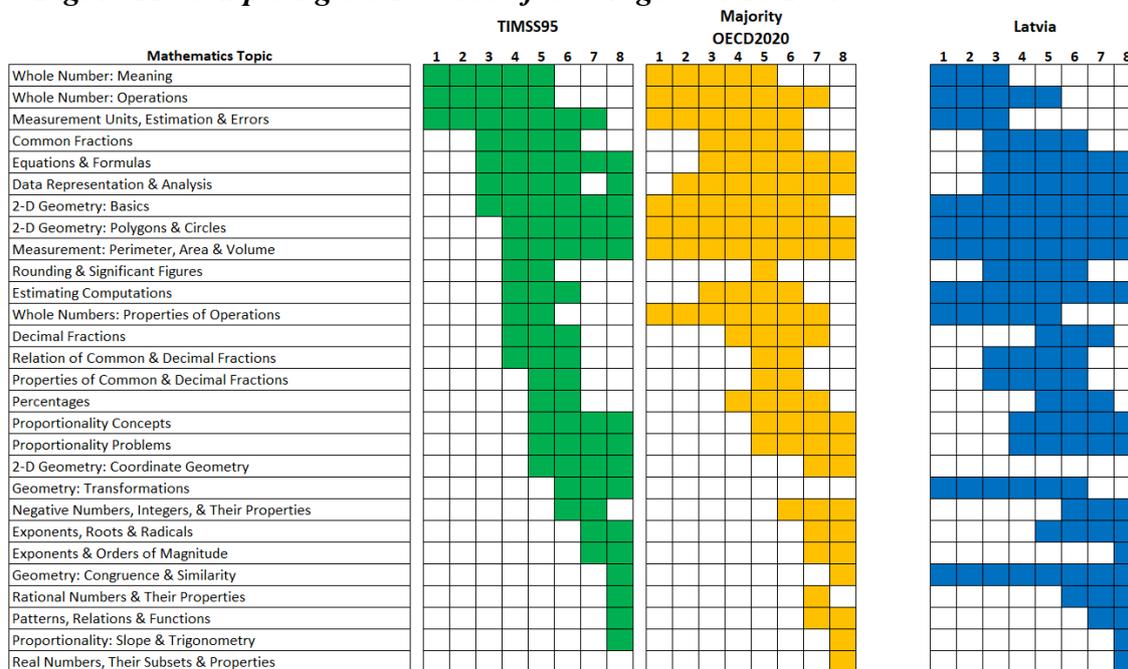
Figure 11. Relative Importance Averaged Across All 19 Countries/Jurisdictions

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	52%	24%	40%	29%	33%
Content of instruction	46%	19%	43%	42%	53%
Methods (including textbooks)	28%	18%	55%	50%	74%
Examinations	55%	16%	30%	40%	41%

Note for Figures 9, 10 & 11. In the above figures looking across rows tells who has what role while looking down the columns especially in Figures 10 and 11, indicates over which facets each locus has the most influence. We acknowledge David E. Wiley's contribution to the study of curriculum decision making.

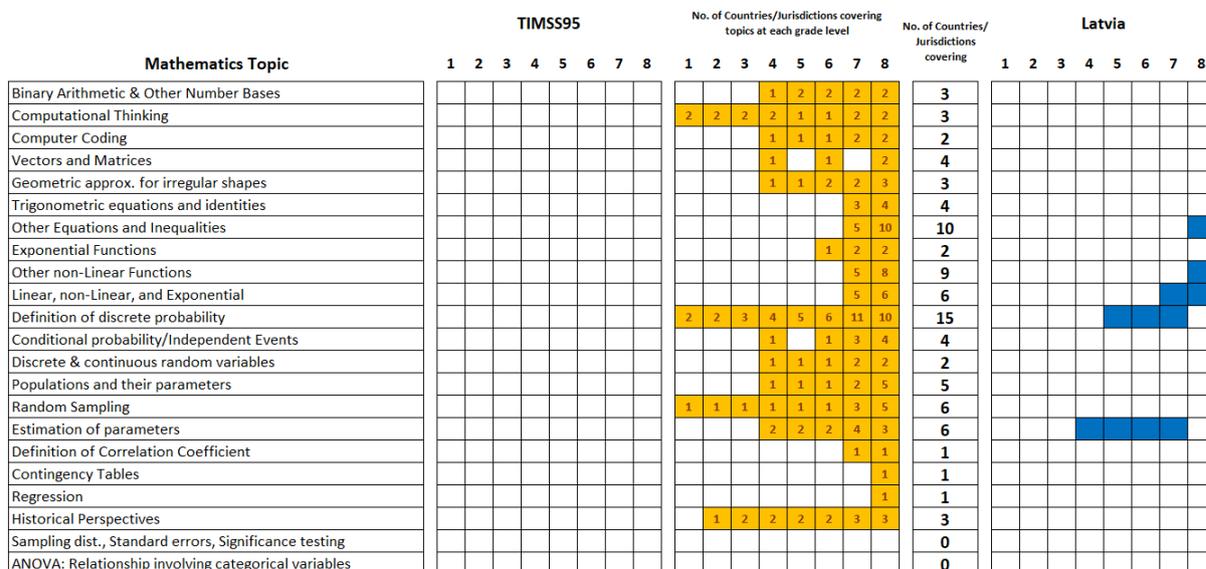
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

Figure 13. Moving into the Future: Current Coverage of Topics Defining a New Literacy



Note. Orange cells indicate the number of countries that cover that topic at that grade level. The accompanying column indicates the number of countries/jurisdictions that included that topic at any grade level; Blue cells indicate specific country/jurisdiction coverage. The absence of green cells indicates the lack of coverage of those topics in TIMSS95.

8th Grade Textbook Exercises: Book 1

Exercise Composition of Textbooks

Figure 5. Totals Over All Participants' Textbooks

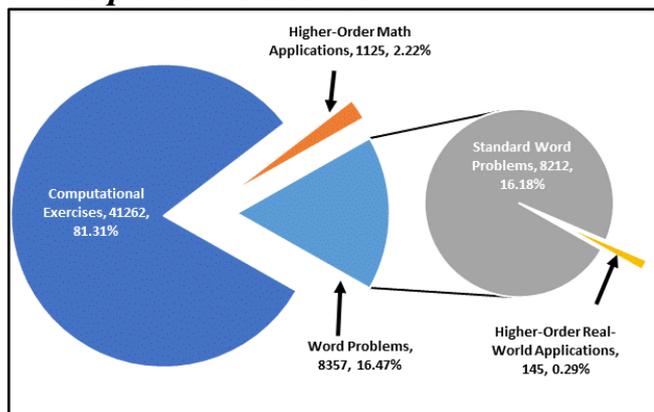
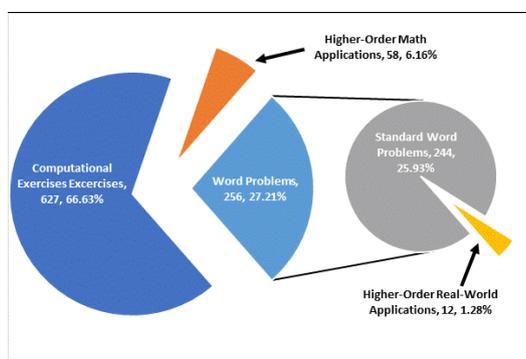


Figure 6. Country/Jurisdiction Textbook



Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

- The Blue pie diagram shows the total number of different types of exercises.
- The Grey pie diagram shows the number of standard word problems (an expansion of the light-blue wedge).
- The Orange wedge represents the number of Higher-Order Math-World applications.
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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Type of Quantitative Reasoning

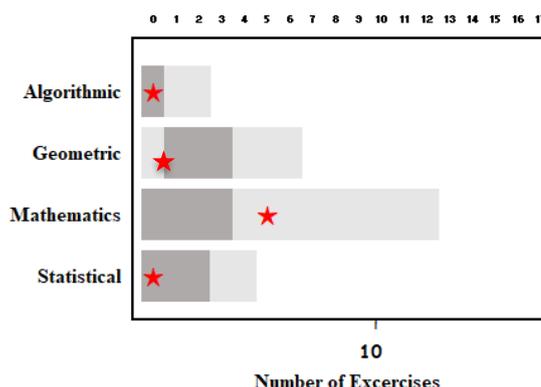
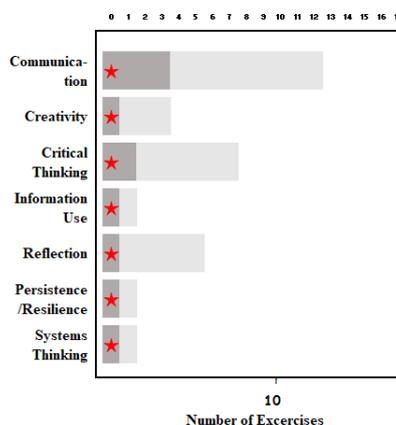


Figure 8. Type of 21st Century Competencies



Notes for Figures 7 & 8:

- Light Grey bars show the range for the number of Higher-Order Real-World application exercises of each type for each country/jurisdiction.
- Dark Grey bars show the Inter-Quartile Range (25th to 75th percentile).
- Special case: in cases where the majority of the country's/jurisdiction's values were 0, the light grey bar encompasses the dark grey bar.
- The stars show the number of Higher-Order Real-World application exercises of each type that are included.

8th Grade Textbook Exercises: Book 2

Exercise Composition of Textbooks

Figure 5. Totals Over All Participants' Textbooks

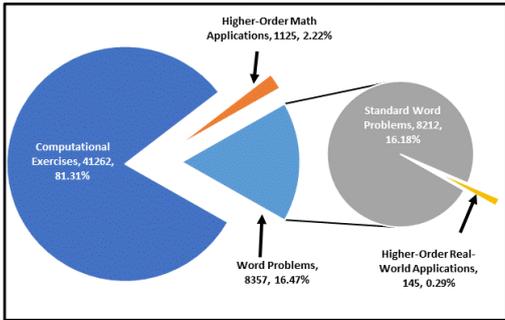
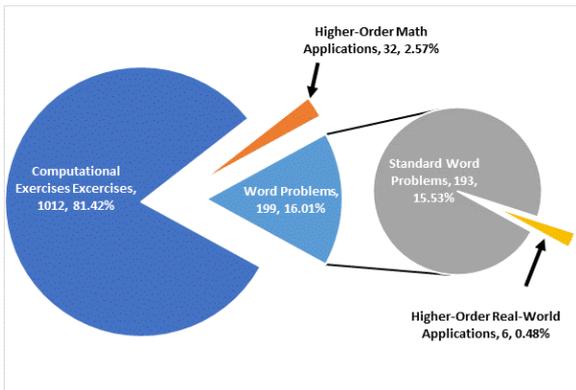


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Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

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Characteristics of Higher-Order Real- World Application Textbook Exercises

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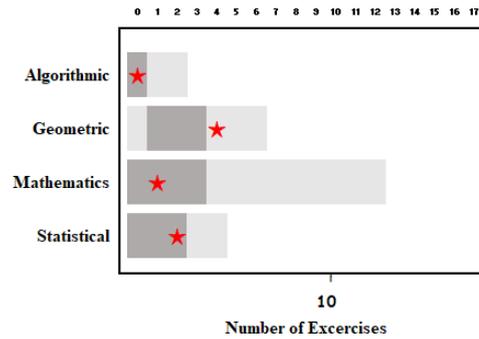
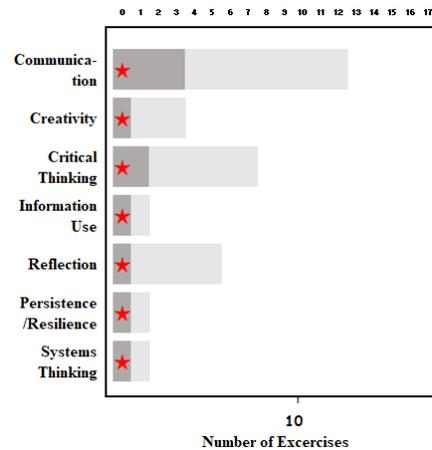


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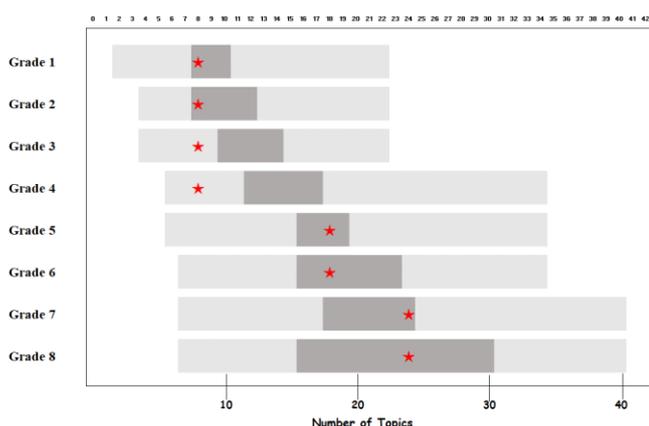
Lithuania

Curriculum Standards

Index

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Figure 1. Number of Topics to be Covered at each Grade



Notes for Figure 1:

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- The stars show the number of topics that the country/ jurisdiction intended to cover at each of the grades.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

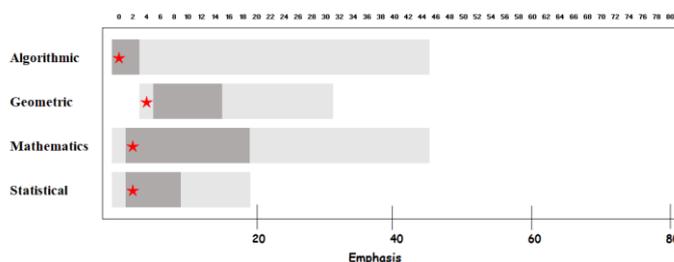


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

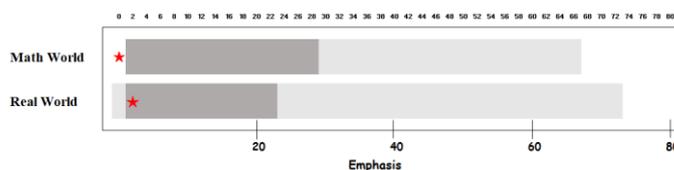
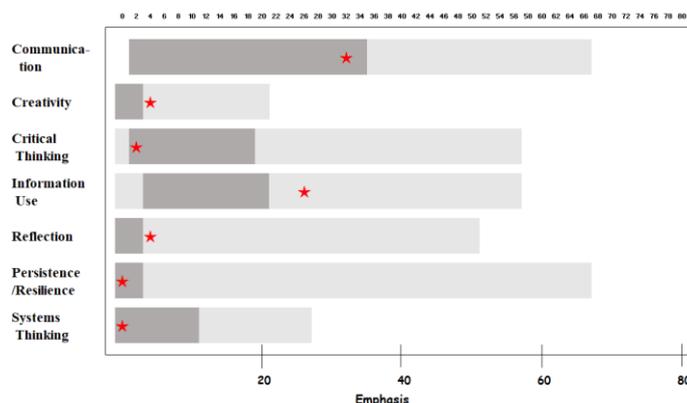


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

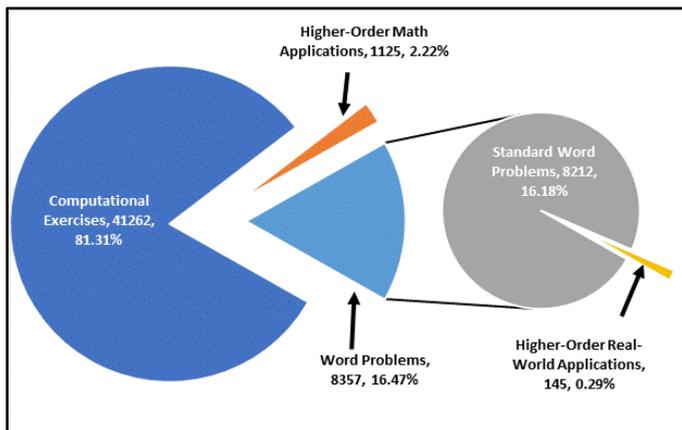
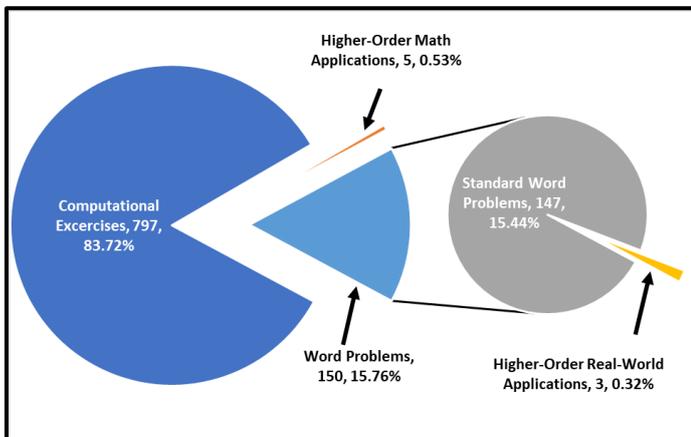


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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

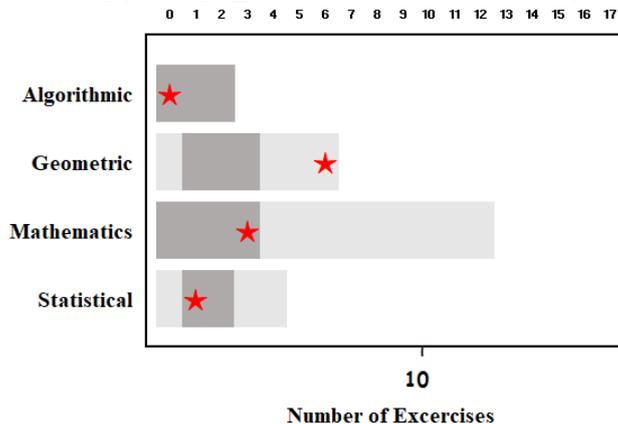
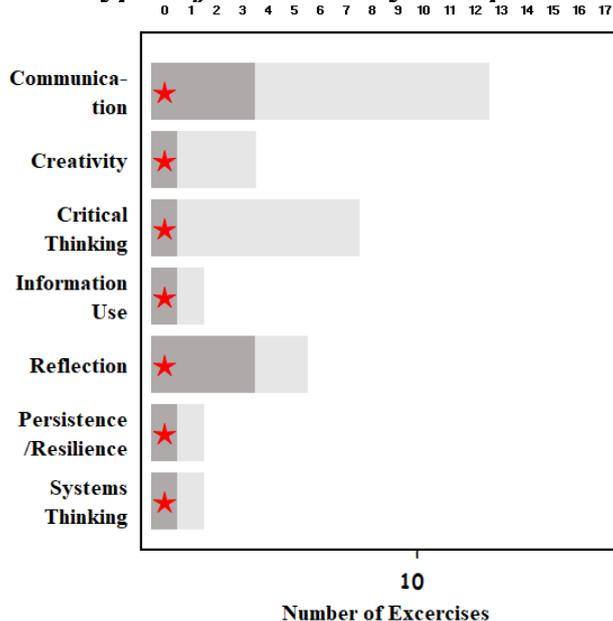


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

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Curriculum Decision Making

	0	1	2	3
Decision Role:	No formal role	Advice & recommendations	Constrain, veto or modify recommendations	Final authority or approval

Figure 9. Who Makes What Decisions?

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils					
A	By overall system completion				
B	For intermediate stages				
C	For differentiated programme types				
D	To be reached in a given grade				
E	To apply for a specific school				
Content of instruction					
F	Course (grade level) offerings				
G	Student course assignment rules				
H	Course content (syllabi)				
I	Auxiliary content outside of syllabi				
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K	Instructional methods/techniques				
Examinations					
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Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

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Examinations	78%	0%	11%	33%	33%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

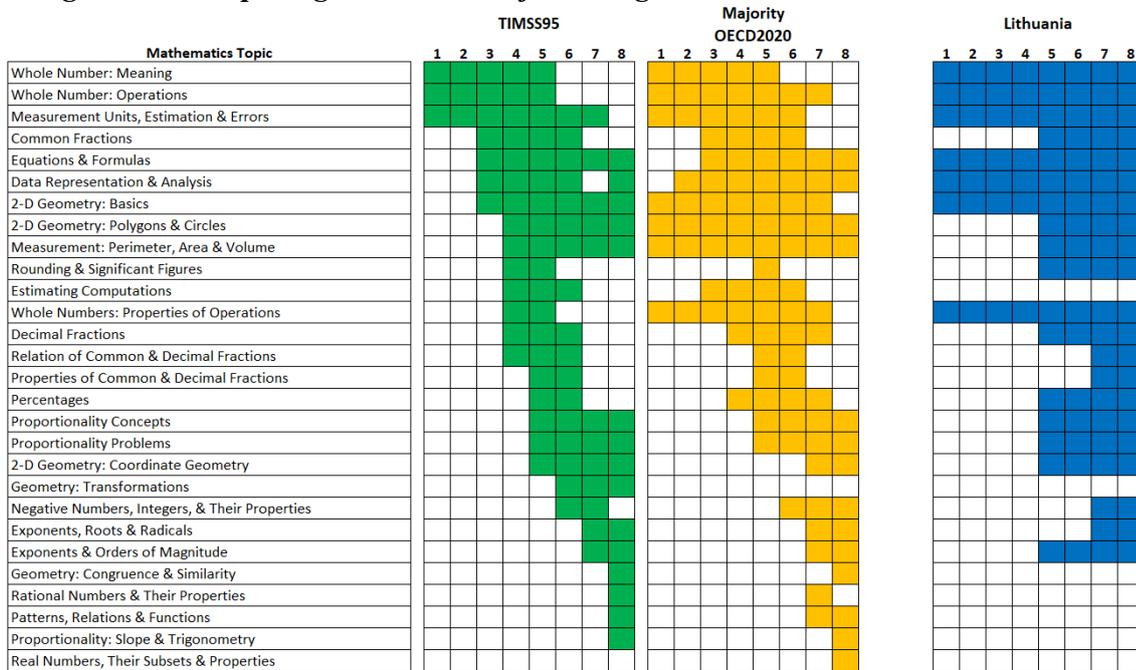
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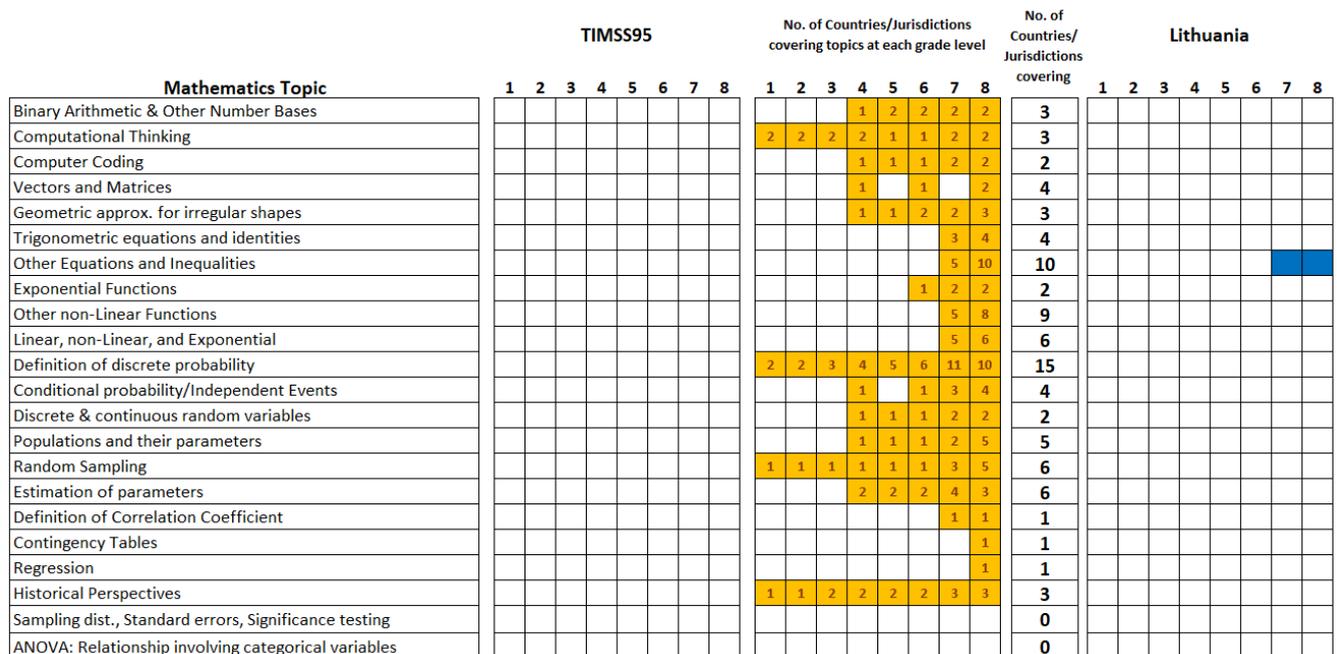
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

Figure 13. Moving into the Future: Current Coverage of Topics Defining a New Literacy



Note. Orange cells indicate the number of countries that cover that topic at that grade level. The accompanying column indicates the number of countries/jurisdictions that included that topic at any grade level; Blue cells indicate specific country/jurisdiction coverage. The absence of green cells indicates the lack of coverage of those topics in TIMSS95.

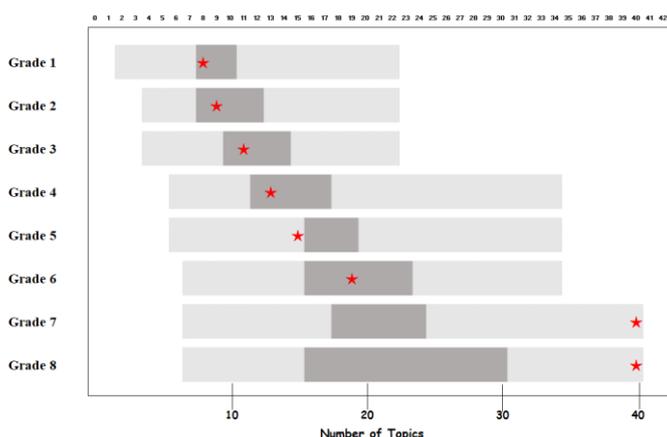
Netherlands

Curriculum Standards

Index

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Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

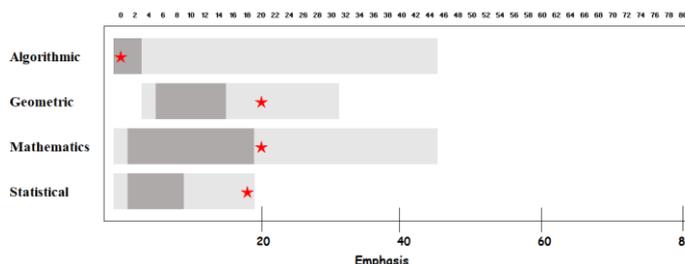


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

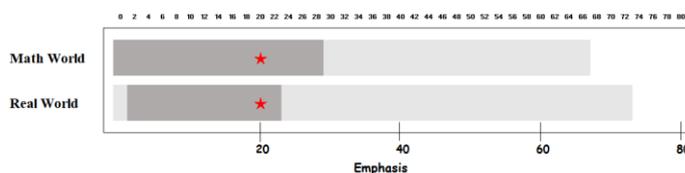
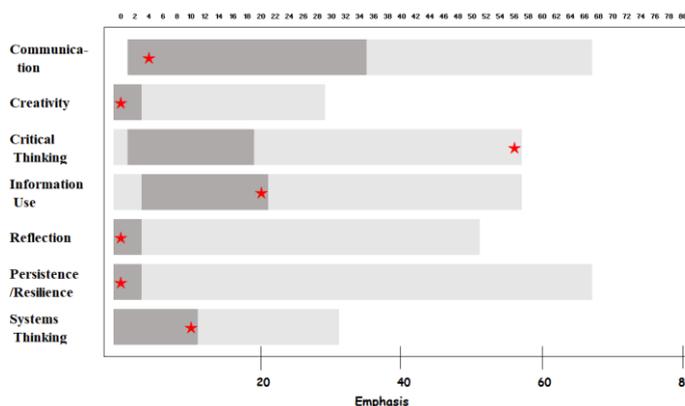


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

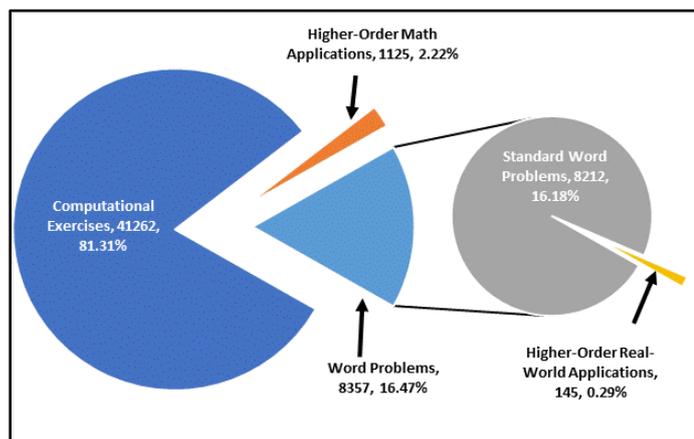
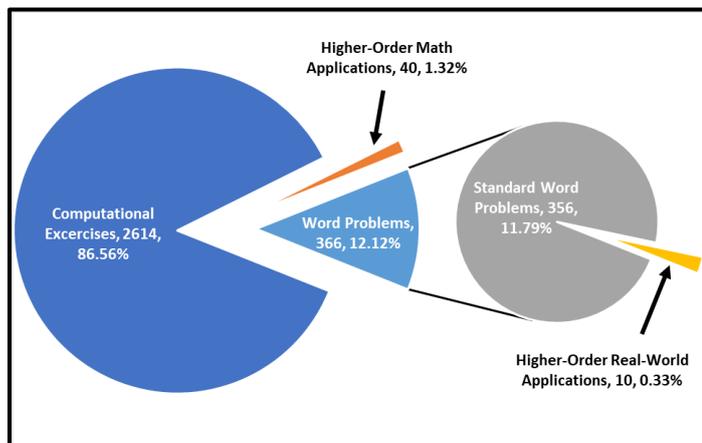


Figure 6. Country/Jurisdiction Textbook



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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

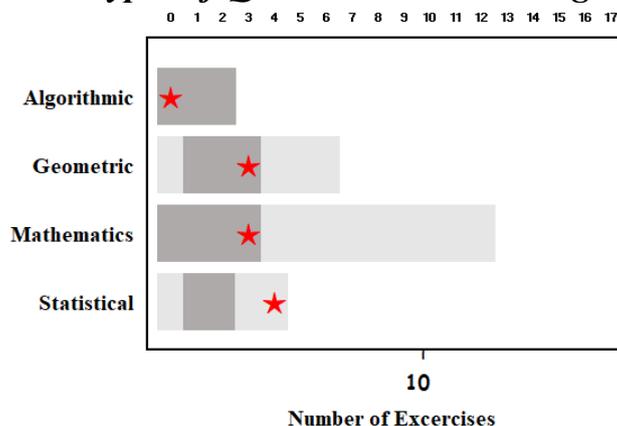
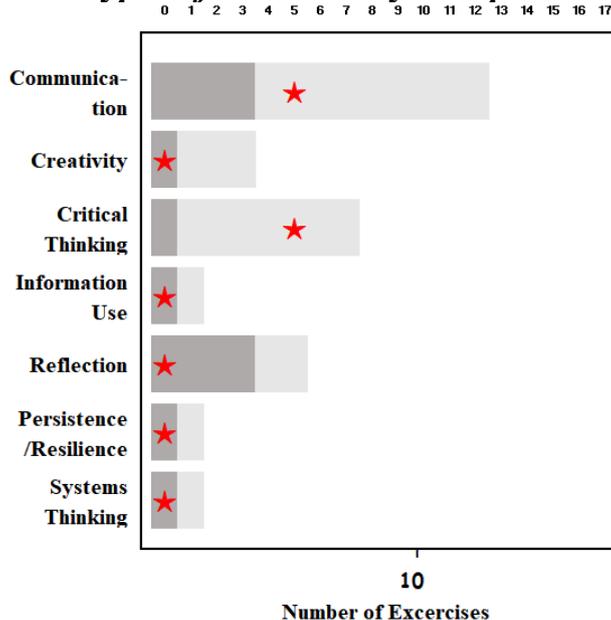


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Content of instruction	0%	0%	0%	100%	100%
Methods (including textbooks)	0%	0%	67%	50%	100%
Examinations	67%	0%	0%	67%	67%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

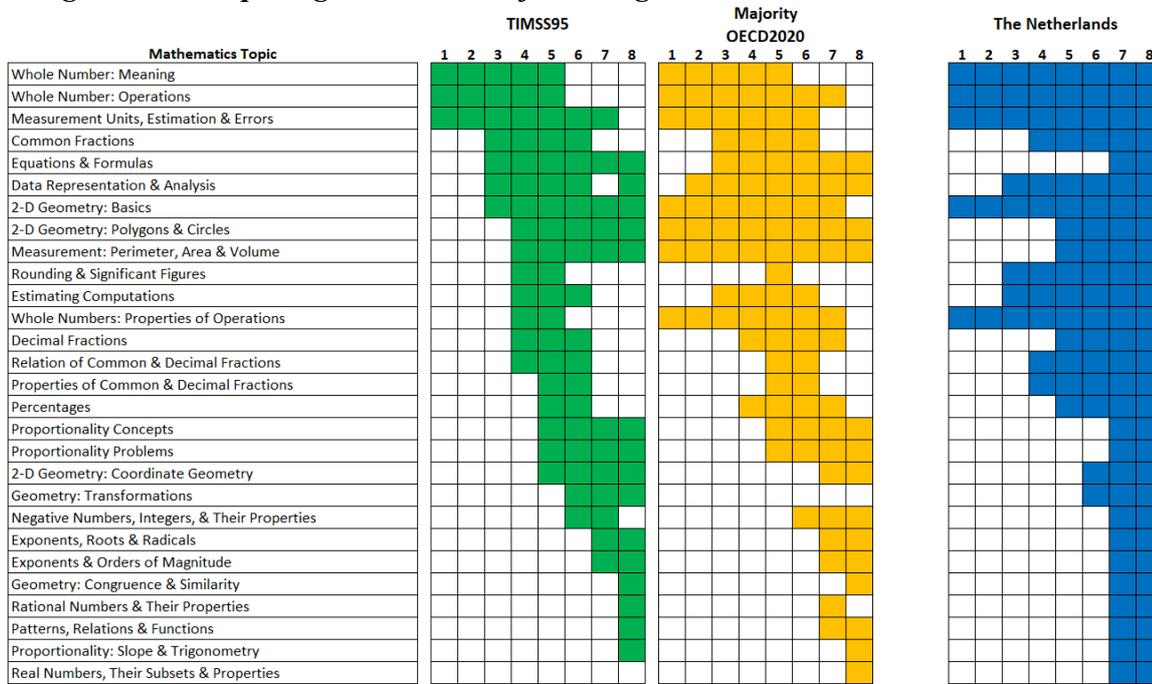
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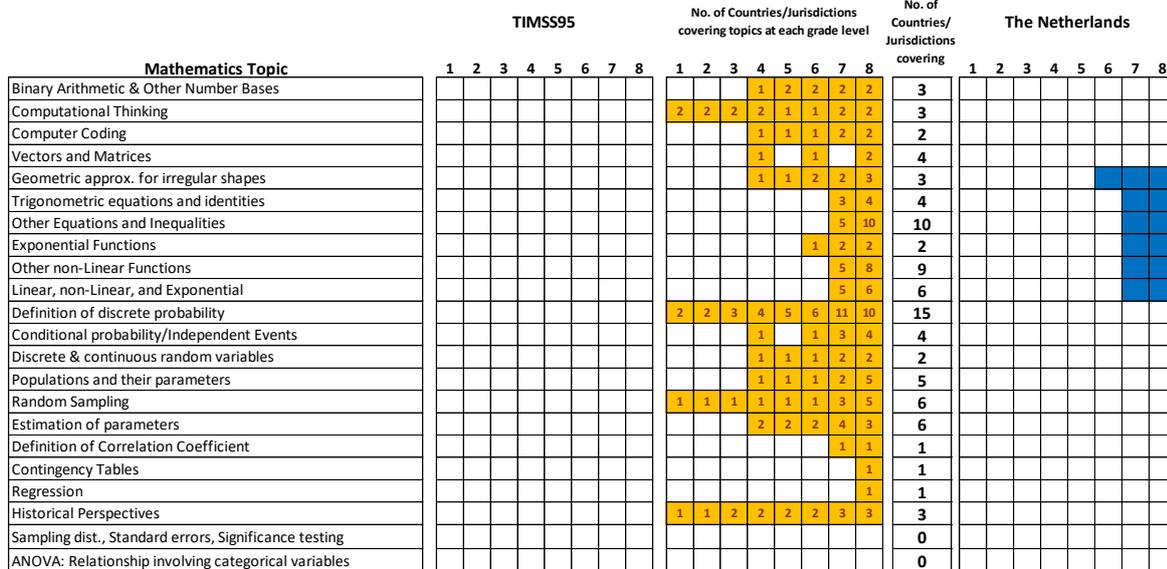
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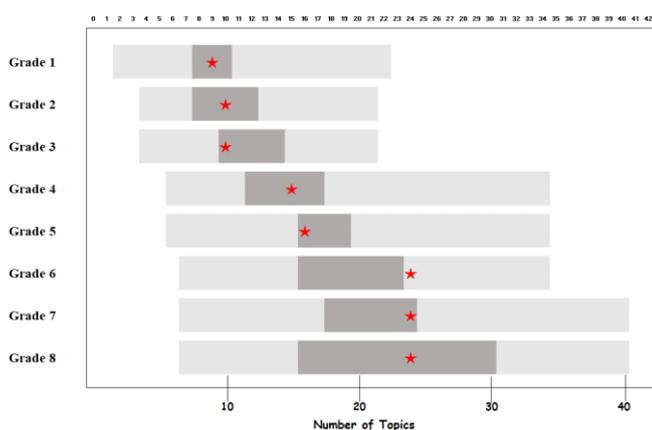
New Zealand

Curriculum Standards

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Notes for Country Level Grade Designations:

- The equivalent grade designations for New Zealand are 1-9 where 9 is the equivalent of 8th grade. Accordingly, when interpreting New Zealand results, grades 1 and 2 are noted by grade 1 throughout the report and grade 9 is equivalent to grade 8 internationally. Between international grades 2 and 7 are New Zealand Grades 3 – 8.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

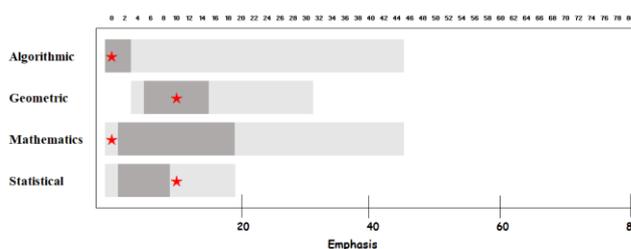


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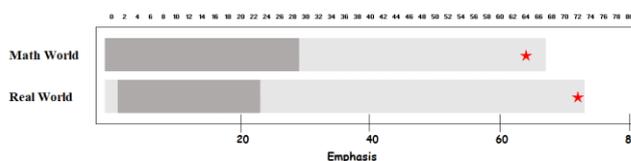
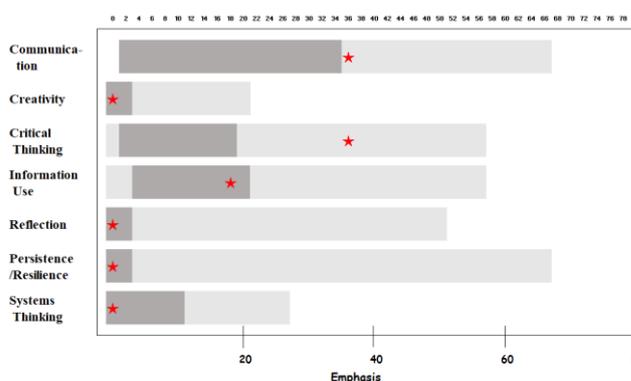


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8th Grade Textbook Exercises

Textbook Exercise Composition

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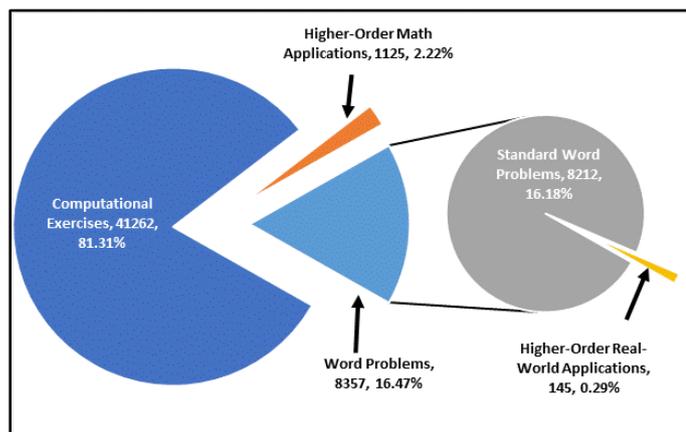
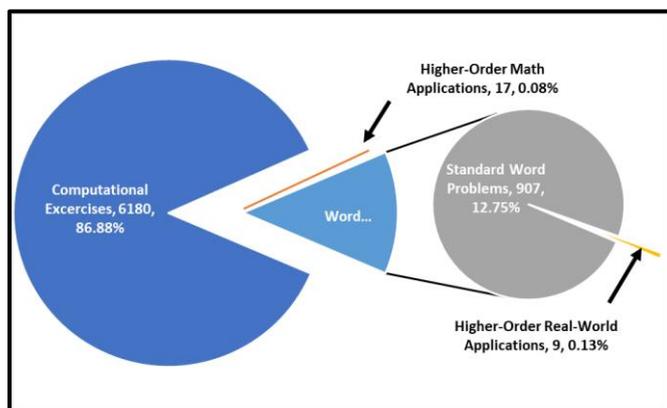


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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

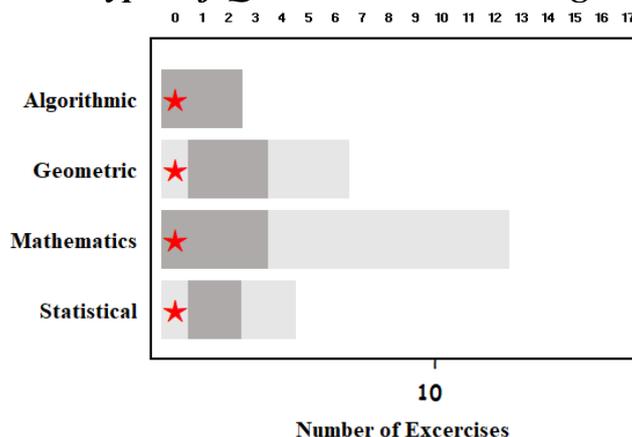
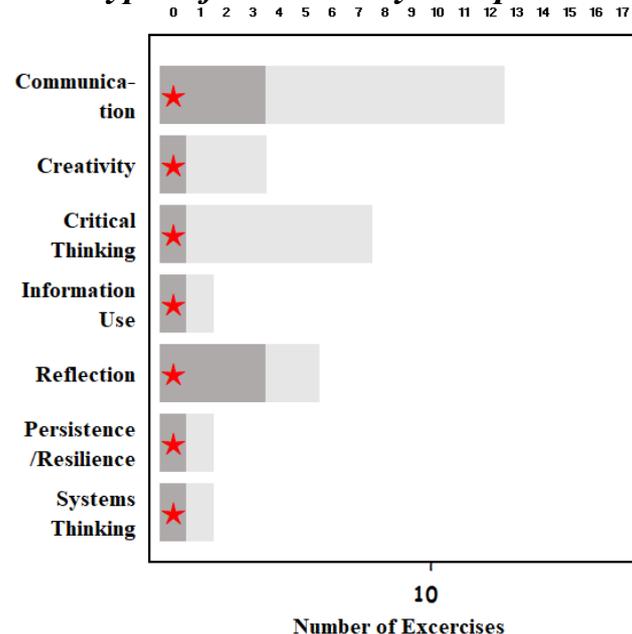


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

- Light Grey bars show the range for the number of Higher-Order Real-World application exercises of each type for each country/jurisdiction.
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Curriculum Decision Making

	0	1	2	3
Decision Role:	No formal role	Advice & recommendations	Constrain, veto or modify recommendations	Final authority or approval

Figure 9. Who Makes What Decisions?

		National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils						
A	By overall system completion					
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H	Course content (syllabi)					
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Methods of instruction						
J	Textbook selection					
K	Instructional methods/techniques					
Examinations						
L	Content of examinations					
M	Examination performance standards					
N	School Examination standards					

Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	60%	0%	87%	87%	87%
Content of instruction	25%	0%	100%	100%	100%
Methods (including textbooks)	0%	0%	100%	100%	100%
Examinations	100%	0%	22%	22%	22%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. Note. The facet Methods of Instruction includes textbook selection as well.

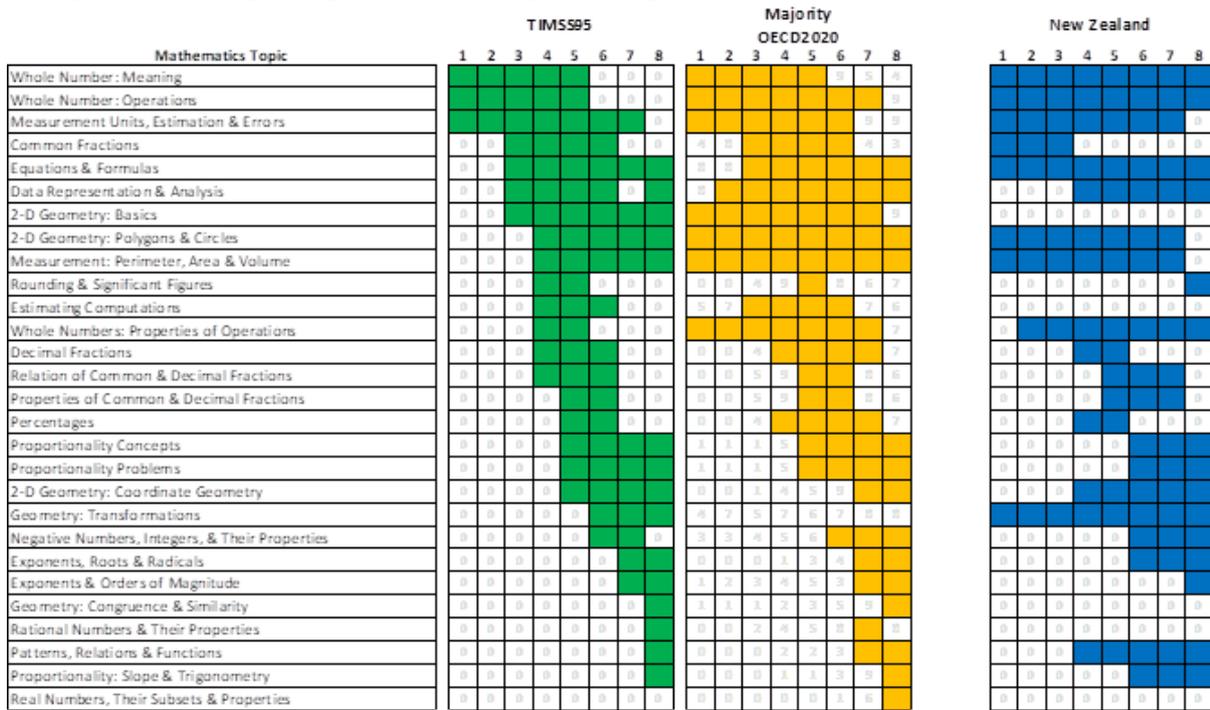
Figure 11. Relative Importance Averaged Across All 19 Countries/Jurisdictions

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	52%	24%	40%	29%	33%
Content of instruction	46%	19%	43%	42%	53%
Methods (including textbooks)	28%	18%	55%	50%	74%
Examinations	55%	16%	30%	40%	41%

Note for Figures 9, 10 & 11. In the above figures looking across rows tells who has what role while looking down the columns especially in Figures 10 and 11, indicates over which facets each locus has the most influence. We acknowledge David E. Wiley's contribution to the study of curriculum decision making.

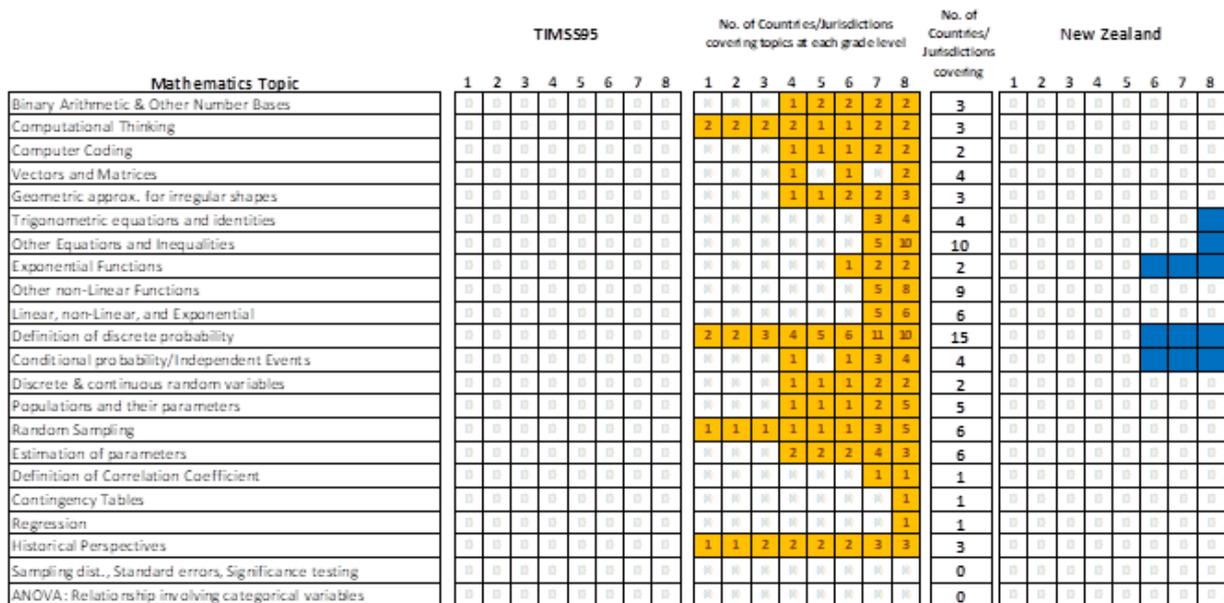
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

Figure 13. Moving into the Future: Current Coverage of Topics Defining a New Literacy



Note. Orange cells indicate the number of countries that cover that topic at that grade level. The accompanying column indicates the number of countries/jurisdictions that included that topic at any grade level; Blue cells indicate specific country/jurisdiction coverage. The absence of green cells indicates the lack of coverage of those topics in TIMSS95.

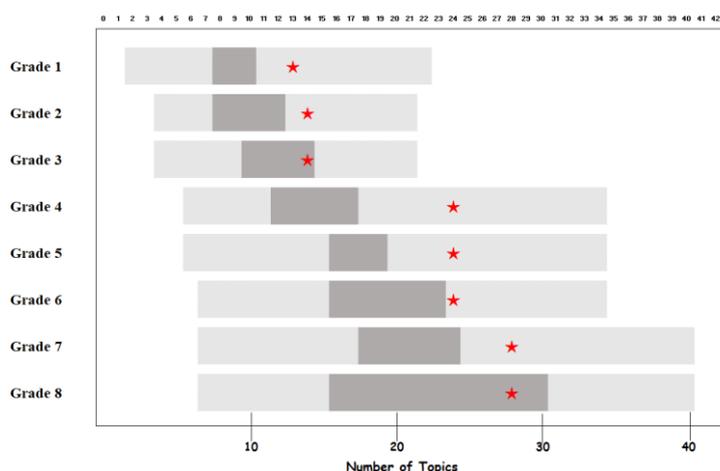
Norway

Curriculum Standards

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Figure 1. Number of Topics to be Covered at each Grade



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Notes for Country Level Grade Designations:

- The equivalent grade designations for Norway are 1-9 where 9 is the equivalent of 8th grade. Accordingly, when interpreting Norwegian results, grades 1 and 2 are noted by grade 1 throughout the report and grade 9 is equivalent to grade 8 internationally. Between international grades 2 and 7 are Norway Grades 3 – 8.
- Norway refers to the above curriculum as LK06.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

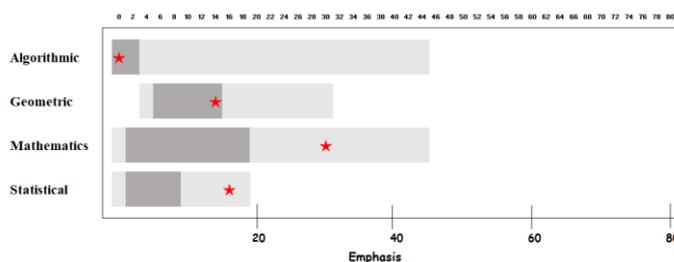


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

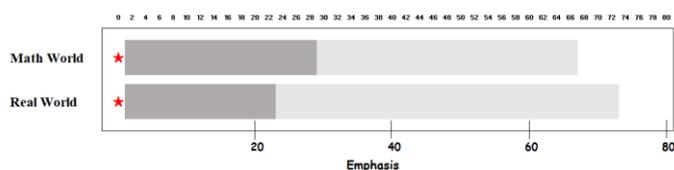
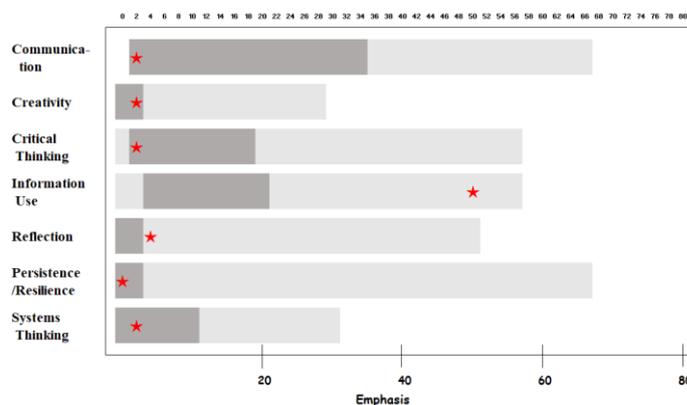


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

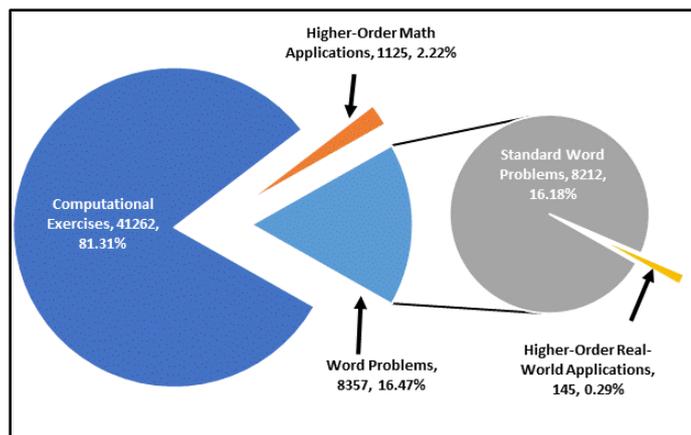
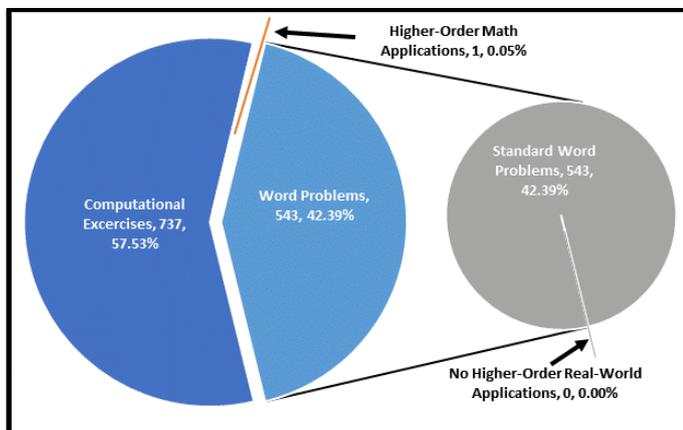


Figure 6. Country/Jurisdiction Textbook



Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

- The Blue pie diagram shows the total number of different types of exercises.
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- The Orange wedge represents the number of Higher-Order Math-World applications.
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- For countries/jurisdictions that coded 2 textbooks, the average number of exercises of the two textbooks was used in Figures 5, 6, 7 and 8.

Characteristics of Higher-Order Real-World Application Textbook Exercises

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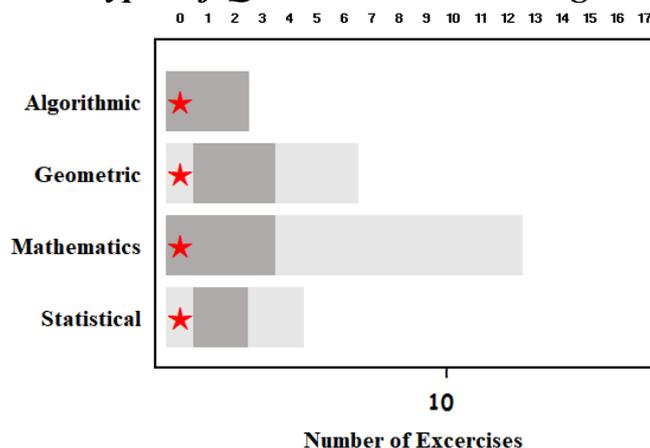
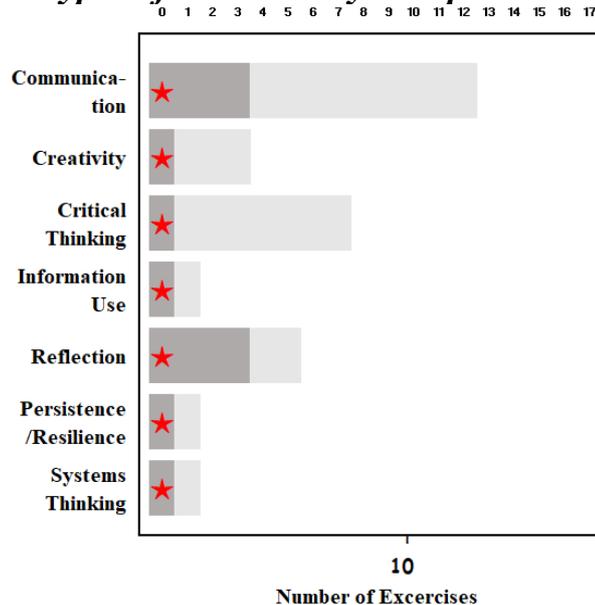


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Content of instruction	75%	25%	25%	25%	25%
Methods (including textbooks)	17%	50%	67%	67%	100%
Examinations	100%	33%	33%	78%	56%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

Figure 11. Relative Importance Averaged Across All 19 Countries/Jurisdictions

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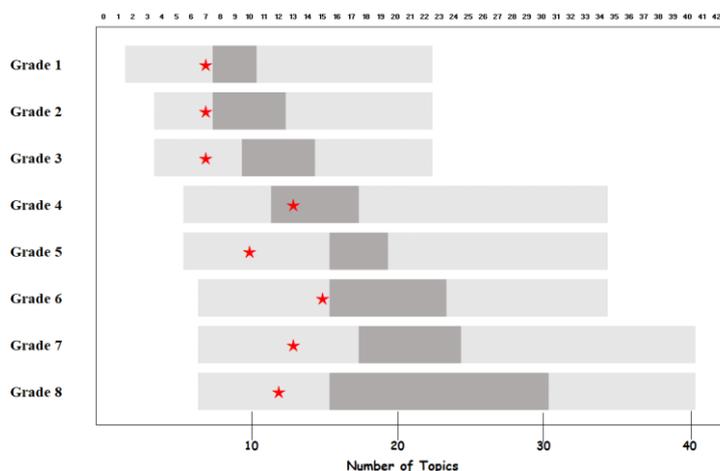
Norway

Revised Curriculum Standards*

Index

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Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

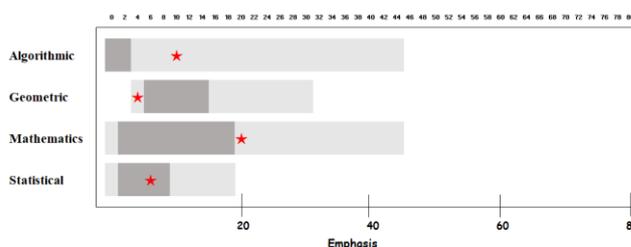


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

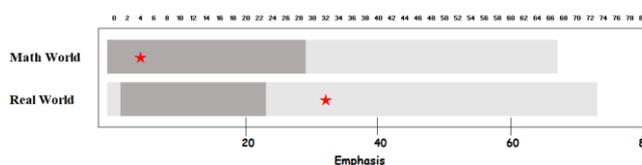
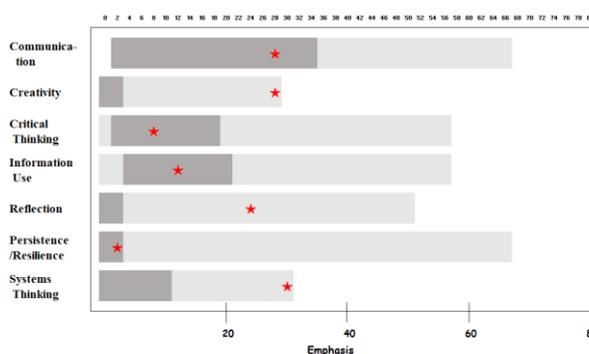


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

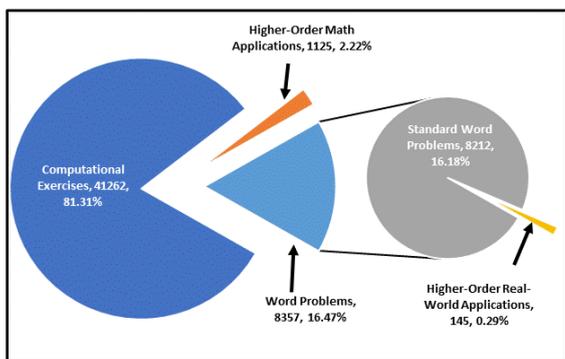
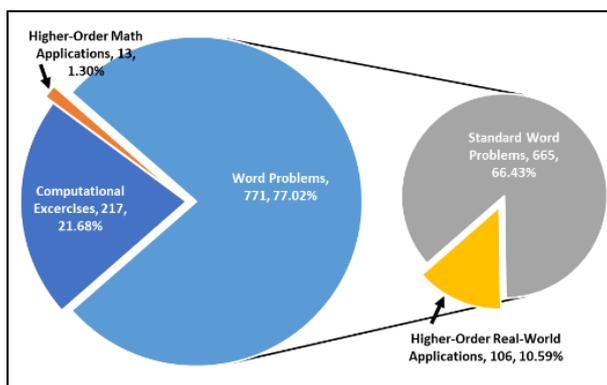


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Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

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- The Yellow wedge represents the number of Higher-Order Real-World applications.
- For countries/jurisdictions that coded 2 textbooks, the average number of exercises of the two textbooks was used in Figures 5, 6, 7 and 8.

Notes for Textbook Data:

- The data reported in the figures on this page were based on a Norwegian textbook that was coded very late in the process at Norway's special request – so as to have characteristics of a textbook written for the revised standards.
- The number of Higher-Order Real-World Application Exercises found in Figure 6 has not been verified. All the remaining numbers have been verified and are accurate.
- Figure 5 does not include the data from this textbook.

Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

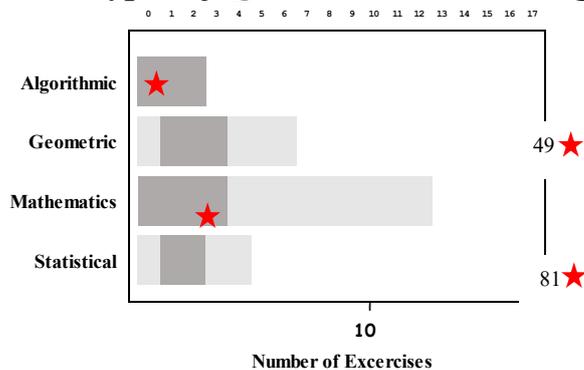
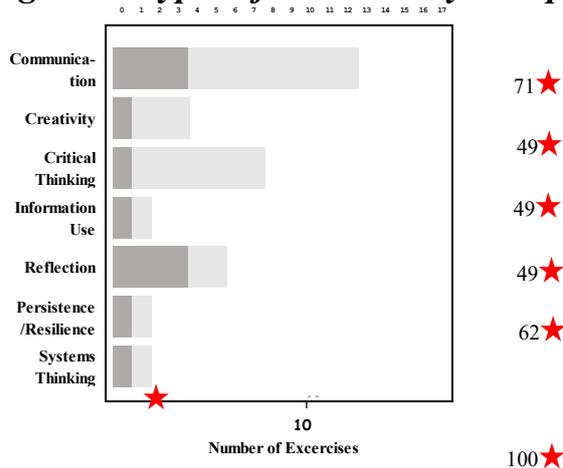


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- The stars show the number of Higher-Order Real-World application exercises of each type that are included.
- In Figures 7 and 8, because the number of exercises reported was so large and were often outside the range they are reported as actual numbers. If the number was within the scale it is represented by a star. The Ranges and Inter-Quartile Ranges were not altered.
- The large number of exercises identified as Higher-Order Real-World by Norway have not been verified, as such the numbers in Figures 7 and 8 have not been validated.

Curriculum Decision Making

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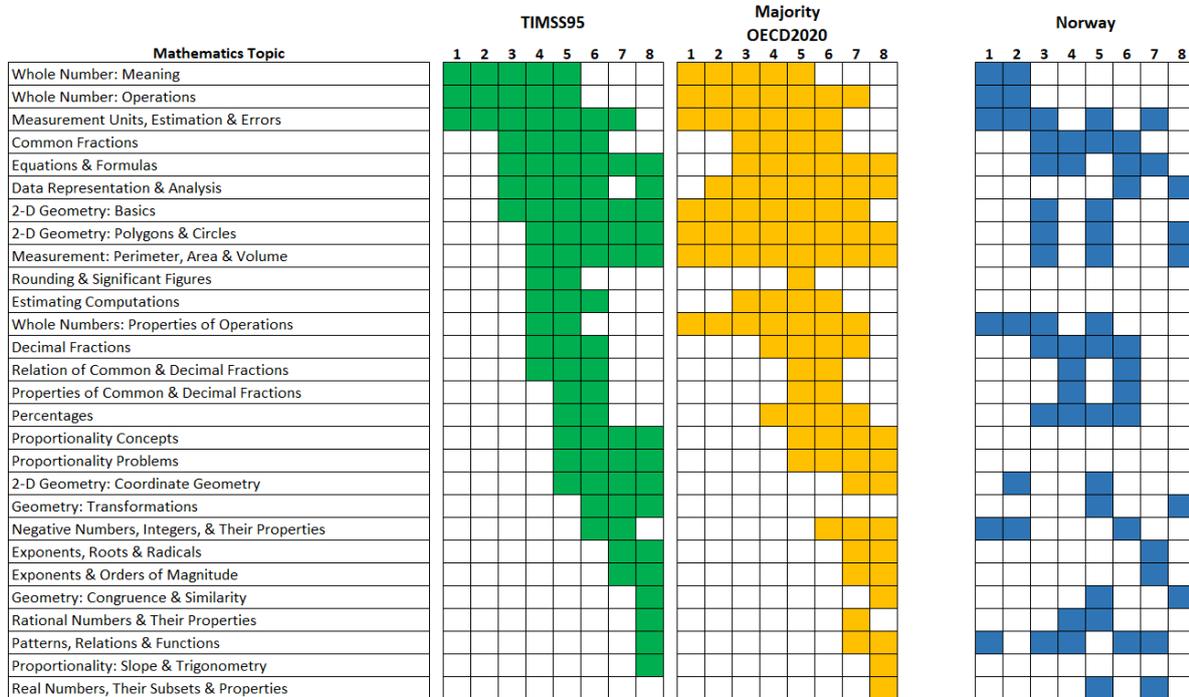
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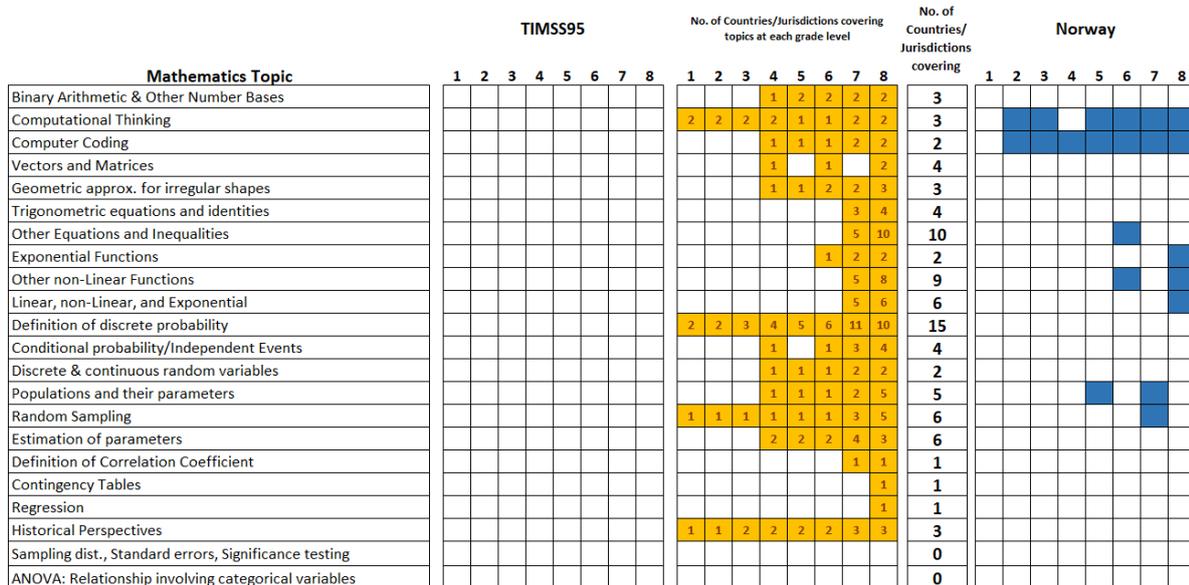
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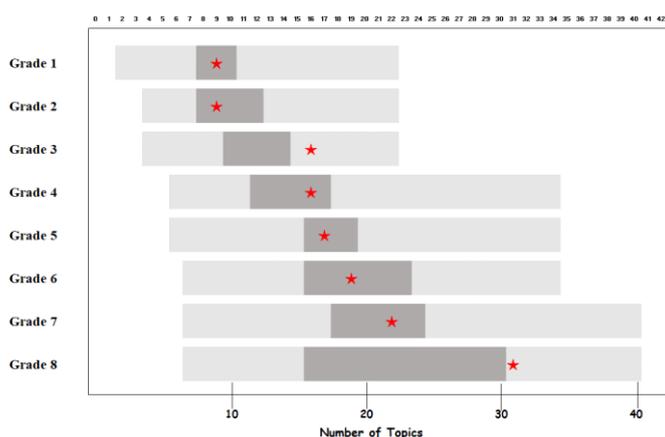
Portugal

Curriculum Standards

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Note:

- In 2021 Portugal adopted a new set of mathematics standards for grades 1-9 that will be implemented in 2022/23. Several new literacy topics (found in Figure 13) were added to the new curriculum.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

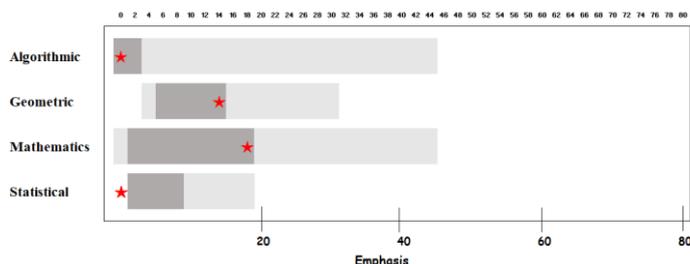


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

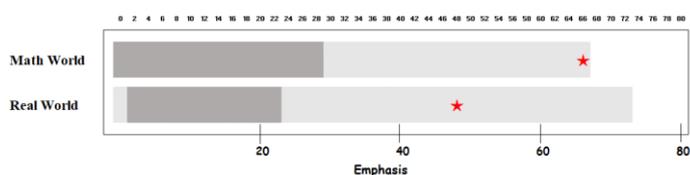
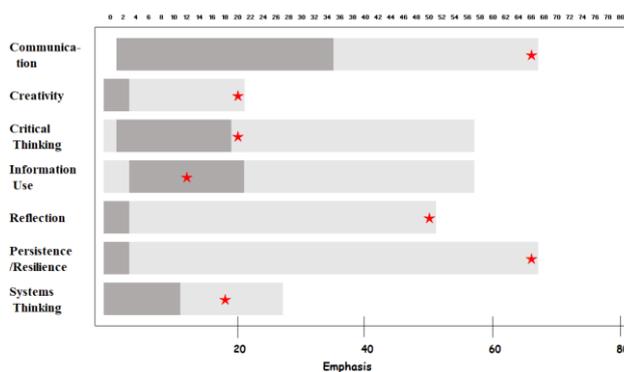


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8th Grade Textbook Exercises

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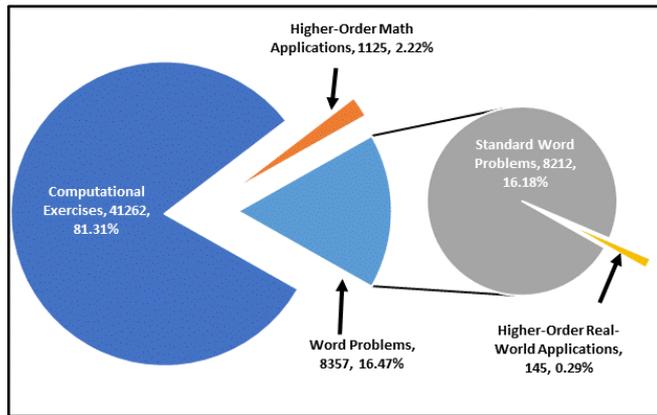
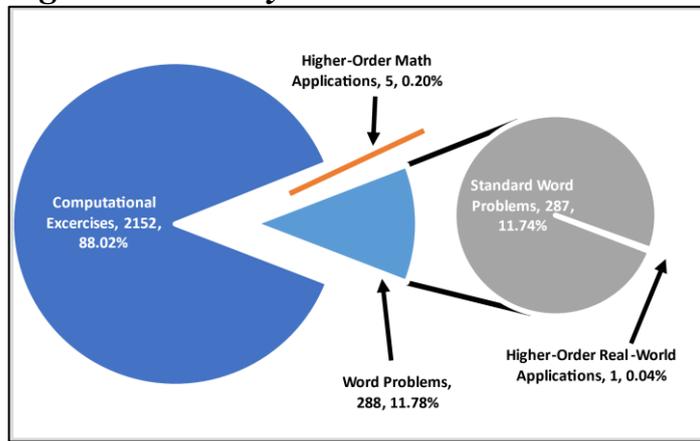


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Characteristics of Higher-Order Real-World Application Textbook Exercises

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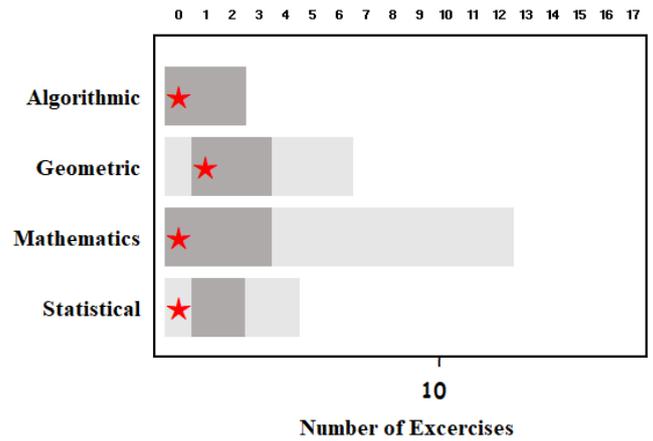
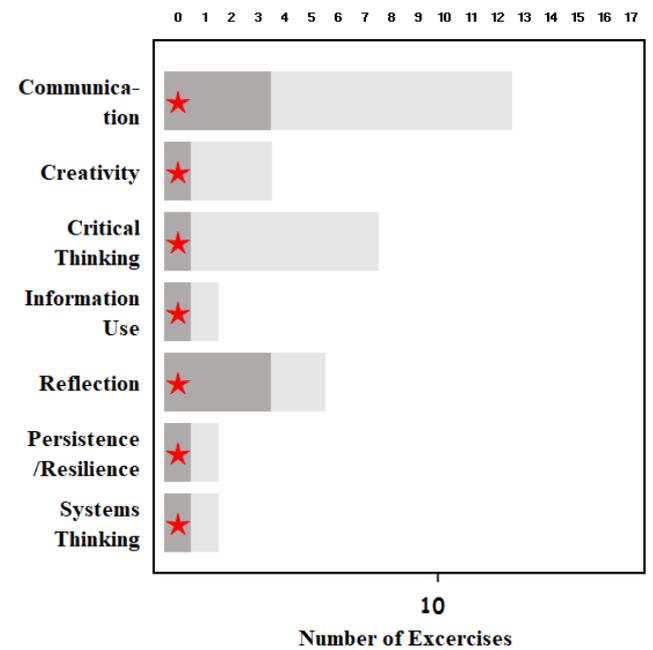


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Content of instruction	83%	0%	75%	25%	17%
Methods (including textbooks)	33%	0%	67%	33%	67%
Examinations	78%	0%	33%	11%	0%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

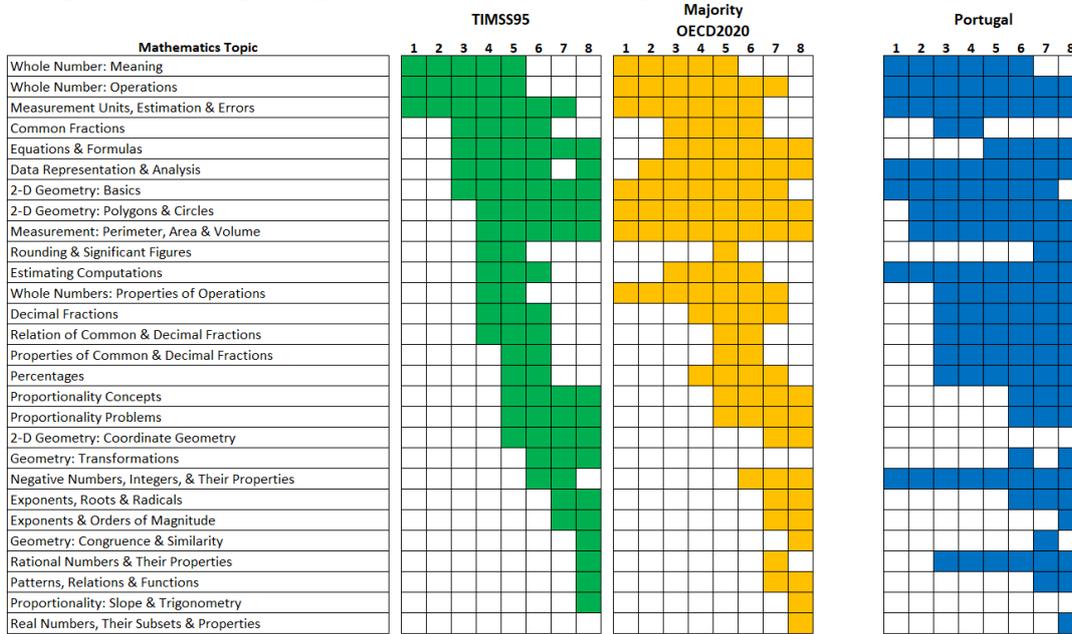
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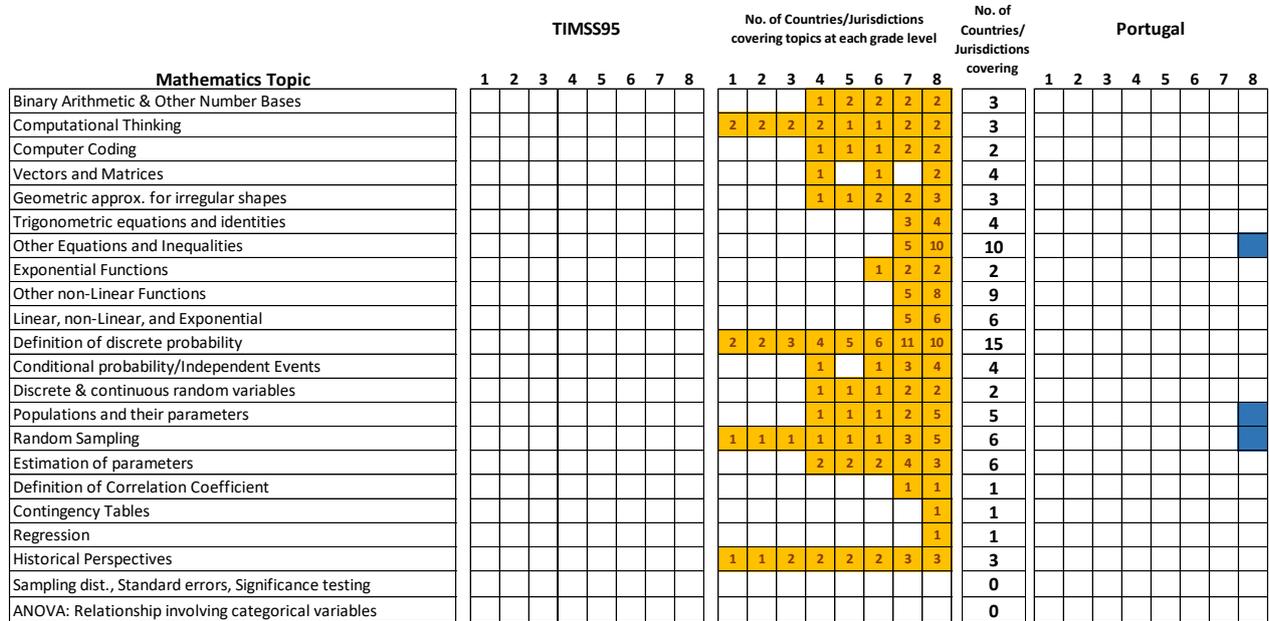
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

Figure 13. Moving into the Future: Current Coverage of Topics Defining a New Literacy



Note. Orange cells indicate the number of countries that cover that topic at that grade level. The accompanying column indicates the number of countries/jurisdictions that included that topic at any grade level; Blue cells indicate specific country/jurisdiction coverage. The absence of green cells indicates the lack of coverage of those topics in TIMSS95.

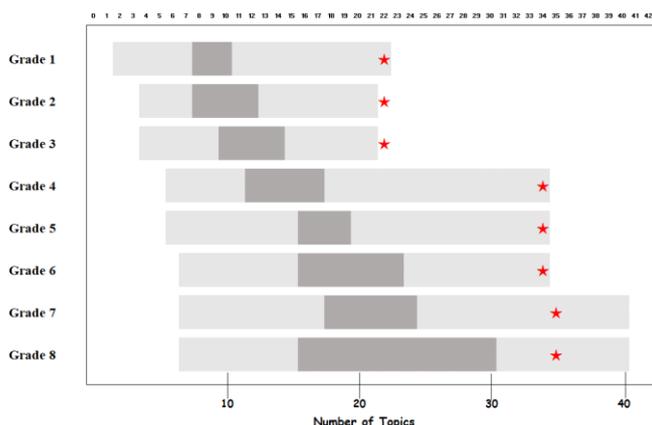
Sweden

Curriculum Standards

Index

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Figure 1. Number of Topics to be Covered at each Grade



Notes for Figure 1:

- Light Grey bars show the range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
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- The stars show the number of topics that the country/ jurisdiction intended to cover at each of the grades.

Note:

- Sweden will have a new revised curriculum starting in July 2022.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

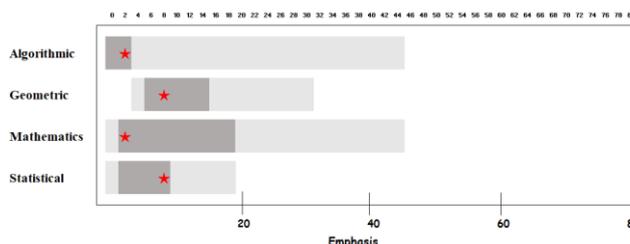


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

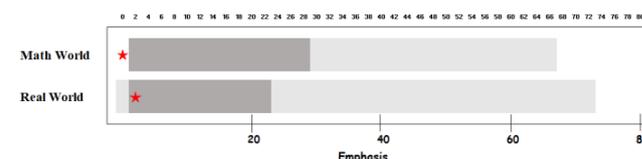
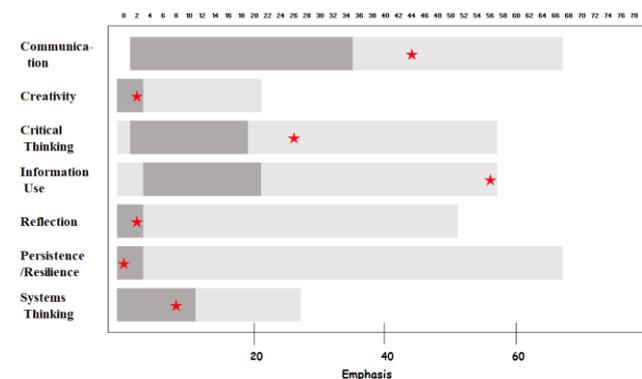


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

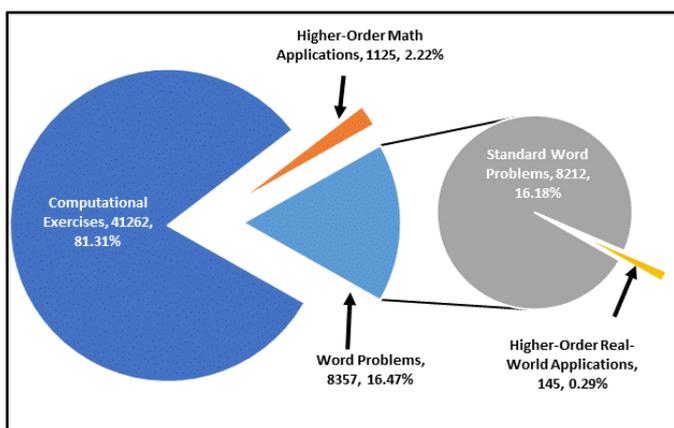
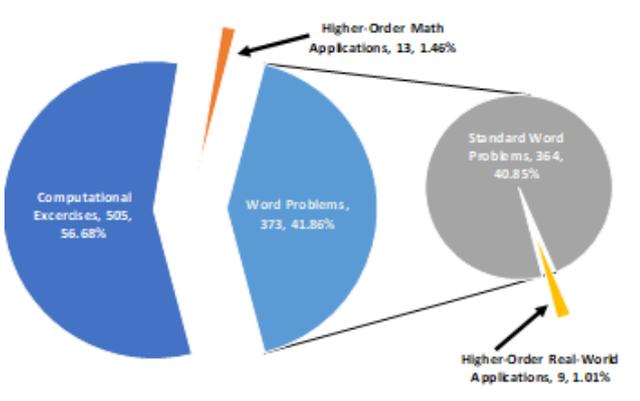


Figure 6. Country/Jurisdiction Textbook



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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

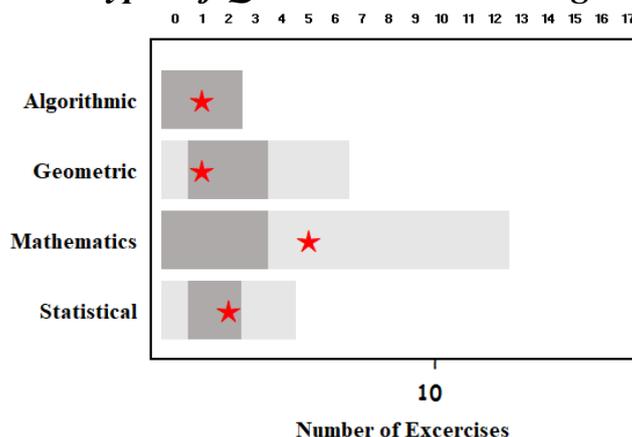
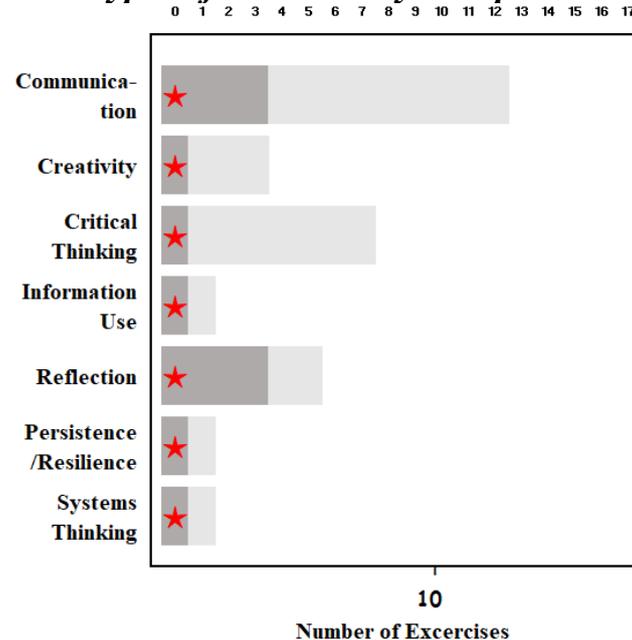


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Curriculum Decision Making

	0	1	2	3
Decision Role:	No formal role	Advice & recommendations	Constrain, veto or modify recommendation	Final authority or approval

Figure 9. Who Makes What Decisions?

		National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils						
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Examinations						
L	Content of examinations					
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N	School Examination standards					

Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	80%	20%	7%	20%	7%
Content of instruction	33%	8%	0%	8%	50%
Methods (including textbooks)	17%	0%	0%	0%	100%
Examinations	56%	0%	0%	0%	67%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

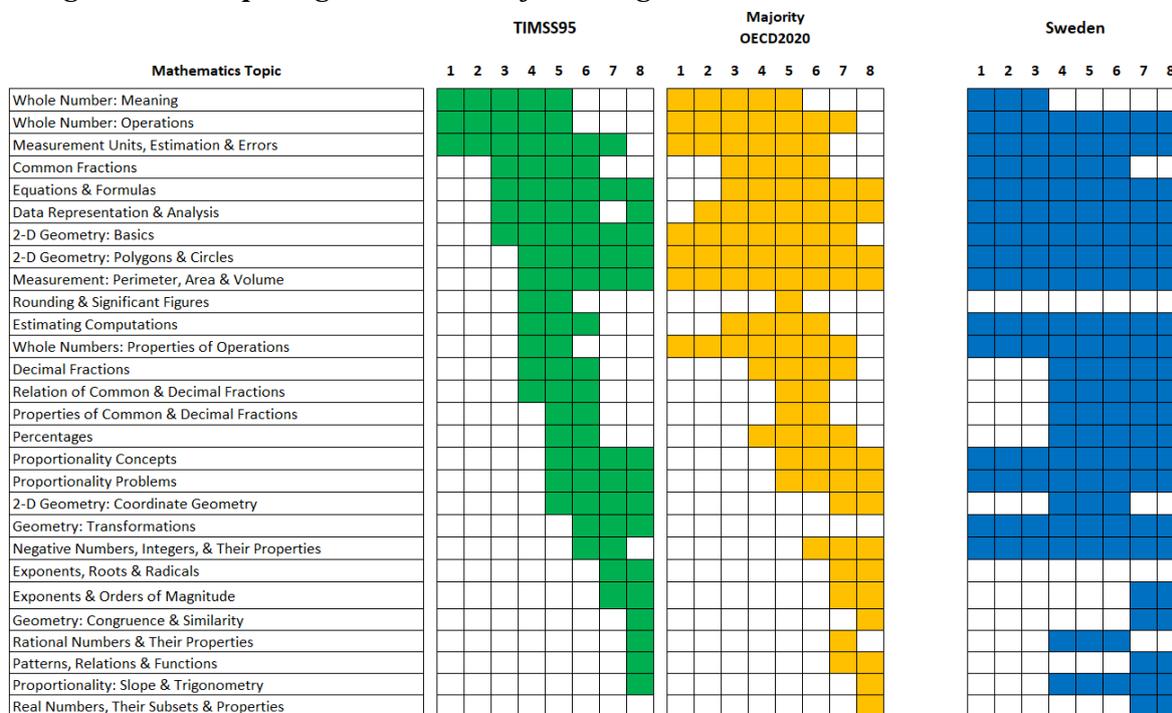
Figure 11. Relative Importance Averaged Across All 19 Countries/Jurisdictions

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	52%	24%	40%	29%	33%
Content of instruction	46%	19%	43%	42%	53%
Methods (including textbooks)	28%	18%	55%	50%	74%
Examinations	55%	16%	30%	40%	41%

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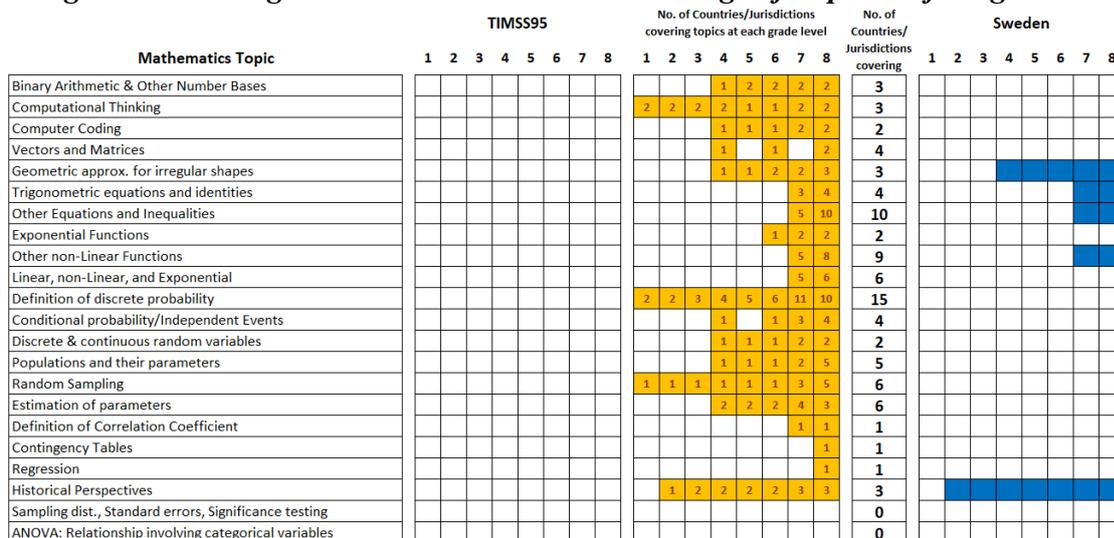
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

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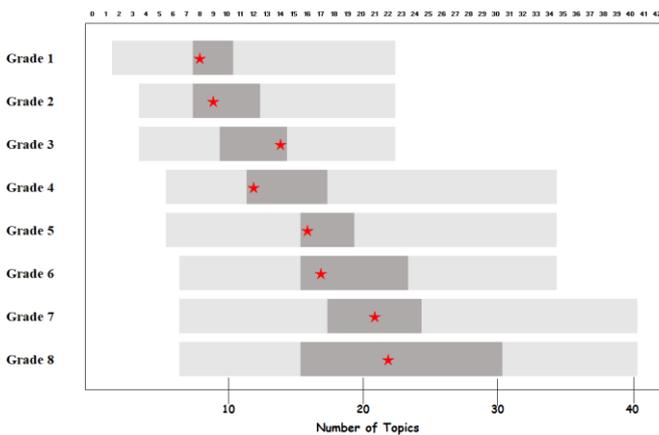
United States

Curriculum Standards

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Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

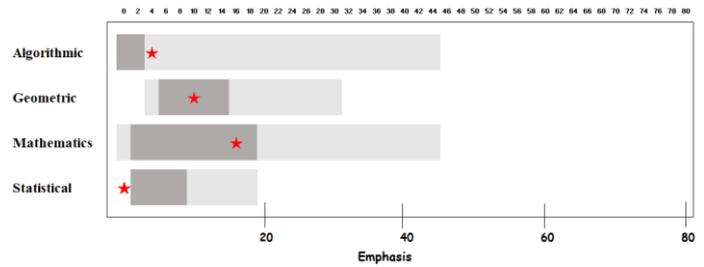


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

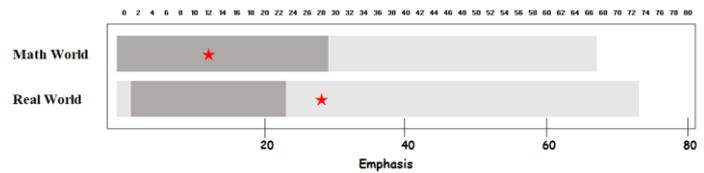
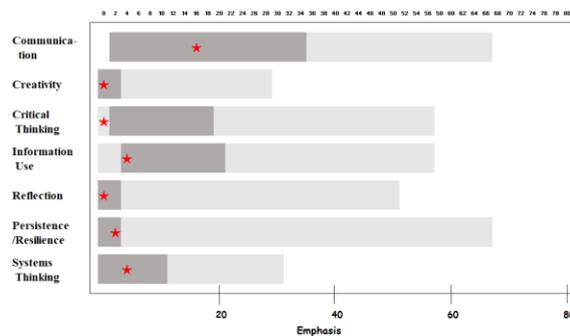


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

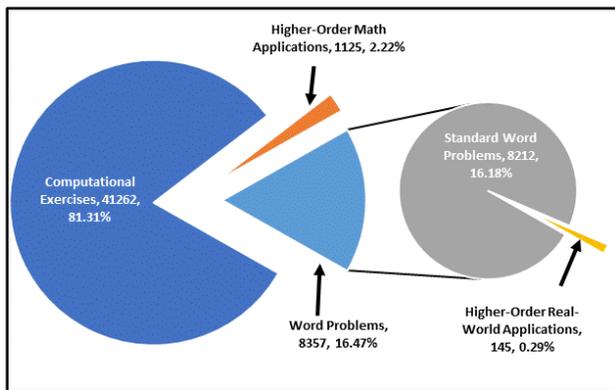
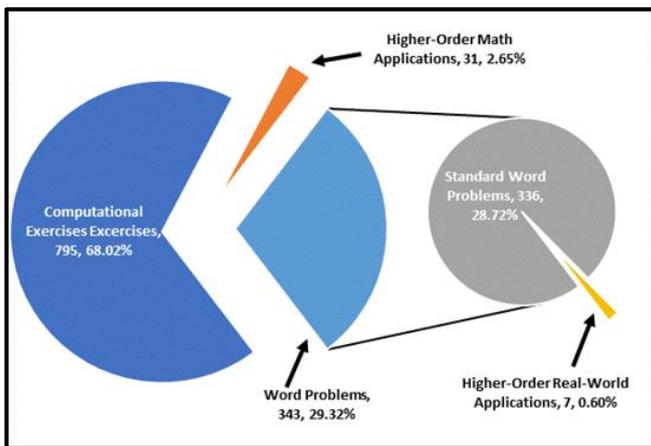


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Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

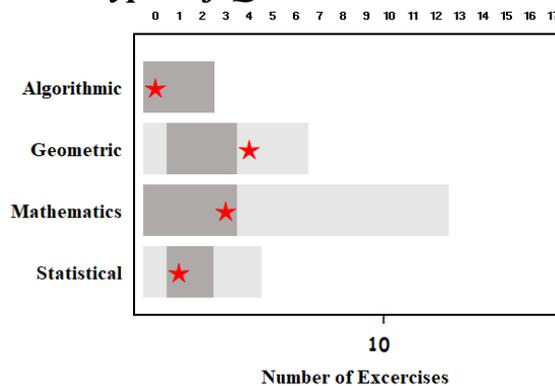
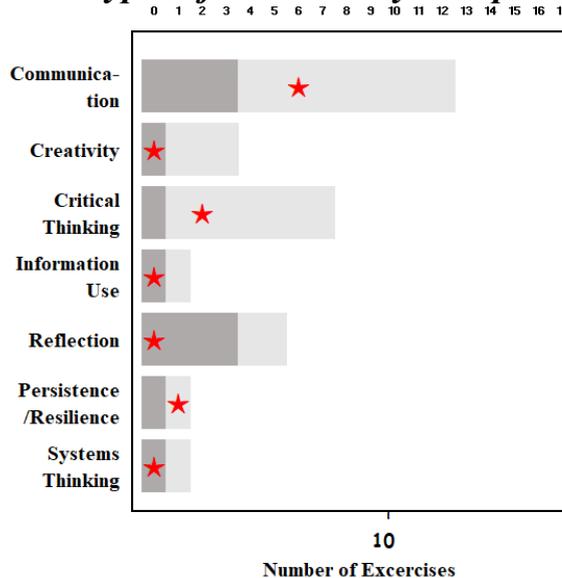


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

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Curriculum Decision Making



Figure 9. Who Makes What Decisions?

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Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	0%	100%	0%	0%	0%
Content of instruction	0%	58%	83%	50%	42%
Methods (including textbooks)	0%	17%	67%	33%	50%
Examinations	44%	100%	0%	0%	0%

Notes The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. Note. The facet Methods of Instruction includes textbook selection as well.

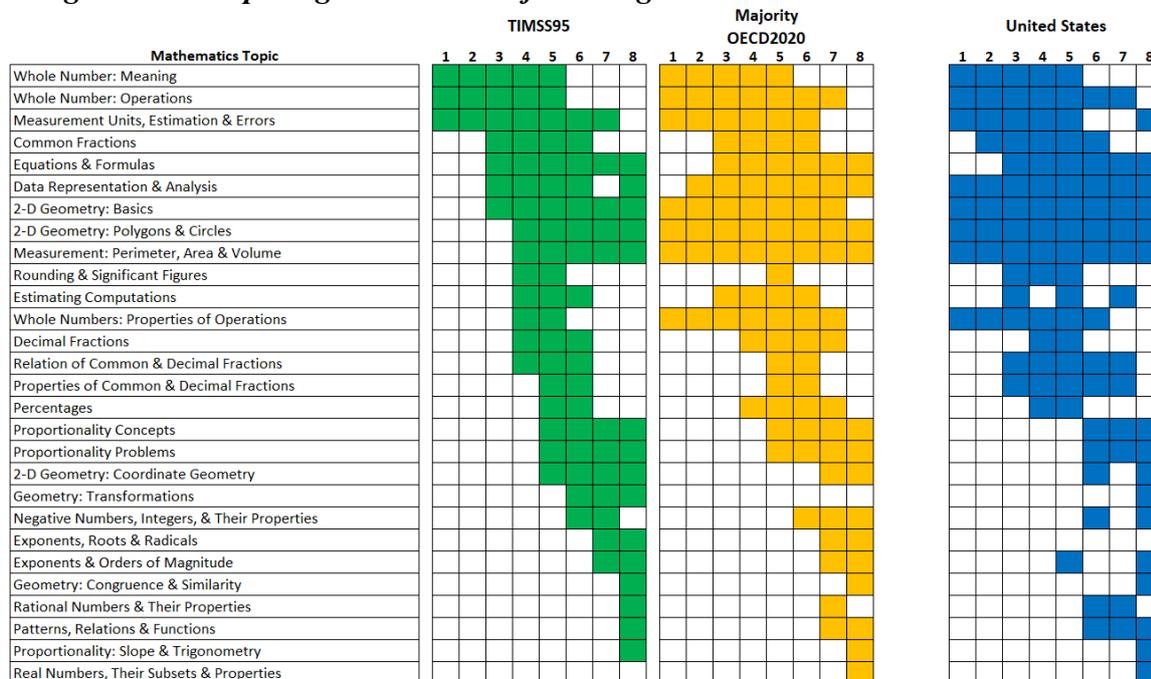
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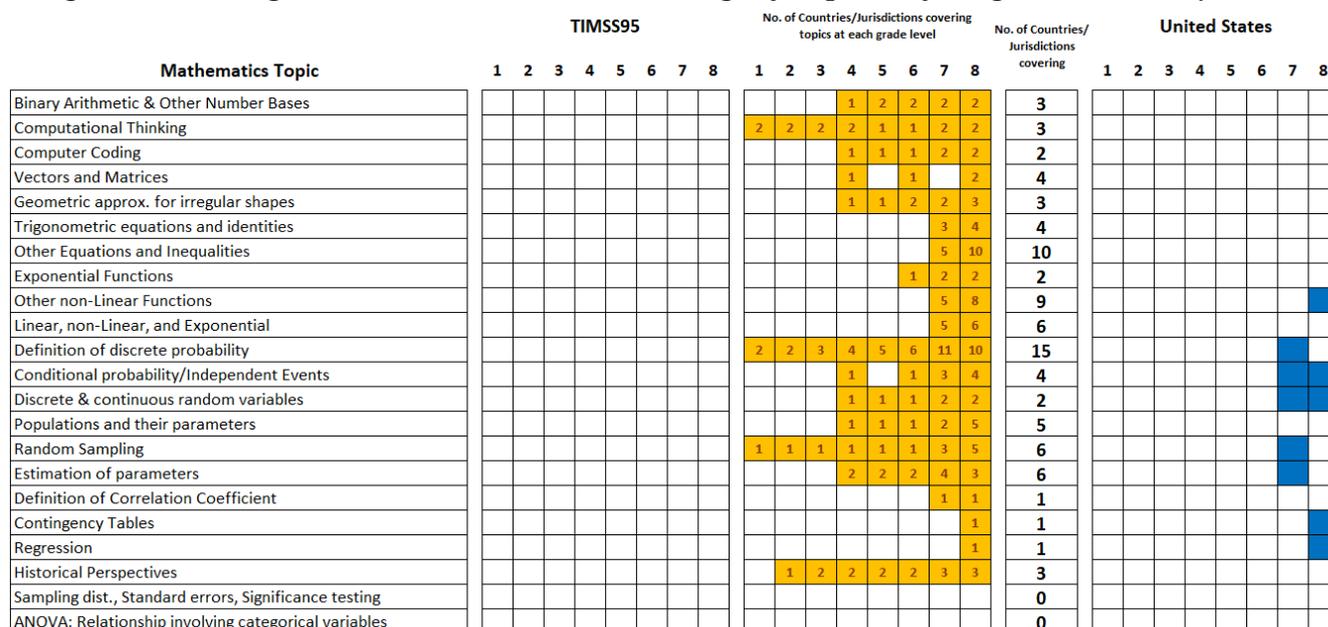
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8th Grade Textbook Exercises: Book 1

Exercise Composition of Textbooks

Figure 5. Totals Over All Participants' Textbooks

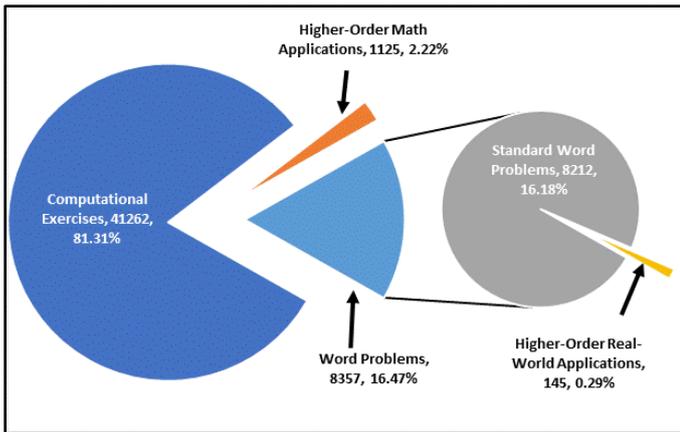
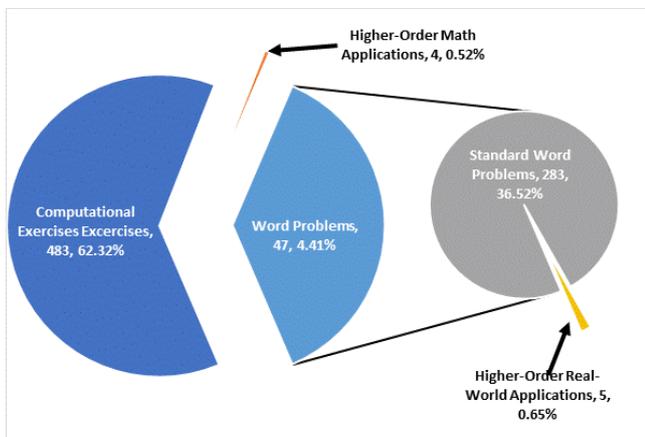


Figure 6. Country/Jurisdiction Textbook



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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Type of Quantitative Reasoning

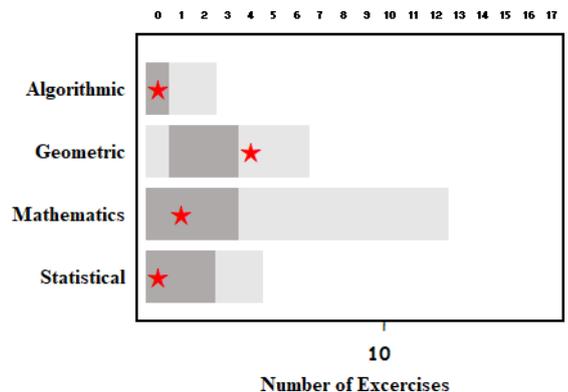
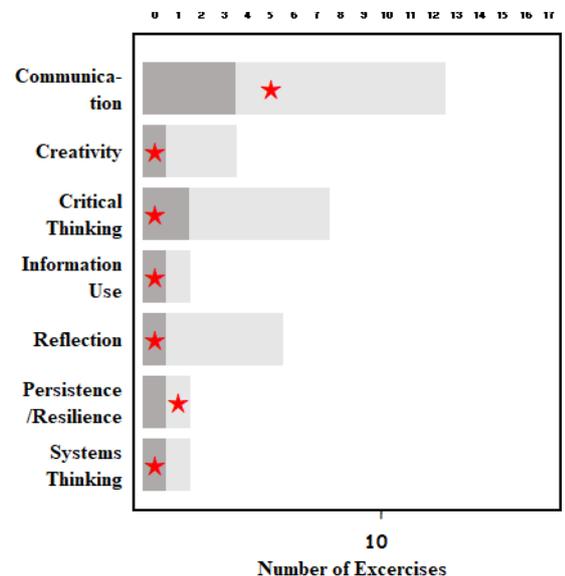


Figure 8. Type of 21st Century Competencies



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8th Grade Textbook Exercises: Book 2

Exercise Composition of Textbooks

Figure 5. Totals Over All Participants' Textbooks

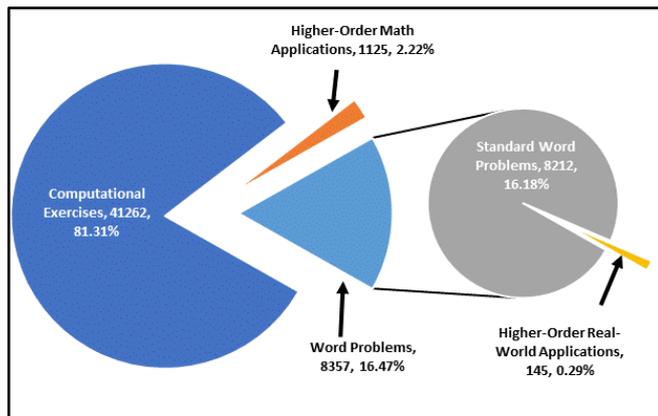
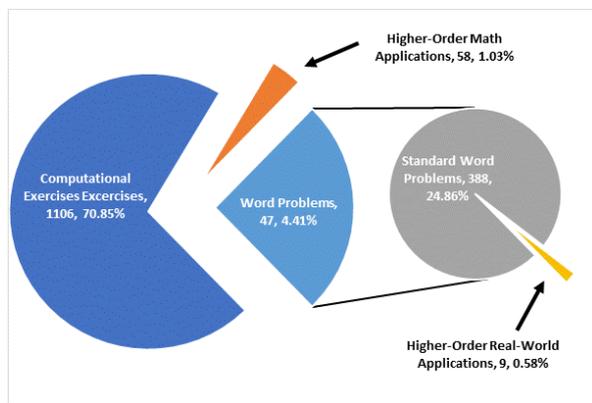


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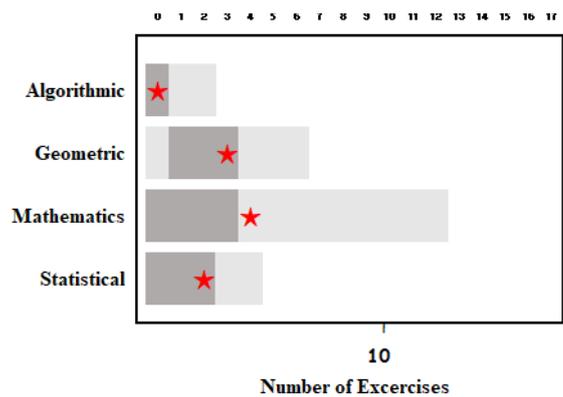
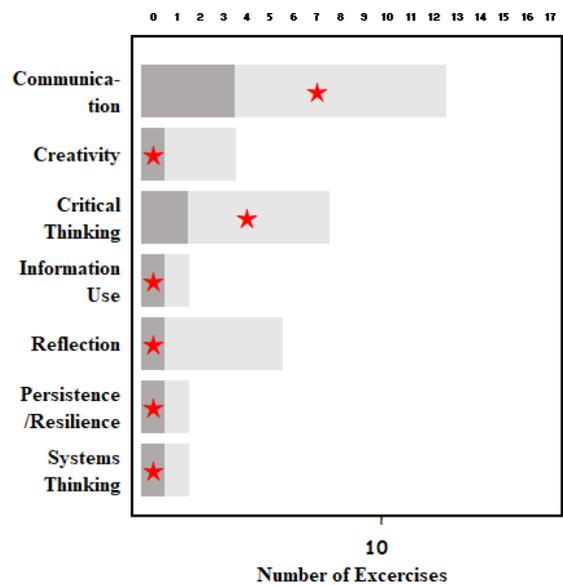


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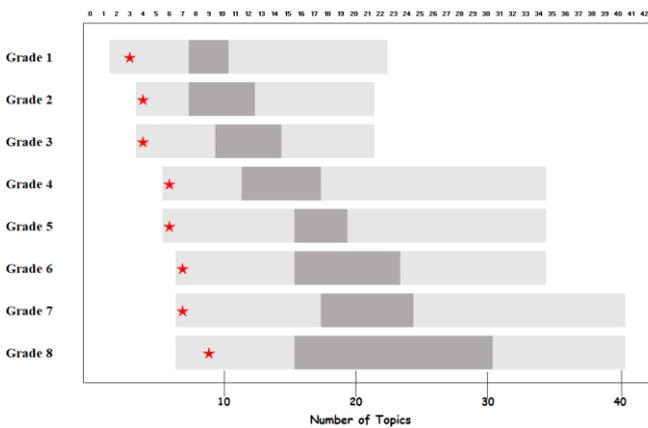
Argentina

Curriculum Standards

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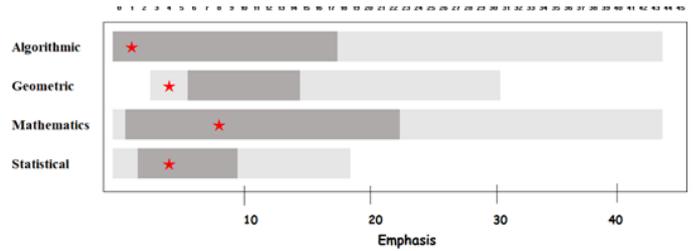


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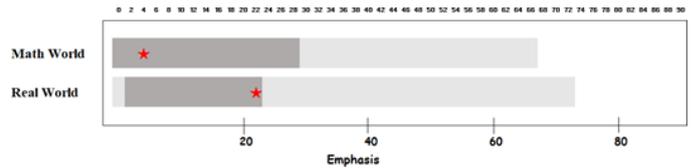
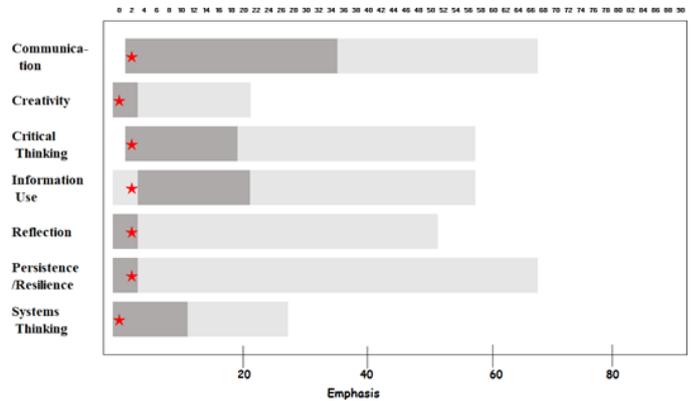


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8th Grade Textbook Exercises

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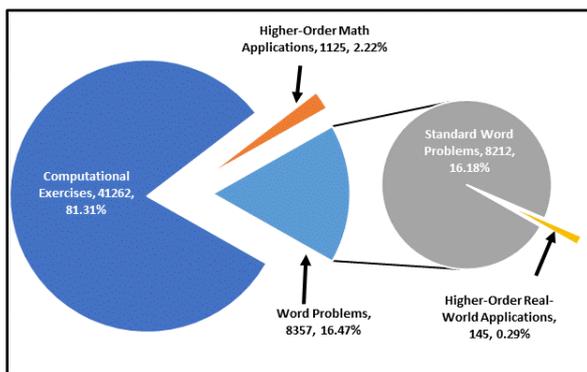
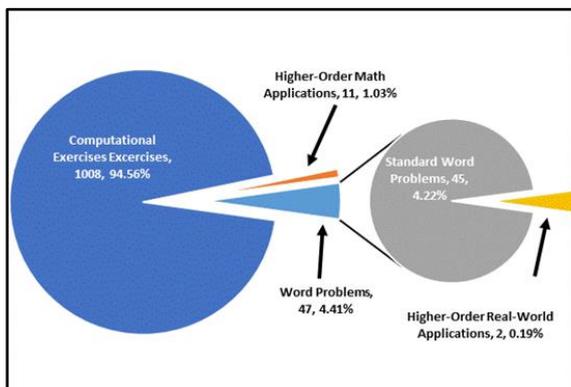


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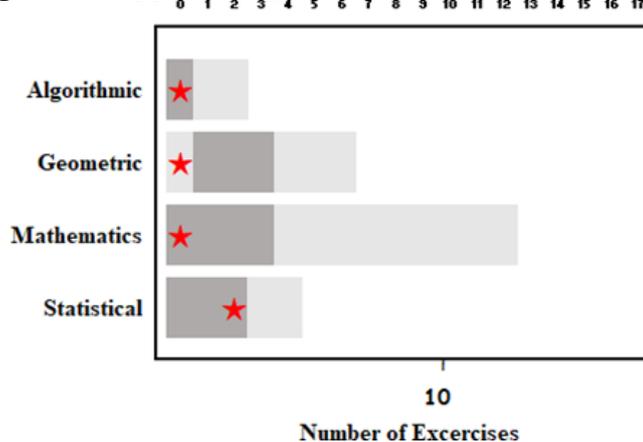
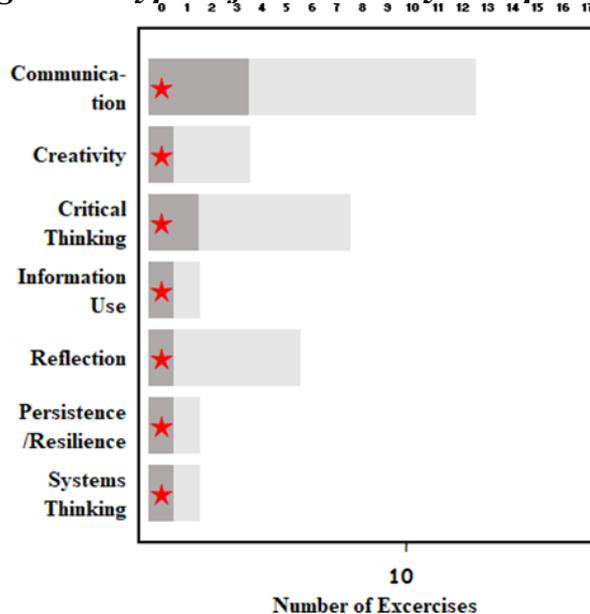


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Goals for pupils	0%	87%	20%	7%	13%
Content of instruction	0%	42%	75%	42%	67%
Methods (including textbooks)	33%	50%	33%	33%	100%
Examinations	67%	44%	11%	22%	33%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

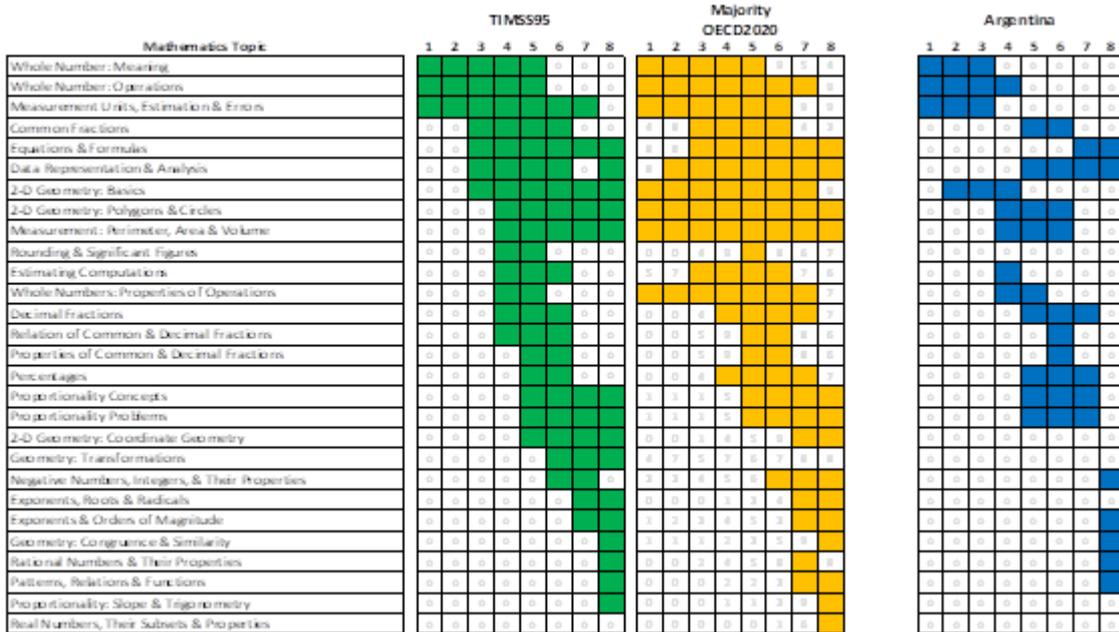
Figure 11. Relative Importance Averaged Across All 19 Countries/Jurisdictions

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	52%	24%	40%	29%	33%
Content of instruction	46%	19%	43%	42%	53%
Methods (including textbooks)	28%	18%	55%	50%	74%
Examinations	55%	16%	30%	40%	41%

Note for Figures 9, 10 & 11. In the above figures looking across rows tells who has what role while looking down the columns especially in Figures 10 and 11, indicates over which facets each locus has the most influence. We acknowledge David E. Wiley's contribution to the study of curriculum decision making

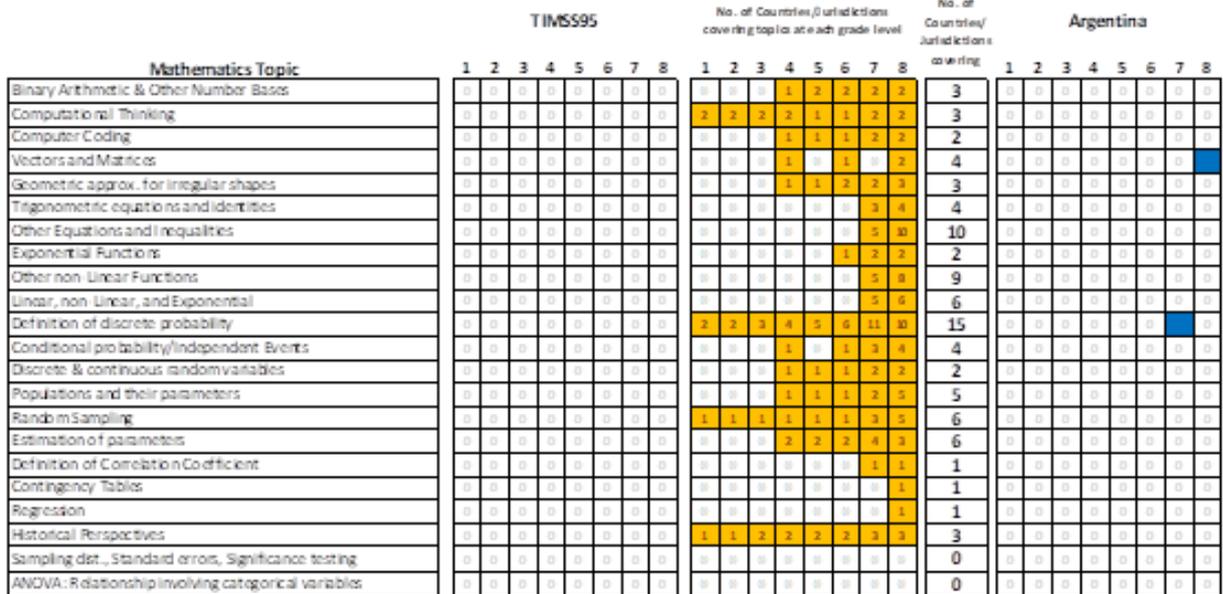
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

Figure 13. Moving into the Future: Current Coverage of Topics Defining a New Literacy



Note. Orange cells indicate the number of countries that cover that topic at that grade level. The accompanying column indicates the number of countries/jurisdictions that included that topic at any grade level; Blue cells indicate specific country/jurisdiction coverage. The absence of green cells indicates the lack of coverage of those topics in TIMSS95.

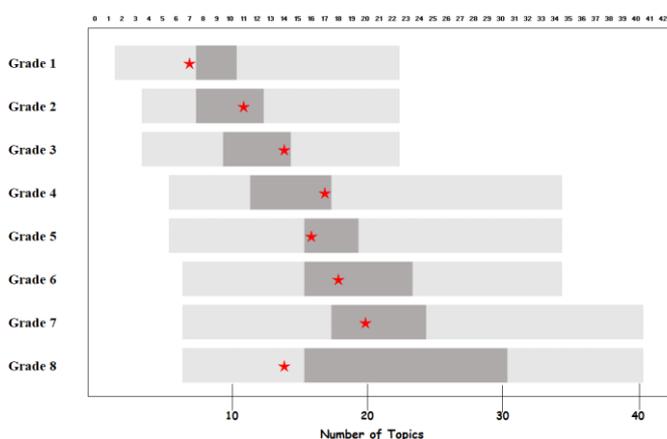
Chinese Taipei

Curriculum Standards

Index

- Page 1 portrays the composition of the country's/ jurisdiction's curriculum standards.
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Figure 1. Number of Topics to be Covered at each Grade



Notes for Figure 1:

- Light Grey bars show the range for the number of topics that each of the 19 countries/jurisdictions *intended* to cover.
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- The stars show the number of topics that the country/ jurisdiction *intended* to cover at each of the grades.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

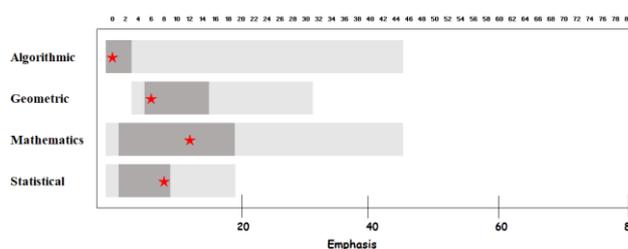


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

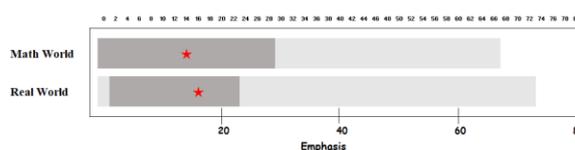
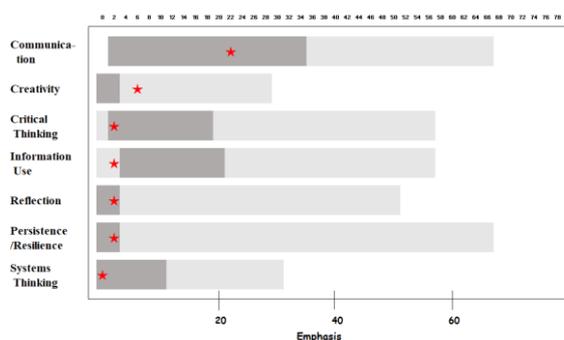


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

- The structure of these figures is the same as described in the note for Figure 1.
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8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

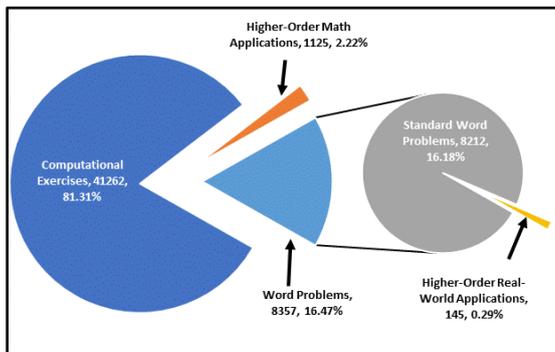
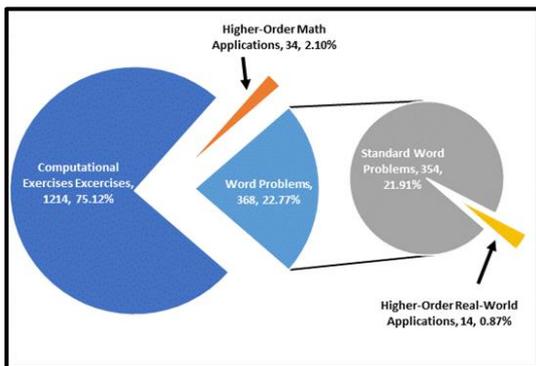


Figure 6. Country/Jurisdiction Textbook



Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

- The Blue pie diagram shows the total number of different types of exercises.
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Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

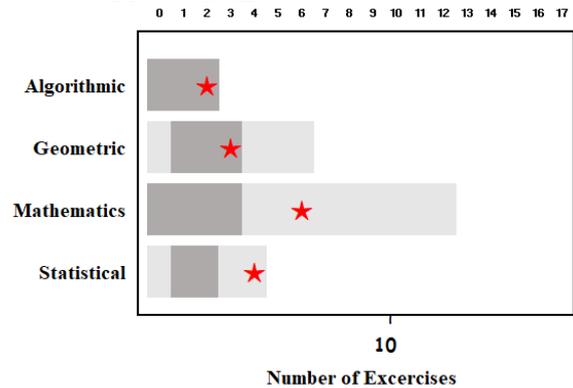
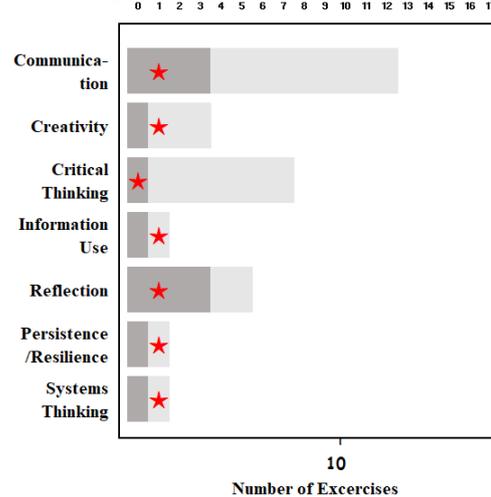


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

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- The stars show the number of Higher-Order Real-World application exercises of each type that are included.

Curriculum Decision Making



Figure 9. Who Makes What Decisions?

		National	Regional	School	Teachers Collectively	Teachers Individually
Goals for Pupils						
A	By overall system completion	100%	0%	0%	0%	0%
B	For intermediate stages	100%	0%	0%	0%	0%
C	For differentiated programme types	0%	0%	0%	0%	0%
D	To be reached in a given grade	100%	0%	0%	0%	0%
E	To apply for a specific school	100%	0%	0%	100%	100%
Content of Instruction						
F	Course (grade level) offerings	100%	0%	0%	0%	0%
G	Student course assignment rules	100%	0%	0%	0%	0%
H	Course content (syllabi)	0%	0%	0%	50%	50%
I	Auxiliary content outside of syllabi	0%	0%	0%	100%	100%
Methods of instruction						
J	Textbook selection	0%	0%	0%	100%	0%
K	Instructional methods/techniques	0%	0%	0%	0%	100%
Examinations						
L	Content of examinations	100%	0%	0%	100%	100%
M	School Examination performance standards	100%	0%	0%	0%	0%
N	Examination standards	0%	0%	100%	100%	100%

Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	80%	0%	0%	20%	20%
Content of instruction	50%	0%	0%	42%	42%
Methods (including textbooks)	0%	0%	0%	50%	50%
Examinations	67%	0%	33%	67%	67%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

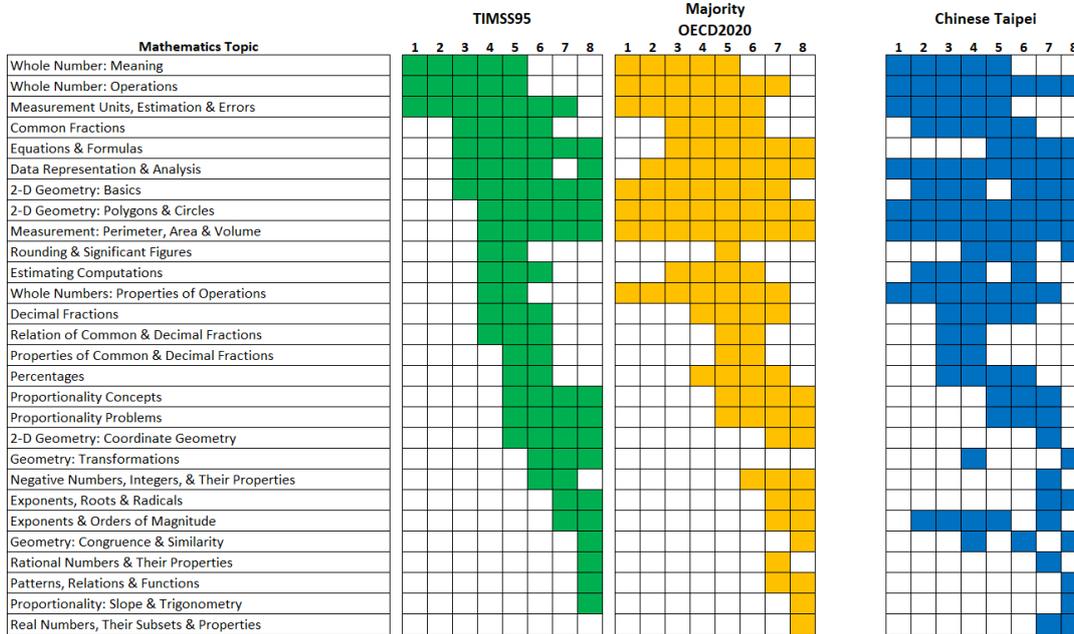
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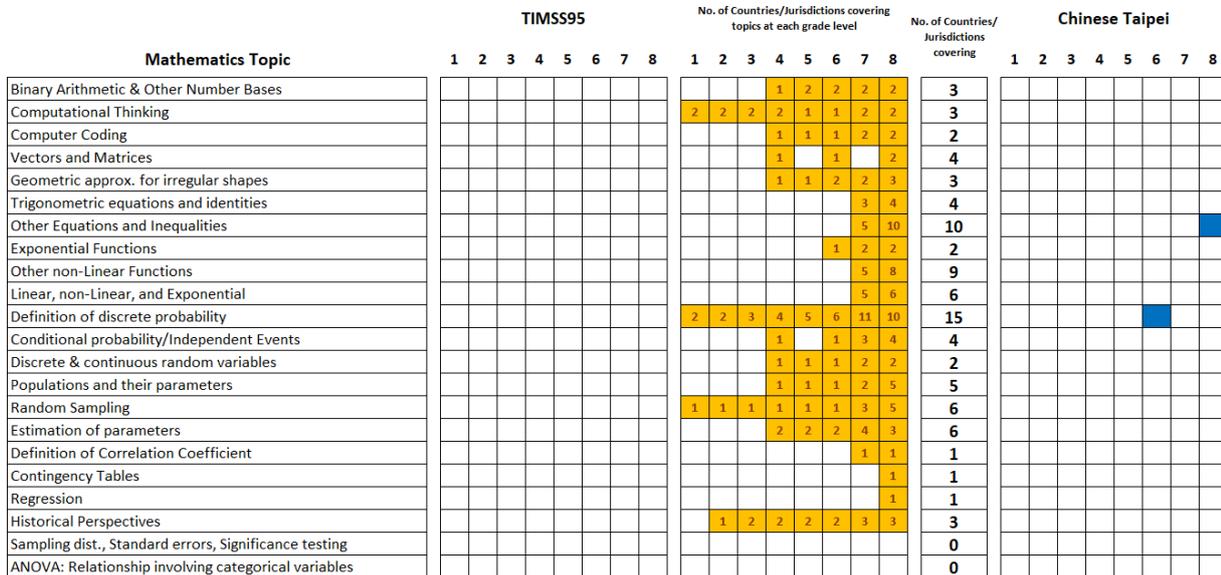
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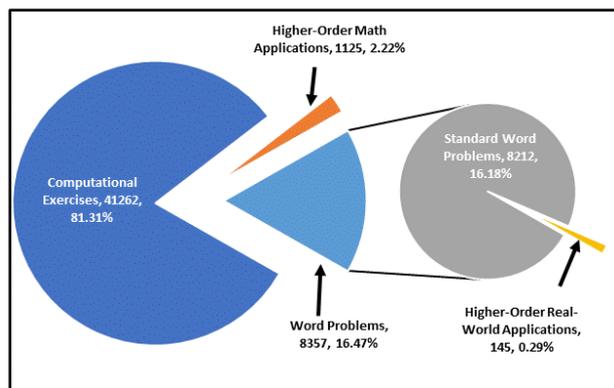


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8th Grade Textbook Exercises: Book 1

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks



Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Type of Quantitative Reasoning

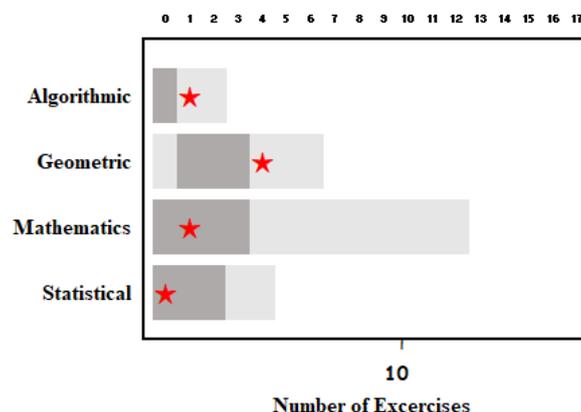


Figure 8. Type of 21st Century Competencies

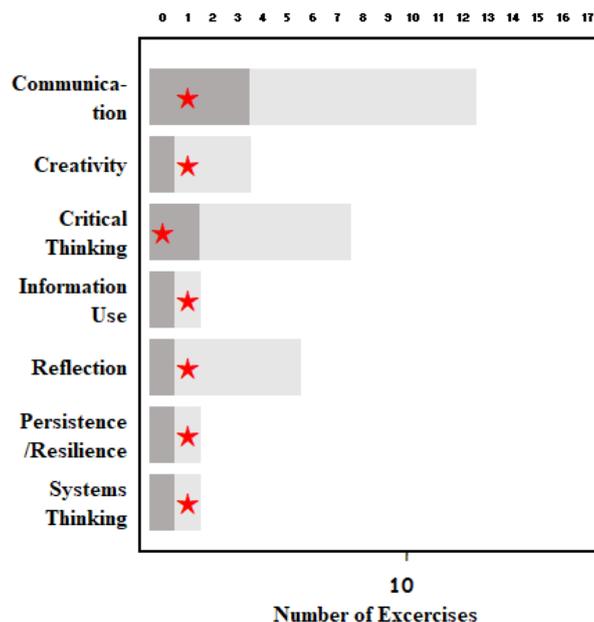
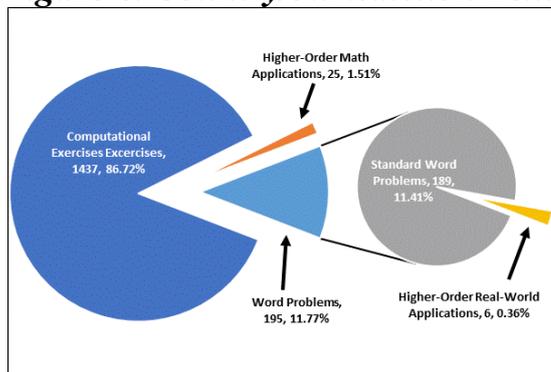


Figure 6. Country/Jurisdiction Textbook



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8th Grade Textbook Exercises: Book 2

Textbook Exercise Composition

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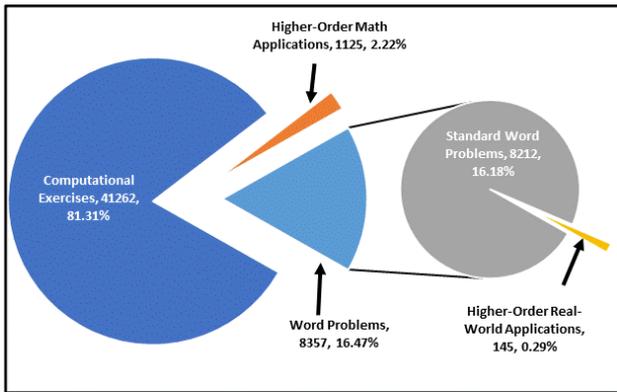
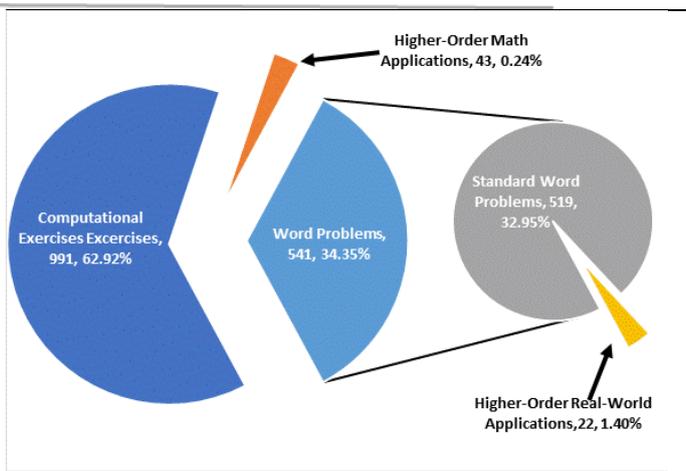


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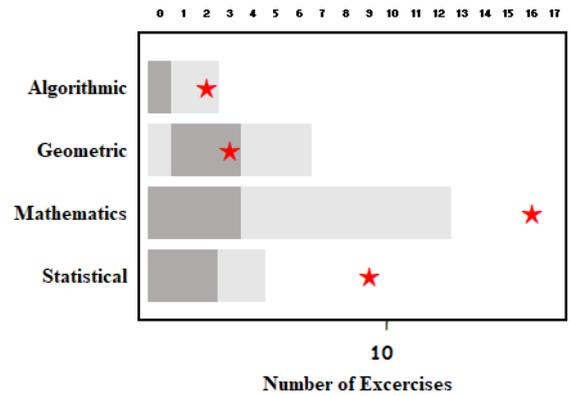
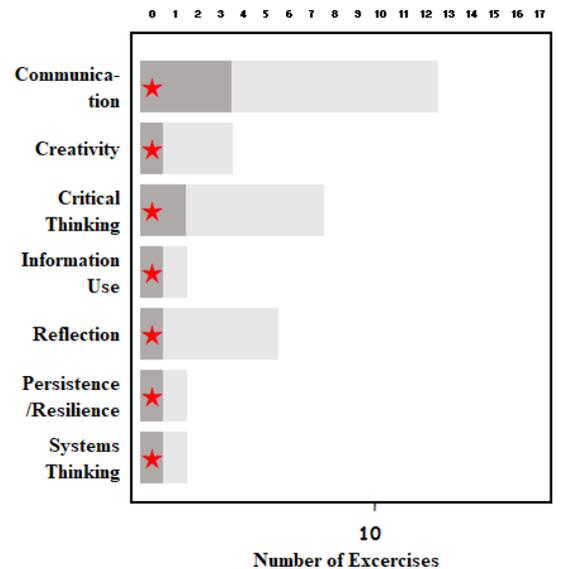


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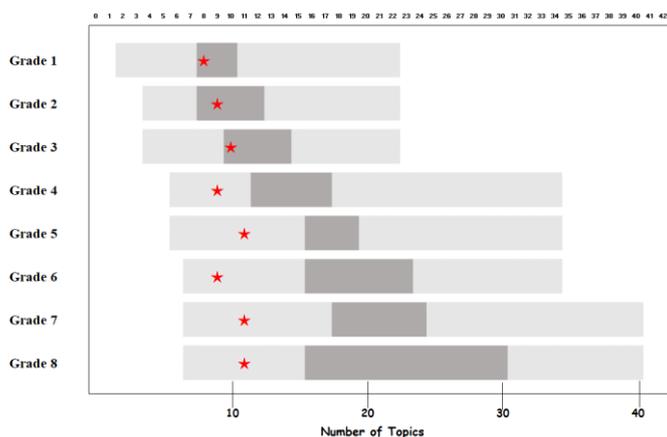
Hong Kong (China)

Curriculum Standards

Index

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- The stars show the number of topics that the country/ jurisdiction *intended* to cover at each of the grades.

Note:

- The Hong Kong curriculum at grades 7 to 9 is organised as a whole (called Key Stage 3), and teachers have some liberty to organise their course sequencing logically amongst all of the 32 topics that are included in this Key Stage. It was not clear how to divide the 32 topics into 3 partitions for grades 7 to 9. Hong Kong decided to essentially divide the 32 topics evenly across the three grades (11, 11, 11).

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

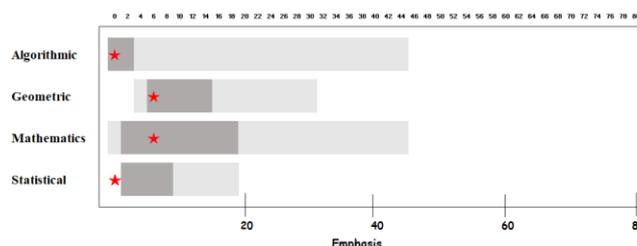


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

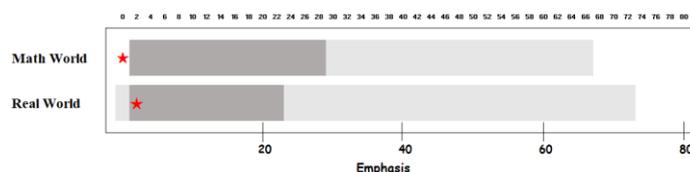
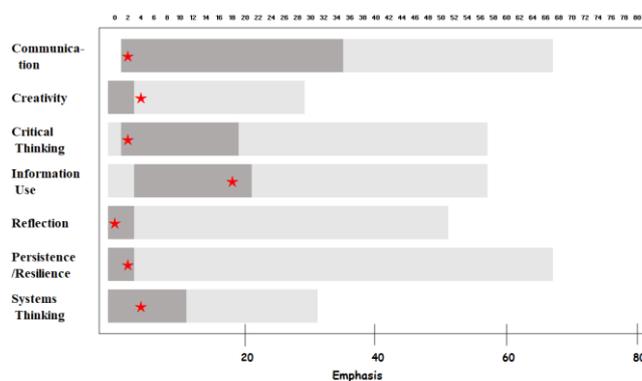


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8th Grade Textbook Exercises

Textbook Exercise Composition

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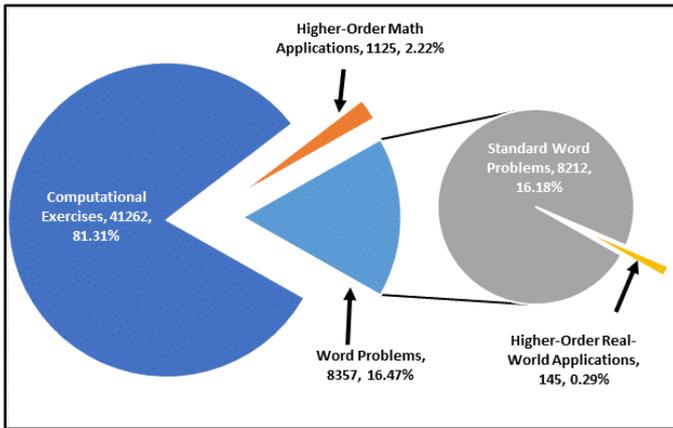
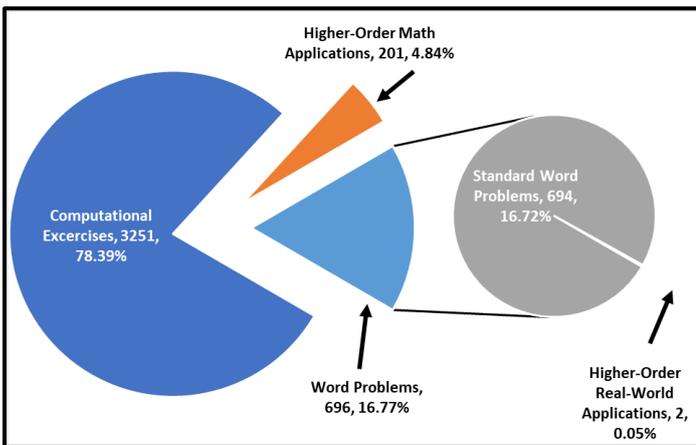


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Characteristics of Higher-Order Real-World Application Textbook Exercises

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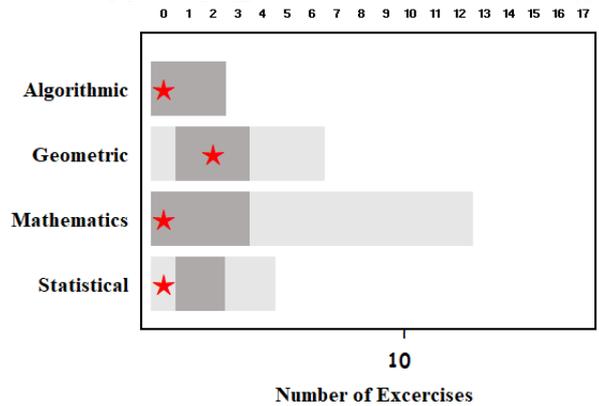
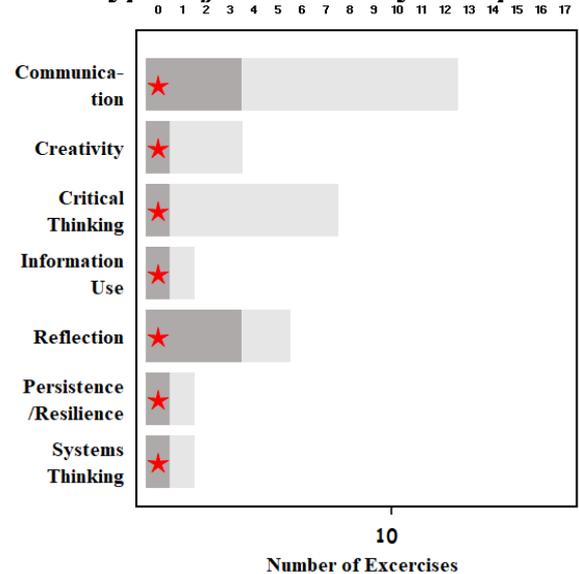


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Curriculum Decision Making

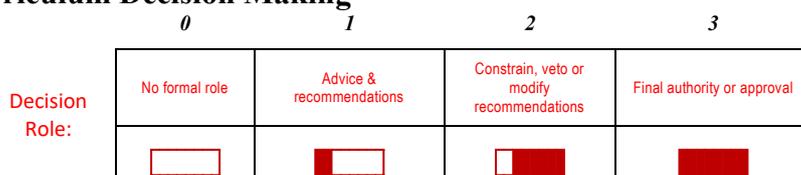


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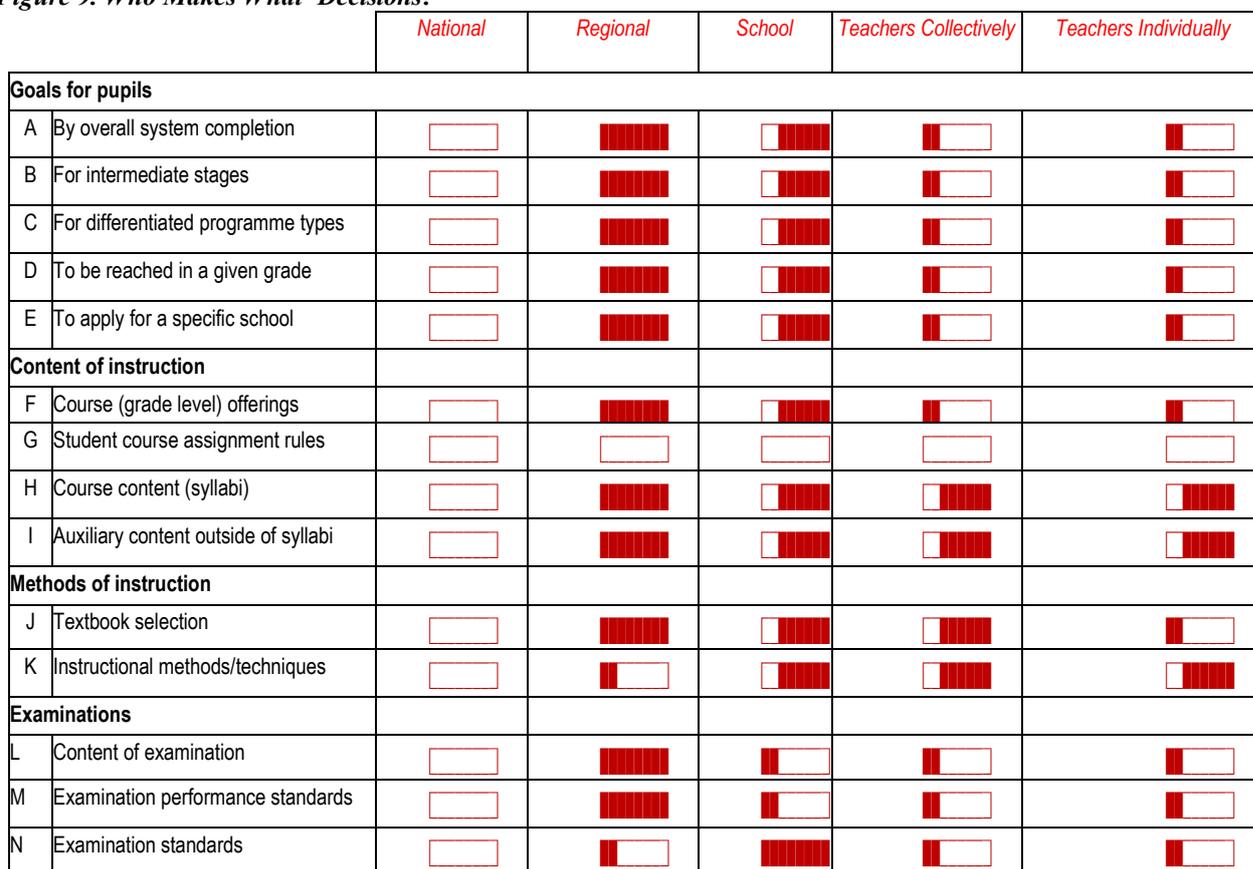


Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	0%	100%	67%	33%	33%
Content of instruction	0%	75%	50%	42%	42%
Methods (including textbooks)	0%	67%	67%	67%	50%
Examinations	0%	78%	56%	33%	33%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. Note. The facet Methods of Instruction includes textbook selection as well.

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8th Grade Textbook Exercises: Book 1

Textbook Exercise Composition

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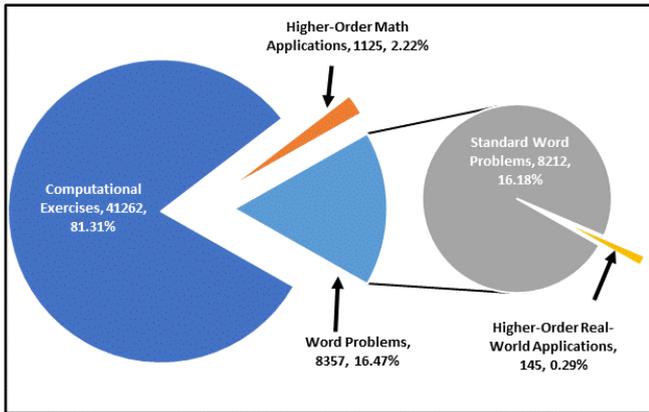
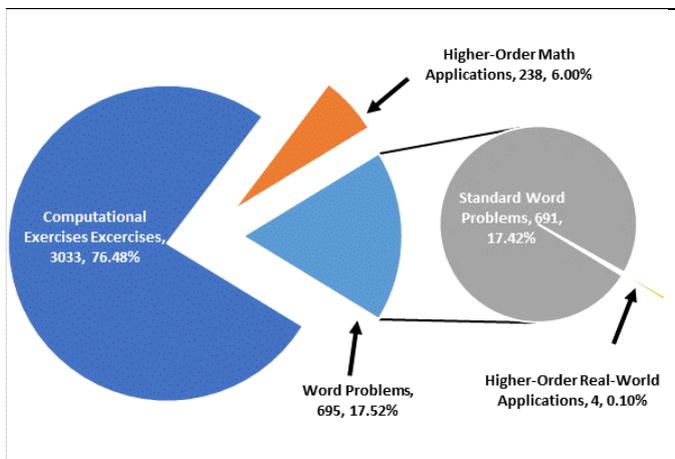


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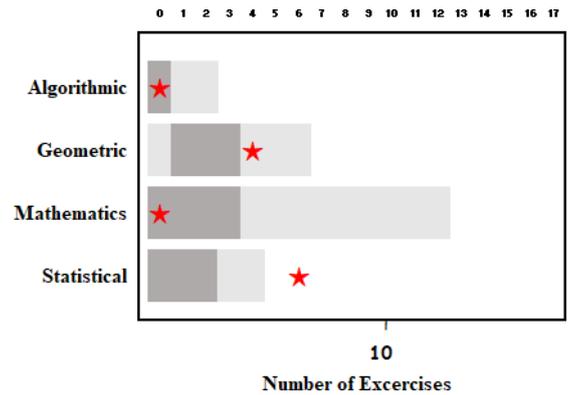
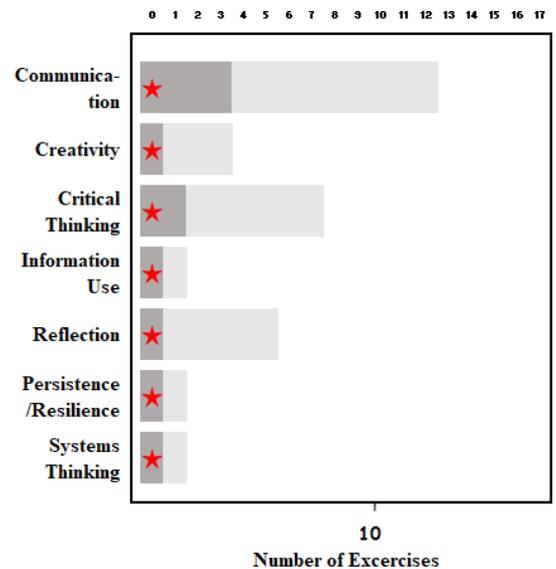


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8th Grade Textbook Exercises: Book 2

Textbook Exercise Composition

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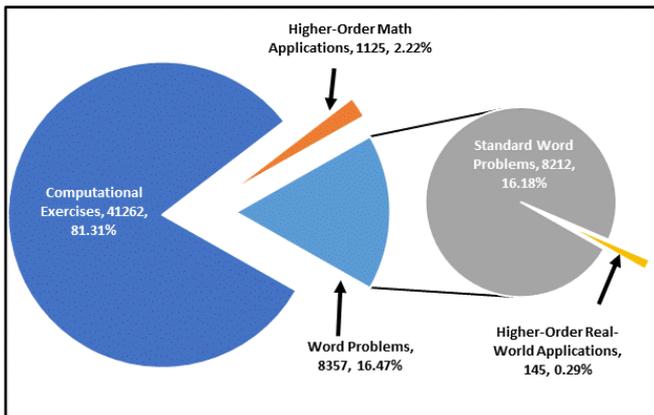
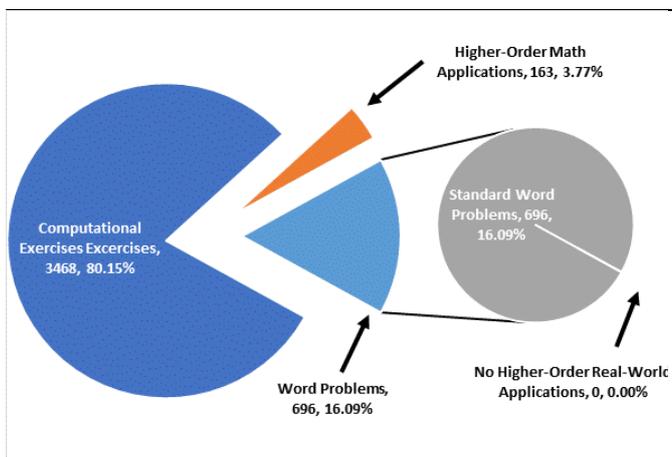


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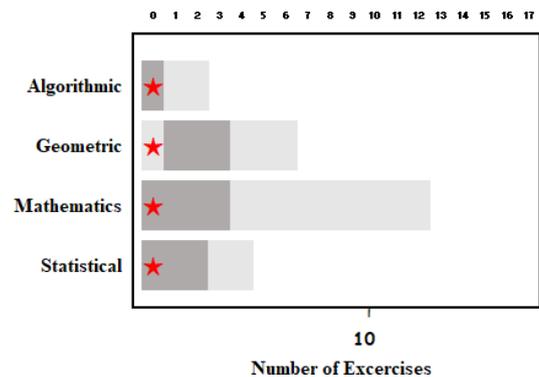
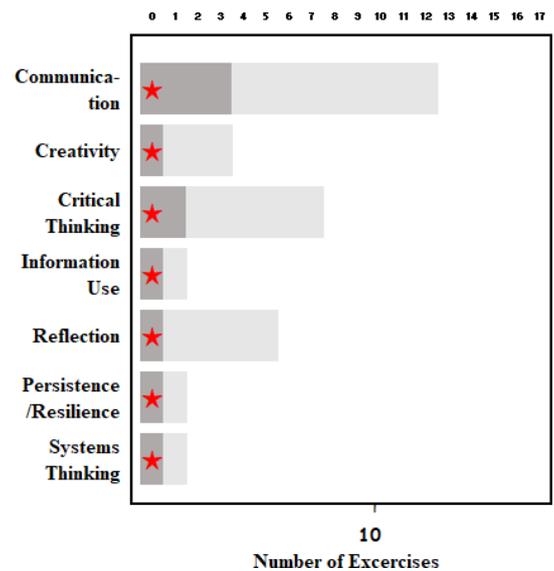


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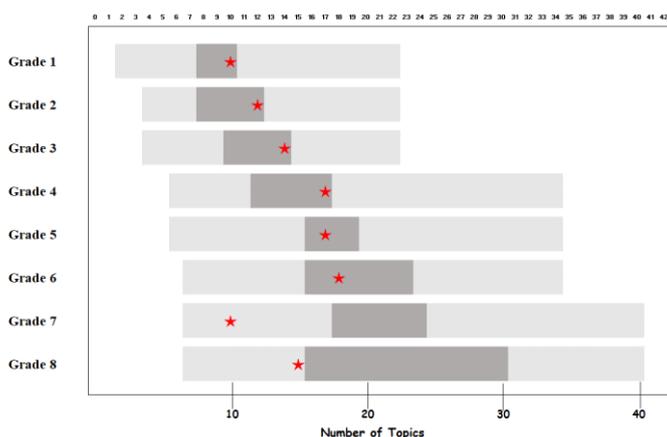
Kazakhstan

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- Page 2 portrays the composition of a representative 8th grade mathematics textbook.
- Page 3 portrays the curriculum decision-making authority within the educational system.
- Page 4 portrays the mathematics topic coverage of the country's/jurisdiction's curriculum standards across grades 1-8 in comparison to the 1995 TIMSS A+ benchmark curriculum.

Figure 1. Number of Topics to be Covered at each Grade



Notes for Figure 1:

- Light Grey bars show the range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
- Dark Grey bars show the Inter-Quartile Range (25th to 75th Percentile) found within the broader range for the number of topics that each of the 19 countries/jurisdictions intended to cover.
- The stars show the number of topics that the country/ jurisdiction intended to cover at each of the grades.

Figure 2. Degree of Emphasis for the Coverage of Four Types of Quantitative Reasoning

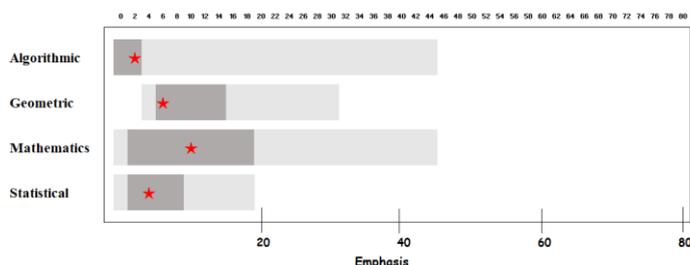


Figure 3. Degree of Emphasis for the Coverage of Higher-Order Applications

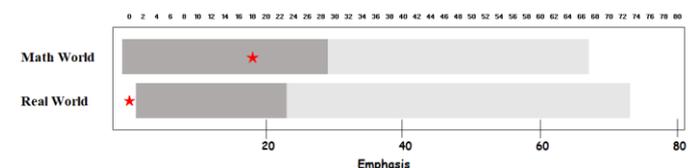
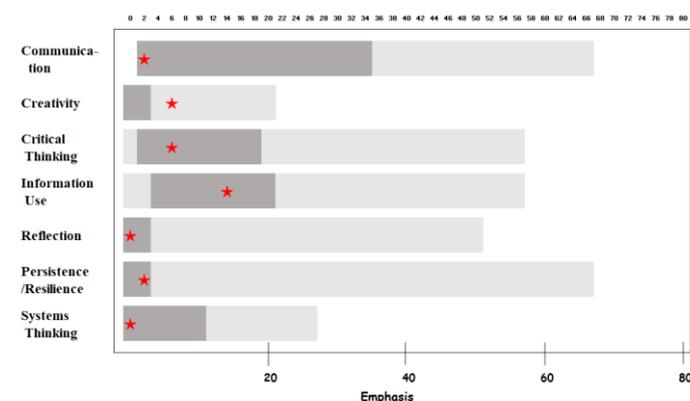


Figure 4. Degree of Emphasis for the Coverage of 21st Century Competencies/Skills



Notes for Figures 2-4:

- The structure of these figures is the same as described in the note for Figure 1.
- The variable represented in each of these figures is a measure of the intensity/emphasis that the curriculum standards for each of the countries/jurisdictions placed on each of these three dimensions of mathematics literacy.
- The measure is defined with 0 indicating no mention of the dimension and 1-75 indicating the degree of emphasis (see methods section of the introduction to the country/jurisdiction reports).

8th Grade Textbook Exercises

Textbook Exercise Composition

Figure 5. Totals Over All Participants' Textbooks

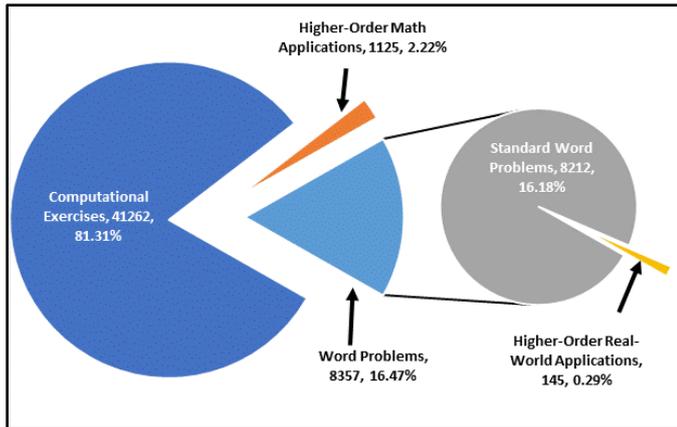
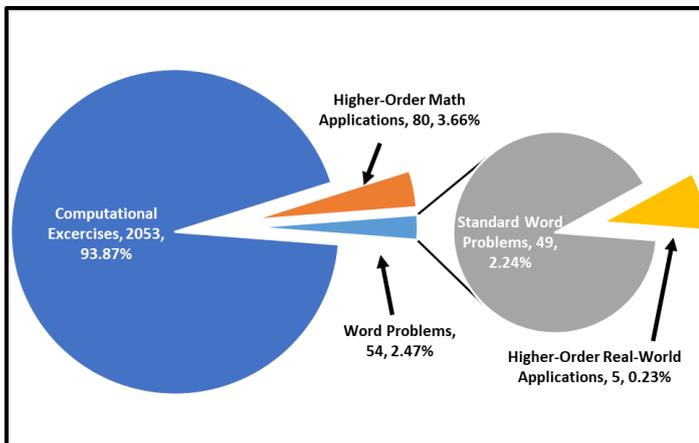


Figure 6. Country/Jurisdiction Textbook



Notes for Figures 5 (total number of exercises across all countries/jurisdictions) & 6 (country/jurisdiction specific):

- The Blue pie diagram shows the total number of different types of exercises.
- The Grey pie diagram shows the number of standard word problems (an expansion of the light-blue wedge).
- The Orange wedge represents the number of Higher-Order Math-World applications.
- The Yellow wedge represents the number of Higher-Order Real-World applications.
- For countries/jurisdictions that coded 2 textbooks, the average number of exercises of the two textbooks was used in Figures 5, 6, 7 and 8.

Characteristics of Higher-Order Real-World Application Textbook Exercises

Figure 7. Types of Quantitative Reasoning

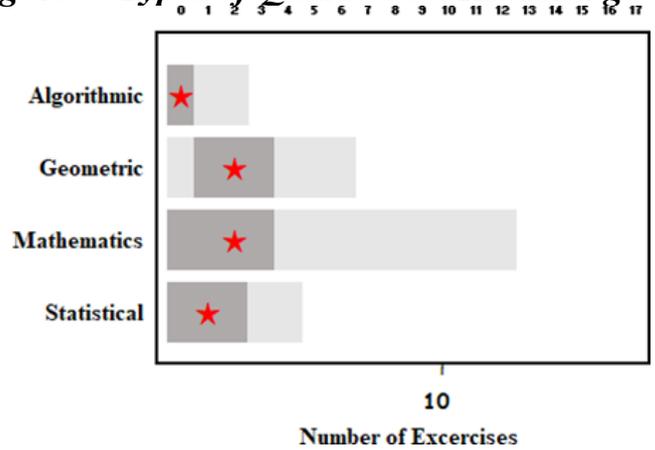
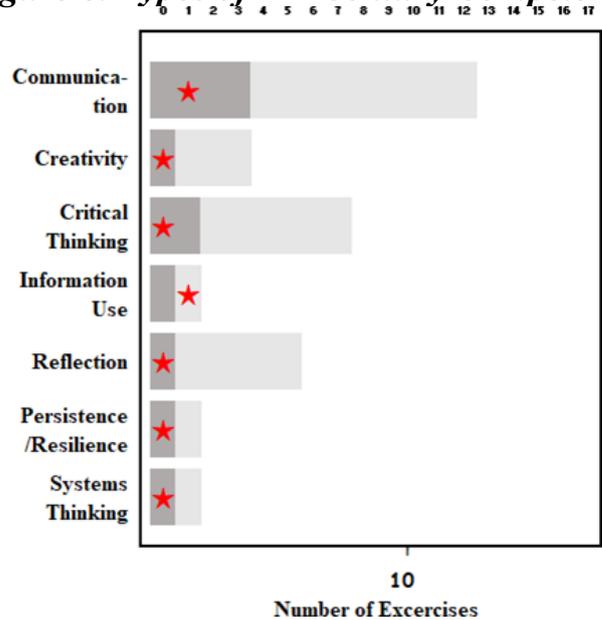


Figure 8. Types of 21st Century Competencies



Notes for Figures 7 & 8:

- Light Grey bars show the range for the number of Higher-Order Real-World application exercises of each type for each country/jurisdiction.
- Dark Grey bars show the Inter-Quartile Range (25th to 75th percentile).
- Special case: in cases where the majority of the country's/jurisdiction's values were 0, the light grey bar encompasses the dark grey bar.
- The stars show the number of Higher-Order Real-World application exercises of each type that are included.

Curriculum Decision Making

	0	1	2	3
Decision Role:	No formal role	Advice & recommendations	Constrain, veto or modify recommendations	Final authority or approval

Figure 9. Who Makes What Decisions?

		National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils						
A	By overall system completion					
B	For intermediate stages					
C	For differentiated programme types					
D	To be reached in a given grade					
E	To apply for a specific school					
Content of instruction						
F	Course (grade level) offerings					
H	Student course assignment rules					
I	Course content (syllabi)					
J	Auxiliary content outside of syllabi					
Methods of instruction						
J	Textbook selection					
K	Instructional methods/techniques					
Examinations						
L	Content of examinations					
M	Examination performance standards					
N	School Examination standards					

Figure 10. Country/Jurisdictions: Relative Importance for each of the Four Facets

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	100%	0%	0%	33%	33%
Content of instruction	100%	0%	8%	33%	33%
Methods (including textbooks)	100%	33%	83%	33%	33%
Examinations	78%	11%	11%	33%	33%

Note. The denominator for the percentages is the number of subcategories (as defined in Figure 9) within each category x 3. The numerator (x) is the sum of the values assigned for each chosen subcategory; for example, for cell (1,1) the formula is x/15. The facet Methods of Instruction includes textbook selection as well.

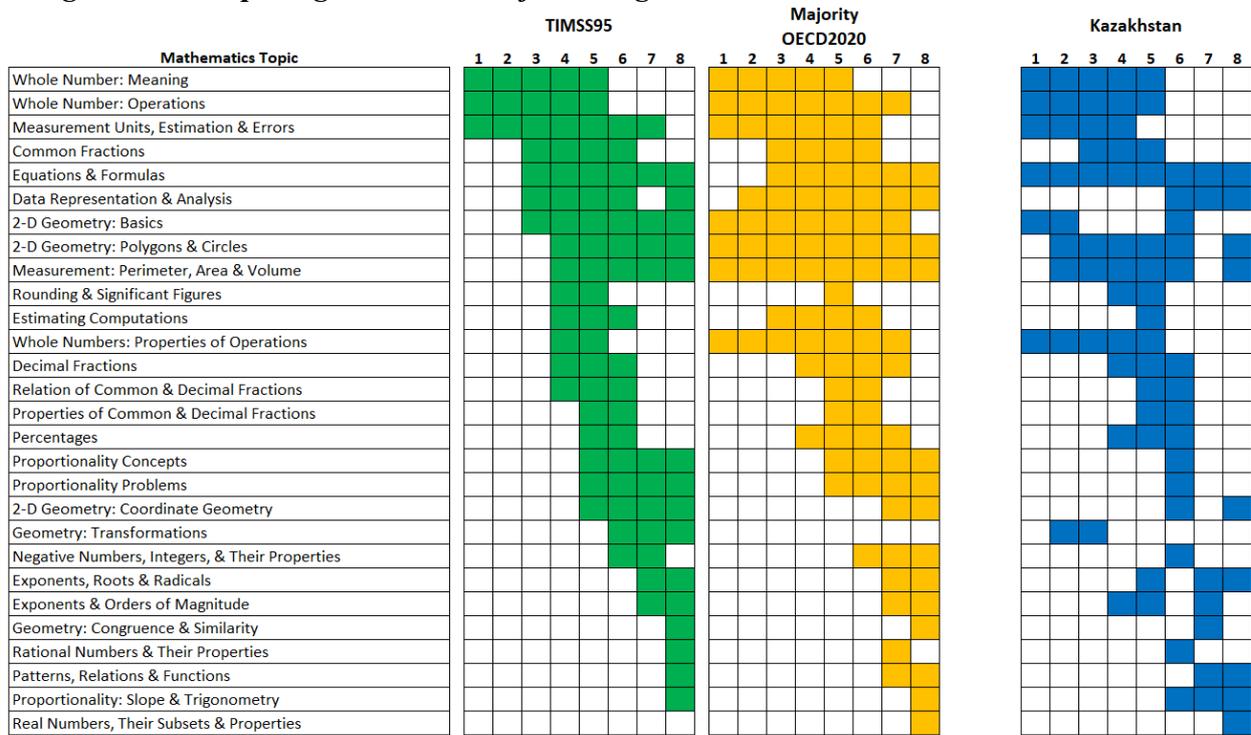
Figure 11. Relative Importance Averaged Across All 19 Countries/Jurisdictions

	National	Regional	School	Teachers Collectively	Teachers Individually
Goals for pupils	52%	24%	40%	29%	33%
Content of instruction	46%	19%	43%	42%	53%
Methods (including textbooks)	28%	18%	55%	50%	74%
Examinations	55%	16%	30%	40%	41%

Note for Figures 9, 10 & 11. In the above figures looking across rows tells who has what role while looking down the columns especially in Figures 10 and 11, indicates over which facets each locus has the most influence. We acknowledge David E. Wiley's contribution to the study of curriculum decision making.

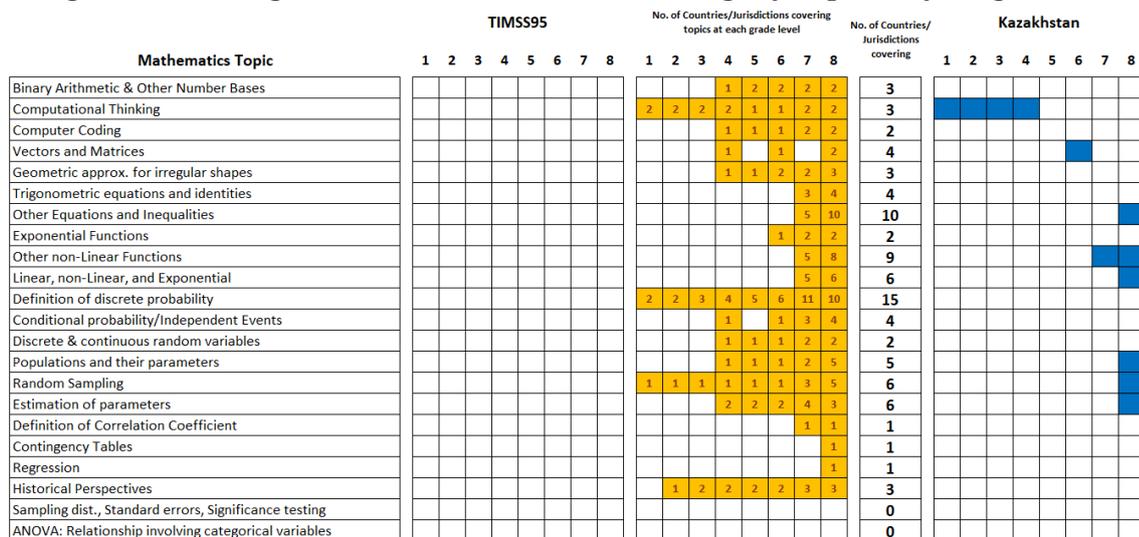
Coverage of Mathematics Topics in the Standards

Figure 12. Comparing the Patterns of Coverage over 25 Years



Note. Green cells indicate coverage defined by TIMSS A+; Orange cells indicate coverage defined by at least a simple majority of the 19 countries/jurisdictions; Blue cells indicate specific country/jurisdiction coverage.

Figure 13. Moving into the Future: Current Coverage of Topics Defining a New Literacy



Note. Orange cells indicate the number of countries that cover that topic at that grade level. The accompanying column indicates the number of countries/jurisdictions that included that topic at any grade level; Blue cells indicate specific country/jurisdiction coverage. The absence of green cells indicates the lack of coverage of those topics in TIMSS95.

6. Discussion

We designed this report so that all of each country/jurisdiction's results from the various analyses described in the previous section would be combined in an individual country/jurisdiction report thus creating a more complete characterisation of the issues related to that country's/jurisdiction's curriculum. This we felt to be a more important format for country/jurisdiction use rather than to have the results for the countries listed in a rank-ordered table. Each country/jurisdiction report includes: how curriculum decisions are made; what the national curriculum standards specify to be covered; a comparison to the A+ curriculum from 25 years ago; and a characterisation of at least one 8th grade mathematics textbook.

All the results within a country/jurisdiction report are anchored within the distribution of all 19 countries/jurisdictions providing them with an overall comparison but not specifically to any individual country/jurisdiction. If any country/jurisdiction desires such a one-on-one comparison to another country/jurisdiction, it will have to find the section containing the data for the other country/jurisdiction and draw the comparison themselves.

Three research questions pertain to the coverage of formal mathematics content as well as to the three dimensions related to mathematics literacy as found in the MCDA mathematics content framework. The comparison of the formal mathematics topics – both those known to have been covered 25 years ago as well as a set of new topics entering the curriculum of some countries early in the 21st century – were compared to those of 25 years ago as reflected in the TIMSS-95 study. A third question pertained directly to the coverage of the three aspects of the mathematics framework related to the development of mathematics literacy.

Pertaining to the formal mathematics topics the main finding was that for a majority of the 19 countries/jurisdictions, the overall pattern of coverage was very similar to that found for the A+ countries in TIMSS-95. Most formal topics undergirding K-8 school mathematics were included in most countries'/jurisdictions' national standards – not always in the same order or at the same grades, but they were covered. The more recently appearing formal topics were in general not covered by most participants as might be expected. The data showed the occurrence of more statistics topics being covered, but only a few countries/jurisdictions going into the more formal aspects of statistical inference. The other topics such as algorithmic reasoning and non-linear statistical models were rarely included.

We found, but to varying degrees of emphasis, that all three dimensions of mathematics literacy have become the norm in the national curriculum standards of all 19 countries/jurisdictions. The country/jurisdiction standards bring to the fore, not only formal mathematics related to K-8 schooling, but the dimensions of quantitative reasoning, real-world applications, and 21st century competencies. There are major differences among countries as to the degree of emphasis placed on each of these three dimensions. Within a country/jurisdiction the degree of emphasis also varies across the three dimensions.

Some countries/jurisdictions mention any one of the three dimensions but only once. Others mention two or three of the dimensions but, again, only once. Still others include one or more of the three dimensions at each grade level. While still others achieve the greatest degree of emphasis by including references to one or more of the three dimensions in association with specific topics at specific grades. The repeated and/or specific references to topic/grade combinations for these three dimensions, we hypothesise, indicate to the teachers the importance of covering them. As such, teachers are told to teach not only the formal and fundamental aspects of K-8 mathematics but also to include the aspects related to the development of mathematics literacy.

Opportunities to learn in mathematics are clearly related to the types of exercises provided in student textbooks. Teachers are generally not expected to develop their own exercises but to rely on the textbook. Studies indicate that most do as was the case in these 19 countries/jurisdictions. The

following quote by education psychologists is relevant here as it talks about engaging students in building connections within a domain of knowledge by “...providing opportunities for students to engage *repeatedly* in this process over time as they deepen and extend their domain knowledge [mathematics literacy]” (Fries et al., 2020_[16]).

Textbook data related to the availability of higher-order real-world application exercises in country/jurisdiction textbooks paint a dismal picture at best. From the point-of-view of the students, such opportunities to learn and develop mathematics literacy are so few so as to be almost non-existent averaging less than six exercises per 8th grade textbook. The analysis shows what is given to them in the form of word problems (averaging around 15% per book) are really nothing more than computational problems surrounded by words and as such provide weak opportunities to develop mathematics literacy. Pollack, some 40 years ago, looked at the issue of how to teach the application of mathematics to the real-world. What he recommended, essentially, is the use of what we have defined as higher-order real-world applications. He noted that word problems are “silly, redundant and even stupid” (Pollak, 1969_[17]). Pollack also indicated that many times the applications around which the exercises are developed make assumptions that are incorrect and inconsistent with the reality that the item tries to represent.

It is here where the gap between policy and practice occurs as we found very few higher-order real-world application exercises in any of the countries/jurisdiction textbooks. They occurred in such small numbers that the average country/jurisdiction would run out of such exercises in one and a half months even if they only included one such exercise per week. The results of this study indicate that the countries’/jurisdictions’ education policy makers have “talked the talk” in terms of the importance of providing opportunities to all students in order to develop mathematics literacy that enables them to reason mathematically toward finding solutions to the problems that arise in their current lives and certainly almost daily in their future lives as citizens.

Unfortunately, the analysis of the 23 textbooks that provide opportunities to learn to ostensibly become mathematically literate in these 19 countries/jurisdictions, amount to less than one percent of all the exercises contained in those 23 textbooks. Clearly, the textbooks fail to deliver the relevant opportunities to learn. Recent research studies related to OECD Programme for International Students Assessment (PISA) 2012 that contained a measure of mathematics opportunities to learn (OTL) indicated the consistent and strong relationship of OTL to PISA performance with large estimated effect sizes. The effect sizes varied across countries/jurisdictions but one thing that did not vary is both the practical and statistical significance of mathematics OTL to PISA assessment performance (Cogan, Schmidt and Guo, 2019_[18]; Schmidt and Burroughs, 2016_[19]; Schmidt et al., 2015_[20]; Schmidt, Guo and Houang, 2021_[21]).

This leaves us with the serious predicament of a rather large gap between policy and practice. Unfortunately, we do not have data pertaining to what the teachers actually taught in each country/jurisdiction, but previous research indicates the strikingly large correlation (.9) between teacher content coverage and textbook content coverage. Assuming this to be true, unfortunately, this leaves countries/jurisdictions with strong policy but weak implementation.

Countries/jurisdictions do not publish textbooks but rely on the private sector for their development, however, this does not imply that the policy makers have no influence over the content of the textbooks. Perhaps newly developed policies could impact the content of mathematics textbooks. Without such, one can only imagine the difficulties of reaching the important goal of providing *all* children, no matter their socio-economic status the opportunity to acquire the second most important literacy – mathematics. Without this, we are depriving many students of the opportunity to develop the mathematics knowledge and quantitative reasoning necessary to, as a society, address the serious problems facing the world including climate change, raging pandemics, and even the very survival of democracy.

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Annex A. Mathematics Curriculum Document Analysis (MCDA) Framework

Content

Quantity

Whole number

- Meaning (place value, ordering, comparison)
- Operations (meaning and computations)
- Properties of operations (order of operation, relationship among operations)

Fractions & decimals

- Common fractions
- Decimal fractions & percentages
- Properties and relationships of common & decimal fractions

Number sense & estimation

- Measurement units, estimation & errors
- Rounding & significant figures
- Estimating computations
- Exponents & orders of magnitude

Number systems

- Integers, negative numbers & their properties
- Rational numbers & their properties
- Real numbers, their subsets & properties
- Complex numbers

Other number concepts

- Simple number patterns and sequences
- Binary arithmetic &/or other number bases
- Roots, radicals and complex numbers
- Combinatorics (permutations and combinations)
- Computational thinking: Algorithmic mathematics & computer simulations
- Computer coding (including both formal and informal (pseudocode) syntax)

Space and shape

Position, visualisation & shape

- 2-D Geometry: Basics (points, lines, segments, rays, angles)
- 2-D Geometry: Polygons & circles (formulas, properties, perimeter, area)
- 3-D Geometry (shapes, volume, surfaces, cross-sections)

- Co-ordinate geometry (analytical geometry)
- Trigonometry of right-angled triangles including the Pythagorean Theorem
- Vectors and matrices
- Geometric approximation for irregular shapes

Symmetry, congruence & similarity

- Symmetry
- Transformations (including geometric patterns)
- Congruence & similarity

Change and relationships

Algebra foundations

- Rates and ratios
- Proportionality

Beginning algebra

- Algebraic sequences and patterns
- Expressions
- Simple linear equations
- Slope and intercept

Algebra

- Linear equations and inequalities
- Trigonometric equations and identities
- Other equations and inequalities (quadratics, polynomials, including factorization and expansion)
- Linear functions
- Exponential functions
- Other non-linear functions

Change

- Infinite processes (e.g. sequence, series, limits and convergence)
- Calculus and analysis
- Linear, non-linear, and exponential for modelling growth and change

Statistics, probability and data

Descriptive statistics

- Mean, mode, median, variance, etc.
- Displays of distributions

Probability distributions

- Definition of discrete probability and related theorems

- Conditional probability and independent events
- Bayes Theorem
- Discrete and continuous random variables and their distributions

Statistical inference

- Populations and their parameters
- Sampling from the population/random sampling
- Estimation of parameters (e.g. mean, variance)
- Sampling distributions (standard errors, bias)
- Confidence intervals
- Hypothesis testing
- Definition of correlation coefficient
- Relationship among categorical variables (contingency tables)
- Relationship involving continuous variables (regression)
- Relationship involving categorical and continuous variables (ANOVA)
- History of Mathematics as a Human Activity

Quantitative reasoning

- Mathematics
- Algorithmic
- Geometric
- Statistical

21st century skills/competencies relevant to mathematics

- Critical thinking
- Creativity
- Information use
- Systems thinking
- Communication
- Reflection
- Resistance/resilience

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