Analysis of Mathematics and Science Standards from the Asia-Pacific Economic Cooperation

APEC Human Resource Development Working Group

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Introduction

On behalf of the Asia-Pacific Economic Cooperation (APEC) and the United States Department of Education, Achieve conducted an analysis of the mathematics and science standards for students in 12 of APEC's 21 member economies.[1] Standards are the primary policy tool for defining expectations for what students must learn and teachers must teach. Standards provide a framework for the development and use of textbooks and other instructional materials, assessments and teacher preparation. The goal of this analysis was to determine similarities and differences among the member economies' expectations and priorities in three main areas:

(A) Qualitative aspects of standards. Achieve reviewed the organization of economies' standards with respect to the organization of the standards into single grade levels or multiple-grade bands. Achieve also documented how the member economies organize their mathematics and science content standards in regard to key strands and broad topics. Finally, Achieve observed the level of detail of the standards from each economy.

(B) Common content expectations. The primary goal of this analysis was to identify and describe expectations for what students should know and be able to do that are common across the participating economies, and to determine the extent to which these common expectations reflect a substantial portion of the standards developed by each economy. Common expectations provide a benchmark that economies can use to review their own standards. Where an economy's standards depart from this international benchmark, for example, that economy may wish to consider whether changes are indicated. At the same time, economies may also want to pay attention to instances in which only one or two economies value a particular set of knowledge or skills. In some cases, these outliers may be signaling skills that will take on increased importance in the global economy. We suspect, for example, that New Zealand's relatively greater emphasis on probability and statistics in its mathematics standards may be an example of this.

(C) Performance expectations. Achieve also considered the levels of performance skills evident in the member economies' standards. In mathematics, analysts identified procedural skills, conceptual understanding skills, and strategic problem solving and reasoning skills; in science, they differentiated between inquiry skills and knowledge skills.

Educational standards are not the only factor affecting teachers' instructional decisions and priorities. While some economies may employ standards as a detailed and binding map of the curriculum, others use a variety of other tools and strategies such as curriculum guides, textbooks and professional development sessions to define and communicate expectations for students. Furthermore, the assessments to which students, teachers and schools are held accountable influence the prioritization of certain topics. These factors all shape the actual expectations that teachers hold for students and the actions they take to support student achievement. Therefore,

[1] For more information about APEC and the standards analyzed in this report, visit http://hrd.apecwiki.org/index.php/Main_Page.

this analysis, focused exclusively on standards, necessarily provides an incomplete picture of the similarities and differences in curricular expectations for students.

Given the different educational, economic and cultural contexts in each economy, there is little reason to expect uniformity in the content or organization of curriculum standards. At the same time, in a global economy where the availability of skilled workers increasingly determines where jobs are located, it is in each economy's interest to set internationally competitive standards. Taken together, these analyses will begin to provide a new basis on which each economy can examine the adequacy and appropriateness of its own standards.

Overview of Methodology

PARTICIPATING ECONOMIES

The 12 economies in this study volunteered for participation and have maintained involvement throughout the process, providing English-language copies of their standards, data about their students and explaining their educational systems and the approach under girding their standards. Some economies that otherwise would have chosen to participate could not because an English translation of the standards for comparison was required for the analysis. China and Thailand provided only mathematics standards for this study. A more detailed list of specific standards coded for this study is available in Appendix A.

TABLE 1: Standards from Participating APEC Economies Achieve Analyzed

APEC Economies	Mathematics	Science
Australia	✓	✓
Canada	✓	✓*
China	✓	
Chinese Taipei	✓	✓*
Hong Kong	✓	✓*
Japan	✓	✓*
Korea	✓	✓
Malaysia	✓	✓*
New Zealand	✓	✓
Singapore	✓	✓
Thailand	✓	
United States	✓	✓
Total	**12**	**10**

**Achieve also analyzed biology course standards from these five economies.*

THE CODING FRAMEWORK

The method of analysis used for this study was modeled on that used by Michigan State University in their 1997 study of content standards and textbooks. Detailed content and performance expectation frameworks, developed for use in the Third International Mathematics and Science Study (TIMSS)[2], were applied by trained content analysts – many of whom had worked with Achieve to apply the same methodology to assessment items in earlier research studies. Achieve analysts assigned multiple content and performance codes to each block of text defined as a standard. Procedures were put in place to calibrate coders and monitor for bias or "drift" from established protocols. Experts from the member economies were invited to review the coding results and provide input. Greater detail on the methodology applied is available in Appendix H.

The coding framework includes two components: a.) content categories, which address the topics covered, and b.) performance expectations, which address what students are expected to do with the content. Achieve selected this coding schema because it is uniquely suited for analysis of

[2] TIMSS is now Trends in International Mathematics and Science Study.

content and performance skills across multiple economies and provides an objective tool against which to compare all standards.

The content coding framework provides a detailed, comprehensive taxonomy of content for each subject. Broad categories are broken down into smaller units to allow for finer-grained comparisons. Coders were asked to code standards to the highest degree of specificity possible.

- At its most general level, the mathematics content is organized according to the following major content strands of mathematics: Number; Measurement; Geometry: Position, Visualization & Shape; Geometry: Symmetry, Congruence & Similarity, Proportionality; Functions, Relations & Equations; Data Representation; Probability & Statistics; Elementary Analysis; and Validation & Structure. These strands are then broken into sub-strands that provide a greater level of detail.

- The science content framework is divided into the major content strands of science: Earth, Life and Physical Sciences, as well as cross-cutting concepts such as Science and Technology, the History of Science, Environmental and Resources Issues, and the Nature of Science. These strands and concepts are further sub-divided. Life science content, for example, is then divided into a variety of categories, such as Structure of Living Things; Life Processes and Systems; Life Spirals and Genetic Continuity; Interactions of Living Things; and Human Biology. Then, these categories, in turn, are further subdivided to capture more specific aspects of the content.

Coders used a similar taxonomy for performance, or cognitive skill, expectations. The performance skill codes are arranged in categories that approximate increasing levels of cognitive demand. The framework was used to determine the balance of basic skills, such as recall, versus advanced skills, such as applying advanced mathematical reasoning or deducing scientific principles, for each economy and in aggregate across all economies. The listing of skills included in each performance category is included in Appendix H.

THE CODED STANDARDS

The standards analyzed by Achieve researchers are the national education standards in all economies, with the exception of a few economies. Australia, Canada and the United States do not publish a single set of national standards, but instead allow states or provinces to develop their own regional standards. Australia provides national frameworks for mathematics and science, and Canada does so for science. However, each state or province develops its own set from those guidelines. Achieve coded the national frameworks in these cases. In mathematics, Achieve coded the provincial standards for Alberta, Canada, a top-performing province. The United States has no national standards (there are 50 different sets of state standards) but does have national assessment frameworks, the National Assessment of Educational Progress – including mathematics (2007) and science (2009) – that were used for analysis in this study.

The research was conducted in English; therefore, member economies submitted translations of their standards where necessary. Because of the challenges inherent in conducting research on translations, linguistic nuances or differences may not be fully captured. Certain words may

carry a meaning in one language that they do not carry in another. For example according to Japanese content experts, "to know" connotes a different, more robust meaning in Japan than in the United States. For the purposes of this study, coders used a low-inference coding approach, coding what was obvious and evident in the printed word. As a result, Japan is not included in the performance analysis because of the difference in their intended meaning of the word "know" and the interpretation of that word in the coding framework.

Some economies were unable to provide literal translations of all subjects, courses or grade levels. Therefore, some standards documents submitted for the study were summaries of the content and performance expectations, rather than word for word translations of the documents. At grade levels or in subjects where economies were unable to provide translations, they were not included in the analysis, resulting in some variation in the total number of economies in the grade span analyses for each subject.

THE GRADE SPAN APPROACH

The grade-level organization of standards varies considerably by economy. To facilitate comparison of standards across economies, Achieve grouped standards into three best-fit grade spans for each subject, as listed below, in order to mediate the differences between economies with dissimilar organizational structures.

Despite the obvious limitations to examining broader grade spans – namely, less specificity about when topics are taught – grouping by grade span facilitates examination of the accumulated content and skills taught by the end of the designated grade spans. A full listing of the standards analyzed and the grade spans they cover is included in Appendix A.

TABLE 2: Achieve Grade Span Groupings by Subject

	Mathematics	Science
Primary	Grades 1-6	Grades 1-4; Grades 5-6
Lower Secondary	Grades 7-9	Grades 7-10
Upper Secondary	Grades 10-12	Biology

With regard to course-taking patterns at the upper secondary level and the standards Achieve analyzed, mathematics and science look very different. In mathematics, the economies split between taking an integrated approach – with such course sequences as Math 1-5 in China and Math I, II, A and B in Japan – and separate courses focused on like content – such as the common Algebra I, Geometry and Algebra II sequence taken in the United States. In science, course taking after grade 10 is mostly based on content specific courses – such as Biology, Chemistry and Physics. However, science course taking does not follow a common pattern across economies, and examining all of the courses was beyond the agreed-upon scope of the study. As a result, study leaders chose to focus this analysis on Biology at the upper secondary level.

THE COMMON TOPICS

The main focus of this analysis is the identification of topics that are common across the participating APEC economies. For purposes of this analysis, Achieve defines the common topics from the mathematics and science coding frameworks as topics addressed by 67 percent or more of participating economies in this study. Sixty-seven percent represents a strong but reasonable consensus of economies (two-thirds or more) upon which to focus the analysis. However, the tables included in this report also provide information about topics that are addressed by more than 67 percent of economies.

THE COMMON PATHWAY

By far the most complex factor in an analysis of expectations for secondary school students is the enormous variation in course requirements and options. In addition to variations in course requirements, there are often several types of schools that students may attend at the secondary level, ranging from university-preparation schools to technical schools. Each type of school has its own set of courses and course standards. Even within a single economy different schools or regions may offer or require different courses. The standards and expectations for students depend on the schools they attend and the courses they take.

In order to determine the course sequence and corresponding standards followed by a majority (more than 50 percent) of students enrolled in secondary school in each member economy, Achieve surveyed member economies on course requirements and clarified remaining doubts in direct communication with mathematics and science education experts in each economy. Achieve then analyzed the standards for courses in which more than 50 percent of students enroll, as indicated by economies. Courses taken by fewer than 50 percent of students were not included in this analysis, nor were standards for which economies could provide no data or no informed estimation of the percent of students completing those courses.

TABLE 3 below shows the decisions Achieve made about which courses to include. More than 50 percent of students enroll in the courses or course components listed in the table below with the exception of the Biology courses. (Achieve analyzed all Biology course standards provided regardless of the percent of students enrolled, due to particular interest in these courses on the part of APEC participants.) The designation "*Not available*" denotes where there was a single set of standards provided for analysis and therefore no decision to be made about what to include. This does not necessarily mean that there is no course differentiation in upper secondary schools in those economies but rather that we were unable to determine this based on the documents we received or in subsequent follow-up conversations.

TABLE 3: Course Sequences Included in Achieve's Analysis[1]

	Math		Science	
Economy	**Courses Coded**	**Percent Students Completing Course**	**Courses Coded**	**Percent Students Completing Course**
Australia	Not available		Not available	
Canada	Pure Math 10	66%	Biology	
	Pure Math 20	66%		
	Pure Math 30	66%		
China	Math 1	100%	Not available	
	Math 2	100%		
	Math 3	100%		
	Math 4	100%		
	Math 5	100%		
Chinese Taipei	Math Elective 1	Expected that most students will complete this course	Basic Biology	No data available
			Biology	No data available
Hong Kong	S4-S5 Math	100%	S4-S6 Biology	Approximately 50%
Japan	Math I	100%	General Science A	No enrollment data available. More than 50% of schools offer this course. Fewer than 50% of schools offer other science course options at level.
	Math A	79%	Biology I	65%
	Math II	87%	Biology II	32%
	Math B	54%		
Korea	Not available		Not available	
Malaysia	Maths Form 1	100%	Science Form 1	100%
	Maths Form 2	100%	Science Form 2	100%
	Maths Form 3	100%	Science Form 3	100%
	Maths Form 4	100%	Science Form 4	100%
	Maths Form 5	100%	Science Form 5	100%
			Biology Form 4	26%
			Biology Form 5	26%
New Zealand	Not available		Not available	
Singapore	Express and Normal Academic Tracks	85%	Express and Normal Academic Tracks	85%
Thailand	Not available		Not available	
USA	Not available		Not available	

[1] *The incomplete course-taking data in this table are based on the economy's responses to surveys from Achieve and the U.S. Department of Education. Achieve was unable to match this data with data from other sources that would provide context regarding the share of all school aged students these percentages represent.*

Findings for Mathematics

The purpose of Achieve's analysis was to determine similarities and differences among the 12 participating APEC member economies' expectations and priorities in three main areas:

(A) Qualitative aspects of standards (determining whether the standards are organized into single grade levels or multiple grade bands, how the standards are organized in regard to key strands and broad topics, and what level of detail they contain);

(B) Core content expectations (describing what topics economies address in their standards, the extent to which those topics are common across most or all of the economies, and the proportion of economies standards that is made up of the common topics); and

(C) Performance expectations (describing the emphasis given to various levels of performance skills – procedural skills, conceptual understanding skills, strategic problem solving and reasoning skills – evident in the member economies' standards).

Twelve APEC economies volunteered for participation in the mathematics portion of the study: Australia, Canada, China, Chinese Taipei, Hong Kong, Japan, Korea, Malaysia, New Zealand, Singapore, Thailand and the United States. (Some economies that otherwise would have chosen to participate could not because an English translation of the standards for comparison was required for the analysis.) The complete list of standards coded for this study is available in Appendix A.

Overall, Achieve observed great variety from economy to economy in terms of the organizational aspects of the standards, including how the member economies organize their mathematics content standards in regard to key strands and broad topics. Despite these differences, Achieve also found a *common set of topics* that is addressed by the majority of economies at each grade span, particularly at the primary grades, indicating a level of international agreement about what mathematics is most important for students to learn. Finally, Achieve determined that the level of performance, or cognitive skill, expected across the participating economies was generally at the lower end of the performance continuum.

What follows are the detailed findings of Achieve's analysis.

A. QUALITATIVE ASPECTS OF THE STANDARDS

To understand the similarities and differences in the way standards are crafted across the economies, Achieve examined how the standards are structured (grade by grade vs. grade spans) and what mathematical strands and topics they include. Despite the considerable variety in structure, standards from the 12 participating economies are more similar than they are different – particularly at the elementary grades.

Grade Level v. Grade Span Approach

There are two approaches to organizing standards: by grade level (i.e., listing objectives and standards for each grade) and by grade spans (i.e., listing objectives and standards over a period

of two, three or four years). The majority of APEC economies studied organize their mathematics standards by grade level: Of the twelve economies, five use the single grade approach for all standards, four blend single grade and multiple-grade groupings, and three use grade spans.

TABLE 4: Organization of Mathematics Standards: Single Grades v. Grade Spans

Economies	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
Australia		✓		✓		✓		✓				
Canada	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
China		✓			✓			✓		✓	✓	
Chinese Taipei	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hong Kong	✓	✓	✓	✓	✓	✓		✓			✓	
Japan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Korea	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Malaysia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
New Zealand[1]		✓		✓		✓		✓		✓	✓	✓
Singapore	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Thailand		✓			✓			✓			✓	
United States[2]			✓			✓			✓			

[1] *New Zealand presents its "blended" mathematics standards in overlapping bands in recognition of the varying pace at which students master material. For the purpose of this report, each set of standards are placed in the chart above in the grade or grade span in which the heaviest emphasis on that set of skills takes place and the grade or grade span in which a majority of students will likely master those skills.*

[2] *The United States has not established national standards (there are 50 different sets of state standards), but Achieve included the National Assessment of Educational Progress (NAEP) assessment framework for mathematics (2007) in this study.*

Years of Required Mathematics Instruction

Achieve surveyed economies to determine how many years of total instruction is required for students. We found that, while all economies begin mathematics instruction at grade 1, if not earlier in the kindergarten year, there is some variation in the total number of years of mathematics required across economies. Seven of the 12 APEC economies in this study have established requirements for the minimum number of years of mathematics instruction, ranging from nine to 11 years, with an average of 10 years. [Note: the number of years of required mathematics does not necessarily correspond to the number of years covered by the standards.] In four economies, mathematics requirements are established "locally," such as at the province, territory or state level. The table below shows the number of years of mathematics required across economies.

TABLE 5: Years of Mathematics Instruction Required by Economies

Economy	Years of Required Mathematics Instruction
Chinese Taipei	11
Hong Kong	9
Japan	11
Korea	10
Malaysia	10
Singapore	10
Thailand	9
Australia	Requirements vary, depending on the state or territory
Canada	Requirements vary, depending on the province or territory
New Zealand	Requirements vary, depending on the locality
United States[1]	Requirements vary, depending on the state
China	Not available

[1] In the United States, all but four states have set statewide graduation requirements. Of the remaining states, 18 require four years of high school mathematics, 22 require threes years and the remaining six require two years. For more information about state graduation requirements, visit http://www.achieve.org/GradRequirements.

Strand Organization & Emphasis by Grade Span

The 12 economies in this analysis organize their standards according to a variety of strands, or domains, using varying levels of specificity; some are very broad categories, while some use more specific topics to arrange their standards. Many economies use similar strand titles to organize their standards.

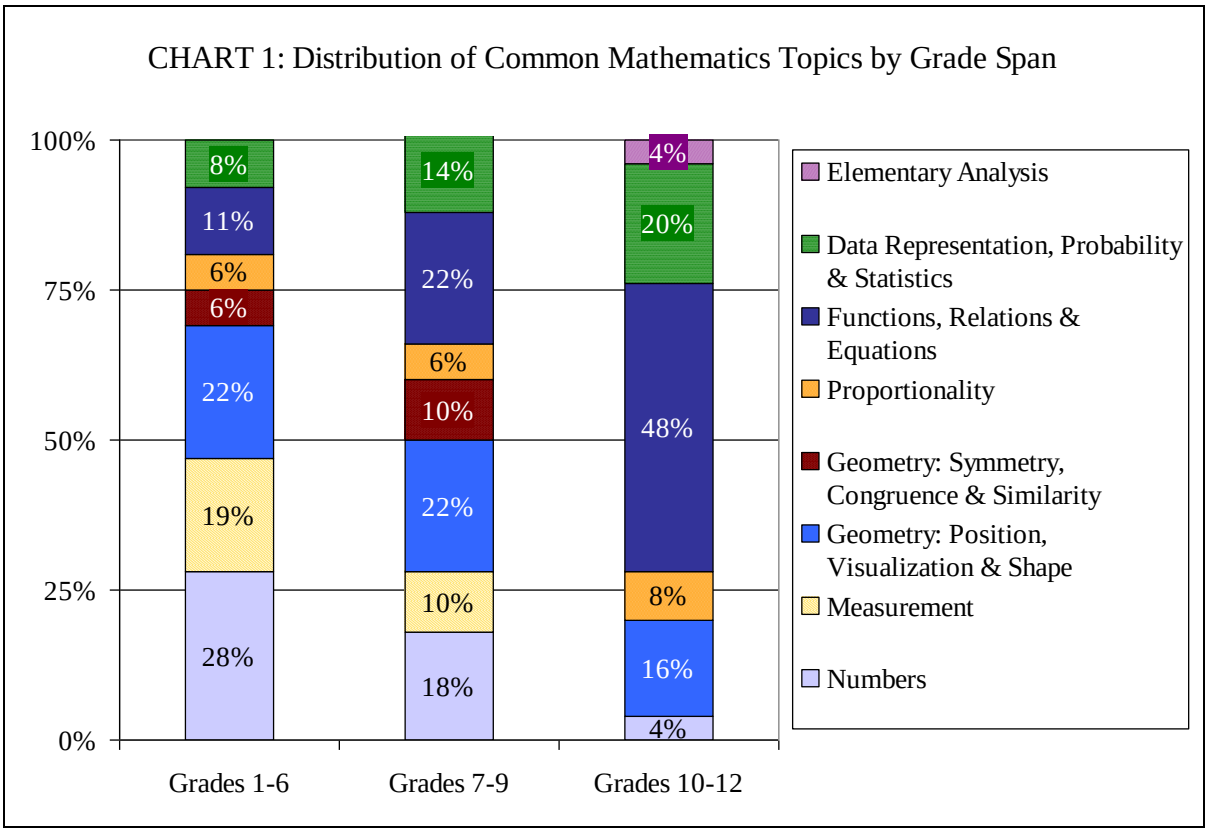
To categorize the economies' mathematics standards, Achieve used a mathematics coding framework developed by Michigan State University that organizes content into 10 strands:

1. Number
2. Measurement
3. Geometry: Position, Visualization & Shape
4. Geometry: Symmetry, Congruence & Similarity
5. Proportionality
6. Functions, Relations & Equations
7. Data Representation, Probability & Statistics
8. Elementary Analysis
9. Validation & Structure
10. Other Content

Achieve noted that the emphasis on certain domains of mathematics shifts clearly across the grade spans, as demonstrated in the graph below. In grades 1-6, collectively across all economies, Number, Measurement and Geometry (position, visualization and shape) compose on average nearly 70 percent of economies standards. This diminishes 50 percent in grades 7-9 and to 20 percent in grades 10-12.

In contrast, the emphasis on Functions, Relations and Equations, relative to other strands across all economies, increases with the grade levels, totaling 11 percent in grades 1-6, and increasing to 22 percent in grades 7-9, and to 48 percent in grades 10-12. Similarly, the emphasis on Data increases over the grades (albeit to a lesser degree), from eight to 14 to 20 percent. The upper secondary span, grades 10-12, includes attention to Elementary Analysis topics, which include, among other content, topics typically addressed in pre-calculus and/or calculus courses.

These inverse shifts in emphasis suggest that economies tend to emphasize number sense and number operations in the early grades, which beyond teaching students vital skills and concepts, lays the groundwork for the study of more abstract concepts presented in the domain of algebra later in a student's career.



Level of Detail

The economies' mathematics standards vary in respect to their level of detail. As the table below indicates, some economies use descriptive language and/or provide elaborations or examples in their mathematics standards. Others use sparer, shorter statements to convey what students need to know. Because Achieve coded English-language versions of all standards, some style differences in the language may be due to the challenges of translation. Yet even within the group of standards written originally and only in English (Australia, Canada, New Zealand and United States), the economies include varying levels of detail in their standards. This, coupled with the organization and structure of economies' standards, results in widely different lengths of the standards documents across economies. In addition, some economies provided only summaries of their standards.

TABLE 6: Level of Detail: Illustrative Examples

Topic	Korea	Canada
Collecting data (Primary Level)	**Grade 3:** By collecting, sorting, and organizing various data, express them in tables, bar graphs, and simple pictographs.	**Grade 2:** Gather and record data about self and others to answer questions. Formulate a question that can be answered by gathering information about self and others; Organize data as it is collected using concrete objects, tallies, checkmarks, charts or lists; Answer questions using collected data.
Pythagorean Theorem (Lower Secondary Level)	**Grade 9:** Understand and prove Pythagorean theorem. Apply Pythagorean theorem to simple figures.	**Grade 8:** Develop and apply the Pythagorean theorem to solve problems. Model and explain the Pythagorean theorem concretely, pictorially or using technology; Explain, using examples, that the Pythagorean theorem applies only to right triangles… (continues)
Quadratic Equations (Upper Secondary Level)	**Grade 10:** Understand the meanings of real root and imaginary root of a quadratic equation. Understand the discriminant of a quadratic equation. Understand the relation between the root and coefficient of a quadratic equation.	**Grade 10:** Solve quadratic equations, and relate the solutions to the zeros of a corresponding quadratic function, using factoring, the quadratic formula, and graphing. Determine the character of the real and non-real roots of a quadratic equation, using the discriminant in the quadratic formula and graphing.

B. CORE CONTENT EXPECTATIONS

Achieve set out to examine the core content included in the standards across the different economies to determine the extent to which there is commonality. To do this, we analyzed the topics treated by each economy at each grade level or span. Although there is variation across economies, Achieve found that there are a number of topics that are common across economies. For the sake of reporting, Achieve focused on three grade level spans: primary (grades 1-6); lower secondary (grades 7-9); and upper secondary (grades 10-12). Although the standards may be written in varying degrees of detail and may be introduced and emphasized at different grade levels, there is an identifiable set of common topics across most or all of the economies participating in this study at each grade span.

Common Topics across Economies by Grade Span

Achieve's analysis found that there is a set of topics at each grade span that are common across the economies. The decision rule for inclusion is based on a constant percentage: 67 percent or more of economies included in any given grade span must address the topic in order for it to be considered a shared or common topic. (Note: The number of economies included in each grade span varies, as not all economies have standards at every grade level; therefore, the number of economies required for a topic to be included in the list is different from span to span.) The

topics included at each grade span are listed below alongside the percentage of economies addressing that topic in their standards. The topics are organized by the categories in the coding framework (Number, Measurement, etc.).

TABLE 7: Common Topics across Economies by Grade Span

	GRADES 1-6 (12 ECONOMIES) 100%=12 Economies 92%=11 Economies 83%=10 Economies 75%=9 Economies 67%=8 Economies	GRADES 7-9 (12 ECONOMIES) 100%=12 Economies 92%=11 Economies 83%=10 Economies 75%=9 Economies 67%=8 Economies	GRADES 10-12 (11 ECONOMIES) 100%=11 Economies 91%=10 Economies 82%=9 Economies 73%=8 Economies
TOPICS	**GRADES 1-6 % of Economies**	**GRADES 7-9 % of Economies**	**GRADES 10-12 % of Economies**
NUMBER*			
Meaning	100%		
Operations	100%		
Properties of Operations	67%		
Common Fractions	100%		
Decimal Fractions	100%		
Relationships of Common & Decimal Fractions	83%	67%	
Percentages	83%	75%	
Negative Numbers, Integers & Their Properties		100%	
Rational Numbers & Their Properties		67%	
Real Numbers, Their Subsets & Properties		92%	73%
Exponents, Roots & Radicals		92%	
Number Theory	100%	75%	
Rounding & Significant Figures	67%	92%	
Estimating Computations	92%	67%	
MEASUREMENT			
Concept of measure (including non-standard units)	100%		
Standard units (including metric system)	100%		
Common measures	100%	75%	
Computations, formulas and properties of length and perimeter	92%	92%	
Computations, formulas and properties of area	100%	92%	
Computations, formulas and properties of surface area		92%	
Computations, formulas and properties of volumes	83%	92%	
Estimation of measurement and	92%		

TOPICS	GRADES 1-6 % of Economies	GRADES 7-9 % of Economies	GRADES 10-12 % of Economies
errors of measurement			
GEOMETRY: POSITION, VISUALIZATION & SHAPE			
Line and coordinate graphs		92%	91%
Equations of lines in a plane			82%
Points, lines, segments, half-lines, and rays	75%	92%	82%
Angles	83%	92%	
Parallelism and perpendicularity	75%	92%	
2-D Geometry: Polygons & Circles		67%	
Triangles and quadrilaterals: their classification and properties	100%	100%	
Pythagorean Theorem and its applications		100%	
Other polygons and their properties	100%	100%	
Circles and their properties	100%	92%	82%
3-Dimensional shapes and surfaces and their properties	100%	100%	
Spatial perception and visualization	83%	83%	
GEOMETRY: SYMMETRY, CONGRUENCE & SIMILARITY			
Patterns, tessellations, friezes, stencils, etc.	67%		
Symmetry	75%	75%	
Transformations		83%	
Congruence		83%	
Similarities (similar triangles and their properties; other similar figures and properties)		92%	
Constructions w/ Straightedge & Compass		83%	
PROPORTIONALITY			
Meaning of ratio and proportion	67%	92%	
Solving practical problems with proportionality		83%	
Scales (maps and plans)	67%		
Proportion based on similarity		67%	
Slope and gradient in straight line graphs			82%
Trigonometry of right triangles			100%
FUNCTIONS, RELATIONS, & EQUATIONS			
Number patterns	83%	83%	
Functions and their properties		67%	91%
Representation of relations and functions		83%	91%

TOPICS	GRADES 1-6 % of Economies	GRADES 7-9 % of Economies	GRADES 10-12 % of Economies
Relationship of functions and equations			73%
Interpretation of function graphs		83%	82%
Linear Functions		92%	
Quadratic Functions			82%
Trigonometric Functions			91%
Representation of numerical situations by equations	92%	92%	
Evaluating expressions		75%	
Equivalent expressions (including factorization and simplification)		83%	82%
Linear equations and their formal (closed) solutions		100%	91%
Quadratic equations and their formal (closed) solutions			100%
Polynomial equations and their solutions			73%
Inequalities and[/or] their graphical representation		67%	82%
Systems of equations and their solutions (including matrix solutions)		75%	82%
Substituting into or rearranging formulas	67%	67%	73%
DATA REPRESENTATION, PROBABILITY, & STATISTICS			
Collecting data from experiments and simple surveys	92%	83%	
Representing data	100%	92%	82%
Interpreting tables, charts, plots, graphs	100%	92%	82%
Measures of central tendency	67%	92%	
Measures of dispersion, variance			82%
Use and misuse of statistics		75%	
Informal likelihoods and the vocabulary of likelihoods		92%	
Numerical probability and probability models		92%	82%
Counting principles			73%
ELEMENTARY ANALYSIS			
Arithmetic and geometric sequences			73%
	Total Topics = 36	**Total Topics = 52**	**Total Topics = 26**

** Two categories – Validation and Structure and Other Content – do not contain any topics that meet the 67% or more of economies threshold to be considered a shared or common topic.*

Primary School: Grades 1-6

The primary school standards introduce essential basic concepts and skills. Within the Number strand, most economies expect students in grades 1-6 to learn number sense and operations with whole numbers, fractions, decimals and percents, as well as how to order and compare such numbers. In addition to the basic operations (addition, subtraction, multiplication and division), standards at this level address basic number theory concepts.

With regard to the Measurement strand, economies expect primary students to learn common measures (such as length, time and temperature), units, conversion between units and estimation of measurements. The standards also tend to cover perimeter, area, volume and calculation of these measurements for a variety of shapes and figures. In Geometry, the set of common topics includes the properties and classification of two- and three-dimensional shapes, facilitated by study of angles, parallelism and perpendicularity. Students also learn about proportionality, particularly by reading and interpreting maps. Not only do economies expose students to basic transformational geometry concepts, such as symmetry and patterns, but also they promote spatial perception[3] with respect to geometric figures and shapes.

A Closer Look at Data in the Primary Grades

All economies expect students in the elementary grades to be able to represent data in tabular or graphic form and to interpret that data.[i]

67 percent of economies also expect these students to be able to calculate measures of central tendency such as mean, median and mode, using data.[ii]

Just two economies expect students at this level to be able to go a step beyond interpretation to use data to make predictions.[iii]

Very few algebra concepts are included in the set of common topics at this level. However, patterns are included in connection with content in the Number and Geometry strands. The remaining algebra concepts lay the foundation for more advanced content students will encounter in secondary school: understanding the use of variables, expressions and equations in abstract representation and substituting values into formulas.

Data is included at this level, specifically basic data collection (e.g., simple surveys) and the representation and interpretation of that data in a variety of formats, including tables, charts and graphs. Economies also commonly address measures of central tendency.

Lower Secondary School: Grades 7-9

Economies share more topics in common at this level than in the primary and upper secondary school levels; there are 44 percent more common topics at this level than the primary school

[3] Students are able to gain a sense of spatial perception conceptually by learning that to move from a two-dimensional figure (for example, a square) to a three-dimensional figure (for example, a cube), it is necessary to introduce the element of height. The area of a square of side s is $A=s \times s = s^2$ while the volume of a cube is $V= s \times s \times s = s^3$. In addition, students also learn to visualize solids and surfaces in three-dimensional space when given two-dimensional representations (such as nets or multiple views) and to create two-dimensional representations for the surfaces of three-dimensional objects.

level and twice as many topics in common as in upper secondary school standards. Across most strands, the common topics build on concepts from grades 1-6. For instance, the Number topics expand beyond whole numbers, fractions, decimals and percents to include treatment of integers, both conceptually and operationally. In addition, economies commonly call for students to conduct multi-step operational problems with rational numbers, requiring the application of order of operations and absolute value. More sophisticated and abstract thinking play a larger role at this juncture; students across these economies are generally expected to understand integer exponents and their properties and the relationship between roots, radicals and rational exponents. They are expected to round numbers and work with significant digits.[4]

At this level, many economies include line and coordinate geometry, the Pythagorean Theorem and its applications, transformations and congruence in the Geometry strand. Students are generally expected to solve problems by applying concepts of proportionality and similarity, as well as to apply concepts of symmetry, congruence and similarity to perform geometric constructions. While economies at the lower secondary school level generally continue to address such measurement topics as perimeter, area and volume that were also addressed at the primary school level, they expand their treatment of three-dimensional geometry to include the computation of surface area. Proportionality is further developed in the lower secondary grades, covering not only the meaning but also the use of proportionality in solving practical problems.

As the emphasis on algebra grows across the grade spans, the set of common topics expands to include functional relationships and their graphs, with a focus on linear functions. Students in these economies are generally expected to be able to solve linear equations and their systems. Simplification and factorization, skills essential to solving such equations, are included at this level also. The primary grade skill of substituting into formulas extends into the evaluation of algebraic expressions and rearrangement of formulas. Economies also tend to cover inequalities and their graphical representations.

The overlapping topics in the Data strand reflect a greater degree of sophistication in the types of plots and graphs students must construct and interpret. The shared content at this level extends beyond basic summary statistics – including the

A Closer Look at Algebra in the Lower Secondary Grades

All economies at the lower secondary level expect students to have familiarity with linear equations and to be able to solve them.[iv]

75 percent of economies expect these students to do the more demanding task of working with systems of linear equations.[v]

Just two economies expect students at this level to work with families of functions, including the effect on graphs of functions when the coefficients of the equation change.[vi]

[4] In applications of numbers in the sciences or financial disciplines, the need often arises to maintain consistency with respect to the level of precision in the data and in the answer calculated from the data. Typically, when multiplying or dividing, the answer should have the same number of significant figures as the data with the smallest number of significant digits. When adding or subtracting, the answer should have the same number of decimal places as the data with the smallest number of decimal places. Significant figures are often associated with rounding – particularly when rounding of an answer is a primary contributor to its uncertainty.

calculation of central tendency – to cover the uses and misuses of statistics, as well as basic concepts in probability.

Upper Secondary School: Grades 10-12
The standards analyzed at this level include content from both required courses and any optional courses taken by more than 50 percent of students – courses in the common pathway. There are the fewest shared topics at this level – half the common topics in the lower secondary level. Some topics from the previous grade span are revisited at this level. For instance, although the number of Geometry topics in common decrease at this level, the few topics carried over – line and coordinate graphs, circle properties and basic two-dimensional concepts – are joined by the expectation that students be able to understand equations of lines in a plane. Right triangle trigonometry and slope in line graphs also appear in this grade span, linked with the addition of trigonometric functions in algebra.

In algebra, the common topics demonstrate that economies tend to build on the grades 7-9 content and place emphasis on the relationship between functions and equations. The algebra content moves beyond linear functions to address non-linear functions, specifically quadratic and trigonometric functions and the solution of quadratic and polynomial equations. Consequently, the determination of equivalent expressions expands to include the factoring and simplification inherent in solving more advanced equations.

The topics economies emphasize in the Data strand suggest a tendency in these economies to maintain a focus on data representation and interpretation, but to apply it to more sophisticated types of plots and graphs. Upper secondary school standards expand on measures of central tendency (covered in the two preceding grade spans) to cover measures of dispersion of data. Finally, the data topics here include counting principles, such as permutations and combinations.

A Closer Look at Algebra in the Upper Secondary Grades

All economies expect students at the upper secondary level to have familiarity with quadratic equations and their solutions.[vii]

73 percent of economies expect students to work with polynomial equations, a more sophisticated type of equation often requiring more than the rote mechanisms used to solve quadratic equations.[viii]

Just two economies expect students to be able to solve parametric equations, which tend to involve multiple variables. These equations are typically taught in calculus courses.[ix]

This is also the only level at which Elementary Analysis receives any attention, and only briefly with the inclusion of arithmetic and geometric sequences. This is not unexpected given the advanced nature of this content.

Summary of Common Topics
Achieve's analysis indicates that at the Primary School level, there is a robust set of common topics that includes an emphasis on Number Sense, Number Operations and Measurement, which provide students with foundational knowledge and skills they need to be successful in other domains of mathematics, such as algebra. Measurement and geometry concepts – including

measures, units, perimeter, area, volume and a basic understanding of two-dimensional figures – provide foundational knowledge and skills that students can then apply in more sophisticated and abstract contexts later in their schooling. The few algebra and data concepts in the common topics at the primary level serve as foundations upon which greater sophistication is built at the lower and upper secondary levels.

By the upper secondary level, the set of common topics has decreased. Collectively, only seven common topics are noted across the strands of number measurement and geometry. Thirteen common topics are noted for algebra/functions and five for Data Representation, Probability and Statistics, reflecting less commonality across economies, likely as a result of a greater number of curricular choices for students.

Featured Economy: New Zealand's focus on Data Representation
Unlike most countries, New Zealand devotes about a third of its standards to statistics at every grade span. Each pass through statistical content emphasizes the *statistical enquiry cycle*, placing individual tasks and skills in the context of a larger process of research and discovery. By 5th grade[5], the standards indicate that students are "gathering, sorting, and displaying multivariate category data, discrete numeric data and simple time-series data to answer questions." At 10th grade,[6] students are planning and conducting their own surveys and experiments. By the end of secondary school[7], they have critiqued and refined the process of statistical enquiry using margins of error, experimental randomization schemes, data modeling and more. These expectations are considerably different from other economies' expectations of their students, not only in the level of mastery expected, but in the consistent focus across all grade levels on data.

Topics that persist across grades spans
Achieve found that some of the common topics are covered across economies in more than one grade span. The table below shows the common topics, as well as the percent of economies that address those topics in each grade span.

[5] See http://nzcurriculum.tki.org.nz/the_new_zealand_curriculum/learning_areas/mathematics_and_statistics/mathematics_and_statistics_curriculum_achievement_objectives#level%203
[6] See http://nzcurriculum.tki.org.nz/the_new_zealand_curriculum/learning_areas/mathematics_and_statistics/mathematics_and_statistics_curriculum_achievement_objectives#level%208
[7] See http://www.nzqa.govt.nz/ncea/assessment/search.do?query=Statistics&view=all&level=03#achievements

TABLE 8: Mathematics Topics that Persist across Grades Spans

MAJOR MATHEMATICS AREAS Sub-topics	Grade Span 1-6 (12 economies)	Grade Span 7-9 (12 economies)	Grade Span 10-12 (11 economies)
GEOMETRY: POSITION, VISUALIZATION & SHAPE			
Points, lines, segments, half-lines, & rays	75% (9/12)	92% (11/12)	82% (9/11)
Circles & their properties	100% (12/12)	92% (11/12)	82% (9/11)
FUNCTIONS, RELATIONS, & EQUATIONS			
Substituting into or rearranging formulas	67% (8/12)	67% (8/12)	73% (8/11)
DATA REPRESENTATION			
Representing data	100% (12/12)	92% (11/12)	82% (9/11)
Interpreting tables, charts, plots, graphs	100% (12/12)	92% (11/12)	82% (9/11)

The fact that some topics are included across multiple grade spans raised questions for the Achieve analysts about whether standards are redundant from grade to grade. A closer look, however, shows that while topics may be repeated, their coverage increases in depth and challenge as the grade spans advance. TABLE 9 illustrates how two topics from TABLE 8 – "representing data" and "circles and their properties" –increase in complexity (albeit with some differences) in the standards of four economies: Alberta, Canada; Chinese Taipei; Korea and Singapore.

TABLE 9: Illustrations of Mathematics Topics that Persist across Grades Spans

Grade Spans	Alberta, Canada	Chinese Taipei	Korea	Singapore
REPRESENTING DATA				
Primary	**Grade 3:** Collect first-hand data and organize it using tally marks, line plots, charts, and lists to answer questions.	**Grade 1:** Students can classify and record simple events and activities in daily life.	**Grade 2:** By using simple pictures, express investigated data in graphs and compare the size of data.	**Grade 3:** reading and interpreting bar graphs in both horizontal and vertical forms, reading scales, and completing a bar graph from given data.
	Grade 6: Create, label and interpret line graphs to draw conclusions.	**Grade 4:** Students can report statistical charts of data in daily life, such as bar chart, line chart and pie chart.	**Grade 5:** Organize data, express them in Stem and leaf diagram, or pictographs, and grasp the properties of the data.	
Lower Secondary	**Grade 7:** Construct, label and interpret circle graphs to solve problems.	**Grade 9:** Able to organize raw data into simple tables and statistical graphs to represent the hidden meaning of data.	**Grade 7:** Understand the distribution of relative frequency and cumulative frequency, and know how to make a graph of it.	**Grade 7:** construction and interpretation of tables, bar graphs, pictograms, line graphs, pie charts, histograms
Upper Secondary	**Grade 10:** Represent data using function models.	**Grade 11:** Understand the data in charts, data showing centralized tendency, data showing dispersion tendency and integrate centralized tendency and dispersion tendency.	This topic is not addressed in Korea's grade 10 standards; no other standard sets for other upper secondary grades were available.	**Grade 10:** drawing graphs from given data [related to] problems derived from practical situations such as… simple interest and compound interest, money exchange, profit and loss, taxation.
CIRCLES & THEIR PROPERTIES				

Grade Spans	Alberta, Canada	Chinese Taipei	Korea	Singapore
Primary	**Grade 2:** Describe, compare and construct 2-D shapes, including triangles, squares, rectangles, circles.	**Grade 3:** Students can draw circles with compasses and recognize the center of a circle, its circumference, radius and diameter.	**Grade 2:** Understand segments, straight lines, triangles, quadrangles, and circles, and know how to make or draw these shapes.	**Grade 2:** Forming, square, triangle, semicircle, and quarter circle.
		Grade 6: Comprehend the formulas of area and perimeter of a circle and apply this knowledge to find the area of circular sectors.	**Grade 6:** Understand the method of calculating the circumference and the area of a circle, and calculate them.	**Grade 6:** Finding the area and perimeter of a figure made up of some of the following shapes: square, rectangle, triangle, semicircle and quarter circle.
Lower Secondary	**Grade 7:** Demonstrate an understanding of circles by describing the relationships among radius, diameter and circumference.	**Grade 8:** Able to recognize geometrical attributes and related terms of circles (center, radius, hypotenuse, diameter, arc, segment, central angle, and sector).	**Grade 9:** Understand the properties of a chord in a circle; Understand the properties of a circle's tangent line.	This topic is not addressed in the Singapore lower secondary standards.
Upper Secondary	**Grade 11:** Solve problems using a variety of circle properties and relevant trigonometric ratios, and justify the solution strategy used.	This topic is not addressed in the Chinese Taipei upper secondary standards.	**Grade 10:** Find the equation of a circle; Understand the positional relation of a circle and a line on the coordinate plane.	**Grade 10:** Symmetry and angle properties of circles (e.g., tangents from an external point are equal in length, angles in opposite segments are supplementary).

As TABLE 9 shows, each economy emphasizes collecting data on issues that pertain to daily life in the standards for the early grades. While the standards vary in terms of the specifics and pacing of the graph types that students are expected to learn over time, all four economies expect their students to master a collection of graph types including line, bar, pie and histogram by the end of the lower secondary grades and to continue toward more challenging explorations of data in the upper secondary grades.[8]

Similarly, the standards covering the topic of circles and their properties show a pattern of both diverse content and increased depth across the grade spans. Where students in Singapore begin in grade 2 by forming shapes from cut-outs, four years later they are finding the area and perimeter of composite figures, and by grade 10 they are exploring the symmetry and angle properties of circles. In Alberta, Canada, there is emphasis on shape classification in the early grades, describing relationships among radius, diameter and circumference in grade 7, and applying trigonometric ratios to the geometry of the circle in grade 11. Each approach offers a slightly different template for guiding students from the fundamentals through the finer points of an important topic as they move from childhood toward the adult world. In each case, however, topics covered deepen in complexity over the grades.

[8] Although the available upper secondary standards from Korea do not include specific coverage of the Representing data topic, they do clearly touch on data as a subject of study. Also worth noting is that translations of standards for grades 11 and 12 in Korea were not available at the time of this report.

Common Topics as Proportion of Economy Standards at Different Grade Spans

Having identified a set of topics that most economies address in common, Achieve was then able to determine what proportion of the content addressed in each economy's standards is comprised of that set of topics. Said differently, Achieve was able to quantify the extent to which the economies' standards are focused around the common set of topics, or whether they include a lot of additional content as well.

TABLE 10 below indicates that at grades 1-6, on average, 76 percent of the content topics addressed across the 12 economies are those included in the set of common topics; 24 percent of the topics across the economies at that grade span are outside of the common set of topics. In grades 7-9, an average of 68 percent of the content included in the standards across the economies is found in the set of common topics. Finally, at the upper secondary level, only an average of 34 percent of the content included in the standards across the economies are found in the set of common topics.

TABLE 10: Overall Overlap between Standards & Common Set of Topics

Grade 1-6 Average	Grade 7-9 Average	Grade 10-12 Average
76% Range: 71%-89%	**68%** Range: 59%-85%	**34%** Range: 26%-55%

These data reflect the fact that on average the proportion of the content addressed by the economies in their standards that are from the set of common topics decreases as the grade levels progress. Looking more specifically at the upper secondary level, as TABLE 11 shows, this trend continues: On average, the set of common topics comprises 47 percent of the content for economies' standards that extend only through grade 10, while they comprise only 32 percent of the content for economies whose standards extend through grade 12.

TABLE 11: Proportion of Content Addressed in Economies' Standards From Common Topics: Grades 10, 11 and 12

Economy	Percent overlap	Final grade of standards coded
Korea	55%	10
Singapore	40%	10
Average: Economies where the common pathway ends at grade 10	**47%**	
China	31%	11
Japan	28%	11
Malaysia	33%	11
Average: Economies where the common pathway ends at grade 11	**31%**	
Alberta, Canada	32%	12
Chinese Taipei	30%	12
Hong Kong	35%	12
New Zealand	26%	12
Thailand	41%	12

Economy	Percent overlap	Final grade of standards coded
United States	26%	12
Average: Economies where the common pathway ends at grade 12	**32%**	
Overall Average	**34%**	

C. PERFORMANCE EXPECTATIONS

In addition to the content, Achieve also analyzed the performance, or cognitive skill expectations of the standards from the 12 economies in this study. Our goal was to determine the balance of basic skills, such as recall, and advanced skills, such as applying advanced mathematical reasoning, across all economies. Below is a direct accounting of the skill expectations contained in the economies' standards that addresses the question of balance.[9]

Mathematics Performance Categories & Levels

Performance expectations from the coding taxonomy have been grouped into a hierarchy of levels approximating increasing levels of cognitive demand. The levels, in increasing order of cognitive demand, are:

1. Recall
2. Using routine procedures and tools to solve problems
3. Using more complex procedures and conceptual understanding to solve problems
4. Formulating problems and strategizing/critiquing solution methods
5. Applying advanced reasoning skills

Level 1 includes demonstrating basic knowledge or recall of a fact or property. Level 2 includes routine problem solving that asks students to do such things as compute, graph, measure or apply a mathematical transformation. Level 3 includes estimating, comparing, classifying and using data to answer a question, or requiring students to make decisions that go beyond a routine problem-solving activity. Level 4 includes asking students to formulate a problem or to strategize or critique a solution method. Level 5 includes asking students to develop algorithms, generalizations, conjectures, justifications or proofs.

The listing of skills included in each performance category is included in Appendix H.

Emphasis of Performance or Cognitive Skills across Grade Spans

Achieve found that most of the economies place the greatest emphasis on the Level 1 and 2 performance expectations – i.e., Recall and Using Routine Procedures – and less emphasis on Level 5, Applying Advanced Reasoning skills. The heavy emphasis on the Level 1 skills – those that come under the Recall category – is due partly to the fact that economies often address both recall skills and more advanced skills in a single standard. Skills found in the Recall category are often necessary – and articulated in the standards – to lay the foundation for students to be able

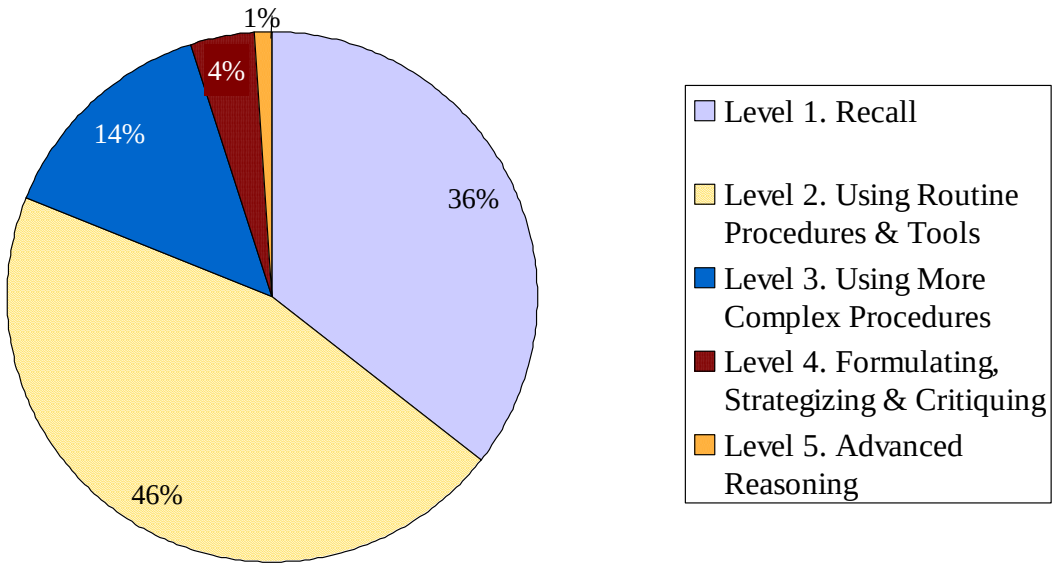
[9] To look beyond balance of performance expectations and compare the rigor of economies' standards was not the intent or purpose of this study. To answer questions regarding comparative rigor of expectations would require additional analysis.

to apply higher-order skills with the very same content. In cases where a standard addressed more than one skill in a standard, Achieve analysts recorded both skills in its analysis.

Primary School: Grades 1-6[x]

Over 80 percent of performances expected of students across the economies in grades 1-6 consist of Level 1 and 2 skills – Recall and Using Routine Procedures. Less than 20 percent of the performances described in the standards address more cognitively demanding skills, with only five percent addressing Levels 4 and 5.

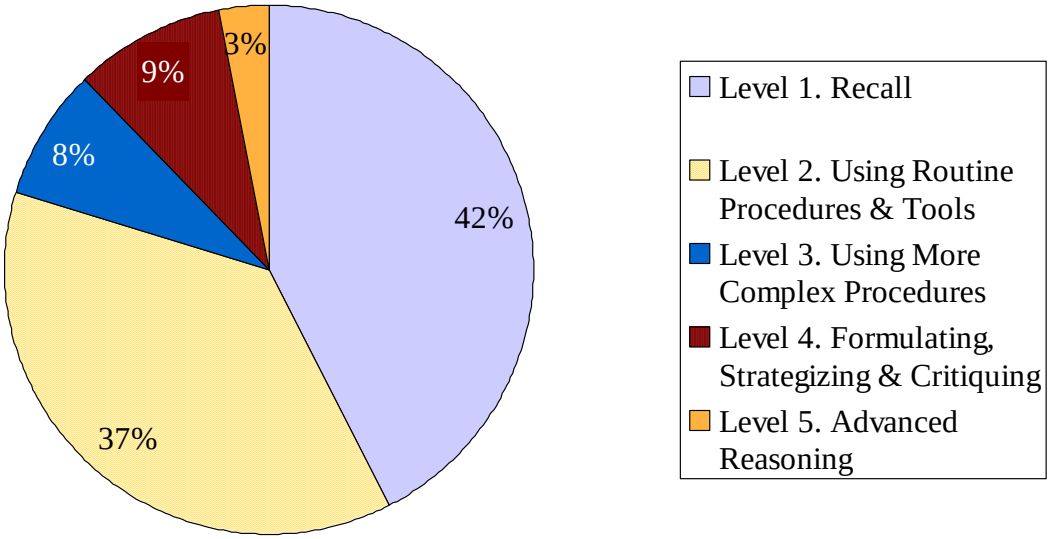
CHART 2: Performance Expectations in Mathematics across the Economies, Grades 1-6



Lower Secondary School: Grades 7-9[xi]

Nearly 80 percent of the performance skills emphasized in grades 7-9 across all economies are from Levels 1 and 2 (Recall and Using Routine Procedures). Just over 20 percent of the performances described in the standards address more cognitively demanding performances, with just 12 percent addressing Levels 4 and 5.

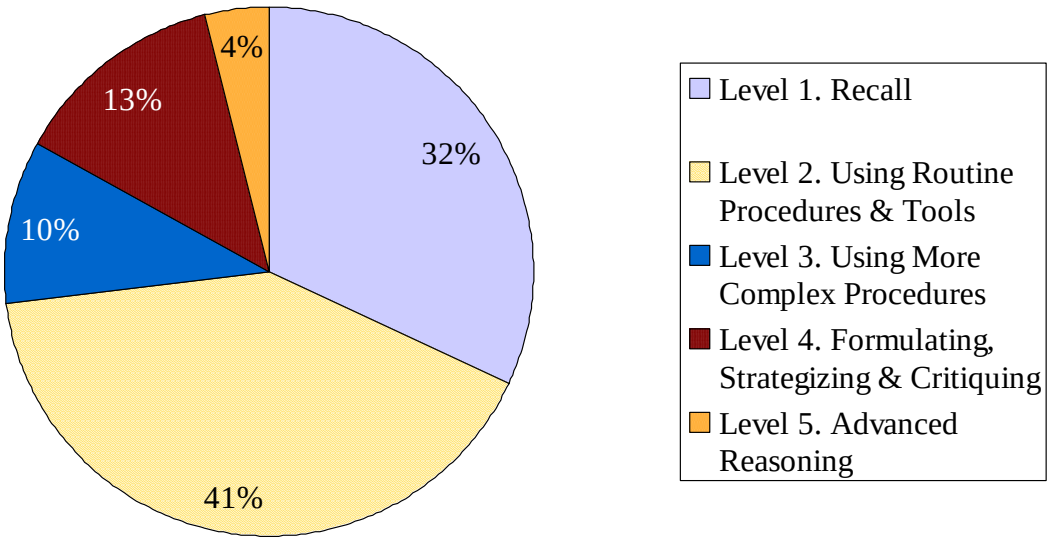
CHART 3: Performance Expectations in Mathematics across the Economies, Grades 7-9



Upper Secondary School: Grades 10-12[xii]

Seventy-three percent of the performances at grades 10-12 consist of Level 1 and 2 expectations, Recall and Using Routine Procedures. The remaining 27 percent of the performances address more cognitively demanding skills, with 17 percent of the emphasis at Levels 4 and 5.

CHART 4: Performance Expectations in Mathematics across the Economies, Grades 10-12

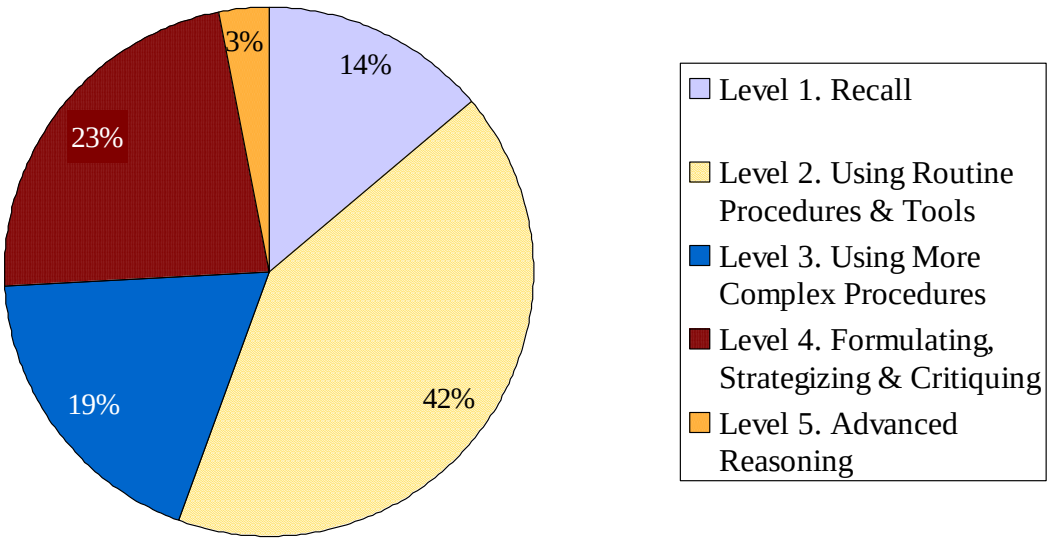


Summary of Performance or Cognitive Skills
Economies generally emphasize more demanding performance skills at the secondary level. Some trends are more readily apparent when performance skill categories are combined. For instance, as the grade spans progress, basic skills (Recall & Using Routine Procedures) decrease slightly from 82 to 79 to 72 percent. In contrast, the group of skills beyond the rote and routine (Using More Complex Procedures, Formulating Problems and Applying Advanced Reasoning) increases from 19 to 20 to 27 percent. This trend suggests that the level of performance or cognitive skill challenge increases over the grade levels as students work with more advanced content.

Variation among Economies
While on average the economies studied tend to emphasize the Level 1 and 2 skills over the higher-level skills, there is great variation among individual economies. What follows are examples that show the variation in the distribution of performance skill expectations across economies for grade span 10-12. These examples are limited to the expectations set at the individual standard statement level – economies may reinforce, expand or raise expectations to a higher level in other ways (e.g., through curricular guides, instructional materials and assessments).

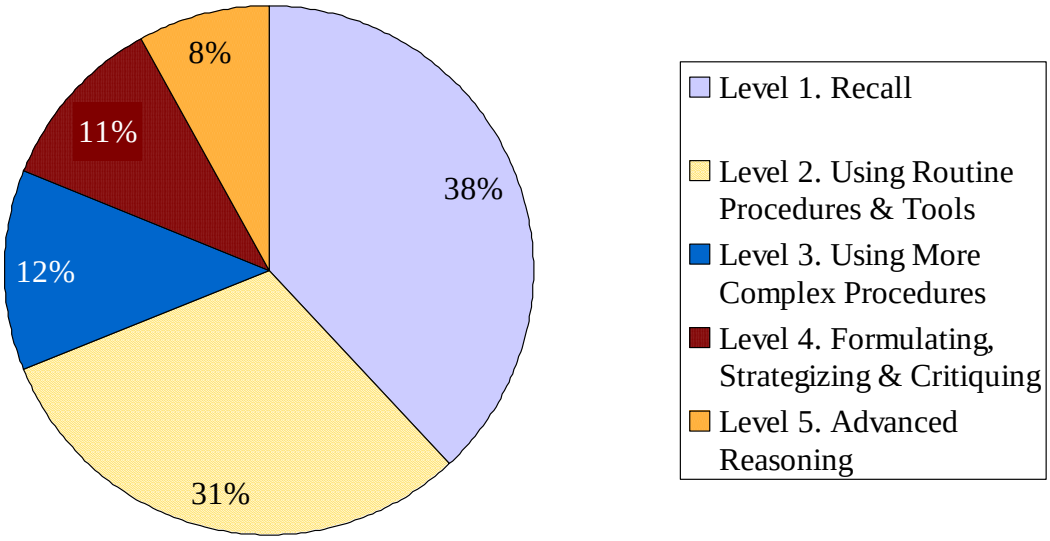
New Zealand dedicates 45 percent of its performance expectations for grades 10-12 to the top three levels, as compared to 27 percent average of all the economies. In the standards from this economy, students are required to critically evaluate data presented by others, make inferences based on data, justify attributes and measures selected, and critique causal relationship claims. Furthermore, they are expected to devise effective solution strategies and to generalize and deduce properties – all of which are higher order cognitive skills.

CHART 5: New Zealand, Performance Expectations in Mathematics, Grades 10-12



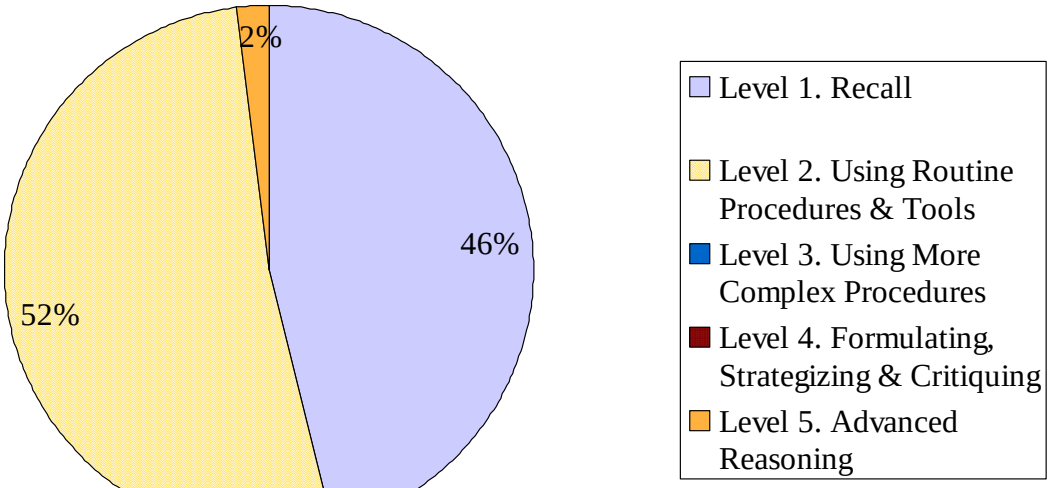
China places slightly more emphasis on the top three performance skill categories overall than average of all the economies, but places the heaviest emphasis among the economies – eight percent – on Applying Advanced Reasoning, the highest performance skill. This economy's standards contain a relatively strong emphasis on proof, including reasoning and argumentation. The course component that highlights trigonometry covers derivation of formulae, also a higher order skill. Finally, the standards provide rich opportunities for students to think deeply and logically about algorithms, algorithmic thinking and the connection to computer technology.

CHART 6: China, Performance Expectations in Mathematics, Grades 10-12



Korea's standards use language focused on memorization, basic representation and the performance of routine procedures, with almost no attention given to Using More Complex Procedures or Formulating, Strategizing and Critiquing, with little attention to Applying Advanced Reasoning.

CHART 7: Korea, Performance Expectations in Mathematics, Grades 10-12



Findings for Science

The purpose of Achieve's analysis was to determine similarities and differences among the 10 participating APEC member economies' organizational patterns and expectations in three main areas:

(A) Qualitative aspects of standards (determining whether the standards are organized into single grade levels or multiple grade bands; how the standards are organized in regard to key strands and broad topics; and what level of detail they contain);

(B) Core content expectations (describing what topics economies address in their standards, the extent to which those topics are common across most or all of the economies and the proportion of economies' standards that is made up of the common topics); and

(C) Performance expectations (determining the emphasis given to various kinds of performance expectations evident in the member economies' standards – with the two major categories being those that are mainly concerned with developing conceptual understanding and those concerned with developing students' ability to conduct investigations.

Ten APEC economies volunteered for participation in the science portion of this study: Australia, Canada, Chinese Taipei, Hong Kong, Japan, Korea, Malaysia, New Zealand, Singapore and the United States. (Some economies that otherwise would have chosen to participate could not because an English translation of the standards for comparison was required for the analysis.) In addition, secondary level course standards from five economies are included in the study. The complete list of standards coded for this study is available in Appendix A.

As stated earlier, economies structure their standards quite differently. Achieve observed great variety from economy to economy in terms of their organization, emphasis, level of detail and the beginning and ending years of the standards. These differences not withstanding, Achieve also found that across the 10 economies included in our science analysis, there is a *core set of topics* that is addressed by the majority of economies at each grade span.

What follows are the detailed findings of Achieve's analysis.

A. QUALITATIVE ASPECTS OF THE STANDARDS

To understand the similarities and differences in the way standards are crafted across the economies, Achieve examined how the standards are structured (grade by grade vs. by grade spans) and what science strands and topics they included. In general, there is more agreement among economies as to the content topics that should be addressed in the upper grade spans than in the lower grade spans.

Grade Level v. Grade Span Approach

Economies follow diverse paths in organizing science content and skills, often presenting subject matter in very different ways from each other. They also tend to group grades together indicating

there is not necessarily a strict sequential pattern in which science content and skills must be organized. The table below shows that at the primary and lower secondary levels a greater number of economies uses multiple grade bands to organize their science standards than single grade-level standards .[10] Only three economies use a single grade approach for their science standards. Two use a blended approach and five use only grade spans.

TABLE 12: Organization of Science Standards: Single Grades v. Grade Spans

Economy	BY GRADE & GRADE SPAN												BY COURSE			
	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Grade 8	Grade 9	Grade 10	Grade 11	Grade 12	Biology	Chemistry	Physics	Earth Science
Australia		✓			✓			✓								
Canada	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
Chinese Taipei		✓		✓		✓		✓					✓	✓	✓	✓
Hong Kong		✓			✓			✓		✓			✓	✓	✓	
Japan			✓	✓	✓	✓		✓		✓			✓	✓	✓	✓
Korea	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	
Malaysia	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
New Zealand[3]		✓		✓		✓		✓		✓	✓					
Singapore			✓		✓			✓								
United States[4]		✓			✓			✓								

[3] *New Zealand presents its "blended" science standards in overlapping bands in recognition of the varying pace at which students master material. For the purpose of this report, each set of standards are placed in the chart above in the grade or grade span in which the heaviest emphasis on that set of skills takes place and the grade or grade span in which a majority of students will likely master those skills.*

[4] *The United States has not established national standards (there are 50 different sets of state standards), but Achieve included the National Assessment of Educational Progress (NAEP) assessment framework for science (2009) in this study.*

[10] This does not include the subject-specific courses in science at the upper secondary level.

Years of Required Science Instruction

There is great variation across economies in science course requirements – including both how many are required and which ones. Some economies require students to complete a certain number of years of standardized courses. Others require students to complete some standardized courses as well as additional credit hours in courses of their choice. Still others vary course requirements based on whether students are enrolled in a humanities course of study or a math/science course of study. The table below summarizes economies' course requirements for science.

TABLE 13: Years of Science Instruction Required by Economies

Economy	Years of Required Science Instruction
Australia	Varies depending on the state or territory
Canada	Varies depending on the province or territory
Chinese Taipei	11 2 credit hours in each science subject (biology, chemistry, physics & Earth science) & 4-6 credit hours in one of the four
Hong Kong	9
Japan	4 credit hours (2 courses at 2 hours/ week/ year) in general secondary science is the minimum requirement. Additional courses depend on track. Starts at grade 3
Korea	10
Malaysia	9
New Zealand	Varies depending on local requirements
Singapore	7 Starts at grade 3
United States[1]	Varies depending on the state

Despite differences in course requirements, most economies begin mathematics and science instruction at grade one, with three exceptions: Japan and Singapore begin science instruction at year three, while Australia begins science instruction at year two. Interestingly, in the early grades, science instruction often includes concepts that overlap with basic mathematics instruction, such as classification, counting, ordering, using whole numbers and fractions in describing objects, measuring and identifying patterns including geometric shapes. Young students are often encouraged to make their descriptions of phenomena quantitative by answering the questions "How many?" or "How much?" Therefore, it is possible that despite the absence of dedicated science standards in the early grades in these particular economies, students may receive foundational science instruction via mathematics or other content areas.

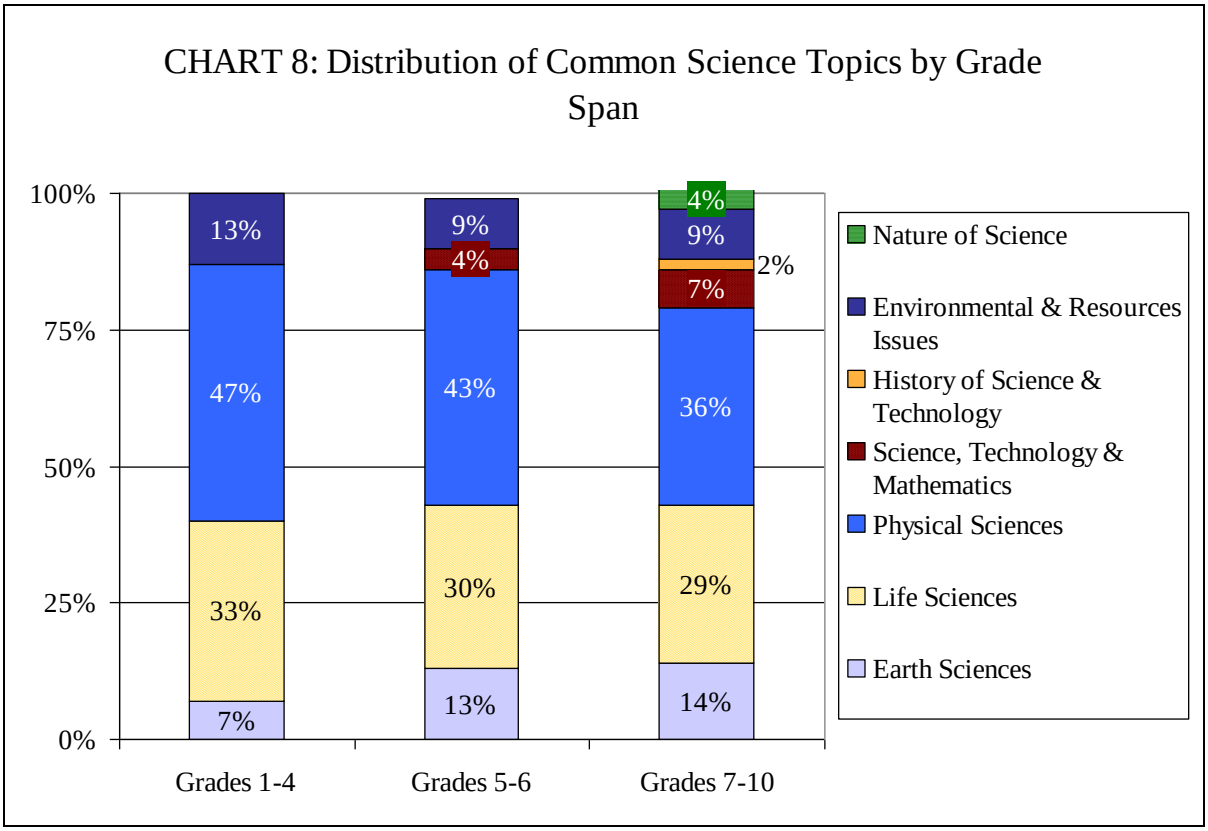
[1] In the United States, all but four states have set statewide graduation requirements. Of the remaining states, five require four years of high school science, 31 require three years, and the remaining 10 require two years. For more information about state graduation requirements, visit http://www.achieve.org/GradRequirements.

Strand Organization & Emphasis by Grade Span

To analyze the standards in the 10 economies in this study, Achieve used a science coding framework developed by Michigan State University that is organized into seven content strands:

1. Earth Sciences
2. Life Sciences
3. Physical Sciences
4. Science, Technology & Mathematics
5. History of Science & Technology
6. Environmental & Resources Issues
7. Nature of Science

While economies may not use exactly the same strand titles, their standards generally address topics in these areas. Most economies in grade spans 1-10 have strands based on the major science fields, i.e., life sciences, physical sciences and Earth sciences. In addition, most economies treat topics that fall under the "nature of science" (including science inquiry) and "science, technology and society" (including environmental and resource issues). In grade spans 1-10, economies take an integrated approach in organizing their content standards, meaning that they do not limit their instruction to one or two fields, but rather draw topics from all the major fields. Beyond grade span 7-10, the pattern shifts with most economies developing specific course standards for biology, chemistry, physics and Earth science. For a complete listing of economies and content categories, see Appendix C.



The science strands in the coding framework address primarily the three major fields – Earth Sciences, Life Sciences and Physical Sciences (Chemistry and Physics) – which are maintained across each grade span. These are supplemented by cross-cutting areas such as the Nature of Science and Environmental & Resource Issues. While the emphasis shifts slightly across grade spans, the three major fields combined account for the majority of the topics of each grade span. All grade spans are characterized by a more noticeable emphasis on Physical Science topics than on Life Science or Earth Science. Two factors may explain the relatively low emphasis on Earth Science topics. First, some economies include Earth science topics, such as landforms (mountains, valleys, continents, etc.) in their geography standards. Additionally, the Environmental and Resource Issues strand, as defined by Achieve's coding framework, contains content that might otherwise be assigned to the Earth Sciences.

Level of Detail

The economies' science standards vary in regard to their level of detail. Some use descriptive language and are very specific about learning outcomes, while others are written at a more general level (see table below). As a result, the standards also vary considerably in terms of their length. Because Achieve analyzed English language translations of the standards, some of the differences detected by the content experts may be a result of translation challenges.

TABLE 14: Level of Detail: Examples from the Upper Secondary Level in Two Economies

Subject	Topic Description	Canada	Chinese Taipei
Biology/Life Science	Cell structure (membranes, nucleus, mitochondria, vacuoles) and basic function	"It is expected that students will…explain the cell theory; describe cell organelles visible with light and electron microscopes..."	**Basic Biology** 3-1 Cell formation and structure; 3-2 Organelles structure and function; • Only briefly discuss the substance synthesis and decomposition • Only briefly discuss the cell nucleus, cell membrane, chloroplast, mitochondrion, ribosome, endoplasmic reticulum, etc. • Observe animal and plant cells, cells of onion root tips
Chemistry	Chemical Reactions	"It is expected that students will...represent chemical reactions and the conservation of mass using molecular models, and balanced symbolic equations"	**Chemical reactions** 1-1 Concepts of subatomic particles and chemical reactions ▪ Law of conservation of mass 1-2 Chemical formulas and chemical reactions ▪ Relationship between Mass and energy in chemical reactions Hess' law. 1-3 Changes of mass and energy between reactants and products

Subject	Topic Description	Canada	Chinese Taipei
Earth Science	Earth, sun, moon in the solar system (Earth/sun/moon system, earthshine, eclipses, features of sun and moon, night/day, tides, north/south hemisphere, seasons)	"analyse why scientific and technological activities take place in a variety of individual and group settings (e.g., analyse the individual and group activities required to study various components of the universe)"	"Know the general environmental conditions in space that surrounds the Earth, including solar radiation, solar wind, cosmic rays, small celestial bodies (i.e. comet, meteor, etc.);" "Know the meanings of the brightness and color of fixed stars." "Know that besides the solar system, there are nebula, star cluster, and galaxies in the immense universe."
Physics	Laws of motion, momentum and collisions	"It is expected that students will...use vectors to represent force, velocity, and acceleration; analyse quantitatively the horizontal and vertical motion of a projectile; identify the frame of reference for a given motion; apply Newton's laws of motion to explain inertia, the relationship between force, mass, and acceleration, and the interaction of forces between two objects..."	2-1 Utilize two-dimensional concepts to discuss displacement, speed, and acceleration in two dimensions; 2-2 Explain constant acceleration in 2-D with projectile motion

B. CORE CONTENT EXPECTATIONS.

Achieve set out to examine the core content included in the standards across the different economies to determine the extent to which there is commonality. To do this, we analyzed the topics treated by each economy at each grade level or span. Although there is variation across economies, Achieve found a number of topics to be common to most economies. Achieve focused its analysis at three grade spans: early primary (grades 1-4); late primary (grades 5-6); and lower secondary (grades 7-10). Achieve also analyzed Biology course standards from five economies as an example of subject-specific standards from upper secondary.

Common Topics across Economies by Grade Span

Achieve's analysis indicates that there is a set of topics for each grade span that are common across the 10 participating economies. The decision rule for inclusion requires that 67 percent or more of the economies' standards included in any grade span must address the topic for it to be considered common. Since the number of economies included in each grade span varies slightly, the number of economies required for inclusion is different for grade span 5-6 than for grade spans 1-4 and 7-10.

The topics included at each grade span are listed below alongside the percentage of economies addressing that topic in their standards. The topics are organized by the categories in the coding framework (Earth Sciences, Life Sciences, Physical Sciences, etc.).

TABLE 15: Common Science Topics across Economies by Grade Span

	GRADES 1-4 (10 ECONOMIES) 100%=10 Economies 90%=9 Economies 80%=8 Economies 70%=7 Economies	GRADES 5-6 (9 ECONOMIES) 100%=9 Economies 89%=8 Economies 78%=7 Economies 67%=6 Economies	GRADES 7-10 (10 ECONOMIES) 100%=10 Economies 90%=9 Economies 80%=8 Economies 70%=7 Economies
TOPICS	**GRADES 1-4 % of Economies**	**GRADES 5-6 % of Economies**	**GRADES 7-10 % of Economies**
EARTH SCIENCES			
Earth Features			70%
Atmosphere			70%
Rocks, soil			70%
Weather & climate	80%	78%	70%
Physical & Chemical Cycles		67%	70%
Earth's history			70%
Earth, sun, moon		78%	90%
Planets in the solar system			70%
LIFE SCIENCES			
Diversity, Organization, Structure of Living Things		67%	90%
Plants	70%	67%	
Animals	80%		
Systems, organs, tissues		67%	90%
Cells			100%
Energy handling, biochemistry of systems			70%
Sensing and responding			70%
Life cycles	70%	67%	90%
Reproduction			80%
Variation and inheritance			80%
Evolution, speciation, diversity			70%
Biochemistry of genetics			70%
Biomes & ecosystems			70%
Habitats & niches	70%	67%	90%
Interdependence of life			70%
Food webs, adaptations to habitats			70%
Needs of living things		78%	90%
Human biology & health	80%	89%	80%
PHYSICAL SCIENCES			
Classification of matter	90%	78%	90%

TOPICS	GRADES 1-4 % of Economies	GRADES 5-6 % of Economies	GRADES 7-10 % of Economies
Physical properties	100%	67%	100%
Chemical properties	90%		100%
Atoms, ions, molecules			80%
Energy types, conversions, sources		67%	90%
Work, Power, Simple machines		67%	70%
Heat and temperature	90%	89%	80%
Wave phenomena			70%
Sound & vibration			70%
Light	80%		80%
Electricity		89%	80%
Magnetism/electromagnetism	70%		80%
Physical changes	70%	78%	80%
Explanations of physical changes		67%	70%
Chemical changes			80%
Definition & evidence of chemical change			70%
Types of reactions			70%
First law of thermodynamics			70%
Contact forces and forces acting at a distance			70%
Time, space and motion		67%	
Dynamics of motion		89%	100%
SCIENCE, TECHNOLOGY, & MATHEMATICS			
Nature or Conceptions of Technology		78%	80%
Science applications in mathematics, technology			70%
Influence of science, technology on society			90%
Influence of society on science, technology			70%
HISTORY OF SCIENCE & TECHNOLOGY			
History of Science & Technology			70%
ENVIRONMENTAL & RESOURCE ISSUES RELATED TO SCIENCE			
Pollution – Causes and Treatment		67%	80%
Land, Water, Sea Resource Conservation	80%		90%
Material & Energy Resource Conservation	70%	78%	100%
World Population			70%
Food Production, Storage			80%
NATURE OF SCIENCE			

TOPICS	GRADES 1-4 % of Economies	GRADES 5-6 % of Economies	GRADES 7-10 % of Economies
Nature of Scientific Knowledge			90%
The Scientific Enterprise			90%
	Total Topics = 15	**Total Topics = 23**	**Total Topics = 56**

Early Primary School: Grades 1-4

Grade span 1-4 includes only 15 common topics – the least number of any of the grade spans, indicating little agreement among economies about what should be taught in science at the early grades. As mentioned earlier, it is important to note in this regard that Japan and Singapore do not formally teach science until students' third year in school, and Australia begins science in the second grade. Ten of the primary core topics appear again in grade span 5-6 and nine appear in all three grade spans. Ninety percent or more of the economies include four Physical Science topics: classification of matter, heat and temperature, physical properties of matter and physical changes.

Late Primary School: Grades 5-6

Between grade span 1-4 and grade span 5-6, the number of topics that are common across the economies increases significantly, by more than 50 percent, from 15 to 23. Topics new to the Earth Sciences include Physical & Chemical Cycles, and Earth, sun, moon. The Life Sciences category expands to include four additional topics: Diversity, Organization, Structure of Living Things; Systems, Organs, Tissues; Life cycles; and Needs of living things. One topic, "Animals," that was treated by most economies in the 1-4 grade span does not receive the equivalent emphasis in grade span 5-6. The Physical Sciences category expands the most with the introduction of eight topics: Energy types, conversions, sources; Work, Power, Simple Machines; Heat and Temperature; Light; Electricity; Physical Changes; Explanations of physical changes; Time, space and motion; and Dynamics of motion. One topic included in grade span 1-4 that is not included by 67 percent of the economies at grade span 5-6 is Chemical properties. An additional three topics – Nature or Conceptions of Technology, Pollution – Causes and Treatment, and Material and Energy Resource Conservation – are included in the cross-cutting categories of Science, Technology, & Mathematics, History of Science & Technology and Environmental & Resource Issues Related to Science. It is difficult to discern patterns in the topics that are added at grade span 5-6 beyond the overall increase in emphasis on physical science and technology topics.

Featured Economy: Canada & Technology Integration

Canada's science standards provide a noteworthy treatment of the scientific enterprise and the relationship between science and technology, as described below.

- The standards include substantial information on the scientific enterprise, such as *explain how a major scientific milestone revolutionized thinking in the scientific communities* and *describe the importance of peer review in the development of scientific knowledge.*
- The standards clearly and accurately portray the complementary nature of science and technology. For example, students are expected to *distinguish between scientific questions and technological problems* and *compare processes used in science with those used in technology.*
- Every standard is accompanied by a related example, often from the history of science and technology. For instance: *Analyze and describe examples where scientific understanding was enhanced or revised as a result of the invention of a technology (e.g., describe examples such as how the equipment used by Coulomb and Cavendish enhanced our scientific understanding.)*
- The standards detail the critical thinking skills that underlie science inquiry and the problem-solving strategies basic related to technology and engineering.

Lower Secondary School: Grades 7-10

The set of topics that are commonly addressed across the economies in grade span 7-10 is larger than that at either of the earlier grade spans. Indeed, grade span 7-10 includes almost all of the content covered at grades 5-6, as well as additional topics that make it more than double the size of the earlier grade span. In the Earth Sciences category, economies include all of the topics listed in Table 15. The Life Sciences category shows a similar expansion with all but two topics – Plants and Animals – addressed by 67 percent of the economies. (By grades 7-10, these broad topics have likely been supplanted by finer-grained topics.) All Physical Science topics included in grade span 5-6 – except the category of time, space and motion – carry over into the 7-10 grade span. The set of topics common to 67 percent of economies expands further to include more chemistry concepts, such as types of reactions.

In grade span 7-10, nearly all economies address the synergistic relationships between Science, Technology and Society, including Applications of Science in Technology and Mathematics, the History of Science and Technology, and the Nature of Science. Most economies also include attention to global problems, incorporating the topics of world population and food production and storage into their standards.

Upper Secondary School: Biology

Achieve also analyzed the Biology courses from five economies, two of which included a two-year sequence of courses (Japan: Biology I and II; Chinese Taipei: Basic Biology and Biology). Achieve found that the comprehensive *Diversity, Organization, Structure of Living Things* topic is presented in greater depth in Secondary School Biology than in earlier grade spans, expanding to include organisms represented by Bacteria, Viruses and Archaea, along with plants, animals.

There are 23 shared topics, as described in the Life Science Content category of Achieve's coding framework, in the sets of Biology standards reviewed. In comparing common standards in Biology with the individual grade spans, Achieve found five Life Science topics in grade span

1-4, seven in grade span 5-6 and 16 in grade span 7-10 that overlap with the set of standards in Biology.

Approximately 70 percent of the Life Science topics in grade span 7-10 are revisited in Biology, while only three topics that were common to all lower grade spans are included in Secondary School Biology, i.e., *life cycles, habitats and niches,* and *human biology and health*.

As would be expected, Secondary School Biology standards are more demanding than the lower grade spans, as they include topics such as *Biochemical processes in cells* (related to the functions of cells, organs and systems), *Population genetics, biotechnology, Genetic engineering* (focusing on the mechanisms and biochemistry of genetics/DNA and RNA), and *Competition among organisms* (fundamental to the mechanism of evolution).

The set of common standards in Biology also included several crosscutting concepts and themes, for example: *Pollution – Causes and Treatment*, *Land, Water, Sea Resource Conservation* and the *Nature of Science.*

Featured Economy: Japan's focus on Scientific Inquiry
Japan's science standards for Upper Secondary promote scientific inquiry and highlight the habits of mind that are fundamental to research. The way in which Japan presents and describes its standards in all four of the major fields of natural science – biology, chemistry, Earth science and physics – underscores the central concern that students develop investigative skills. Teachers are instructed to "*make observations and experiments the core of your teaching … and get the students to engage in the production and presentation of creative reports*."

Courses are organized in a two-part sequence with the second part building directly on the knowledge and skills delivered in the first. For example, the standards for Chemistry I note the importance of students *setting up hypotheses, designing experiments, providing experimental proofs, analyzing and interpreting experimental data and identifying regularities*. The Chemistry II standards reinforce the emphasis on investigative work but raise the level of rigor significantly with explicit mention of a *Research Project* that stresses the preparation and presentation of research reports that show originality. The standards for Biology I and II, Earth Science I and II and Physics I and II follow the same pattern.

Summary of Common Topics
Achieve's analysis indicates that at the Early Primary School level, there is a comparatively small set of 15 common topics, indicating a lack of agreement across economies about what students should be taught. This may in part be a result of the fact that economies vary in terms of when formal instruction in science begins. By Late Primary School, the set of common topics increases significantly to 23 and by Lower Secondary there is an even greater increase in the common topics to 56. The expansion at Lower Secondary adds key topics in Life Science and Physical Science, and shows an increased focus on Science, Technology and Society, Applications of Science in Technology and Mathematics, and the History of Science and

Technology. The Biology standards across economies share a significant set of common topics, indicating there is a good deal of agreement about the topics that should be treated in a year-long high school biology course. Since Biology courses are principally based on the Life Science strand of the coding framework, it follows that there would be greater agreement among economies as to topics addressed in high school Biology than in the earlier grades when science standards draw content from across the major strands.

Topics that persist across grades spans

Achieve found that a limited set of common topics are covered across economies in all three grade spans. The topics listed in TABLE 16 are addressed in 67 percent or more of the economies' standards; in addition, the table indicates the percent of economies that address the topic in each grade span.

TABLE 16: Science Topics that Persist across Grades Spans

MAJOR SCIENCE AREAS **Sub-topics**	**Grades 1-4** **(10 economies)**	**Grades 5-6** **(9 economies)**	**Grades 7-10** **(10 economies)**
EARTH SCIENCES			
Weather & climate	80% (8/10)	78% (7/9)	70% (7/10)
LIFE SCIENCES			
Life cycles	70% (7/10)	67% (6/9)	90% (9/10)
Habitat & niches	70% (7/10)	67% (6/9)	90% (9/10)
Human biology & health	80% (8/10)	89% (8/9)	80% (8/10)
PHYSICAL SCIENCES			
Classification of matter	90% (9/10)	78% (7/9)	90% (9/10)
Physical properties	100% (10/10)	67% (6/9)	100% (10/10)
Heat & temperature	90% (9/10)	89% (8/9)	80% (8/10)
Physical changes	70% (7/10)	78% (7/9)	80% (8/10)
ENVIRONMENTAL ISSUES			
Material & Energy Resource Conservation	70% (7/10)	78% (7/9)	100% (10/10)

Only a few topics appear in the core set of topics at all grade spans, with slightly more of them falling under the Physical Sciences strand. When economies introduce topics and whether they revisit them in subsequent grade spans is partly a function of the centrality of a topic to the field and its complexity. If a topic is core and complex – composed of multiple interrelated and often abstract concepts – then understanding is likely to be developing over time, and instruction moves from developing qualitative conceptual understanding to deepening over time. Instruction will tend to advance from an emphasis on qualitative conceptual understanding to thinking that is more quantitative and rigorous. This type of progression is especially common in the physical sciences, where concepts are based on mathematical relationships. To illustrate, while aspects of heat and temperature are accessible to elementary students, we find that they are revisited by most economies in successive grade spans.

Chinese Taipei's treatment of Heat and Temperature (displayed in Table 17) provides a specific illustration of this point. The performances expected of students in grades 1-6 focus on general descriptions of heat and temperature and guided observations. In grades 7-9, Chinese Taipei's treatment of the concepts of heat and temperature remains essentially qualitative, but the change

in emphasis shifts in its Basic Physics course, where students are expected to know what a calorie is and how to measure it. In its subsequent Required Physics course, Chinese Taipei calls for students to offer quantitative explanations of the relationships between concepts, such that between the boiling point of water and pressure and the relationship among heat energy, work and internal energy. In this example, Chinese Taipei does not just cover content once, but rather scaffolds the content, requiring students to "know" the content with more depth and increased quantitative understanding in each successive grade span or course.

TABLE 17: Heat and Temperature across Grades Spans from Chinese Taipei's Science Standards

Learning Areas in Science and Technology 1-9	Grades 1-2	**Heat Sources** 1a. learn that heat can be generated from sun, combustion, and friction; learn to use a thermometer.
	Grades 3-4	**Heat can be Transmitted, Temperature can be Changed** 2a. learn the methods to compare temperature and notice heat can be transmitted from high to low temperature. **Relationship between Temperature and Properties Changes of Substances** 2b. notice that temperature causes the three stage of water.
	Grades 5-6	**Heat Transmission and Change of Temperature** 3a. learn that heat can be transmitted by conduction, convection, and radiation; utilize these properties in daily life (such as reserving or distributing heat). **Evaporation** 3b. notice evaporation can absorb heat.
	Grades 7-9	**Relationship between Temperature and Calorific Capacity** 4a. explore the relationship between temperature and calorific capacity; define a calorific capacity unit. **Heat Transmission** 4b. explore means of heat transmission: conduction, convection, and radiation. **Relationship between Temperature and Property Changes of Substances** 4c. understand qualitatively about the relationship among volume, temperature, and pressure of a gas. 4d. understand heating can change forms of substances that causes expansion, fusion, evaporation, or diffusion.
Required Subject <u>Basic Physics</u> in Senior High Schools	First Year High School Content Area – iii. Heat	**Temperature and heat** 1-1 Explain how to measure temperature 1-2 Introduce the unit of calorie, and its measurement; briefly introduce specific heat and heat capacity **Heat and change of state** 2-1 Explain the phenomena that things expand in hot temperature and shrink in cold temperature and give examples in everyday life 2-2 Explain the changes of state for water **Heat and life** 3-1 Briefly introduce heat conduction; introduce the application of the law of heat conduction in everyday life (such as air conditioners, refrigerators, heaters etc.) from the perspective of heat loss

Required Subject Physics in Senior High Schools	Senior High School Content Area XI – Heat	**Change of state of a material and latent heat** 2-1 Use water as an example to explain change of state and the energy changes among molecules by heating 2-2 Define boiling point, fusing point, and freezing point; explain the relationship between these points and pressure 2-3 Introduce concepts of change of state and latent heat **Joule's experiment and the mechanical equivalent of heat** 3-1 Explain that heat is one kind of energy 3-2 Introduce Joule's experiment and the mechanical equivalent of heat 3-3 Briefly introduce the concept of internal energy and explain the relationship among heat energy, work, and internal energy **Thermal expansion** 4-1 Introduce the coefficient of thermal expansion; explain applications of thermal expansion in everyday life

Progression across Life Science topics is more difficult to discern without a more fine-grained analysis of each economy's standards. Still, one illustration can be seen in the way Singapore develops student understanding of life cycles and reproduction (TABLE 18). In its Lower Block (P3-P4), Singapore introduces students to similarities and differences in the life cycles of plants and animals. In its Upper Block (P5-P6), Singapore establishes basic concepts about reproduction in plants and animals, drawing students' attention to the processes characteristic of sexual reproduction in flowering plants, including fertilization and germination, and linking these to the process of fertilization in the sexual reproduction of humans. At Lower Secondary, Singapore builds on the previous conceptions, focusing on heredity and the transfer of genetic information from parents to offspring. Ultimately, in its Biology H2 course, Singapore emphasizes the importance of mitosis in the growth, repair and asexual reproduction of cells, and the significance of controlled and uncontrolled replication. As evident from this example, concept development is as important in the life sciences as in the physical sciences, but generally has less dependence on application of mathematical skills.

TABLE 18: Life Cycles/Reproduction across Grades Spans from Singapore's Science Standards

SINGAPORE PRIMARY SCIENCE 2008 LOWER BLOCK (P3 – P4)	**SINGAPORE PRIMARY SCIENCE 2008** UPPER BLOCK (P5 – P6)	**SINGAPORE LOWER SECONDARY 2007**	**SINGAPORE BIOLOGY H2**
CYCLES IN PLANTS AND ANIMALS	CYCLES IN PLANTS AND ANIMALS	SEXUAL REPRODUCTION IN HUMAN BEINGS	REPLICATION AND DIVISION OF NUCLEI AND CELLS
Show an understanding that different organisms have different life cycles. - Plants - Animals	Show an understanding that living things reproduce to ensure continuity of their kind and that many characteristics of an organism are passed on from parents to offspring.	recognize that heredity is a process where genetic information is transmitted from one generation to another	Explain the importance of mitosis in growth, repair and asexual reproduction.

SINGAPORE PRIMARY SCIENCE 2008 LOWER BLOCK (P3 – P4)	**SINGAPORE PRIMARY SCIENCE 2008** UPPER BLOCK (P5 – P6)	**SINGAPORE LOWER SECONDARY 2007**	**SINGAPORE BIOLOGY H2**
Observe and compare the life cycles of plants grown from seeds over a period of time.	Investigate the various ways in which plants reproduce and communicate findings. - spores - seeds	recognize that in sexual reproduction a new individual is formed through the union of an egg and a sperm	Explain the need for the production of genetically identical cells and fine control of replication.
Observe and compare the life cycles of animals over a period of time. e.g. butterfly, mealworm, grasshopper, cockroach, chicken, frog	Recognize the processes in the sexual reproduction of flowering plants. - pollination - fertilization (seed production) - seed dispersal - germination	recognize that a new individual formed through sexual reproduction receives genetic information from its mother (via the egg) and its father (via the sperm)	Explain how uncontrolled cell division can result in cancer, and identify factors which can increase the chances of cancerous growth.
	Recognize the process of fertilisation in the sexual reproduction of humans.	state some of the physical changes that occur during puberty and early adolescence	Describe with the aid of diagrams, the behaviour of chromosomes during the mitotic cell cycle and the associated behaviour of the nuclear envelope, cell membrane and centrioles. (Names of the main stages are expected)
	Recognize the similarity in terms of fertilisation in the sexual reproduction of flowering plants and humans.	describe briefly the structures and functions of human male and female reproductive systems	Explain what is meant by homologous pairs of chromosomes.
			Describe, with the aid of diagrams, the behaviour of chromosomes during meiosis, and the associated behaviour of the nuclear envelope, cell membrane and centrioles. (Names of the main stages are expected, but not the sub-divisions of prophase)

Common Topics as Proportion of Economy Standards at Different Grade Spans
Having identified a set of common topics that economies address at each grade span, Achieve was then able to determine what proportion of the content addressed in each economy's standards is comprised of that set of common topics. In other words, Achieve was able to quantify the extent to which each economy's standards focus on the common set of topics and whether the standards include additional topics as well. In science, on average the proportion of the economies' standards that is comprised of the set of topics that are common across the economies increases across the grade spans. The proportion increases from an average of 35 percent at grade 1-4, to 43 percent in grades 5-6 and to 67 percent in grades 7-10.

In general, the larger the number of science topics defined as common across economies, the more likely it is that the set of common topics represents a larger part of the standards in any given economy. For example, in grade span 1-4, 35 percent of the content included in the standards across the economies is made up of 15 common topics. In grade span 5-6, 43 percent of the content included in the standards across the economies are made up of 23 common topics. In grade span 7-10, which contains 56 common topics – the largest number of topics of the grade spans examined – 67 percent of the content included in the standards across the economies are made up of the common topics.

TABLE 19: Common Topics as Proportion of Economies' Standards

Grade 1-4 Average	Grade 5-6 Average	Grade 7-10 Average
35% Range: 22%-53%	**43%** Range: 31%-53%	**67%** Range: 56%-82%

The data suggest that, on average, the proportion of the topics addressed by the economies that fall in the set of common topics increases across the grade spans. As the number of common topics increases, the number of additional topics addressed by economies decreases, indicating greater agreement across economies about what is most important to teach.

C. PERFORMANCE EXPECTATIONS

In addition to the content, Achieve also analyzed the performance expectations from the standards of the 10 economies in this study. Our goal was to determine the relative emphasis given to basic and advance skills in each economy and in aggregate across all economies.

Science Performance Categories & Levels
Science performance expectations can be viewed as falling into two major categories – Science Inquiry and Science Knowledge. The Science Inquiry category is concerned with the skills essential for learning how to conduct research, whereas the Science Knowledge category includes the various kinds of performances involved in learning science content.[11]

[11] To look beyond performance expectations and compare the rigor of economies' standards was not the intent or purpose of this study. To answer questions regarding comparative rigor of expectations would require additional analysis.

Science Inquiry
The performance expectations included in the inquiry or research category are unique to science in that they reflect the empirical nature of science and the methodologies scientists employ in pursuit of new knowledge. (These skills are distinct from those delineated in the Science Knowledge category, described below, although there is certainly overlap. Evidence-based reasoning, for example, is characteristic of both categories.) Inquiry skills are divided into two sub-categories:

1. Basic Inquiry Skills[xiii]
2. Advanced Inquiry Skills[xiv]

Basic inquiry skills are foundational and consist of such proficiencies as gathering data by making observations and measurements, using laboratory equipment and simple computer applications, and carrying out routine experimental operations. As expected, advanced inquiry skills build upon and take introductory skills to a higher level, essentially shifting to an emphasis on skills required for carrying out independent investigations, as opposed to those needed for executing prescribed procedures.

Science Knowledge
The performance expectations included in the knowledge category have been grouped into levels of generally increasing cognitive demand, or rigor. These levels (or categories) of performance expectations are neither discrete nor strictly hierarchical, although there is a general increase in cognitive demand from Level 1 to Level 5. The levels are as follows:

1. Acquiring Knowledge[xv]
2. Explaining Knowledge[xvi]
3. Applying Knowledge[xvii]
4. Analyzing Knowledge[xviii]
5. Constructing Knowledge[xix]

Level 1 skills are concerned with recalling simple information such as facts, definitions, symbols or describing simple concepts. Level 2 skills have a wider range and include using knowledge to explain phenomena, understanding complex information, organizing, representing and interpreting data, and processing and sharing information. Level 3 skills include solving quantitative problems, using scientific laws or principles to develop explanations or make predictions, and applying science and technology to solve practical problems. Level 4 skills call for students to relate and interpret cross-cutting themes common to multiple fields; construct, interpret and apply models; and debate and make decisions based on the weight of evidence. Level 5 skills involve abstracting or deducing underlying principles when presented with data.[12]

[12] It should be noted that the assignment of the codes in regard to the higher-level categories in science knowledge (that is, analyzing and constructing knowledge) was adjusted to the developmental level of the students in the given grade span. For example, asking a grade 1 student to describe the relationship between water and the growth of a bean plant meets the criteria of "Constructing Knowledge," whereas if the same was asked of a student in the 5-6 grade span it would more appropriately be coded at a lower level – perhaps "Applying Science Knowledge."

For the full listing of skills included in each category, the average percent of emphasis across economies and the range of percent of emphasis across economies, please see Appendix E.

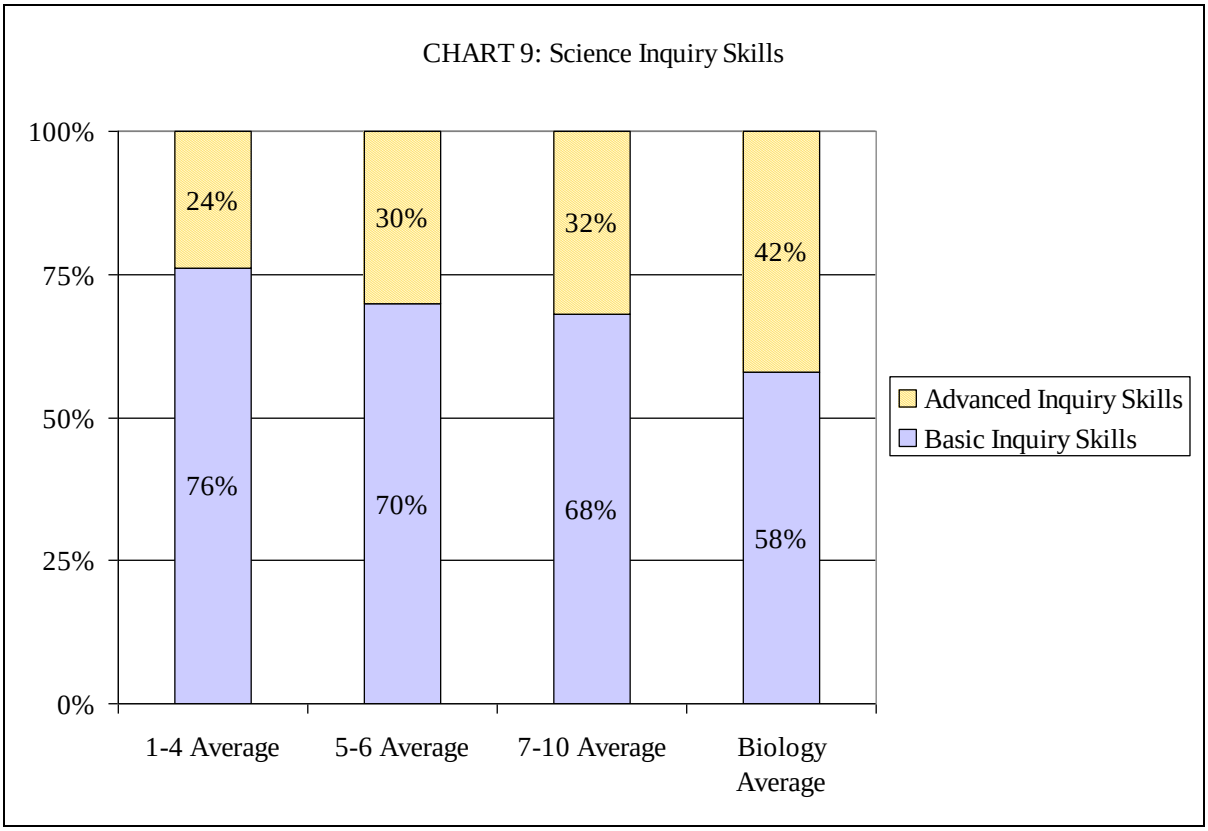
Emphasis of Performance or Cognitive Skills across Grade Spans

Science Performance Overview

Across the grade spans, the emphasis on each category for both science inquiry and science knowledge remains very consistent on average across the economies. In the Science Knowledge category, the greatest amount of emphasis is placed on lower level performances such as Acquiring Knowledge, with much less emphasis given to more cognitively demanding performances, such as Analyzing Knowledge. In the Science Inquiry category, the same trend is evident, with more emphasis on basic than advanced skills.

Science Inquiry Skills

The balance between basic and advanced inquiry skills changes more than the balance among the five categories of knowledge skills across the grade spans. As grade spans increase, the emphasis on Advanced Science Inquiry becomes more pronounced, from 24 percent in grades 1-4 to 42 percent in Biology, as shown in the table below. As noted above, Advanced Inquiry is concerned with students being able to pursue independent research.



Science Knowledge Skills

Primary School Knowledge Skills: Grades 1-4 & 5-6

On average, over 80 percent of the performances expected of students across the economies in grades 1-4 and 5-6 involve Acquiring or Explaining Knowledge, as shown in Charts 10 and 11. The emphasis on the more cognitively demanding skills (Applying, Analyzing and Constructing Knowledge) is less than 20 percent for both grade spans. Although the emphasis on higher-level performances is slightly greater in grades 5 and 6, this trend is not sustained into the secondary grades.

CHART 10: Science Knowledge across the Economies, Grades 1-4

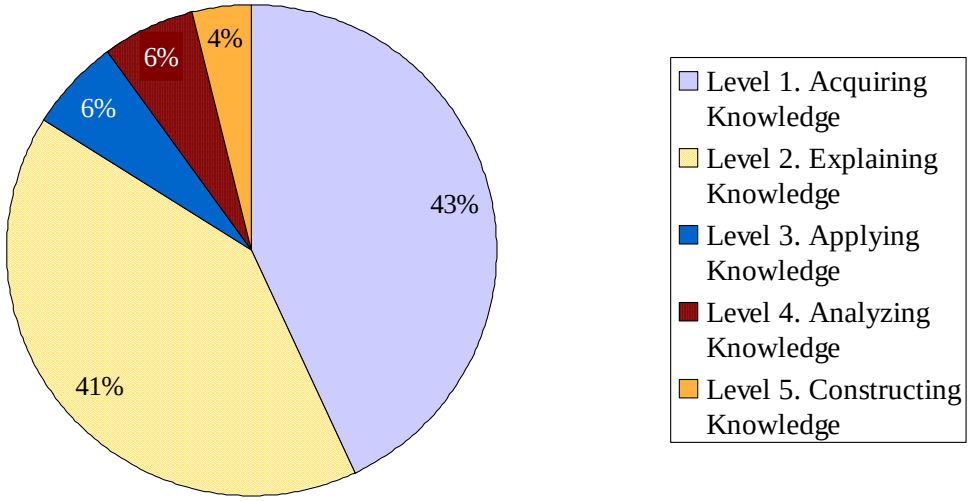
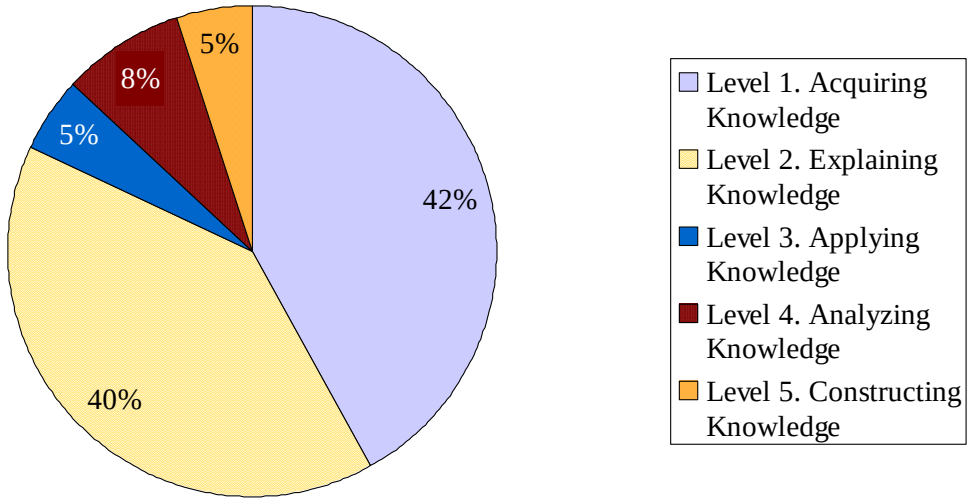


CHART 11: Science Knowledge across the Economies, Grades 5-6

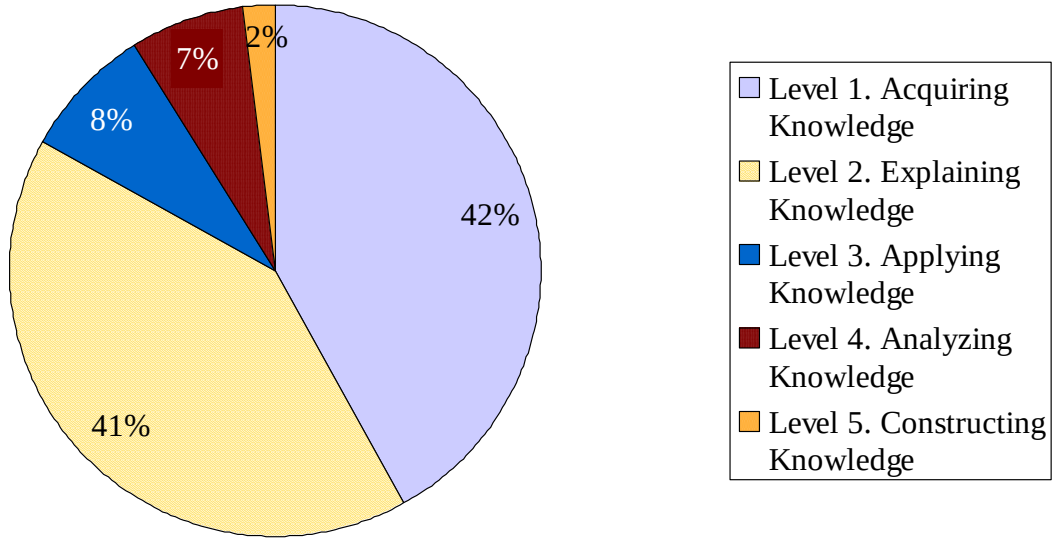


Lower Secondary School Knowledge Skills: Grades 7-10
As in grade spans 1-4 and 5-6, over 80 percent of performances expected of students across the economies at grade span 7-10 are lower level skills, i.e., Acquiring or Explaining Knowledge.

Less than 20 percent of the performances expected are in the three most demanding categories. Emphasis on the skill that requires the greatest cognitive demand, Constructing Knowledge, declines to only two percent.

However, as noted below in the Biology discussion, this apparent decline may be accounted for in that the Advanced Inquiry Skills include the kinds of performances that result in the construction of new knowledge through formal experimentation procedures.

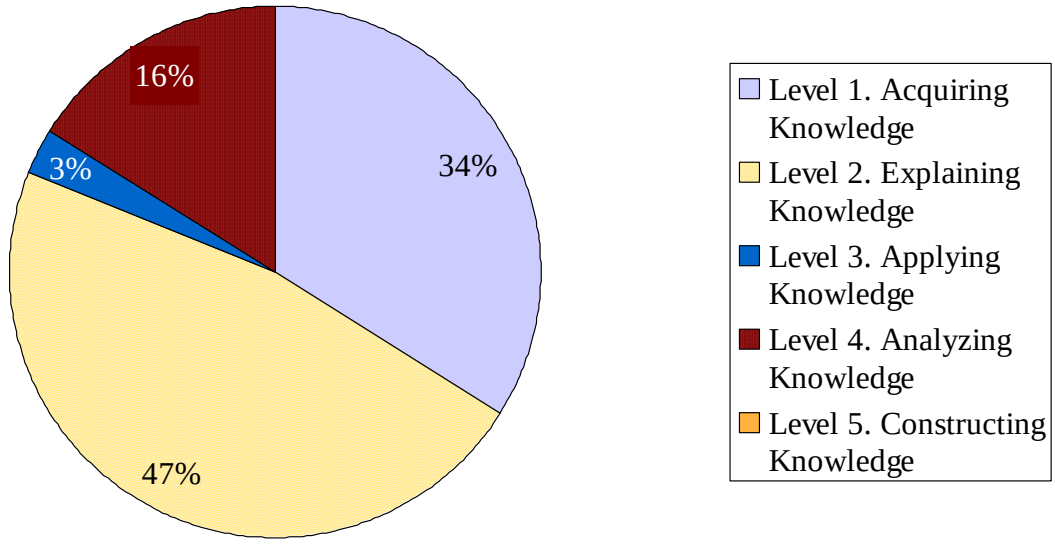
CHART 12: Science Knowledge across the Economies, Grades 7-10



Upper Secondary School Knowledge Skills: Biology
The balance between the lower and higher levels of knowledge skills for the Biology course standards is similar to that found for the primary school, lower secondary and upper secondary standards: over 80 percent of lower-level skills and less than 20 percent of upper level skills. This analysis is limited to the expectations set at the individual standard statement level – economies may reinforce, expand or raise expectations to a higher level in other ways (e.g., through curricular guides, instructional materials and assessments)

Constructing Knowledge, the highest level of cognitive demand among science knowledge skills, averaged less than one percent across the five economies. However, it is important to note that Advanced Inquiry skills received considerable attention in Biology courses. In the upper level categories of both knowledge and inquiry, students are engaged in the construction of new knowledge. Therefore, a view incorporating both knowledge and inquiry indicates economies do expect some higher-level skills of students in Biology.

CHART 13: Science Knowledge across the Economies, Biology



Summary of Inquiry and Knowledge Skills

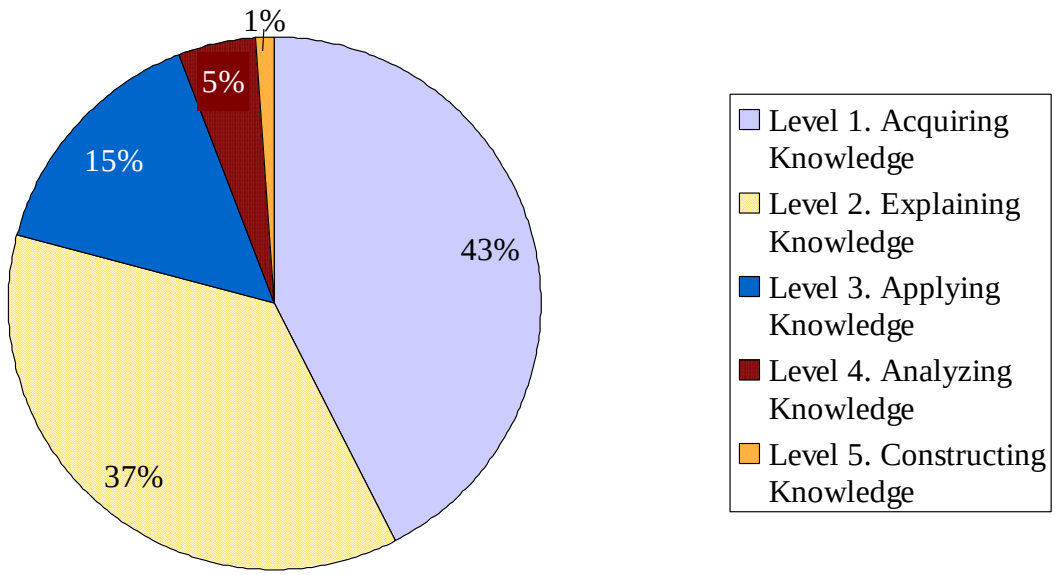
In science, economies generally show an increase in emphasis from basic to advanced inquiry skills in going from grade span 1-4 to 7-10 and Biology. In contrast, the focus on Level 1 and Level 2 Knowledge categories – Acquiring and Explaining – is quite consistent across grade spans.

Variation among Economies

At the individual economy level, economies differ significantly from each other in their emphases on science knowledge skills. The three economies highlighted below provide a glimpse into the diversity in balance among levels of cognitive demand at the 7-10 grade span.

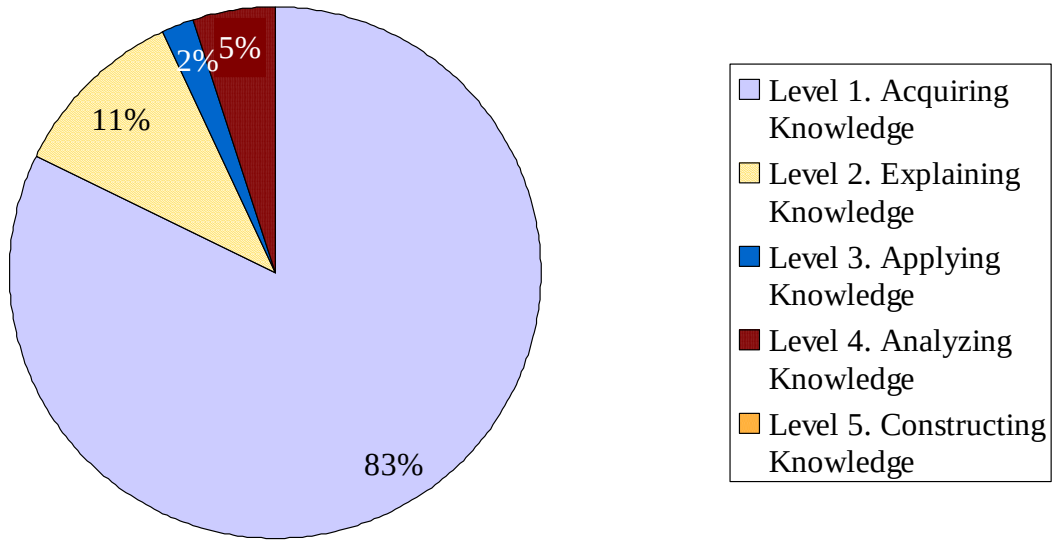
The balance of performance expectations in the grades 7-10 standards from Singapore displayed in Chart 14 resembles the average balance of performance expectations. The top three categories of cognitive demand compose roughly 20 percent of the expectations, and the lower two levels compose roughly 80 percent. Each category of cognitive demand receives some attention in this economy.

CHART 14: Singapore, Science Knowledge, Grades 7-10



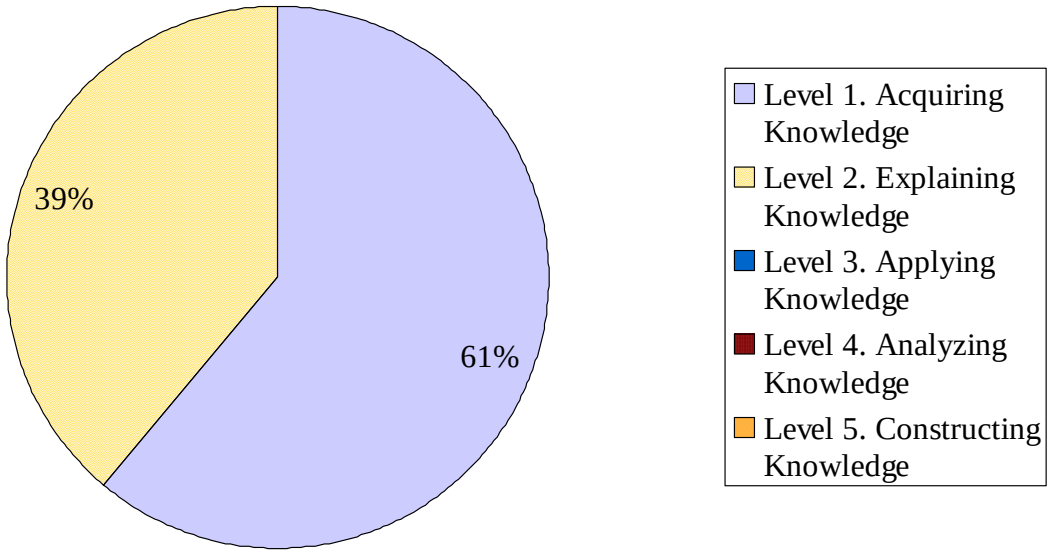
Chinese Taipei, represented in the chart below, places less emphasis on the top three performance skill categories overall with no attention to the highest level – Constructing Knowledge. Indeed, 83 percent of its standards – the heaviest emphasis among the economies coded – focuses on Acquiring Knowledge.

CHART 15: Chinese Taipei, Science Knowledge, Grades 7-10



Hong Kong's standards include only references to the two levels of performance expectations – Acquiring Knowledge and Explaining Knowledge.

CHART 16: Hong Kong, Science Knowledge, Grades 7-10



Conclusion

Achieve's analysis of the mathematics and science standards on behalf of the Asia-Pacific Economic Cooperation (APEC) and the United States Department of Education indicates there is a set of common content expectations for students – although the size and nature of the common set varies across grade spans and disciplines. Achieve also found that most of the economies that participated in the study place the greatest emphasis on the lower levels of performance or cognitive demand. In mathematics, for instance, the emphasis is on Recall and Using Routine Procedures, while in science the emphasis is on Acquiring Knowledge and Basic Inquiry Skills.

While Achieve found common aspects regarding the content and performance skill demands, qualitatively, Achieve found a great deal of variation across economies in terms of the structure, volume and level of detail of their standards, as well as the level of emphasis each places on particular areas of the two disciplines. Given the different educational, economic and cultural contexts in each economy, there was little reason to expect uniformity.

While standards define expectations for what students must know and be able to do, provide a framework for the development of textbooks and other instructional materials, and help to shape teacher preparation and ongoing training, standards are not the only mechanism for communicating what students are expected to know. In particular, assessments (both classroom and standardized tests) are often regarded as the de facto student expectations in school. Curriculum and instruction too – what occurs in the classroom from day to day – may be influenced, but is not bound by the content contained in the standards. Therefore, this analysis, focused exclusively on standards, necessarily provides an important but incomplete snapshot of the expectations that economies from around the world hold for their students. Future study of curriculum and assessment – as well as a comprehensive analysis of the pathways students take in secondary school – would be a useful complement to this analysis.

We hope this analysis will provide a lens through which the APEC economies can examine the similarities and differences among their standards in their efforts to determine the extent to which they have consistent expectations of students in an increasingly flat world.

About Achieve

Created in 1996 by the nation's governors and corporate leaders, Achieve is an independent, bipartisan, non-profit education reform organization based in Washington, DC, that helps states raise academic standards and graduation requirements, improve assessments, and strengthen accountability. In 2006, Achieve was named by *Education Week* as one of the most influential education groups in the nation. Achieve is leading the effort to make college and career readiness a national priority so that the transition from high school graduation to postsecondary education and careers is seamless. In 2005 Achieve launched the American Diploma Project (ADP) Network. Starting with 13 states, the network has now grown to include 34 states educating nearly 85 percent of all U.S. public school students. Through the ADP Network, governors, state education officials, postsecondary leaders and business executives work together to improve postsecondary preparation by aligning high school standards, assessments, graduation requirements and accountability systems with the demands of college and careers.

A number of members of the Achieve staff and Achieve consultants contributed to this report. They are listed alphabetically.

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[*] For biographies of Achieve consultants, see Appendix I.

APPENDIX A. LISTING OF STANDARDS CODED: MATHEMATICS

The 12 economies in this study volunteered for participation and have maintained involvement throughout the process, providing English-language copies of their standards, providing data about their students and explaining their educational systems and the approach undergirding their standards. Some economies that otherwise would have chosen to participate could not because an English translation of the standards for comparison was required for the analysis. China and Thailand provided only mathematics standards for this study.

Elementary-Secondary		
Economy	**Title/Publication date**	**Grades**
Alberta, Canada	The Alberta K–9 Mathematics Program of Studies with Achievement Indicators 2007	Primary: Grades 1, 2, 3, 4, 5 and 6
		Middle School: Grades 7, 8, 9
		High School: Pure Math 10, 20 and 30
Australia	Statements of Learning for Mathematics 2006	Primary: Grades 3 and 5
		Middle School: Grades 7 and 9
China	No title page or publication date	Primary: Grades 3 and 6
		Middle School: Grade 9
		High School: Grades 10 & 11 (Math 1, 2, 3, 4)
Chinese Taipei	No title page or publication date	Primary: Years 1, 2, 3, 4, 5, 6
		Middle School: Years 7, 8 and 9
		High School: Years 10, 11, 12 1st year, 2nd year, Elective 1
Hong Kong	Key Learning Area Curriculum Guide 2002	Primary: Grades 1, 2, 3, 4, 5 and 6
		Middle School: Grades 7, 8 and 9
		High School: Grades 10 and 11
Japan	Mathematics for Elementary School Mathematics for Lower Secondary School Mathematics for Upper Secondary School No title page or publication date	Primary: Grades 1, 2, 3, 4, 5, 6
		Middle School: Grades 7, 8 and 9 (Years 1, 2, 3)
		High School: Grades 10, 11 and 12 (Math I, II, III, A, B, C)

Elementary-Secondary		
Economy	**Title/Publication date**	**Grades**
Korea	Seventh National Curriculum 1998	Primary: Grades 1, 2, 3, 4, 5, 6
		Middle School: Grades 7, 8, 9
		High School: Grade 10
Malaysia	Integrated Curriculum for Primary Schools, Integrated Curriculum for Secondary Schools 2003	Primary: Grades 1, 2, 3, 4, 5, 6
		Middle School: Grades 7, 8, 9 and 10
		High School: Grades 10 and 11
New Zealand[1]	The New Zealand Curriculum: Achievement Objectives 2007	Primary: Grades 1, 2, 3, 4, 5, 6 (Levels 1, 2, 3)
		Middle School: Grades 7, 8, 9 and 10 (Levels 4, 5)
		High School: Grades 11 and 12 (Levels 6, 7, 8)
Singapore	H2 Mathematics: Content Outline 2009	Primary: Grades 1, 2, 3, 4, 5, 6
		Middle School: Grades 7 and 8 (O-Levels 1, 2, 3)
		High School: Grade 10 (O-Level 4)
Thailand	Basic Education Curriculum 2001	Primary: Grades 1, 2, 3, 4 ,5 and 6
		Middle school: Grades 7, 8 and 9
		High school: Grades 10, 11 and 12
United States	Mathematics Framework for the National Assessment of Educational Progress (NAEP) 2007	Primary: Grade 4
		Middle School: Grade 8
		High School: Grade 12

[1] *New Zealand presents its "blended" mathematics standards in overlapping bands in recognition of the varying pace at which students master material*

APPENDIX A (CONTINUED). LISTING OF STANDARDS CODED: SCIENCE

Ten APEC economies volunteered for participation in the science portion of this study: Australia, Canada, Chinese Taipei, Hong Kong, Japan, Korea, Malaysia, New Zealand, Singapore and the United States. (Some economies that otherwise would have chosen to participate could not because an English translation of the standards for comparison was required for the analysis.) In addition, secondary level course standards from seven economies are included in the study.

Elementary-Secondary General Science		
Economy	**Title/Publication date**	**Grades**
Australia	Statements of Learning 2006	Grades 3, 5, 7 and 9
Canada	Common Framework of Science Learning Outcomes 1997	Grades 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10
Chinese Taipei	Learning Areas in Science and Technology 2004	Grades 1, 2, 3, 4, 5, 6, 7, 8 and 9
Hong Kong	Key Learning Area Curriculum Guide 2002	Grades 1-3, 4-6, 7-9 and 10
Japan	The Courses of Study in Japan 2004	Grades 3, 4, 5, 6, 7-9, 10
Korea	Seventh National Curriculum 1998	Grades 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10
Malaysia	Integrated Curriculum for Primary Schools, Integrated Curriculum for Secondary Schools 2003	Grades 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10
New Zealand[2]	The New Zealand Curriculum 2007	Grades 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 (Levels 1-8)
Singapore	Science Syllabus Lower Secondary Express/Normal Academic 2007	Grades 3, 4, 5, 6, 7, 8, 9 and 10
United States	Science Framework for the National Assessment of Educational Progress (NAEP) 2005	Grade 4, 8, and 12

[2] *New Zealand presents its science standards in overlapping bands in recognition of the varying pace at which students master material.*

Grades 10-12: Science Subjects				
Economy	**Biology**	**Chemistry**	**Earth Science**	**Physics**
Australia				
Canada	X	X	X	X
Chinese Taipei	X	X	X	X
Hong Kong	X	X		X
Japan	X	X	X	X
Korea				X
Malaysia	X	X		X
New Zealand				
Singapore				
United States				

APPENDIX B: TOPICS COMMON ACROSS ECONOMIES
MATHEMATICS GRADES 1-12
ORGANIZED BY CODING FRAMEWORK

The set of common topics in mathematics consists of the mathematics content included in the coding framework addressed by two-thirds or more of participating economies' standards. The number of economies included in each grade span varies slightly; therefore, the number of economies required for a topic to be included in the set of common topics shifts slightly from span to span. The decision rule for inclusion in the set of common topics is based on a constant percentage: Sixty-seven percent or more of economies included in any given grade span must address the topic in order for the topic to be included.

The topics included in the set of common topics for each grade span are listed below alongside the percentage of economies addressing that topic in their standards grouped into that grade span. The topics are organized by the categories in the framework (number, measurement, etc.).

TOPICS	GRADES 1-6 % Economies: 12	GRADES 7-9 % Economies: 12	GRADES 10-12 % Economies: 11
NUMBERS			
Whole Numbers	8%	8%	0%
Meaning	100%	50%	9%
Operations	100%	42%	0%
Properties of Operations	67%	33%	9%
Fractions & Decimals	0%	0%	0%
Common Fractions	100%	58%	0%
Decimal Fractions	100%	58%	9%
Relationships of Common & Decimal Fractions	83%	67%	0%
Percentages	83%	75%	27%
Properties of Common & Decimal Fractions	17%	25%	0%
Integer, Rational & Real Numbers	0%	0%	0%
Negative Numbers, Integers & Their Properties	17%	100%	36%
Rational Numbers & Their Properties	8%	67%	36%
Real Numbers, Their Subsets & Properties	33%	92%	73%
Other Numbers & Number Concepts	0%	0%	0%
Binary Arithmetic and/or Other Number Bases	0%	17%	0%
Exponents, Roots & Radicals	0%	92%	64%
Real exponents	0%	17%	9%
Complex Numbers & Their Properties	0%	0%	55%
Number Theory	100%	75%	36%
Systematic Counting	0%	17%	45%
Matrices	0%	0%	36%
Estimation & Number Sense Concepts	8%	0%	0%
Estimating Quantity & Size	50%	50%	0%
Rounding & Significant Figures	67%	92%	45%
Estimating Computations	92%	67%	18%

TOPICS	GRADES 1-6 % Economies: 12	GRADES 7-9 % Economies: 12	GRADES 10-12 % Economies: 11
Exponents & Orders of Magnitude	0%	50%	27%
MEASUREMENT			
Measurement Units	0%	0%	0%
Concept of measure (including non-standard units)	100%	17%	0%
Standard units (including metric system)	100%	50%	27%
Use of appropriate instruments	58%	25%	0%
Common measures (Length; area; volume; time; calendar; money; temp; mass; weight; angles)	100%	75%	18%
Quotients and products of units (km/h, m/s, etc.)	42%	33%	27%
Dimensional analysis	8%	25%	0%
Computations & Properties of Length, Perimeter, Area & Volume	0%	25%	0%
Computations, formulas and properties of length and perimeter	92%	92%	45%
Computations, formulas and properties of area	100%	92%	64%
Computations, formulas and properties of surface area	33%	92%	27%
Computations, formulas and properties of volumes	83%	92%	45%
Estimation & Error	0%	17%	0%
Estimation of measurement and errors of measurement	92%	50%	27%
Precision and accuracy of measurement	17%	42%	18%
GEOMETRY: POSITION, VISUALIZATION & SHAPE			
1-D & 2-D Coordinate Geometry	0%	0%	9%
Line and coordinate graphs	58%	92%	91%
Equations of lines in a plane	8%	33%	82%
Conic sections and their equations	0%	17%	55%
2-D Geometry: Basics	8%	33%	9%
Points, lines, segments, half-lines, and rays	75%	92%	82%
Angles	83%	92%	64%
Parallelism and perpendicularity	75%	92%	55%
2-D Geometry: Polygons & Circles	33%	67%	36%
Triangles and quadrilaterals: their classification and properties	100%	100%	64%
Pythagorean Theorem and its applications	0%	100%	55%
Other polygons and their properties	100%	100%	27%
Circles and their properties	100%	92%	82%
3-D Geometry	8%	17%	0%
3-Dimensional shapes and surfaces and their properties	100%	100%	55%
Planes and lines in space	17%	17%	36%
Spatial perception and visualization	83%	83%	55%
Coordinate systems in three dimensions	0%	0%	27%
Equations of lines, planes and surfaces in space	0%	0%	9%
Vectors	0%	0%	45%
Simple Topology	0%	17%	0%

TOPICS	GRADES 1-6 % Economies: 12	GRADES 7-9 % Economies: 12	GRADES 10-12 % Economies: 11
GEOMETRY: SYMMETRY, CONGRUENCE & SIMILARITY			
Geometry: Transformations	0%	0%	0%
Patterns, tessellations, friezes, stencils, etc	67%	58%	0%
Symmetry	75%	75%	36%
Transformations	58%	83%	64%
Congruence & Similarity	0%	0%	0%
Congruence	33%	83%	36%
Similarities (similar triangles and their properties; other similar figures and properties)	25%	92%	36%
Constructions w/ Straightedge & Compass	42%	83%	9%
PROPORTIONALITY			
Proportionality Concepts	0%	0%	0%
Meaning of ratio and proportion	67%	92%	27%
Direct and inverse proportion	25%	33%	36%
Proportionality Problems	0%	0%	0%
Solving proportional equations	17%	33%	27%
Solving practical problems with proportionality	33%	83%	27%
Scales (maps and plans)	67%	50%	27%
Proportion based on similarity	8%	67%	18%
Slope & Simple Trigonometry	0%	0%	0%
Slope and gradient in straight line graphs	0%	33%	82%
Trigonometry of right triangles	0%	50%	100%
Linear Interpolation & Extrapolation	0%	17%	27%
FUNCTIONS, RELATIONS, & EQUATIONS			
Patterns, Relations & Functions	0%	0%	0%
Number patterns	83%	83%	55%
Relations and their properties	0%	17%	27%
Functions and their properties	0%	67%	91%
Representation of relations and functions	17%	83%	100%
Families of functions (graphs and properties)	0%	17%	45%
Operations on functions	0%	42%	27%
Related functions (inverse, derivative, etc.)	0%	0%	55%
Relationship of functions and equations (e.g., zeros of functions as roots of equations)	0%	42%	73%
Interpretation of function graphs	0%	83%	82%
Functions of several variables	0%	0%	0%
Recursion	0%	0%	36%
Linear Functions	0%	92%	64%
Quadratic Functions	0%	50%	82%
Logarithmic and Exponential Functions	0%	17%	64%
Trigonometric Functions	0%	0%	91%
Equations & Formulas	0%	8%	27%
Representation of numerical situations by equations	92%	92%	45%
Informal solution of simple equations	75%	33%	9%

TOPICS	GRADES 1-6 % Economies: 12	GRADES 7-9 % Economies: 12	GRADES 10-12 % Economies: 11
Evaluating expressions	17%	75%	27%
Equivalent expressions (including factorization and simplification)	25%	83%	82%
Linear equations and their formal (closed) solutions	58%	100%	91%
Quadratic equations and their formal (closed) solutions	0%	58%	100%
Polynomial equations and their solutions	0%	42%	73%
Trigonometrical equations and identities	0%	0%	55%
Logarithmic and exponential equations and their solutions	0%	0%	45%
Solution of equations reducing to quadratics, radical equations, absolute value equations, etc.	0%	8%	64%
Other solution methods for equations (e.g., successive approximation)	0%	0%	18%
Inequalities and their graphical representation	0%	67%	82%
Systems of equations and their solutions (including matrix solutions)	0%	75%	82%
Systems of inequalities	0%	25%	55%
Substituting into or rearranging formulas	67%	67%	73%
General equation of the second degree and its interpretation	0%	8%	45%
Trigonometry and Analytic Geometry	0%	0%	0%
Angle measures: radians and degrees	0%	0%	64%
Law of sines and cosines	0%	0%	64%
Unit circle and trigonometric functions	0%	0%	64%
Parametric equations	0%	0%	18%
Polar coordinates	0%	8%	9%
Polar equations and their graphs	0%	0%	18%
DATA REPRESENTATION, PROBABILITY, & STATISTICS			
Data Representation & Analysis	0%	17%	27%
Collecting data from experiments and simple surveys	92%	83%	55%
Representing data	100%	92%	82%
Interpreting tables, charts, plots, graphs	100%	92%	82%
Kinds of scales (nominal, ordinal, interval, ratio)	17%	8%	9%
Measures of central tendency	67%	92%	64%
Measures of dispersion	25%	58%	82%
Sampling, randomness, and bias related to data samples	0%	58%	55%
Prediction and inferences from data	8%	58%	64%
Fitting lines and curves to data	0%	8%	27%
Correlations and other measures of relations	0%	0%	45%
Use and misuse of statistics	17%	75%	36%
Uncertainty & Probability	0%	0%	9%
Informal likelihoods and the vocabulary of likelihoods	58%	92%	64%

TOPICS	GRADES 1-6 % Economies: 12	GRADES 7-9 % Economies: 12	GRADES 10-12 % Economies: 11
Numerical probability and probability models	42%	92%	82%
Counting principles	25%	42%	73%
Mutually exclusive events	0%	0%	27%
Conditional probability and independent events	0%	8%	45%
Bayes' Theorem	0%	0%	27%
Contingency tables	0%	0%	9%
Probability distributions for discrete random variables	0%	8%	36%
Probability distributions for continuous random variables	0%	8%	36%
Expectation and the algebra of expectations	0%	8%	9%
Sampling (distributions and populations)	0%	17%	45%
Estimation of population parameters	0%	0%	27%
Hypothesis testing	0%	0%	9%
Confidence intervals	0%	0%	27%
Bivariate distributions	0%	0%	9%
Markov processes	0%	0%	9%
Monte Carlo methods and computer simulations	0%	8%	0%
ELEMENTARY ANALYSIS			
Infinite Processes	0%	0%	0%
Arithmetic and geometric sequences	0%	17%	73%
Arithmetic and geometric series	0%	8%	55%
Binomial Theorem	0%	0%	18%
Other sequences and series	0%	0%	27%
Limits and convergence of series	0%	0%	27%
Limits and convergence of functions	0%	0%	18%
Continuity	0%	0%	9%
Change	0%	0%	0%
Growth and decay	0%	0%	9%
Differentiation	0%	0%	18%
Integration	0%	0%	18%
Differential equations	0%	0%	9%
Partial differentiation	0%	0%	0%
VALIDATION & STRUCTURE			
Validation & Justification	0%	33%	0%
Logical connectives	0%	8%	36%
Quantifiers ("for all", "there exists")	0%	8%	9%
Boolean algebra and truth tables	0%	0%	9%
Conditional statements; equivalence of statements (including converse, contrapositive, and inverse)	8%	25%	36%
Inference schemes (e.g., *modus ponens*, *modus tollens*)	0%	0%	18%
Direct deductive proofs	0%	25%	36%
Indirect proofs and proof by contradiction	0%	8%	18%
Proof by mathematical induction	0%	0%	18%

TOPICS	GRADES 1-6 % Economies: 12	GRADES 7-9 % Economies: 12	GRADES 10-12 % Economies: 11
Consistency and independence of axiom systems	0%	0%	18%
Structuring and Abstracting	0%	0%	0%
Sets, set notation, and set combinations	0%	17%	45%
Equivalence relations, partitions, and classes	0%	0%	9%
Groups	0%	0%	0%
Fields	0%	0%	0%
Linear (vectors) spaces	0%	0%	0%
Subgroups, subspaces, etc.	0%	0%	9%
Other axiomatic systems	0%	0%	0%
Isomorphism	0%	0%	0%
Homomorphism	0%	0%	0%
OTHER CONTENT			
Informatics	0%	0%	27%
History and nature of mathematics	8%	17%	36%
Special application of mathematics	0%	0%	36%
Problem solving heuristics	17%	0%	0%
Non-mathematical science content	0%	8%	9%
Non-mathematical content other than science	0%	8%	27%

APPENDIX B (CONTINUED): TOPICS COMMON ACROSS ECONOMIES: SCIENCE GRADES 1-10 & BIOLOGY ORGANIZED BY CODING FRAMEWORK

The set of topics that are common across economies in science consist of the science content included in the coding framework addressed by two-thirds or more of participating economies' standards. The number of economies included in each grade span varies slightly; therefore, the number of economies required for a topic to be included in the set of common topics shifts slightly from span to span. The decision rule for inclusion in the common set of topics is based on a constant percentage: Sixty-seven percent or more of economies included in any given grade span must address the topic in order for the topic to be included in the set of common topics.

The topics included in the set of common topics for each grade span are listed below alongside the percentage of economies addressing that topic in their standards grouped into that grade span. The topics are organized by the categories in the framework (number, measurement, etc.).

TOPICS	GRADES 1-4 % of Economies Addressing Topic 10 Economies	GRADES 5-6 % of Economies Addressing Topic 9 Economies	GRADES 7-10 % of Economies Addressing Topic 10 Economies	BIOLOGY % of Economies Addressing Topic 5 Economies
EARTH SCIENCES				
Earth Features	40%	56%	60%	0%
Earth's composition	20%	11%	60%	0%
Landforms	10%	11%	40%	20%
Bodies of water	40%	33%	50%	0%
Atmosphere	30%	44%	70%	0%
Rocks, soil	50%	44%	60%	0%
Ice forms	0%	11%	20%	0%
Earth Processes	10%	33%	40%	0%
Weather & climate	80%	78%	70%	40%
Physical & Chemical Cycles	30%	67%	70%	20%
Constructive and Destructive Processes	40%	22%	60%	0%
Earth's history	40%	44%	70%	20%
Earth and the Universe	10%	33%	30%	0%
Earth, sun, moon	60%	78%	90%	20%
Planets in the solar system	20%	33%	70%	0%
Beyond the solar system	20%	11%	50%	0%
Evolution of the universe	0%	11%	50%	0%
Motion/location of celestial bodies	40%	33%	50%	0%
LIFE SCIENCES				
Diversity, Organization, Structure of Living Things	60%	67%	90%	80%
Plants	70%	67%	40%	100%
Animals	80%	56%	40%	100%
Other organisms	40%	56%	50%	100%
Systems, organs, tissues	60%	67%	90%	100%

TOPICS	GRADES 1-4 % of Economies Addressing Topic 10 Economies	GRADES 5-6 % of Economies Addressing Topic 9 Economies	GRADES 7-10 % of Economies Addressing Topic 10 Economies	BIOLOGY % of Economies Addressing Topic 5 Economies
Cells	20%	22%	100%	100%
Life Processes and Systems Enabling Life Functions	50%	44%	30%	40%
Energy handling, biochemistry of systems	50%	56%	70%	100%
Sensing and responding	30%	56%	70%	100%
Biochemical processes in cells	0%	22%	60%	100%
Life Spirals, Genetic Continuity, Diversity	10%	11%	10%	20%
Life cycles	70%	67%	90%	100%
Reproduction	40%	33%	80%	100%
Variation and inheritance	30%	11%	80%	100%
Population genetics, biotechnology	0%	0%	50%	80%
Evolution, speciation, diversity	20%	44%	70%	100%
Biochemistry of genetics	0%	0%	70%	100%
Genetic engineering	0%	0%	0%	100%
Interactions of Living Things	20%	44%	40%	40%
Biomes & ecosystems	60%	56%	70%	100%
Habitats & niches	70%	67%	90%	100%
Interdependence of life	60%	33%	70%	80%
Food webs, adaptations to habitats	20%	44%	70%	100%
Competition among organisms	10%	56%	50%	100%
Animal behavior	40%	33%	30%	20%
Needs of living things	60%	78%	90%	100%
Human Biology and Health	80%	89%	80%	80%
Human Nutrition	40%	56%	40%	80%
Human Disease and health	20%	33%	40%	100%
PHYSICAL SCIENCES				
Matter	20%	11%	40%	0%
Classification of matter	90%	78%	90%	0%
Physical properties	100%	67%	100%	0%
Chemical properties	90%	56%	100%	0%
Acids, Bases, Salts	10%	22%	60%	0%
Structure of Matter	10%	11%	40%	0%
Atoms, ions, molecules	10%	11%	80%	0%
Formulas/Equations/Nomenclature Stoichiometry	0%	0%	60%	0%
Macromolecules	10%	11%	20%	0%
Subatomic particles	10%	11%	50%	0%
Energy and Physical Processes	20%	22%	20%	0%
Energy types, conversions, sources	50%	67%	90%	0%
Work, Power, Simple machines	0%	67%	70%	0%
Heat and temperature	90%	89%	80%	0%
Wave phenomena	10%	22%	70%	0%

TOPICS	GRADES 1-4 % of Economies Addressing Topic 10 Economies	GRADES 5-6 % of Economies Addressing Topic 9 Economies	GRADES 7-10 % of Economies Addressing Topic 10 Economies	BIOLOGY % of Economies Addressing Topic 5 Economies
Sound & vibration	50%	33%	70%	0%
Light	80%	56%	80%	0%
Electricity	60%	89%	80%	0%
Magnetism/ electromagnetism	70%	56%	80%	0%
Physical Transformations	20%	0%	30%	0%
Physical changes	70%	78%	80%	0%
Explanations of physical changes	50%	67%	70%	0%
Kinetic-molecular theory	20%	0%	40%	0%
Quantum theory & fundamental particles	0%	0%	0%	0%
Chemical Transformations	20%	0%	40%	0%
Chemical changes	30%	56%	80%	0%
Definition & evidence of chemical change	10%	22%	70%	0%
Types of reactions	10%	44%	70%	0%
Law of Conservation of Matter	0%	44%	30%	0%
Explanations of chemical changes	0%	0%	40%	0%
Determinants/trends of chemical reactivity	0%	0%	10%	0%
Rate of change and equilibria	10%	22%	50%	20%
Energy and chemical change	0%	0%	20%	0%
Calorimetry, exothermic/endothermic reactions	0%	11%	10%	0%
First law of thermodynamics	0%	11%	70%	0%
Second law of thermodynamics	0%	0%	10%	0%
Organic & biochemical changes	0%	11%	20%	20%
Nuclear chemistry	0%	0%	20%	0%
Electrochemistry	20%	11%	40%	0%
Forces and Motion	20%	33%	20%	0%
Types of forces	40%	33%	40%	0%
Contact forces and forces acting at a distance	20%	44%	70%	0%
Pressure - force applied to a surface	10%	11%	40%	0%
Time, space and motion	50%	67%	40%	0%
Measurement of time/space/mass	20%	11%	50%	20%
Types of motion/describing motion	10%	33%	60%	0%
Frames of reference	10%	11%	10%	0%
Dynamics of motion	60%	89%	100%	0%
Relativity theory	0%	0%	0%	0%
Air/fluid behavior	30%	22%	50%	0%
SCIENCE, TECHNOLOGY, & MATHEMATICS				
Nature or Conceptions of Technology	60%	78%	80%	60%
Interactions of Science, Mathematics, & Technology	20%	11%	30%	0%

TOPICS	GRADES 1-4 % of Economies Addressing Topic 10 Economies	GRADES 5-6 % of Economies Addressing Topic 9 Economies	GRADES 7-10 % of Economies Addressing Topic 10 Economies	BIOLOGY % of Economies Addressing Topic 5 Economies
Mathematics, technology influence on science	10%	0%	30%	40%
Science applications in mathematics, technology	40%	44%	70%	40%
Interactions of Science, Technology and Society	30%	44%	50%	20%
Influence of science, technology on society	40%	44%	90%	60%
Influence of society on science, technology	30%	22%	70%	40%
HISTORY OF SCIENCE & TECHNOLOGY				
Environmental and Resource Issues Related to Science	40%	44%	40%	80%
Pollution - Causes and Treatment	40%	67%	80%	80%
Land, Water, Sea Resource Conservation	80%	56%	90%	80%
Material & Energy Resource Conservation	70%	78%	100%	40%
World Population	20%	11%	70%	60%
Food Production, Storage	40%	44%	80%	80%
Effects of Natural Disasters	30%	11%	40%	40%
NATURE OF SCIENCE				
Nature of Scientific Knowledge	60%	56%	90%	80%
The Scientific Enterprise	30%	44%	90%	80%
SCIENCE & OTHER DISCIPLINES				
Science & Mathematics	10%	11%	20%	0%
Science and Other Disciplines	0%	0%	30%	0%

APPENDIX C: ECONOMIES' ORGANIZING STRANDS: MATHEMATICS PRIMARY AND UPPER SECONDARY SCHOOLS

The following topics represent the strands, or organizing topics, used by each economy as the organizational framework in their mathematics standards.

Economy	Grade	Strand
Australia	Years 7 and 9	Working mathematically
		Number
		Algebra, function and pattern
		Measurement, chance and data
		Space
Canada	Grade 7	Number
		Patterns and relations
		Shape and space (measurement)
		Shape and space: 2-D and 3-D Objects
		Shape and space: Transformations
		Statistics and probability: data analysis
		Statistics and probability" Chance and uncertainty
	Grade 8	Number
		Patterns and relations: Variables and equations
		Shape and space (measurement)
		Shape and space: 2-D and 3-D shapes
		Shape and space: Transformations
		Statistics and probability: data analysis
		Statistics and probability: Chance and uncertainty
	Grade 9	Number
		Patterns and relations: Variables and equations
		Shape and space (measurement)
		Shape and space: 2-D and 3-D shapes
		Shape and space: Transformations
		Statistics and probability: data analysis
		Statistics and probability: Chance and uncertainty
		Number
		Patterns and relations: Variables and equations
		Shape and space (measurement)
		Shape and space: 2-D and 3-D shapes
		Shape and space: Transformations
		Statistics and probability: data analysis
		Statistics and probability: Chance and uncertainty
China	Grades 7, 8 and 9	Numbers & Algebra
		Space & Figures
		Statistics & Probability

Economy	Grade	Strand
Chinese Taipei	Grade 7	Numbers and Quantity
		Algebra
	Grade 8	Numbers and Quantity
		Algebra
		Geometry
	Grade 9	Geometry
		Algebra
Hong Kong	Key Stage 3	Number and algebra dimensions
		Measures, shape and Space Dimension
		Data handling dimension
Japan	Middle School: Grades 1-3	Numbers and algebraic expressions
		Geometrical figures
		Mathematical relations
Korea	Middle School: First Grade	Numbers and operations
		Variables and Expressions
		Probability and Statistics
		Geometry
	Middle School: Second Grade	Numbers and operations
		Variables and Expressions
		Functions
		Probability and Statistics
		Geometry
	Middle School: Third Grade	Numbers and operations
		Variables and Expressions
		Functions
		Probability and Statistics
		Geometry
Malaysia	Grade 7	Whole Numbers
		Number Patterns and Sequences
		Fractions
		Decimals
		Percentages
		Integers
		Algebraic Expressions
		Basic Measurements
		Lines and angles
		Polygons
		Perimeter and area
		Solid Geometry
	Grade 8	Directed Numbers
		Squares, square roots, cubes and cube roots
		Algebraic expressions 2
		Linear equations
		Ratios, rates and proportions
		Pythagoras' Theorem
		Geometrical constructions
		Coordinates
		Loci in Two Dimensions
		Circles
		Transformations
		Solid Geometry

Economy	Grade	Strand
Malaysia		Statistics
	Grade 9	Lines and angles II
		Polygons II
		Circles II
		Statistics II
		Indices
		Algebraic Expressions III
		Algebraic Formulae
		Solid Geometry III
		Scale Drawings
		Transformations II
		Linear equations II
		Linear inequalities
		Graphs of functions
		Ratio, rate and proportion II
		Trigonometry
New Zealand	Levels 3, 4, 5 and 6	Number and Algebra
		Geometry and Measurement
		Statistics
Singapore	O-Level Mathematics: Secondary 1, 2, 3 and 4	Numbers and algebra
		Geometry
		Statistics
Thailand	All grades	Numbers and operations
		Measurement
		Geometry
		Algebra
		Data analysis and probability
		Mathematical skills and processes
		Numbers and operations
		Measurement
United States	Grade 8	Number properties and operations
		Measurement
		Geometry
		Data analysis and probability
		Algebra

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APPENDIX C (CONTINUED): ECONOMIES' ORGANIZING STRANDS: MATHEMATICS UPPER SECONDARY

The following topics represent the strands, or organizing topics, used by each economy as the organizational framework in their mathematics standards.

Economy	Grade	Strands	Sub strands
China	10-12	Numbers & Algebra	Knowing Numbers Number Operations Common Quantities (1-3) Expressions and Equations (4-6) Exploring Patterns (1-6) Equations and Inequalities (7-9) Functions (7-9)
		Space & Figures	Knowing Figures Measurements (1-6) Figures and their Transformation Figures and their Positions (1-6) Figures and their Coordinates (7-9) Figures and Proofs (7-9)
		Statistics & Probability	Statistical Data Activities for Beginners (1-3) Phenomenon of Uncertainty (1-3) Simple Statistical Data Processing (4-6) Possibility (4-6) Statistics (7-9) Probability (7-9)
		Practical and Integrated Applications	
Chinese Taipei	Senior High (2 years)	Numbers and Coordinate Systems	Integers
			Rational Numbers and real numbers
			Plane coordinate system
			Complex numbers and planar complex numbers
		Number Lines and Progression	Arithmetical series and geometric progressions
			Infinite geometric progressions and recurring decimals
			Finite induction
		Polynomials	The arithmetic of polynomials
			Remainder theorem and factor theorem
			Highest common factor and lowest common multiple
			Polynomial functions
			Polynomial equations
			Polynomial inequalities
		Attachment	Recognize proofs

Economy	Grade	Strands	Sub strands
Chinese Taipei		Exponent and Logarithm	Exponents
			Exponent functions and figures
			Logarithms
			Logarithm functions and figures
			Checking tables and interpolation method
		Basic concept of trigonometric functions	Acute trigonometric functions
			Basic relationship of trigonometric functions
			Simple measurements and trigonometric function tables
			Trigonometric function of generalized diagonals
			Law of sines and cosines.
			Basic measurements of a triangle
		Characters and application of trigonometric functions	Figures of trigonometric functions*
			Sum and Difference Formulas
			Double angle formula* and half-angle formula
			Congruence of sinusoidal function
			Polar form (of complex numbers)
		Attachment	Concept of functions
			Figures of cotangent function, secant function and cosecant function
		Vector	Directed line segments and vectors
			Basic application of vectors
			The presentation of plane vectors on the coordinate grid
			Inner product of plane vectors
		Straight line and plane of space	Space concept
			Space coordinate system
			The presentation of Space vectors on coordinates
			Plane equations
			Space rectilinear equation
			Linear equation groups
		Circle and sphere equation	Circle equation
			The relationship between circles and straight lines
			Sphere equation
			The relationship of spheres and planes
		Conic Section	The origin of the name of conic section
			Parabola (Standard)
			Ellipse (Standard)
			Hyperbola (Standard)
			Light characteristics of conic section
		Permutation and	Counting combined elements

Economy	Grade	Strands	Sub strands
Chinese Taipei		Combination	Addition and multiplication
			Permutation
			Combination
			Binomial theorem
			Recurrence relationships
		Probability and Statistics	Events and combination
			Characteristics of probability
			Mathematical expectations
			Sources of statistic data
			Analyze one-dimensional data
			Recognition of confidence interval and confidence level
Hong Kong	Key Stage 4	Number and algebra dimensions	More about Polynomials
			Arithmetic and Geometric Sequences and their Summation
			Quadratic Equations in One Unknown
			More about Equations
			Variations
			Linear Inequalities in Two Unknowns
			Exponential and Logarithmic Functions
			Functions and Graphs
		Geometry	Qualitative Treatment of Locus
			Basic Properties of Circles
			Coordinate Treatment of Simple Locus Problems
			More about Trigonometry
		Data handling dimensions	Measures of Dispersion
			Uses and Abuses of Statistics
			Conducting Surveys
			More about Probability
			Further apply mathematics in various dimensions to more sophisticated real-life or mathematical situations
Korea	High School: First Grade	Numbers and Operations	Operations of Sets
			Propositions
			Real Number
Malaysia	Grade 10	Standard Form	Understand and use the concept of significant figures.

Economy	Grade	Strands	Sub strands
Malaysia			Understand and use the concept of standard form to solve problems
		Quadratic Expressions and Equations	Understand the concept of quadratic expression
			Factorize quadratic expressions
			Understand the concept of quadratic equations.
			Understand and use the concept of roots of quadratic equations to solve problems
		Sets	Understand the concept of set
			Understand and use the concept of subset, universal set and the complement of a set.
			Perform operations on the intersection of sets and the union of sets.
		Mathematical Reasoning	Understand the concept of statement
			Understand the concept of quantifiers "all" and "some."
			Perform operations involving the words "not" or "no," "and" and "or" on statements.
			Understand the concept of implications.
			Understand the concept of argument.
			Understand and use the concept of induction and deduction to solve problems.
		The Straight Line	Understand the concept of a gradient of a straight line
			Understand the concept of a gradient of a straight line in Cartesian coordinates.
			Understand the concept of intercept
			Understand and use equation of a straight line
			Understand and use the concept of parallel lines.
		Statistics	Understand the concept of class interval
			Understand and use the concept of mode and mean of grouped data.
			Represent and interpret data in histograms with class intervals of the same size to solve problems.
			Represent and interpret data in frequency polygons to solve problems
			Understand the concept of cumulative frequency
			Understand and use the concept of measures of dispersion to solve problems.
		Probability I	Understand the concept of sample space
			Understand the concept of events

Economy	Grade	Strands	Sub strands
Malaysia			Understand and use the concept of probability of an event to solve problems
		Circles III	Understand and use the concept of tangents to a circle
			Understand and use the properties of angle between tangent and chord to solve problems
			Understand and use the properties of common tangents to solve problems
		Lines and Planes in 3 dimensions	Understand and use the concept of angle between lines and planes to solve problems
			Understand and use the concept of angle between two planes to solve problems
	Grade 11	Number Bases	Understand and use the concept of number in base two, eight and five
		Graphs of Functions II	Understand and use the concept of graphs of functions
			Understand and use the concept of the solution of an equation by graphical method
			Understand and use the concept of the region representing inequalities in two variables
		Transformations III	Understand and use the concept of combination of two transformations
		Matrices	Understand and use the concept of matrix
			Understand and use the concept of equal matrices
			Perform addition and subtraction on matrices
			Perform multiplication of a matrix by number
			Perform multiplication of two matrices
			Understand and use the concept of identity matrix
			Understand and use the concept of inverse matrix
			Solve simultaneous linear equations by using matrices
		Variations	Understand and use the concept of direct variation
			Understand and use the concept of inverse variation
			Understand and use the concept of joint variation
		Gradient and Area under a graph	Understand and use the concept of quantity represented by the gradient of a graph
			Understand the concept of quantity represented by the area under a graph

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Economy	Grade	Strands	Sub strands
Malaysia		Probability II	Understand and use the concept of probability of an event
			Understand and use the concept of probability of the complement of an event
			Understand and use the concept of probability of combined event
		Bearing	Understand and use the concept of bearing
		Earth as a sphere	Understand and use the concept of latitude
			Understand and use the concept of longitude
			Understand the concept of location of a place
			Understand and use the concept of distance on the surface of the earth to solve problems
		Plans and Elevations	Understand and use the concept of orthogonal projection
			Understand and use the concept of plan and elevation
New Zealand	Level Five	Number and Algebra	Number strategies and knowledge
			Equations and expressions
			Patterns and relationships
		Geometry and Measurement	Measurement
			Shape
			Positions and orientation
			Transformation
		Statistics	Statistical investigation (thinking
			Statistical literacy
			Probability
	Level Six	Number and Algebra	Number strategies and knowledge
			Equations and expressions
			Patterns and relationships
		Geometry and Measurement	Measurement
			Shape
			Positions and orientation
			Transformation
		Statistics	Statistical investigation (thinking
			Statistical literacy
			Probability
	Level Seven	Number and Algebra	Number strategies and knowledge
			Equations and expressions
			Patterns and relationships
		Geometry and Measurement	Measurement
			Shape
			Positions and orientation
			Transformation
		Statistics	Statistical investigation (thinking

Economy	Grade	Strands	Sub strands
New Zealand			Statistical literacy
			Probability
		Mathematics	Patterns and relationships
			Equations and expressions
			Calculus
	Level Eight	Number and Algebra	Number strategies and knowledge
			Equations and expressions
			Patterns and relationships
		Geometry and Measurement	Measurement
			Shape
			Positions and orientation
			Transformation
		Statistics	Statistical investigation (thinking
			Statistical literacy
			Probability
		Mathematics	Patterns and relationships
			Equations and expressions
			Calculus
Singapore	A Level Mathematics (H2)	Pure Mathematics	Functions and Graphs
			Sequences and Series
			Vectors
			Complex numbers
			Calculus
		Statistics	Permutations, combinations and probability
			Binomial, poisson, and normal distributions
			Sampling and hypothesis testing
			Correlation and regression
Thailand	All Grades	Numbers and operations	
		Measurement	
		Geometry	
		Algebra	
		Data analysis and probability	
		Mathematical skills and processes	

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Strands
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APPENDIX C (CONTINUED): ECONOMIES' ORGANIZING STRANDS: SCIENCE
LOWER SECONDARY SCHOOL

The following topics represent the strands, or organizing topics, used by each economy as the organizational framework in their science standards.

Economy	Grade Level	Strands	Sub-Strands
Australia	Years 7 and 9	Science as a human Endeavour	
		Science as a way to know	
		Science as a body of knowledge	Energy and force
			Matter
			Living things
			Earth and space
Canada	Grades 1-3	STSE (Science, technology, society and environment)	Nature of science and technology
			Relationships between science and technology
			Social and environmental contexts of science and technology
		Skills	Initiating and planning
			Performing and recording
			Analyzing and interpreting
			Communication and teamwork
		Attitudes	Appreciation of science
			Interest in science
			Scientific inquiry
			Collaboration
			Stewardship
			Safety in science
		Knowledge	Life science
			Physical science
			Earth and space science
	Grade 1	STSE & Skills subsumed under the Knowledge Topics:	LIFE SCIENCE /Properties of objects and materials
			PHYSICAL SCIENCE / Properties of objects and materials
			PHYSICAL SCIENCE / Materials and our senses
			EARTH AND SPACE SCIENCE / Daily and seasonal changes
	Grade 2	STSE & Skills subsumed under the Knowledge Topics:	Life Science / Animal growth and changes
			Physical Science / Liquids and solids
			Physical Science / Relative position and motion
			Earth & Space Science / Air and water in the environment
	Grade 3	STSE & Skills subsumed under the	Life Science / Plant growth and changes
			Physical Science / Materials and structures

Economy	Grade Level	Strands	Sub-Strands
Canada		Knowledge Topics:	Physical Science / Invisible forces
			Earth & Space Science / Exploring soils
	Grades 4-6	STSE (Science, technology, society and environment)	Nature of science and technology
			Relationships between science and technology
			Social and environmental contexts of science and technology
		Skills	Initiating and planning
			Performing and recording
			Analyzing and interpreting
			Communication and teamwork
		Knowledge	Life science
			Physical science
			Earth and space science
		Attitudes	Appreciation of science
			Interest in science
			Scientific inquiry
			Collaboration
			Stewardship
			Safety in science
	Grade 4	STSE & Skills subsumed under the Knowledge Topics:	Life Science / Habitats and communities
			Physical Science / Light
			Physical Science / Sound
			Earth & Space Science / Rocks, minerals, and erosion
	Grade 5	STSE & Skills subsumed under the Knowledge Topics:	Life Science / Meeting basic needs and maintaining a healthy body
			Physical Science / Properties and changes of materials
			Physical Science / Forces and simple machines
			Earth & Space Science /Weather
	Grade 6	STSE & Skills subsumed under the Knowledge Topics:	Life Science / Diversity of Life
			Physical Science / Electricity
			Physical Science / Flight
			Earth & Space Science / Space
	Grades 7-9	STSE (Science, technology, society and environment)	Nature of science and technology
			Relationships between science and technology
			Social and environmental contexts of science and technology
		Skills	Initiating and planning
			Performing and recording
			Analyzing and interpreting
			Communication and teamwork
		Knowledge	Life science
			Physical science
			Earth and space science
		Attitudes	Appreciation of science

Appendix C
Strands
Science

Economy	Grade Level	Strands	Sub-Strands
Canada			Interest in science
			Scientific inquiry
			Collaboration
			Stewardship
			Safety in science
	Grade 7	STSE & Skills subsumed under the Knowledge Topics:	LIFE SCIENCE / Interactions within ecosystems
			PHYSICAL SCIENCE / Mixtures and solutions
			PHYSICAL SCIENCE / Heat
			EARTH AND SPACE SCIENCE / Earth's crust
	Grade 8	STSE & Skills subsumed under the Knowledge Topics:	Life Science / Cells, tissues, organs, and systems
			Physical Science / Optics
			Physical Science / Fluids
			Earth & Space Science / Water systems on Earth
	Grade 9	STSE & Skills subsumed under the Knowledge Topics:	Life Science / Reproduction
			Physical Science / Atoms and elements
			Physical Science / Characteristics of electricity
			Earth & Space Science / Space exploration
	Grade 10	STSE & Skills subsumed under the Knowledge Topics:	Life Science / Sustainability of Ecosystems
			Physical Science / Chemical Reactions
			Physical Science / Motion
			Earth & Space Science / Weather Dynamics
Chinese Taipei	Stage Four (Grades 7-9)	Recognition levels	
		Recognition of the Physiology of plants and animals	
		Recognition of environment	
		Recognition of substances	
		Recognition of reactions	
		Viewpoints of energy	
		Recognition of common technology	
Japan	First Field (Grade 7)	Familiar physical phenomena	Light and sound
			Force and pressure
		Familiar substances	The characteristics of substances
			Water solution
		Electric current and its uses	Electric Current
			The uses of electric current
		Chemical change, and atoms / molecules	Formation of substances
			Chemical change and the mass of substances
		The regularity of motion	

Economy	Grade Level	Strands	Sub-Strands
Japan		The uses of substances and chemical reactions	
		Science-technology and human beings	Energy resources
			Science-technology and human beings
	Second Field (Grade 8)	Life and kinds of plants	Observation of living things
			Body structure and function of plants
			Families of plants
		Changes of the earth	Strata and the state of the earth in the past
			Volcanoes and earthquakes
		Life and kinds of animals	Body structure and function of animals
			Families of animals
		The weather and its changes	Observation of the weather
			Changes of the weather
		Cells and reproduction in living things	Living things and cells
			Reproduction of living things
		The earth and space	The movement of celestial bodies and the rotation and revolution of the earth
			The solar system and the planets
		Nature and human beings	Nature and the environment
			Nature and human beings
	Integrated Science A *(aka General Science A)*	Investigation of nature	Scientific view of nature
			Method of doing investigation
		Human life resources and energy	The development and utilization of resources
			Various energy
		Matter and human life	Composition and change of matter
			Utilization of matter
		Human life and the progress of science and technology	
Korea	First Grade	Motion and Energy	Height
			Distance
		Material	Putting things in order
			Learning how to use tools
		Life	Learning about safety
			Playing hospital
	Second Grade	Motion and Energy	Time
			Weight
		Material	Picture maps
			Collecting fruits and seeds
			Collecting materials
		Life	Animal and plant growth
			Observation of changes over the course of time
		Earth and Space	shadows
	Third Grade	Motion and Energy	Properties of magnets
			Light traveling in a straight line

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Strands
Science

Economy	Grade Level	Strands	Sub-Strands
Korea		Material	Object and materials
			Liquid and gases
			Separation of mixtures
		Life	Life cycle of animals
			Animal's world
		Earth and Space	Weather and our life
	Fourth Grade	Motion and Energy	Weight
			Heat transfer
		Material	Phase change of water
		Life	Life cycle of plants
			Plant's world
		Earth and Space	Geological strata and fossils
			Volcanoes and earthquakes
			Change in the earth surface
	Fifth Grade	Motion and Energy	Speed of an object
			Electric Circuit
		Material	Dissolution and solution
		Life	Plant structures and functions
			World of micro-organism
			Human body
		Earth and Space	Earth and the moon
			Solar system and stars
	Sixth Grade	Motion and Energy	Light
			Energy
			Magnetic Fields
		Material	Acids and bases
			Various gases
			Combustion and extinguishment
		Life	Ecosystems and environments
		Earth and Space	Weather changes
			Seasonal changes
	Seventh Grade	Motion and Energy	Force and motion
			Electrostatics
		Material	Three Phases of matter
			Molecular motion
			Phase change and energy
		Life	Organization and diversity of living organisms
			Plant nutrition
		Earth and Space	Earth's crust materials and changes
			Tectonic movements and Plate tectonics
	Eighth Grade	Motion and Energy	Thermal Energy
			Light and waves
		Material	Composition of substances
			Compounds around us
		Life	Digestion and circulation

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Strands
Science

Economy	Grade Level	Strands	Sub-Strands
Korea			Respiration and excretion
		Earth and Space	Solar system
			Stars and the Universe
	Ninth Grade	Motion and Energy	Work and energy
			Electricity
		Material	Nature of matter
			Electrolytes and ions
		Life	Stimulus and response
			Reproduction and development
		Earth and Space	Characteristics of atmosphere and weather change
			Composition and movement of sea water
	Tenth Grade	Motion and Energy	Motion of an object
			Electromagnetism
		Material	Regularity in chemical reaction
			Various chemical reactions
		Life	Inheritance and evolution
			Life science and the future of human species
			Energy in nature
		Earth and Space	Earth system
			Movement of celestial bodies
Hong Kong	Grades 1-3	Scientific Investigation	
		Life and Living	
		The Material World	
		Energy and Change	
		The Earth and Beyond	
		Science, Technology and Society	
	Grades 4-6	Scientific Investigation	
		Life and Living	
		The Material World	
		Energy and Change	
		The Earth and Beyond	
		Science, Technology and Society	
	Grades 7-9	Scientific Investigation	
		Life and Living	
		The Material World	
		Energy and Change	
		The Earth and Beyond	
		Science, Technology and Society	
	Grade 10	Scientific Investigation	

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Strands
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Economy	Grade Level	Strands	Sub-Strands
Hong Kong		Life and Living	
		The Material World	
		Energy and Change	
		The Earth and Beyond	
		Science, Technology and Society	
Malaysia	Year 1	Learning about living things	Ourselves
			Animals
			Plants
		Learning about the world around us	Using our senses
			Finding out about things that float and sink
			Finding out about light and dark
	Year 2	Learning about living things	Living things and non-living things
			Ourselves
			Animals
			Plants
		Learning about the world around us	Long or short
			The magic batteries
			Mixing things
			Push and pull
	Year 3	Learning about living things	Animals
			Plants
		Learning about the world around us	Magnets
			Electricity
			Springs
			Absorption
			Soil
			Mixing substances
	Year 4	Learning about living things	Living things have basic needs
			Living things undergo life processes
			Animals and plants protect themselves
		Investigating the Earth and the Universe	The solar system
		Investigating materials	Properties of materials
		Investigating force and energy	Measurement
		Investigating technology	Technology
	Year 5	Learning about living things	Microorganism
			Survival of the species
			Food chain and food web
		Investigating force and energy	Energy
			Electricity
			Light

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Economy	Grade Level	Strands	Sub-Strands
Malaysia			Heat
		Investigating materials	States of matter
			Acid and alkali
		Investigating the Earth and the Universe	Constellation
			The earth, the moon and the sun
		Investigating technology	Strength and stability
	Year 6	Investigating living things	Interaction among living things
		Investigating force and energy	Force
			Movement
		Investigating materials	Food preservation
			Waste management
		Investigating the Earth and the Universe	Eclipses
		Investigating technology	Machine
	Form 1 (Grade 7)	Introduction to science	
		Man and the variety of living things	Cell as a unit of life
		Matter in nature	Matter
			The variety of resources on earth
			The air around us
		Energy	Sources of energy
			Heat
	Form 2 (Grade 8)	Management and continuity of life	The world through our senses
			Nutrition
		Man and the variety of living things	Biodiversity
			Interdependence among living organisms and the environment
		Matter in nature	Water and solution
			Air pressure
		Force and Motion	Dynamics
			Support and movement
		Technological and industrial development in society	Stability
			Simple machine
	Form 3 (Grade 9)	Management and continuity of life	Respiration
			Blood circulation and transport
			Excretion
			Reproduction
			Growth
		Matter in nature	Land and its resources

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Strands
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Economy	Grade Level	Strands	Sub-Strands
Malaysia		Energy in life	Electricity
			Generation of electricity
		Astronomy and space exploration	Stars and galaxies
			Space exploration
	Form 4 (Grade 10)	Introducing science	Scientific investigation
		Maintenance and continuity of life	Body coordination
			Heredity and variation
		Matter in nature	Matter and substance
		Energy in life	Energy and chemical changes
			Nuclear energy
			Light, color, and sight
		Technological and industrial development in society	Chemicals in industry
New Zealand	Level 1 and 2	Nature of science	Understanding about science
			Investigating in science
			Communicating in science
			Participating and contributing
		Living world	Life processes
			Ecology
			Evolution
		Planet Earth and beyond	Earth systems
			Interacting systems
			Astronomical systems
		Physical world	Physical inquiry and physics concepts
		Material world	Properties and changes of matter
			Structure of matter
			Chemistry and society
	Level 3	Nature of science	Understanding about science
			Investigating in science
			Communicating in science
			Participating and contributing
		Living world	Life processes
			Ecology
			Evolution
		Planet Earth and beyond	Earth systems
			Interacting systems
			Astronomical systems
		Physical world	Physical inquiry and physics concepts
		Material world	Properties and changes of matter
			Structure of matter
			Chemistry and society
	Level 4	Nature of science	Understanding about science
			Investigating in science
			Communicating in science

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Economy	Grade Level	Strands	Sub-Strands
New Zealand			Participating and contributing
		Living world	Life processes
			Ecology
			Evolution
		Planet Earth and beyond	Earth systems
			Interacting systems
			Astronomical systems
		Physical world	Physical inquiry and physics concepts
		Material world	Properties and changes of matter
			Structure of matter
			Chemistry and society
	Level 5	Nature of science	Understanding about science
			Investigating in science
			Communicating in science
			Participating and contributing
		Living world	Life processes
			Ecology
			Evolution
		Planet Earth and beyond	Earth systems
			Interacting systems
			Astronomical systems
		Physical world	Physical inquiry and physics concepts
		Material world	Properties and changes of matter
			Structure of matter
			Chemistry and society
	Level 6	Nature of science	Understanding about science
			Investigating in science
			Communicating in science
			Participating and contributing
		Living world	Life processes
			Ecology
			Evolution
		Planet Earth and beyond	Earth systems
			Interacting systems
			Astronomical systems
		Physical world	Physical inquiry and physics concepts
		Material world	Properties and changes of matter
			Structure of matter
			Chemistry and society
Singapore	Primary 3 and 4	Diversity	Diversity of living and non-living things
			Diversity of materials
		Cycle	Cycles in plants and animals
			Cycles of matter and water
		Systems	Plant system
			Human system

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Economy	Grade Level	Strands	Sub-Strands
Singapore		Energy	Energy forms and uses
		Interactions	Interactions and forces
	Primary 5 and 6	Diversity	
		Cycle	Cycles in plants and animals
			Cycles of matter and water
		Systems	Plant system
			Human system
			Electrical system
			Cell system
		Energy	Energy conversion
			Energy forms and uses
		Interactions	Interaction and forces
			Interaction within the environment
	Express/ Normal - Academic: Lower Secondary (Grades 7-10)	Knowledge, understanding and application	Diversity
			Cycle
			Systems
			Energy
			Interactions
United States	National Assessment of Educational Progress: Grade 4	Earth Science	Solid earth
			Water
			Air
			Earth in space
		Physical Science	Matter and its transformations
			Energy and its transformations
			Motion
		Life Science	Change and evolution
			Cells and their functions
			Organisms
			Ecology
	National Assessment of Educational Progress: Grade 8	Earth Science	Solid earth
			Water
			Air
			Earth in space
		Physical Science	Matter and its transformations
			Energy and its transformations
			Motion
		Life Science	Change and evolution
			Cells and their functions
			Organisms
			Ecology

APPENDIX C (CONTINUED): ECONOMIES' ORGANIZING STRANDS: SCIENCE
UPPER SECONDARY COURSES (GRADES 10-12)

The following topics represent the strands, or organizing topics, used by each economy as the organizational framework in their science standards.

Economy	Courses	Strands	Sub-Strands
Canada	Life Science Objectives	STSE & Skills subsumed under the Knowledge Topics	Reproduction and Development
			Matter and Energy For Life
			Genetic Continuity
			Evolution, Change, and Diversity
			Maintaining Dynamic Equilibrium
			Interactions among Living Things
	Physics Objectives	STSE & Skills subsumed under the Knowledge Topics	Force, Motion, and Work
			Energy and Momentum
			Waves
			Fields
			Radioactivity and Modern Physics
	Earth & Space Science Objectives	STSE & Skills subsumed under the Knowledge Topics	Earth Systems
			Earth Resources
			Historical Geology
			Astronomy
	Chemistry objectives	STSE & Skills subsumed under the Knowledge Topics	Organic Chemistry
			Acids and Bases
			From Structures to Properties
			Electrochemistry
			Solutions and Stoichiometry
			Thermochemistry
Chinese Taipei	Basic Biology	Characteristics of life	Phenomena of life
			Cell chemical composition
			Cell structure
			Cell division
		Biodiversity	Meaning of biodiversity
			Bioclassification
			Virus and bacteria
			Fungi and algae
			Plant
			Animal
		Organisms and Environment	Individual and population
			Community Ecosystem
			Terrestrial ecosystem
			Aquatic ecosystem
		Human Beings and Environment	Development and use of resources
			Impact of human kind on ecosystems

Economy	Courses	Strands	Sub-Strands
Chinese Taipei			Conservation and sustainable development of nature
	Biology	Cell and organisms	Cell
			Tissues, organs and systems
		Nutrition in plants	Structures of roots, stems and leaves
			Absorption and transportation of water and inorganic salts
			Photosynthesis and respiration
			Transportation of nutrients
		Reproduction, growth and development of plants	Reproduction of plants
			Seed germination and growth
			Substances regulating the development and growth of plants
			Plant reaction of environmental stimulation
		Metabolism and homeostasis of animals	Digestion and nutrition
			Nutrient circulation and transport
			Breathing and exchange of gases
			Excretion and fluid balance
		Coordination of animals	immunity
			Nerves and movements
			Hormones and coordination
			Animal Behaviors
		Animal reproduction and genetics	Animal reproduction
			Human reproduction and embryogeny
			Genes and heredity
			Human genetics
		Science and human life	Gene Expression
			Biotechnology and other applications
			Impacts of biotechnology
	Basic Physics	Overview	Importance of physics and its relationship with other scientific subjects
			Measurement and units
		Motion and force	Common types of motion in everyday life
			Common types of force in every day life
			Force and motion
		Heat	Temperature and heat
			Heat and change of state
			Heat and life
		Sounds	Generation of sounds and its traveling
			Sound deflection
			Musical notes and instruments
			noise
		Light	Human perception of light
			Transmission of light
			Refraction and reflection of light
			Light and our daily life

Economy	Courses	Strands	Sub-Strands
Chinese Taipei		Electricity and Magnetism	Understanding of electricity
			Direct and alternating current
			Magnets and terrestrial magnetism
			The heat and magnetic forces of electric current
			Transformers and the flow of change
			Family electricity use and safety
		Energy and life	Various forms of energy and energy conversion
			Nuclear and replacement energy
			Energy efficiency and power saving
		Modern Technology	Brief introduction to modern technology
		Modern Physics	Brief introduction to modern physics
		Attachment 1. Brief introduction to cosmology	Observation of planets and Hubble's law
			Cosmological theories about the origin of the universe
			evolution of planets
		Attachment 2. Brief history of physics	Brief history of development of physics
	Physics	Statics	Transitional equilibrium
			Torque and rotational equilibrium
			Static equilibrium
			Centre of gravity and centre of mass
		Kinematics	Rectilinear motion
			two-dimensional motions
		Newton's laws	Inertia and Newton's first law
			Newton's second law
			Newton's third law
			Friction
		Momentum and the application of Newton's laws	Momentum and impulse
			Conservation of momentum
			The motion of the center of mass
			Uniform circular motion
			Simple harmonic motions
			Dimensions in physical situation
		Rotation	Rotation around a fixed axis
			Angular momentum and moment of inertia
			Angular momentum as a conserved quantity
		Gravitation	Kepler's laws of planetary motion
			The law of universal gravitation
			Gravitational field and acceleration
			Satellites
		Work and energy	Work and power
			Definition of kinetic energy and mechanical energy
			potential energy
			Conservation of mechanical energy
		Collisions	Elastic collisions

Economy	Courses	Strands	Sub-Strands
Chinese Taipei			Inelastic collisions
		Properties of fluids	Pressure and buoyant force of fluids at rest
			Pascal's principle and its applications
			Atmospheric pressure
			Surface tension and capillary action of fluids
			Bernoulli equation and its applications
		Heat	Thermal capacity and specific heat
			Change of state of a material and latent heat
			Thermal expansion
			Ideal gas equation
			Kinetic Theory of gas
	Basic Chemistry	Overview	Chemistry
			Chemistry and life
		Substances of the natural world	Natural world
			Water
			Atmosphere
			Soil
		Formation and changes of substances	Formation of substances
			Mass of substances
			Features of substances
			Changes of substances
		The power in our life	Introduction to power
			Fossil power and burning heat
			Chemical batteries
			Other power
		The substances in our daily lives	Food and chemistry
			Clothing material and chemistry
			Materials and chemistry
			Medicine and chemistry
	Chemistry	Structure of substances	Structure of atoms
			Element and periods
			Formation of substances
			The structure of hydrocarbons
		State of Substances	Changing states of substances
			Properties of gas
			Nature of solutions
		Changes of substances	Chemical reactions
			Chemical reaction rate
			Acids and Bases
			Oxidation and reduction
			Additions and substitutions
		Properties of substance	Properties of nonmetal elements
			Properties of metal elements
	Basic Earth Science	Humans and global environment	Explore the origin of earth
			A general overview of human and global

Economy	Courses	Strands	Sub-Strands
Chinese Taipei			environment
		The earth in space	View the earth from space
			View the sky from earth
		Active earth	Structure of the earth
			Atmosphere and transformation of oceans
			Transformation of solid earth
		Natural disasters	Water disasters
			Geologic disasters
		The transformation of global environment	The change of climate
			The change of coast
		Global resources and future development	Resources, environment and future development
	Earth Science	The earth in ancient and modern times	Explore the origin, shape and size of the earth
			Explore the origin of time
		Exploration of the global environment	Observe the winds and clouds
			Predict the phenomena of the oceans
			Explore the stratum
			Watch the sky
			Observational skills for the global environment in modern times
		Global environment and its characteristics	Gorgeous mountains and rivers
			Deep oceans
			Varied weather
			Bright sky
		Daily lives and global environment	Minerals, energy and daily life
			Beautiful stones
			Water resources and daily life
			Watch the weather when going out
			Chose the land to build houses
			Travel and global environment
		Interaction of human being and the global environment	Biology, human being and the global environment
			Face the global change on earth
Japan	Biology I	Continuity of life	Cells
			Reproduction and development
			Heredity
			Investigation activities concerned with the continuity of life
		Reactions between living things and the environment	Reactions of animals to the environment
			Reactions of plants to the environment
			Research projects concerned with reactions of living things to the environment
	Biology II	Biological phenomena and substances	The functions of proteins and biological organisms
			Genetic information and its manifestation
		Biological	The classification and phylogeny of living things

Economy	Courses	Strands	Sub-Strands
Japan		classification and evolution	The evolution of living things
		Groups of living things	Structure and maintenance of populations
			Biocenoses and ecosystems
		Research project	
	Chemistry I	Composition of substances	Substances and human life
			Constituent particles of substances
			Investigation activities concerning the composition of substances
		Kinds and properties of substances	Inorganic substances
			Organic compounds
			Investigation activities with kinds and properties of substances
		Changes in substances	Chemical reactions
			Investigation activities concerned with changes in substances
	Chemistry II	Structure of substances and chemical equilibrium	Structure of substances
			Chemical equilibrium
		Substances and daily life	Chemistry of food and clothing
			Chemistry of materials
		Substances and living things	Chemistry of life
			Chemistry of medical supplies
		Research project	Research on specific chemical phenomena
			Research on some experiments that develop chemistry further
	Earth Science I	The composition of the earth	Overview of the earth
			Interior of the earth
			History of the earth
			Research project concerned with the composition of the earth
		Composition of the atmosphere, the oceans and the universe	Atmosphere and the oceans
			Composition of the universe
			Research project concerned with the composition of the atmosphere, the oceans and the universe
	Earth Science II	Investigation of the earth	Movement of plates and changes in the earth's mantle
			Passage of time in the Japanese archipelago
		Investigation of the earth's crust	Observation of the earth
			Phenomena in the atmosphere and the oceans
		Investigation of the universe	Observation of heavenly bodies
			Spatial extent of the universe
		Research project	
	Physics I	Electricity	Electricity in daily life
			Exploratory activities concerned with electricity
		Waves	Different kinds of waves

Economy	Courses	Strands	Sub-Strands
Japan			Sound and light
			Exploratory activities concerned with waves
		Motion and energy	Motion of objects
			Energy
			Exploratory activities concerned with motion and energy
	Physics II	Force and motion	Motion of objects
			Circular motion and universal gravitation
		Electricity and magnetism	Electric fields and magnetic fields
			Electromagnetic induction and electromagnetic waves
		Matter and atoms	Motion of atoms and molecules
			Atoms, electrons and the properties of matter
		Atoms and atomic nuclei	Structure of an atom
			Atomic nucleus and elementary particles
		Topic-based research	Research into specified physical phenomena
			Research into experiments designed to let physics advance further
Korea	Physics	Power and Energy	Velocity and accelerated velocity
			Laws of motion
			Momentum and impulse
			Work and power
			Conservation of mechanical energy
			Conservation of energy
		Electricity and magnetism	Voltage and electric current
			Electric resistance
			Heat effect on electron current
			Galvono- magnetic effect
			Electromagnetic induction
		Wave and Particle	Generation of wave and propagation
			Reflection and refraction of wave
			Interference and diffraction of wave
			Polarized light
			Photoelectric effect
			Material wave
Hong Kong	Biology S4-S6	Cells and Molecules of Life	Molecules of life
			Cellular organization
			Movement of substances across membrane
			Cell cycle and division
			Cellular energetic
			Respiration
		Genetics and Evolution	Basic genetics
			Molecular genetics
			Biodiversity and evolution
		Organisms and	Essential life processes in plants

Economy	Courses	Strands	Sub-Strands
Hong Kong		Environment	Essential life processes in animals
			Reproduction, growth and development
			Coordination and response
			Homeostasis
			Ecosystems
		Health and Disease	Personal health
			Diseases
			Body defense mechanisms
		Human Physiology: Regulation and Control (Elective)	Regulation of water content
			Regulation of body temperature
			Regulation of gas content in blood
			Hormonal control of reproductive cycle
		Applied Ecology (Elective)	Human impact on the environment
			Pollution control
			Conservation
			Sustainable development
		Microorganisms and Humans (Elective)	Microbiology
			Use of microorganisms
			Microbial genetics
			Harmful effects of microorganisms
		Biotechnology (Elective)	Introduction to biotechnology
			Techniques in modern biotechnology
			Biotechnology in medicine
			Biotechnology in agriculture
			Transgenic plants
			Bioethics
	Chemistry S4-S6	Topic I Planet Earth	The atmosphere
			The ocean
			Rocks and minerals
		Microscopic World I	elements, atoms and symbols
			The Periodic Table
			Metallic bonding
			Structures and properties of metals
			Ionic and covalent bond
			Structures and properties of giant ionic substances
			Structures and properties of simple molecular substances
			Structures and properties of giant covalent substances
			Comparison of structures and properties of important types of substances
		Metals	Occurrence and extraction of metals
			Reactivity of metals
			Corrosion of metals and their protection
		Acids and Bases	Indicators and pH

Economy	Courses	Strands	Sub-Strands
Hong Kong			Strength of acids and alkalis
			Salts and neutralization
			Concentration of solutions
			Volumetric analysis involving acids and alkalis
		Fossil Fuels and Carbon Compounds	Homologous series, structural formulae and naming of carbon compounds
			Alkanes and alkenes
			Addition polymers
		Microscopic World II	Bond polarity
			Intermolecular forces
			Structures and properties of molecular crystals
			Simple molecular substances with non- octet structures
			Shapes of simple molecules
		Redox Reactions, Chemical Cells and Electrolysis	Chemical cells in daily life
			Reactions in simple chemical cells
			Redox reactions
			Redox reactions in chemical cells
			Electrolysis
			Importance of redox reactions in modern ways of living
		Chemical Reactions and Energy	Energy changes in chemical reactions
			Standard enthalpy change of neutralization, solution, formation and combustion
			Hess's law
		Rate of Reaction	Rate of chemical reaction
			Factors affecting rate of reaction
			Molar volume of gases at room temperature and pressure
		Chemical Equilibrium	Dynamic equilibrium
			Equilibrium constant
			The effect of changes in concentration and temperature on chemical equilibria
		Chemistry of Carbon Compounds	Introduction to selected homologous series
			Isomerism
			Typical reactions of various functional groups
			Inter-conversions of carbon compounds inter-conversions between the functional groups
			Important organic substances
		Patterns in the Chemical World	Periodic variation in physical properties of the elements from Li to Ar
			Bonding, stoichiometric composition and acid-base properties of the oxides of elements from Na to Cl
			General properties of transition metals
	Physics S4-S6	Electricity and	Electrostatics

Economy	Courses	Strands	Sub-Strands
Hong Kong		Magnetism	Circuits and domestic electricity
			Electromagnetism
		Radioactivity and Nuclear Energy	Radiation and Radioactivity
			Atomic model
			Nuclear energy
		Wave Motion	Nature and properties of waves
			Light
			Sound
		Energy and Momentum	Projectile motion
			Work, energy and power
			Momentum
			Uniform circular motion
			Gravitation
Malaysia	Biology Form 4	Introducing Biology	
		Investigating the cell as a basic unit of living things	Cell structure and cell organization
			Movement of substances across the plasma membrane
			Chemical composition of the cell
			Cell division
		Investigating the physiology of things	Nutrition
			Respiration
		Investigating the relationship between living things and the environment	Dynamic ecosystem
			Endangered ecosystem
	Biology Form 5	Physiology of living things	Transport
			Locomotion and support
			Coordination and response
			Reproduction and growth
		Variation and inheritance	Inheritance
			Variation
	Chemistry Form 4	Introducing Chemistry	
		Matter around us	The structure of an atom
			Chemical formula and equations
			Periodic table of elements
			Chemical bonds
		Interaction between chemicals	Electrochemistry
			Acids and Bases
			Salts
		Production and management of manufactured chemicals	Manufactured substances in industry
	Chemistry Form 5	Interaction between chemicals	Rate of reaction
			Carbon compounds

Appendix C
Strands
Science

Economy	Courses	Strands	Sub-Strands
Malaysia			Oxidation and reduction
			Thermochemistry
		Production and management of manufactured chemicals	Chemicals for consumers
	Physics Form 4	Introduction to physics	
		Force and motion	
		Forces and pressure	
		Heat	
		Light	
	Physics Form 5		

APPENDIX D: TOPICS NOT ADDRESSES BY ANY ECONOMY: MATHEMATICS

None of the economies' standards addressed the following mathematics topics in their corresponding grade level standards. The table below shows some topics did not surface in any grade span, such as "Functions of Several Variables." Others did not surface in one or two grade spans but did in the other(s), such as "Operations," which did not appear in any grade 10-12 standards but did appear in both grade 1-6 and grade 7-9 standards.

The list below is an unfiltered, comprehensive list of all unaddressed topics at each grade span. Even topics one would not expect certain grade level standards to cover have been included. For instance, it would be quite unusual to find *Vectors* in standards from grade span 1-6, but we have listed it below to confirm no economies' standards addressed it in grades 1-4.

GRADES 1-6 12 Economies	**GRADES 7-9** 12 Economies	**GRADES 10-12** 11 Economies
Numbers		
		Operations
		Common Fractions
		Relationships of Common & Decimal Fractions
		Properties of Common & Decimal Fractions
Binary Arithmetic and/or Other Number Bases		Binary Arithmetic and/or Other Number Bases
Exponents, Roots & Radicals		
Real exponents		
Complex Numbers & Their Properties	Complex Numbers & Their Properties	
Systematic Counting		
Matrices	Matrices	
		Estimating Quantity & Size
Exponents & Orders of Magnitude		
Measurement		
		Concept of measure
		Use of appropriate instruments
		Dimensional analysis
Geometry: Position, Visualization & Shape		
Conic sections and their equations		
Pythagorean Theorem and its applications		
Coordinate systems in three dimensions	Coordinate systems in three dimensions	
Equations of lines, planes and surfaces in space	Equations of lines, planes and surfaces in space	
Vectors	Vectors	
Simple Topology		Simple Topology

GRADES 1-6 12 Economies	**GRADES 7-9** 12 Economies	**GRADES 10-12** 11 Economies
Geometry: Transformations		
		Patterns, tessellations, friezes, stencils, etc
Proportionality		
Slope and gradient in straight line graphs		
Trigonometry of right triangles		
Linear Interpolation & Extrapolation		
Functions, Relations, & Equations		
Relations and their properties		
Functions and their properties		
Families of functions (graphs and properties)		
Operations on functions		
Related functions (inverse, derivative, etc.)	Related functions (inverse, derivative, etc.)	
Relationship of functions and equations (e.g., zeros[/max/min/asymptotes] of functions as roots of equations)		
Interpretation of function graphs		
Functions of several variables	Functions of several variables	Functions of several variables
Recursion	Recursion	
Linear Functions		
Quadratic Functions		
Logarithmic and Exponential Functions		
Trigonometric Functions	Trigonometric Functions	
Quadratic equations and their formal (closed) solutions		
Polynomial equations and their solutions		
Trigonometrical equations and identities	Trigonometrical equations and identities	
Logarithmic and exponential equations and their solutions	Logarithmic and exponential equations and their solutions	
Solution of equations reducing to quadratics, radical equations, absolute value equations, etc.		
Other solution methods for equations (e.g., successive approximation)	Other solution methods for equations (e.g., successive approximation)	
Inequalities and[/or] their graphical representation		
Systems of equations and their solutions		
Systems of inequalities		

GRADES 1-6 12 Economies	**GRADES 7-9** 12 Economies	**GRADES 10-12** 11 Economies
General equation of the second degree and its interpretation		
Angle measures: radians and degrees	Angle measures: radians and degrees	
Law of sines and cosines	Law of sines and cosines	
Unit circle and trigonometric functions	Unit circle and trigonometric functions	
Parametric equations	Parametric equations	
Polar coordinates		
Polar equations and their graphs	Polar equations and their graphs	
Data Representation, Probability, & Statistics		
Sampling, randomness, and bias related to data samples		
Fitting lines and curves to data		
Correlations and other measures of relations	Correlations and other measures of relations	
Mutually exclusive events	Mutually exclusive events	
Conditional probability and independent events		
Bayes' Theorem	Bayes' Theorem	
Contingency tables	Contingency tables	
Probability distributions for discrete random variables		
Probability distributions for continuous random variables		
Expectation and the algebra of expectations		
Sampling (distributions and populations)		
Estimation of population parameters	Estimation of population parameters	
Hypothesis testing	Hypothesis testing	
Confidence intervals	Confidence intervals	
Bivariate distributions	Bivariate distributions	
Markov processes	Markov processes	
Monte Carlo methods and computer simulations		Monte Carlo methods and computer simulations
Elementary Analysis		
Arithmetic and geometric sequences		
Arithmetic and geometric series		
Binomial Theorem	Binomial Theorem	
Other sequences and series	Other sequences and series	
Limits and convergence of series	Limits and convergence of series	
Limits and convergence of functions	Limits and convergence of functions	
Continuity	Continuity	
Growth and decay	Growth and decay	
Differentiation	Differentiation	

GRADES 1-6 12 Economies	**GRADES 7-9** 12 Economies	**GRADES 10-12** 11 Economies
Integration	Integration	
Differential equations	Differential equations	
Partial differentiation	Partial differentiation	Partial differentiation
Validation & Structure		
Logical connectives		
Quantifiers ("for all", "there exists")		
Boolean algebra and truth tables	Boolean algebra and truth tables	
Inference schemes (e.g., modus ponens, modus tollens)	Inference schemes (e.g., modus ponens, modus tollens)	
Direct deductive proofs		
Indirect proofs and proof by contradiction		
Proof by mathematical induction	Proof by mathematical induction	
Consistency and independence of axiom systems	Consistency and independence of axiom systems	
Sets, set notation, and set combinations		
Equivalence relations, partitions, and classes	Equivalence relations, partitions, and classes	
Groups	Groups	Groups
Fields	Fields	Fields
Linear (vectors) spaces	Linear (vectors) spaces	Linear (vectors) spaces
Subgroups, subspaces, etc.	Subgroups, subspaces, etc.	
Other axiomatic systems	Other axiomatic systems	Other axiomatic systems
Isomorphism	Isomorphism	Isomorphism
Homomorphism	Homomorphism	Homomorphism
Other Content		
Informatics	Informatics	
Special application of mathematics	Special application of mathematics	
	Problem solving heuristics	Problem solving heuristics
Non-mathematical science content		
Non-mathematical content other than science		

Appendix D
Topics Not Addressed By Any Economy
Mathematics

APPENDIX D (CONTINUED): TOPICS NOT ADDRESSES BY ANY ECONOMY: SCIENCE

None of the economies' standards addressed the following mathematics topics in their corresponding grade level standards. The table below shows some topics did not surface in any grade span, such as "Genetic Engineering." Others did not surface in one or two grade spans but did in the other(s), such as "Ice Forms," which did not appear in any grade 1-4 standards but did appear in both grade 5-6 and grade 7-10 standards.

The list below is an unfiltered, comprehensive list of all unaddressed topics at each grade span. Even topics one would not expect certain grade level standards to cover have been included. For instance, it would be quite unusual to find *Genetic Engineering* in standards from grade span 1-4, but we have listed it below to confirm no Economies' standards addressed it in grades 1-4.

GRADES 1-4 10 Economies	**GRADES 5-6** 10 Economies	**GRADES 7-10** 9 Economies
Earth Sciences		
Ice forms		
Evolution of the universe		
Life Sciences		
Biochemical processes in cells		
Population genetics, biotechnology	Population genetics, biotechnology	
Biochemistry of genetics	Biochemistry of genetics	
Genetic engineering	Genetic engineering	Genetic engineering
Physical Sciences		
Formulas/Equations/Nomenclature, Stoichiometry	Formulas/Equations/Nomenclature, Stoichiometry	
Work, Power, Simple machines		
	Kinetic-molecular theory	
Quantum theory & fundamental particles	Quantum theory & fundamental particles	Quantum theory & fundamental particles
Law of Conservation of Matter		
Explanations of chemical changes	Explanations of chemical changes	
Determinants/trends of chemical reactivity	Determinants/trends of chemical reactivity	
Energy and chemical change	Energy and chemical change	
Calorimetry, exothermic/endothermic reactions		
First law of thermodynamics		
Second law of thermodynamics	Second law of thermodynamics	
Organic & biochemical changes		
Nuclear chemistry	Nuclear chemistry	
Relativity theory	Relativity theory	Relativity theory
Science, Technology, & Mathematics		
	Mathematics, technology influence on science	
Science & Other Disciplines		
Science and Other Disciplines	Science and Other Disciplines	

APPENDIX E: INDIVIDUAL ECONOMY PORTRAITS
MATHEMATICS

The following individual economy profiles show the specific topics addressed by each economy's standards in the corresponding grade spans. The third column, labeled "Core," denotes with the word "YES" the topics included in the set of common topics. Those topics not included in this "Core" are denoted with the word "NO". Five economies marked with an asterisk (*) are examples of high performing economies on PISA and TIMSS.

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
1	**Numbers**	**NO**						
2	**Whole Numbers**	**NO**						
3	Meaning	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
4	Operations	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
5	Properties of Operations	**NO**	**X**		**X**		**X**	
6	**Fractions & Decimals**	**NO**						
7	Common Fractions	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
8	Decimal Fractions	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
9	Relationships of Common & Decimal Fractions	**YES**	**X**	**X**	**X**	**X**	**X**	
10	Percentages	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
11	Properties of Common & Decimal Fractions	**NO**					**X**	
12	**Integer, Rational & Real Numbers**	**NO**						
13	Negative Numbers, Integers & Their Properties	**NO**						
14	Rational Numbers & Their Properties	**NO**						
15	Real Numbers, Their Subsets & Properties	**NO**	**X**	**X**	**X**		**X**	
16	**Other Numbers & Number Concepts**	**NO**						
17	Binary Arithmetic and/or Other Number Bases	**NO**						
18	Exponents, Roots & Radicals	**NO**						
19	Real exponents	**NO**						
20	Complex Numbers & Their Properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
21	Number Theory	**NO**						
22	Systematic Counting	**NO**						
23	Matrices	**NO**						
24	**Estimation & Number Sense Concepts**	**NO**	**X**	**X**				
25	Estimating Quantity & Size	**NO**	**X**	**X**	**X**	**X**	**X**	
26	Rounding & Significant Figures	**YES**	**X**	**X**	**X**	**X**	**X**	
27	Estimating Computations	**NO**						
28	Exponents & Orders of Magnitude	**NO**						
29	**Measurement**	**NO**						
30	**Measurement Units**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
31	Concept of measure (including non-standard units)	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
32	Standard units (including metric system)	**NO**	**X**	**X**			**X**	**X**
33	Use of appropriate instruments	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
34	Common measures (Length; area; volume; time; calendar; money; temp; mass; weight; angles)	**NO**	**X**	**X**	**X**	**X**	**X**	
35	Quotients and products of units (km/h, m/s, etc.)	**NO**						
36	Dimensional analysis / Cancellation of Units	**NO**						
37	**Computations & Properties of Length, Perimeter, Area & Volume**	**YES**	**X**	**X**	**X**	**X**	**X**	
38	Computations, formulas and properties of length and perimeter	**YES**	**X**	**X**	**X**	**X**	**X**	**X**

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
39	Computations, formulas and properties of area	**NO**		**X**				
40	Computations, formulas and properties of surface area	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
41	Computations, formulas and properties of volumes	**NO**						
42	**Estimation & Error**	**YES**	**X**	**X**	**X**	**X**	**X**	
43	Estimation of measurement and errors of measurement	**NO**						
44	Precision and accuracy of measurement	**NO**						
45	**Geometry: Position, Visualization & Shape**	**NO**						
46	**1-D & 2-D Coordinate Geometry**	**NO**	**X**		**X**	**X**		**X**
47	Line and coordinate graphs	**NO**						
48	Equations of lines in a plane	**NO**						
49	Conic sections and their equations	**NO**						
50	**2-D Geometry: Basics**	**YES**	**X**	**X**	**X**	**X**		
51	Points, lines, segments, half-lines, and rays	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
52	Angles	**YES**	**X**	**X**	**X**	**X**	**X**	
53	Parallelism and perpendicularity	**NO**	**X**					
54	**2-D Geometry: Polygons & Circles**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
55	Triangles and quadrilaterals: their classification and properties	**NO**						

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
56	Pythagorean Theorem and its applications	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
57	Other polygons and their properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
58	Circles and their properties	**NO**						
59	**3-D Geometry**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
60	3-Dimensional shapes and surfaces and their properties	**NO**			**X**		**X**	
61	Planes and lines in space	**YES**	**X**	**X**	**X**	**X**	**X**	
62	Spatial perception and visualization	**NO**						
63	Coordinate systems in three dimensions	**NO**						
64	Equations of lines, planes and surfaces in space	**NO**						
65	**Vectors**	**NO**						
66	**Simple Topology**	**NO**						
67	**Geometry: Symmetry, Congruence & Similarity**	**NO**						
68	**Geometry: Transformations**	**NO**		**X**		**X**	**X**	**X**
69	Patterns, tessellations, friezes, stencils, etc	**YES**	**X**	**X**	**X**	**X**		
70	Symmetry	**NO**		**X**	**X**			**X**
71	Transformations	**NO**						
72	**Congruence & Similarity**	**NO**		**X**	**X**			
73	Congruence	**NO**			**X**			**X**
74	Similarities (similar triangles and their properties; other similar figures and properties)	**NO**		**X**	**X**	**X**		

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
75	**Constructions w/ Straightedge & Compass**	**NO**						
76	**Proportionality**	**NO**						
77	**Proportionality Concepts**	**NO**		**X**	**X**	**X**	**X**	
78	Meaning of ratio and proportion	**NO**		**X**	**X**			
79	Direct and inverse proportion	**NO**						
80	**Proportionality Problems**	**NO**		**X**		**X**		
81	Solving proportional equations	**NO**	**X**		**X**	**X**		
82	Solving practical problems with proportionality	**YES**	**X**		**X**	**X**		**X**
83	Scales (maps and plans)	**NO**			**X**			
84	Proportion based on similarity	**NO**						
85	**Slope & Simple Trigonometry**	**NO**						
86	Slope and gradient in straight line graphs	**NO**						
87	Trigonometry of right triangles	**NO**						
88	**Linear Interpolation & Extrapolation**	**NO**						
89	**Functions, Relations, & Equations**	**NO**						
90	**Patterns, Relations & Functions**	**YES**		**X**	**X**	**X**		**X**
91	Number patterns	**NO**						
92	Relations and their properties	**NO**						
93	Functions and their properties	**NO**						
94	Representation of relations and functions	**NO**						
95	Families of functions (graphs and properties)	**NO**						
96	Operations on functions	**NO**						

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
97	Related functions (inverse, derivative, etc.)	**NO**						
98	Relationship of functions and equations	**NO**						
99	Interpretation of function graphs	**NO**						
100	Functions of several variables	**NO**						
101	Recursion	**NO**						
102	Linear Functions	**NO**						
103	Quadratic Functions	**NO**						
104	Logarithmic and Exponential Functions	**NO**						
105	Trigonometric Functions	**NO**						
106	**Equations & Formulas**	**YES**	**X**	**X**	**X**	**X**	**X**	
107	Representation of numerical situations by equations	**YES**	**X**	**X**	**X**	**X**		
108	Informal solution of simple equations	**NO**				**X**		
109	Evaluating expressions	**NO**	**X**			**X**	**X**	
110	Equivalent expressions (including factorization and simplification)	**NO**	**X**		**X**	**X**		
111	Linear equations and their formal (closed) solutions	**NO**						
112	Quadratic equations and their formal (closed) solutions	**NO**						
113	Polynomial equations and their solutions	**NO**						
114	Trigonometrical equations and identities	**NO**						
115	Logarithmic and exponential equations and their solutions	**NO**						

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
116	Solution of equations reducing to quadratics, radical equations, absolute value equations, etc.	**NO**						
117	Other solution methods for equations (e.g., successive approximation)	**NO**						
118	Inequalities and/or their graphical representation	**NO**						
119	Systems of equations and their solutions (including matrix solutions)	**NO**						
120	Systems of inequalities	**NO**	**X**		**X**	**X**	**X**	
121	Substituting into or rearranging formulas	**NO**						
122	General equation of the second degree and its interpretation	**NO**						
123	**Trigonometry and Analytic Geometry**	**NO**						
124	Angle measures: radians and degrees	**NO**						
125	Law of sines and cosines	**NO**						
126	Unit circle and trigonometric functions	**NO**						
127	Parametric equations	**NO**						
128	Polar coordinates	**NO**						
129	Polar equations and their graphs	**NO**						
130	**Data Representation, Probability, & Statistics**	**NO**						
131	**Data Representation & Analysis**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
132	Collecting data from experiments and simple surveys	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
133	Representing data	**YES**	**X**	**X**	**X**	**X**	**X**	**X**

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
134	Interpreting tables, charts, plots, graphs	**NO**	**X**			**X**		
135	Kinds of scales (nominal, ordinal, interval, ratio)	**YES**	**X**	**X**	**X**	**X**	**X**	
136	Measures of central tendency	**NO**						
137	Measures of dispersion	**NO**						
138	Sampling, randomness, and bias related to data samples	**NO**						**X**
139	Prediction and inferences from data	**NO**						
140	Fitting lines and curves to data	**NO**						
141	Correlations and other measures of relations	**NO**						**X**
142	Use and misuse of statistics	**NO**						
143	**Uncertainty & Probability**	**NO**		**X**				**X**
144	Informal likelihoods and the vocabulary of likelihoods	**NO**		**X**				**X**
145	Numerical probability and probability models	**NO**		**X**				
146	Counting principles	**NO**						
147	Mutually exclusive events	**NO**						
148	Conditional probability and independent events	**NO**						
149	Bayes' Theorem	**NO**						
150	Contingency tables	**NO**						
151	Probability distributions for discrete random variables	**NO**						
152	Probability distributions for continuous random variables	**NO**						

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
153	Expectation and the algebra of expectations	**NO**						
154	Sampling (distributions and populations)	**NO**						
155	Estimation of population parameters	**NO**						
156	Hypothesis testing	**NO**						
157	Confidence intervals	**NO**						
158	Bivariate distributions	**NO**						
159	Markov processes	**NO**						
160	Monte Carlo methods and computer simulations	**NO**						
161	**Elementary Analysis**	**NO**						
162	**Infinite Processes**	**NO**						
163	Arithmetic and geometric sequences	**NO**						
164	Arithmetic and geometric series	**NO**						
165	Binomial Theorem	**NO**						
166	Other sequences and series	**NO**						
167	Limits and convergence of series	**NO**						
168	Limits and convergence of functions	**NO**						
169	Continuity	**NO**						
170	**Change**	**NO**						
171	Growth and decay	**NO**						
172	Differentiation	**NO**						
173	Integration	**NO**						
174	Differential equations	**NO**						
175	Partial differentiation	**NO**						

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
176	**Validation & Structure**	**NO**						
177	**Validation & Justification**	**NO**						
178	Logical connectives	**NO**						
179	Quantifiers ("for all", "there exists")	**NO**						
180	Boolean algebra and truth tables	**NO**						
181	Conditional statements; equivalence of statements (including converse, contrapositive, and inverse)	**NO**						
182	Inference schemes (e.g., *modus ponens*, *modus tollens*)	**NO**						
183	Direct deductive proofs	**NO**						
184	Indirect proofs and proof by contradiction	**NO**						
185	Proof by mathematical induction	**NO**						
186	Consistency and independence of axiom systems	**NO**						
187	**Structuring and Abstracting**	**NO**						
188	Sets, set notation, and set combinations	**NO**						
189	Equivalence relations, partitions, and classes	**NO**						
190	Groups	**NO**						
191	Fields	**NO**						
192	Linear (vectors) spaces	**NO**						
193	Subgroups, subspaces, etc.	**NO**						
194	Other axiomatic systems	**NO**						
195	Isomorphism	**NO**						

Grade Spans 1-6								
	Text	**Core >66%)**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
196	Homomorphism	**NO**						
197	**Other Content**	**NO**						
198	**Informatics (operation of computers, flow charts, learning a programming language, programs, algorithms with applications to the computer, complexity)**	**NO**	**X**					
199	**History and nature of mathematics**	**NO**						
200	**Special application of mathematics (kinematics, Newtonian mechanics, population growth, networks, linear programming, critical path analysis, examples from economics)**	**NO**		**X**				
201	**Problem solving heuristics**	**NO**						
202	**Non-mathematical science content**	**NO**						
203	**Non-mathematical content other than science**	**NO**						

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
1.	**Numbers**	**NO**						
2.	**Whole Numbers**	**NO**		**X**				
3.	Meaning	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
4.	Operations	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
5.	Properties of Operations	**NO**	**X**	**X**	**X**	**X**		**X**
6.	**Fractions & Decimals**	**NO**						
7.	Common Fractions	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
8.	Decimal Fractions	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
9.	Relationships of Common & Decimal Fractions	**YES**	**X**	**X**		**X**	**X**	**X**
10.	Percentages	**YES**		**X**		**X**	**X**	**X**
11.	Properties of Common & Decimal Fractions	**NO**			**X**			
12.	**Integer, Rational & Real Numbers**	**NO**						
13.	Negative Numbers, Integers & Their Properties	**NO**					**X**	**X**
14.	Rational Numbers & Their Properties	**NO**				**X**		
15.	Real Numbers, Their Subsets & Properties	**NO**						
16.	**Other Numbers & Number Concepts**	**NO**						
17.	Binary Arithmetic and/or Other Number Bases	**NO**						
18.	Exponents, Roots & Radicals	**NO**						
19.	Real exponents	**NO**						

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
20.	Complex Numbers & Their Properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
21.	Number Theory	**NO**						
22.	Systematic Counting	**NO**						
23.	Matrices	**NO**	**X**					
24.	**Estimation & Number Sense Concepts**	**NO**		**X**		**X**	**X**	**X**
25.	Estimating Quantity & Size	**NO**	**X**	**X**				**X**
26.	Rounding & Significant Figures	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
27.	Estimating Computations	**NO**						
28.	Exponents & Orders of Magnitude	**NO**						
29.	**Measurement**	**NO**						
30.	**Measurement Units**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
31.	Concept of measure (including non-standard units)	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
32.	Standard units (including metric system)	**NO**	**X**		**X**	**X**		
33.	Use of appropriate instruments	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
34.	Common measures (Length; area; volume; time; calendar; money; temp; mass; weight; angles)	**NO**						
35.	Quotients and products of units (km/h, m/s, etc.)	**NO**				**X**		
36.	Dimensional analysis / Cancellation of Units	**NO**						
37.	**Computations & Properties of Length, Perimeter, Area & Volume**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
38.	Computations, formulas and properties of length and perimeter	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
39.	Computations, formulas and properties of area	**NO**		**X**		**X**	**X**	
40.	Computations, formulas and properties of surface area	**YES**		**X**	**X**		**X**	**X**
41.	Computations, formulas and properties of volumes	**NO**						
42.	**Estimation & Error**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
43.	Estimation of measurement and errors of measurement	**NO**	**X**		**X**			
44.	Precision and accuracy of measurement	**NO**						
45.	**Geometry: Position, Visualization & Shape**	**NO**						
46.	**1-D & 2-D Coordinate Geometry**	**NO**	**X**				**X**	**X**
47.	Line and coordinate graphs	**NO**						**X**
48.	Equations of lines in a plane	**NO**						
49.	Conic sections and their equations	**NO**				**X**		
50.	**2-D Geometry: Basics**	**YES**	**X**	**X**		**X**	**X**	**X**
51.	Points, lines, segments, half-lines, and rays	**YES**	**X**		**X**		**X**	**X**
52.	Angles	**YES**	**X**		**X**		**X**	**X**
53.	Parallelism and perpendicularity	**NO**			**X**	**X**		**X**
54.	**2-D Geometry: Polygons & Circles**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
55.	Triangles and quadrilaterals: their classification and properties	**NO**						

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
56.	Pythagorean Theorem and its applications	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
57.	Other polygons and their properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
58.	Circles and their properties	**NO**						**X**
59.	**3-D Geometry**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
60.	3-Dimensional shapes and surfaces and their properties	**NO**						
61.	Planes and lines in space	**YES**		**X**	**X**	**X**	**X**	**X**
62.	Spatial perception and visualization	**NO**						
63.	Coordinate systems in three dimensions	**NO**						
64.	Equations of lines, planes and surfaces in space	**NO**						
65.	**Vectors**	**NO**						
66.	**Simple Topology**	**NO**						
67.	**Geometry: Symmetry, Congruence & Similarity**	**NO**						
68.	**Geometry: Transformations**	**NO**	**X**		**X**		**X**	**X**
69.	Patterns, tessellations, friezes, stencils, etc	**YES**	**X**	**X**	**X**		**X**	**X**
70.	Symmetry	**NO**	**X**		**X**		**X**	**X**
71.	Transformations	**NO**						
72.	**Congruence & Similarity**	**NO**	**X**					**X**
73.	Congruence	**NO**					**X**	
74.	Similarities (similar triangles and their properties; other similar figures and properties)	**NO**	**X**				**X**	

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
75.	**Constructions w/ Straightedge & Compass**	**NO**						
76.	**Proportionality**	**NO**						
77.	**Proportionality Concepts**	**NO**	**X**	**X**			**X**	**X**
78.	Meaning of ratio and proportion	**NO**					**X**	
79.	Direct and inverse proportion	**NO**						
80.	**Proportionality Problems**	**NO**						
81.	Solving proportional equations	**NO**					**X**	
82.	Solving practical problems with proportionality	**YES**		**X**	**X**	**X**	**X**	
83.	Scales (maps and plans)	**NO**						
84.	Proportion based on similarity	**NO**						
85.	**Slope & Simple Trigonometry**	**NO**						
86.	Slope and gradient in straight line graphs	**NO**						
87.	Trigonometry of right triangles	**NO**						
88.	**Linear Interpolation & Extrapolation**	**NO**						
89.	**Functions, Relations, & Equations**	**NO**						
90.	**Patterns, Relations & Functions**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
91.	Number patterns	**NO**						
92.	Relations and their properties	**NO**						
93.	Functions and their properties	**NO**	**X**					**X**
94.	Representation of relations and functions	**NO**						

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
95.	Families of functions (graphs and properties)	**NO**						
96.	Operations on functions	**NO**						
97.	Related functions (inverse, derivative, etc.)	**NO**						
98.	Relationship of functions and equations	**NO**						
99.	Interpretation of function graphs	**NO**						
100.	Functions of several variables	**NO**						
101.	Recursion	**NO**						
102.	Linear Functions	**NO**						
103.	Quadratic Functions	**NO**						
104.	Logarithmic and Exponential Functions	**NO**						
105.	Trigonometric Functions	**NO**						
106.	**Equations & Formulas**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
107.	Representation of numerical situations by equations	**YES**	**X**	**X**	**X**		**X**	**X**
108.	Informal solution of simple equations	**NO**						**X**
109.	Evaluating expressions	**NO**						
110.	Equivalent expressions (including factorization and simplification)	**NO**	**X**			**X**	**X**	**X**
111.	Linear equations and their formal (closed) solutions	**NO**						
112.	Quadratic equations and their formal (closed) solutions	**NO**						

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
113.	Polynomial equations and their solutions	**NO**						
114.	Trigonometrical equations and identities	**NO**						
115.	Logarithmic and exponential equations and their solutions	**NO**						
116.	Solution of equations reducing to quadratics, radical equations, absolute value equations, etc.	**NO**						
117.	Other solution methods for equations (e.g., successive approximation)	**NO**						
118.	Inequalities and/or their graphical representation	**NO**						
119.	Systems of equations and their solutions (including matrix solutions)	**NO**						
120.	Systems of inequalities	**NO**	**X**	**X**			**X**	**X**
121.	Substituting into or rearranging formulas	**NO**						
122.	General equation of the second degree and its interpretation	**NO**						
123.	**Trigonometry and Analytic Geometry**	**NO**						
124.	Angle measures: radians and degrees	**NO**						
125.	Law of sines and cosines	**NO**						
126.	Unit circle and trigonometric functions	**NO**						
127.	Parametric equations	**NO**						

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
128.	Polar coordinates	**NO**						
129.	Polar equations and their graphs	**NO**						
130.	**Data Representation, Probability, & Statistics**	**NO**						
131.	**Data Representation & Analysis**	**YES**		**X**	**X**	**X**	**X**	**X**
132.	Collecting data from experiments and simple surveys	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
133.	Representing data	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
134.	Interpreting tables, charts, plots, graphs	**NO**						
135.	Kinds of scales (nominal, ordinal, interval, ratio)	**YES**	**X**	**X**			**X**	
136.	Measures of central tendency	**NO**	**X**	**X**	**X**			
137.	Measures of dispersion	**NO**						
138.	Sampling, randomness, and bias related to data samples	**NO**						
139.	Prediction and inferences from data	**NO**						
140.	Fitting lines and curves to data	**NO**						
141.	Correlations and other measures of relations	**NO**					**X**	
142.	Use and misuse of statistics	**NO**						
143.	**Uncertainty & Probability**	**NO**	**X**		**X**	**X**	**X**	**X**
144.	Informal likelihoods and the vocabulary of likelihoods	**NO**	**X**				**X**	**X**
145.	Numerical probability and probability models	**NO**			**X**			**X**

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
146.	Counting principles	**NO**						
147.	Mutually exclusive events	**NO**						
148.	Conditional probability and independent events	**NO**						
149.	Bayes' Theorem	**NO**						
150.	Contingency tables	**NO**						
151.	Probability distributions for discrete random variables	**NO**						
152.	Probability distributions for continuous random variables	**NO**						
153.	Expectation and the algebra of expectations	**NO**						
154.	Sampling (distributions and populations)	**NO**						
155.	Estimation of population parameters	**NO**						
156.	Hypothesis testing	**NO**						
157.	Confidence intervals	**NO**						
158.	Bivariate distributions	**NO**						
159.	Markov processes	**NO**						
160.	Monte Carlo methods and computer simulations	**NO**						
161.	**Elementary Analysis**	**NO**						
162.	**Infinite Processes**	**NO**						
163.	Arithmetic and geometric sequences	**NO**						
164.	Arithmetic and geometric series	**NO**						
165.	Binomial Theorem	**NO**						

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
166.	Other sequences and series	**NO**						
167.	Limits and convergence of series	**NO**						
168.	Limits and convergence of functions	**NO**						
169.	Continuity	**NO**						
170.	**Change**	**NO**						
171.	Growth and decay	**NO**						
172.	Differentiation	**NO**						
173.	Integration	**NO**						
174.	Differential equations	**NO**						
175.	Partial differentiation	**NO**						
176.	**Validation & Structure**	**NO**						
177.	**Validation & Justification**	**NO**						
178.	Logical connectives	**NO**						
179.	Quantifiers ("for all", "there exists")	**NO**						
180.	Boolean algebra and truth tables	**NO**			**X**			
181.	Conditional statements; equivalence of statements (including converse, contrapositive, and inverse)	**NO**						
182.	Inference schemes (e.g., *modus ponens*, *modus tollens*)	**NO**						
183.	Direct deductive proofs	**NO**						
184.	Indirect proofs and proof by contradiction	**NO**						
185.	Proof by mathematical induction	**NO**						
186.	Consistency and independence of axiom systems	**NO**						

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
187.	**Structuring and Abstracting**	**NO**						
188.	Sets, set notation, and set combinations	**NO**						
189.	Equivalence relations, partitions, and classes	**NO**						
190.	Groups	**NO**						
191.	Fields	**NO**						
192.	Linear (vectors) spaces	**NO**						
193.	Subgroups, subspaces, etc.	**NO**						
194.	Other axiomatic systems	**NO**						
195.	Isomorphism	**NO**						
196.	Homomorphism	**NO**						
197.	**Other Content**	**NO**						
198.	**Informatics (operation of computers, flow charts, learning a programming language, programs, algorithms with applications to the computer, complexity)**	**NO**						
199.	**History and nature of mathematics**	**NO**						
200.	**Special application of mathematics (kinematics, Newtonian mechanics, population growth, networks, linear programming, critical path analysis, examples from economics)**	**NO**			**X**			

Grade Spans 1-6								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
201.	**Problem solving heuristics**	**NO**						
202.	**Non-mathematical science content**	**NO**						
203.	**Non-mathematical content other than science**	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
1)	**Numbers**	**NO**						
2)	**Whole Numbers**	**NO**						
3)	Meaning	**NO**		**X**	**X**			**X**
4)	Operations	**NO**			**X**			**X**
5)	Properties of Operations	**NO**			**X**			**X**
6)	**Fractions & Decimals**	**NO**						
7)	Common Fractions	**NO**			**X**			**X**
8)	Decimal Fractions	**NO**		**X**				**X**
9)	Relationships of Common & Decimal Fractions	**NO**		**X**	**X**	**X**		**X**
10)	Percentages	**YES**	**X**		**X**	**X**		**X**
11)	Properties of Common & Decimal Fractions	**NO**			**X**			
12)	**Integer, Rational & Real Numbers**	**NO**						
13)	Negative Numbers, Integers & Their Properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
14)	Rational Numbers & Their Properties	**NO**		**X**		**X**		**X**
15)	Real Numbers, Their Subsets & Properties	**YES**	**X**	**X**	**X**	**X**	**X**	
16)	**Other Numbers & Number Concepts**	**NO**						
17)	Binary Arithmetic and/or Other Number Bases	**NO**	**X**	**X**				
18)	Exponents, Roots & Radicals	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
19)	Real exponents	**NO**						
20)	Complex Numbers & Their Properties	**YES**	**X**	**X**	**X**	**X**		**X**

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
21)	Number Theory	**NO**				**X**		
22)	Systematic Counting	**NO**						
23)	Matrices	**NO**						
24)	**Estimation & Number Sense Concepts**	**NO**		**X**	**X**			
25)	Estimating Quantity & Size	**YES**	**X**	**X**	**X**	**X**		**X**
26)	Rounding & Significant Figures	**NO**	**X**			**X**		
27)	Estimating Computations	**NO**	**X**		**X**			
28)	Exponents & Orders of Magnitude	**NO**						
29)	**Measurement**	**NO**						
30)	**Measurement Units**	**NO**	**X**					
31)	Concept of measure (including non-standard units)	**NO**	**X**			**X**		
32)	Standard units (including metric system)	**NO**				**X**		**X**
33)	Use of appropriate instruments	**YES**	**X**	**X**				**X**
34)	Common measures (Length; area; volume; time; calendar; money; temp; mass; weight; angles)	**NO**				**X**		
35)	Quotients and products of units (km/h, m/s, etc.)	**NO**			**X**			
36)	Dimensional analysis / Cancellation of Units	**NO**	**X**					**X**
37)	**Computations & Properties of Length, Perimeter, Area & Volume**	**YES**	**X**	**X**	**X**	**X**		**X**

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
38)	Computations, formulas and properties of length and perimeter	**YES**	**X**	**X**	**X**	**X**	**X**	
39)	Computations, formulas and properties of area	**YES**	**X**	**X**	**X**	**X**	**X**	
40)	Computations, formulas and properties of surface area	**YES**	**X**	**X**	**X**	**X**	**X**	
41)	Computations, formulas and properties of volumes	**NO**						
42)	**Estimation & Error**	**NO**	**X**					
43)	Estimation of measurement and errors of measurement	**NO**	**X**	**X**				
44)	Precision and accuracy of measurement	**NO**						
45)	**Geometry: Position, Visualization & Shape**	**NO**						
46)	**1-D & 2-D Coordinate Geometry**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
47)	Line and coordinate graphs	**NO**		**X**	**X**	**X**		
48)	Equations of lines in a plane	**NO**			**X**	**X**		
49)	Conic sections and their equations	**NO**				**X**		**X**
50)	**2-D Geometry: Basics**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
51)	Points, lines, segments, half-lines, and rays	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
52)	Angles	**YES**	**X**	**X**	**X**	**X**	**X**	
53)	Parallelism and perpendicularity	**NO**	**X**			**X**	**X**	**X**
54)	**2-D Geometry: Polygons & Circles**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
55)	Triangles and quadrilaterals: their classification and properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
56)	Pythagorean Theorem and its applications	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
57)	Other polygons and their properties	**YES**	**X**	**X**	**X**		**X**	**X**
58)	Circles and their properties	**NO**						
59)	**3-D Geometry**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
60)	3-Dimensional shapes and surfaces and their properties	**NO**					**X**	
61)	Planes and lines in space	**YES**	**X**	**X**	**X**		**X**	**X**
62)	Spatial perception and visualization	**NO**						
63)	Coordinate systems in three dimensions	**NO**						
64)	Equations of lines, planes and surfaces in space	**NO**						
65)	**Vectors**	**NO**						
66)	**Simple Topology**	**NO**						
67)	**Geometry: Symmetry, Congruence & Similarity**	**NO**						
68)	**Geometry: Transformations**	**NO**	**X**					**X**
69)	Patterns, tessellations, friezes, stencils, etc	**YES**	**X**		**X**	**X**	**X**	
70)	Symmetry	**YES**	**X**		**X**	**X**		**X**
71)	Transformations	**NO**						
72)	**Congruence & Similarity**	**YES**	**X**	**X**	**X**	**X**	**X**	
73)	Congruence	**YES**	**X**	**X**	**X**	**X**	**X**	
74)	Similarities (similar triangles and their properties; other similar figures and properties)	**YES**	**X**	**X**	**X**	**X**	**X**	

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
75)	**Constructions w/ Straightedge & Compass**	**NO**						
76)	**Proportionality**	**NO**						
77)	**Proportionality Concepts**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
78)	Meaning of ratio and proportion	**NO**				**X**	**X**	**X**
79)	Direct and inverse proportion	**NO**						
80)	**Proportionality Problems**	**NO**	**X**				**X**	
81)	Solving proportional equations	**YES**	**X**	**X**	**X**	**X**		**X**
82)	Solving practical problems with proportionality	**NO**				**X**		**X**
83)	Scales (maps and plans)	**YES**	**X**	**X**	**X**	**X**	**X**	
84)	Proportion based on similarity	**NO**						
85)	**Slope & Simple Trigonometry**	**NO**	**X**			**X**	**X**	
86)	Slope and gradient in straight line graphs	**NO**	**X**	**X**			**X**	**X**
87)	Trigonometry of right triangles	**NO**						
88)	**Linear Interpolation & Extrapolation**	**NO**						
89)	**Functions, Relations, & Equations**	**NO**						
90)	**Patterns, Relations & Functions**	**YES**	**X**		**X**	**X**		**X**
91)	Number patterns	**NO**			**X**			
92)	Relations and their properties	**YES**	**X**	**X**	**X**			**X**
93)	Functions and their properties	**YES**		**X**	**X**		**X**	**X**
94)	Representation of relations and functions	**NO**						
95)	Families of functions (graphs and	**NO**	**X**	**X**	**X**		**X**	

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
	properties)							
96)	Operations on functions	**NO**						
97)	Related functions (inverse, derivative, etc.)	**NO**		**X**	**X**	**X**	**X**	
98)	Relationship of functions and equations	**YES**	**X**	**X**	**X**	**X**	**X**	
99)	Interpretation of function graphs	**NO**						
100)	Functions of several variables	**NO**						
101)	Recursion	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
102)	Linear Functions	**NO**		**X**	**X**	**X**	**X**	
103)	Quadratic Functions	**NO**						
104)	Logarithmic and Exponential Functions	**NO**						
105)	Trigonometric Functions	**NO**						
106)	**Equations & Formulas**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
107)	Representation of numerical situations by equations	**NO**		**X**			**X**	
108)	Informal solution of simple equations	**YES**	**X**	**X**	**X**	**X**		
109)	Evaluating expressions	**YES**	**X**	**X**	**X**	**X**	**X**	
110)	Equivalent expressions (including factorization and simplification)	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
111)	Linear equations and their formal (closed) solutions	**NO**		**X**	**X**	**X**	**X**	
112)	Quadratic equations and their formal (closed) solutions	**NO**	**X**	**X**	**X**			
113)	Polynomial equations and their solutions	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
114)	Trigonometrical equations and identities	**NO**						
115)	Logarithmic and exponential equations and their solutions	**NO**				**X**		
116)	Solution of equations reducing to quadratics, radical equations, absolute value equations, etc.	**NO**						
117)	Other solution methods for equations (e.g., successive approximation)	**NO**	**X**	**X**	**X**	**X**		
118)	Inequalities and/or their graphical representation	**YES**	**X**	**X**	**X**	**X**	**X**	
119)	Systems of equations and their solutions (including matrix solutions)	**NO**		**X**				
120)	Systems of inequalities	**NO**	**X**		**X**	**X**		**X**
121)	Substituting into or rearranging formulas	**NO**			**X**			
122)	General equation of the second degree and its interpretation	**NO**						
123)	**Trigonometry and Analytic Geometry**	**NO**						
124)	Angle measures: radians and degrees	**NO**						
125)	Law of sines and cosines	**NO**						
126)	Unit circle and trigonometric functions	**NO**						
127)	Parametric equations	**NO**	**X**					
128)	Polar coordinates	**NO**						
129)	Polar equations and their graphs	**NO**						
130)	**Data Representation, Probability, &**	**NO**	**X**					

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
	Statistics							
131)	**Data Representation & Analysis**	**YES**	**X**	**X**		**X**		**X**
132)	Collecting data from experiments and simple surveys	**YES**	**X**	**X**	**X**	**X**		**X**
133)	Representing data	**YES**	**X**	**X**	**X**	**X**		**X**
134)	Interpreting tables, charts, plots, graphs	**NO**						
135)	Kinds of scales (nominal, ordinal, interval, ratio)	**YES**	**X**	**X**	**X**	**X**		**X**
136)	Measures of central tendency	**NO**		**X**	**X**			**X**
137)	Measures of dispersion	**NO**			**X**			**X**
138)	Sampling, randomness, and bias related to data samples	**NO**	**X**			**X**		**X**
139)	Prediction and inferences from data	**NO**						
140)	Fitting lines and curves to data	**NO**						
141)	Correlations and other measures of relations	**YES**	**X**		**X**	**X**		**X**
142)	Use and misuse of statistics	**NO**						
143)	**Uncertainty & Probability**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
144)	Informal likelihoods and the vocabulary of likelihoods	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
145)	Numerical probability and probability models	**NO**	**X**	**X**			**X**	
146)	Counting principles	**NO**						
147)	Mutually exclusive events	**NO**						
148)	Conditional probability and independent events	**NO**						
149)	Bayes' Theorem	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
150)	Contingency tables	**NO**						**X**
151)	Probability distributions for discrete random variables	**NO**						**X**
152)	Probability distributions for continuous random variables	**NO**	**X**					
153)	Expectation and the algebra of expectations	**NO**						**X**
154)	Sampling (distributions and populations)	**NO**						
155)	Estimation of population parameters	**NO**						
156)	Hypothesis testing	**NO**						
157)	Confidence intervals	**NO**						
158)	Bivariate distributions	**NO**						
159)	Markov processes	**NO**						
160)	Monte Carlo methods and computer simulations	**NO**						
161)	**Elementary Analysis**	**NO**						
162)	**Infinite Processes**	**NO**	**X**		**X**			
163)	Arithmetic and geometric sequences	**NO**			**X**			
164)	Arithmetic and geometric series	**NO**						
165)	Binomial Theorem	**NO**						
166)	Other sequences and series	**NO**						
167)	Limits and convergence of series	**NO**						
168)	Limits and convergence of functions	**NO**						
169)	Continuity	**NO**						
170)	**Change**	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
171)	Growth and decay	**NO**						
172)	Differentiation	**NO**						
173)	Integration	**NO**						
174)	Differential equations	**NO**						
175)	Partial differentiation	**NO**						
176)	**Validation & Structure**	**NO**	**X**	**X**			**X**	
177)	**Validation & Justification**	**NO**				**X**		
178)	Logical connectives	**NO**			**X**			
179)	Quantifiers ("for all", "there exists")	**NO**						
180)	Boolean algebra and truth tables	**NO**		**X**	**X**			
181)	Conditional statements; equivalence of statements (including converse, contrapositive, and inverse)	**NO**						
182)	Inference schemes (e.g., *modus ponens, modus tollens*)	**NO**	**X**	**X**				
183)	Direct deductive proofs	**NO**						
184)	Indirect proofs and proof by contradiction	**NO**						
185)	Proof by mathematical induction	**NO**						
186)	Consistency and independence of axiom systems	**NO**						
187)	**Structuring and Abstracting**	**NO**		**X**		**X**		
188)	Sets, set notation, and set combinations	**NO**						
189)	Equivalence relations, partitions, and classes	**NO**						
190)	Groups	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
191)	Fields	**NO**						
192)	Linear (vectors) spaces	**NO**						
193)	Subgroups, subspaces, etc.	**NO**						
194)	Other axiomatic systems	**NO**						
195)	Isomorphism	**NO**						
196)	Homomorphism	**NO**						
197)	**Other Content**	**NO**						
198)	**Informatics (operation of computers, flow charts, learning a programming language, programs, algorithms with applications to the computer, complexity)**	**NO**	**X**		**X**			
199)	**History and nature of mathematics**	**NO**						
200)	**Special application of mathematics (kinematics, Newtonian mechanics, population growth, networks, linear programming, critical path analysis, examples from economics)**	**NO**						
201)	**Problem solving heuristics**	**NO**		**X**				
202)	**Non-mathematical science content**	**NO**						
203)	**Non-mathematical content other than science**	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
1.	**Numbers**	**NO**						
2.	**Whole Numbers**	**NO**		**X**				
3.	Meaning	**NO**	**X**	**X**				**X**
4.	Operations	**NO**		**X**	**X**			**X**
5.	Properties of Operations	**NO**	**X**					**X**
6.	**Fractions & Decimals**	**NO**						
7.	Common Fractions	**NO**	**X**	**X**	**X**		**X**	**X**
8.	Decimal Fractions	**NO**	**X**	**X**	**X**		**X**	**X**
9.	Relationships of Common & Decimal Fractions	**NO**		**X**	**X**		**X**	**X**
10.	Percentages	**YES**	**X**	**X**	**X**	**X**		**X**
11.	Properties of Common & Decimal Fractions	**NO**			**X**			**X**
12.	**Integer, Rational & Real Numbers**	**NO**						
13.	Negative Numbers, Integers & Their Properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
14.	Rational Numbers & Their Properties	**NO**	**X**	**X**	**X**	**X**		**X**
15.	Real Numbers, Their Subsets & Properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
16.	**Other Numbers & Number Concepts**	**NO**						
17.	Binary Arithmetic and/or Other Number Bases	**NO**						
18.	Exponents, Roots & Radicals	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
19.	Real exponents	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
20.	Complex Numbers & Their Properties	**YES**	**X**	**X**	**X**			**X**
21.	Number Theory	**NO**						**X**
22.	Systematic Counting	**NO**						
23.	Matrices	**NO**						
24.	**Estimation & Number Sense Concepts**	**NO**	**X**		**X**		**X**	**X**
25.	Estimating Quantity & Size	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
26.	Rounding & Significant Figures	**NO**	**X**	**X**	**X**	**X**	**X**	**X**
27.	Estimating Computations	**NO**	**X**		**X**	**X**	**X**	
28.	Exponents & Orders of Magnitude	**NO**						
29.	**Measurement**	**NO**						
30.	**Measurement Units**	**NO**			**X**			
31.	Concept of measure (including non-standard units)	**NO**	**X**	**X**	**X**	**X**		
32.	Standard units (including metric system)	**NO**			**X**			
33.	Use of appropriate instruments	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
34.	Common measures (Length; area; volume; time; calendar; money; temp; mass; weight; angles)	**NO**	**X**	**X**	**X**			
35.	Quotients and products of units (km/h, m/s, etc.)	**NO**			**X**		**X**	
36.	Dimensional analysis / Cancellation of Units	**NO**			**X**			

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
37.	**Computations & Properties of Length, Perimeter, Area & Volume**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
38.	Computations, formulas and properties of length and perimeter	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
39.	Computations, formulas and properties of area	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
40.	Computations, formulas and properties of surface area	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
41.	Computations, formulas and properties of volumes	**NO**			**X**		**X**	
42.	**Estimation & Error**	**NO**	**X**	**X**	**X**	**X**	**X**	
43.	Estimation of measurement and errors of measurement	**NO**	**X**		**X**		**X**	
44.	Precision and accuracy of measurement	**NO**	**X**				**X**	
45.	**Geometry: Position, Visualization & Shape**	**NO**						
46.	**1-D & 2-D Coordinate Geometry**	**YES**	**X**	**X**	**X**		**X**	**X**
47.	Line and coordinate graphs	**NO**					**X**	
48.	Equations of lines in a plane	**NO**						
49.	Conic sections and their equations	**NO**			**X**			**X**
50.	**2-D Geometry: Basics**	**YES**	**X**	**X**	**X**		**X**	**X**
51.	Points, lines, segments, half-lines, and rays	**YES**	**X**	**X**	**X**		**X**	**X**
52.	Angles	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
53.	Parallelism and perpendicularity	**NO**		**X**	**X**		**X**	**X**
54.	**2-D Geometry: Polygons & Circles**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
55.	Triangles and quadrilaterals: their classification and properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
56.	Pythagorean Theorem and its applications	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
57.	Other polygons and their properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
58.	Circles and their properties	**NO**			**X**		**X**	
59.	**3-D Geometry**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
60.	3-Dimensional shapes and surfaces and their properties	**NO**			**X**			
61.	Planes and lines in space	**YES**	**X**	**X**	**X**		**X**	**X**
62.	Spatial perception and visualization	**NO**						
63.	Coordinate systems in three dimensions	**NO**						
64.	Equations of lines, planes and surfaces in space	**NO**						
65.	**Vectors**	**NO**			**X**		**X**	
66.	**Simple Topology**	**NO**	**X**					
67.	**Geometry: Symmetry, Congruence & Similarity**	**NO**						
68.	**Geometry: Transformations**	**NO**	**X**	**X**	**X**		**X**	**X**
69.	Patterns, tessellations, friezes, stencils, etc	**YES**	**X**	**X**	**X**		**X**	**X**
70.	Symmetry	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
71.	Transformations	**NO**						
72.	**Congruence & Similarity**	**YES**	**X**	**X**	**X**	**X**	**X**	
73.	Congruence	**YES**	**X**	**X**	**X**	**X**	**X**	**X**

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
74.	Similarities (similar triangles and their properties; other similar figures and properties)	**YES**		**X**	**X**	**X**	**X**	**X**
75.	**Constructions w/ Straightedge & Compass**	**NO**						
76.	**Proportionality**	**NO**						
77.	**Proportionality Concepts**	**YES**	**X**	**X**	**X**	**X**		**X**
78.	Meaning of ratio and proportion	**NO**					**X**	
79.	Direct and inverse proportion	**NO**						
80.	**Proportionality Problems**	**NO**	**X**	**X**				
81.	Solving proportional equations	**YES**	**X**	**X**	**X**		**X**	**X**
82.	Solving practical problems with proportionality	**NO**	**X**	**X**	**X**			**X**
83.	Scales (maps and plans)	**YES**	**X**	**X**			**X**	
84.	Proportion based on similarity	**NO**						
85.	**Slope & Simple Trigonometry**	**NO**	**X**					
86.	Slope and gradient in straight line graphs	**NO**		**X**			**X**	
87.	Trigonometry of right triangles	**NO**	**X**				**X**	
88.	**Linear Interpolation & Extrapolation**	**NO**						
89.	**Functions, Relations, & Equations**	**NO**						
90.	**Patterns, Relations & Functions**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
91.	Number patterns	**NO**			**X**			
92.	Relations and their properties	**YES**	**X**	**X**	**X**		**X**	
93.	Functions and their properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
94.	Representation of relations and functions	**NO**	**X**				**X**	
95.	Families of functions (graphs and properties)	**NO**					**X**	
96.	Operations on functions	**NO**						
97.	Related functions (inverse, derivative, etc.)	**NO**	**X**					
98.	Relationship of functions and equations	**YES**		**X**	**X**	**X**	**X**	**X**
99.	Interpretation of function graphs	**NO**						
100.	Functions of several variables	**NO**						
101.	Recursion	**YES**	**X**		**X**	**X**	**X**	**X**
102.	Linear Functions	**NO**			**X**		**X**	
103.	Quadratic Functions	**NO**	**X**		**X**			
104.	Logarithmic and Exponential Functions	**NO**						
105.	Trigonometric Functions	**NO**						**X**
106.	**Equations & Formulas**	**YES**	**X**	**X**	**X**		**X**	**X**
107.	Representation of numerical situations by equations	**NO**	**X**					**X**
108.	Informal solution of simple equations	**YES**	**X**	**X**	**X**		**X**	**X**
109.	Evaluating expressions	**YES**	**X**	**X**	**X**		**X**	**X**
110.	Equivalent expressions (including factorization and simplification)	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
111.	Linear equations and their formal (closed) solutions	**NO**		**X**	**X**		**X**	

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
112.	Quadratic equations and their formal (closed) solutions	**NO**			**X**			**X**
113.	Polynomial equations and their solutions	**NO**						
114.	Trigonometrical equations and identities	**NO**						
115.	Logarithmic and exponential equations and their solutions	**NO**						
116.	Solution of equations reducing to quadratics, radical equations, absolute value equations, etc.	**NO**						
117.	Other solution methods for equations (e.g., successive approximation)	**NO**		**X**	**X**		**X**	**X**
118.	Inequalities and/or their graphical representation	**YES**		**X**	**X**	**X**	**X**	
119.	Systems of equations and their solutions (including matrix solutions)	**NO**		**X**			**X**	
120.	Systems of inequalities	**NO**	**X**	**X**	**X**			**X**
121.	Substituting into or rearranging formulas	**NO**						
122.	General equation of the second degree and its interpretation	**NO**						
123.	**Trigonometry and Analytic Geometry**	**NO**						
124.	Angle measures: radians and degrees	**NO**						
125.	Law of sines and cosines	**NO**						
126.	Unit circle and trigonometric	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
	functions							
127.	Parametric equations	**NO**						
128.	Polar coordinates	**NO**						
129.	Polar equations and their graphs	**NO**						
130.	**Data Representation, Probability, & Statistics**	**NO**						**X**
131.	**Data Representation & Analysis**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
132.	Collecting data from experiments and simple surveys	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
133.	Representing data	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
134.	Interpreting tables, charts, plots, graphs	**NO**						**X**
135.	Kinds of scales (nominal, ordinal, interval, ratio)	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
136.	Measures of central tendency	**NO**	**X**		**X**		**X**	**X**
137.	Measures of dispersion	**NO**	**X**		**X**	**X**	**X**	**X**
138.	Sampling, randomness, and bias related to data samples	**NO**	**X**		**X**	**X**	**X**	
139.	Prediction and inferences from data	**NO**	**X**					
140.	Fitting lines and curves to data	**NO**						
141.	Correlations and other measures of relations	**YES**	**X**		**X**	**X**	**X**	**X**
142.	Use and misuse of statistics	**NO**						
143.	**Uncertainty & Probability**	**YES**	**X**		**X**	**X**	**X**	**X**
144.	Informal likelihoods and the vocabulary of likelihoods	**YES**	**X**		**X**	**X**	**X**	**X**

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
145.	Numerical probability and probability models	**NO**			**X**		**X**	
146.	Counting principles	**NO**						
147.	Mutually exclusive events	**NO**	**X**					
148.	Conditional probability and independent events	**NO**						
149.	Bayes' Theorem	**NO**						
150.	Contingency tables	**NO**						
151.	Probability distributions for discrete random variables	**NO**						
152.	Probability distributions for continuous random variables	**NO**						
153.	Expectation and the algebra of expectations	**NO**						**X**
154.	Sampling (distributions and populations)	**NO**						
155.	Estimation of population parameters	**NO**						
156.	Hypothesis testing	**NO**						
157.	Confidence intervals	**NO**						
158.	Bivariate distributions	**NO**						
159.	Markov processes	**NO**	**X**					
160.	Monte Carlo methods and computer simulations	**NO**						
161.	**Elementary Analysis**	**NO**						
162.	**Infinite Processes**	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
163.	Arithmetic and geometric sequences	**NO**						
164.	Arithmetic and geometric series	**NO**						
165.	Binomial Theorem	**NO**						
166.	Other sequences and series	**NO**						
167.	Limits and convergence of series	**NO**						
168.	Limits and convergence of functions	**NO**						
169.	Continuity	**NO**						
170.	**Change**	**NO**						
171.	Growth and decay	**NO**						
172.	Differentiation	**NO**						
173.	Integration	**NO**						
174.	Differential equations	**NO**						
175.	Partial differentiation	**NO**						
176.	**Validation & Structure**	**NO**					**X**	
177.	**Validation & Justification**	**NO**						
178.	Logical connectives	**NO**						
179.	Quantifiers ("for all", "there exists")	**NO**						
180.	Boolean algebra and truth tables	**NO**					**X**	
181.	Conditional statements; equivalence of statements (including converse, contrapositive, and inverse)	**NO**						
182.	Inference schemes (e.g., *modus ponens, modus tollens*)	**NO**					**X**	
183.	Direct deductive proofs	**NO**					**X**	
184.	Indirect proofs and proof by contradiction	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
185.	Proof by mathematical induction	**NO**						
186.	Consistency and independence of axiom systems	**NO**						
187.	**Structuring and Abstracting**	**NO**						
188.	Sets, set notation, and set combinations	**NO**						
189.	Equivalence relations, partitions, and classes	**NO**						
190.	Groups	**NO**						
191.	Fields	**NO**						
192.	Linear (vectors) spaces	**NO**						
193.	Subgroups, subspaces, etc.	**NO**						
194.	Other axiomatic systems	**NO**						
195.	Isomorphism	**NO**						
196.	Homomorphism	**NO**						
197.	**Other Content**	**NO**						
198.	**Informatics (operation of computers, flow charts, learning a programming language, programs, algorithms with applications to the computer, complexity)**	**NO**						
199.	**History and nature of mathematics**	**NO**						
200.	**Special application of mathematics (kinematics, Newtonian mechanics, population growth, networks, linear programming, critical path analysis, examples from economics)**	**NO**						

Grade Spans 7-9								
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**	**Economy 12**
201.	**Problem solving heuristics**	**NO**						
202.	**Non-mathematical science content**	**NO**						**X**
203.	**Non-mathematical content other than science**	**NO**						

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
1.	**Numbers**	**NO**					**X**	
2.	**Whole Numbers**	**NO**						
3.	Meaning	**NO**						
4.	Operations	**NO**						
5.	Properties of Operations	**NO**						**X**
6.	**Fractions & Decimals**	**NO**						
7.	Common Fractions	**NO**						
8.	Decimal Fractions	**NO**						
9.	Relationships of Common & Decimal Fractions	**NO**						
10.	Percentages	**NO**	**X**					**X**
11.	Properties of Common & Decimal Fractions	**NO**						
12.	**Integer, Rational & Real Numbers**	**NO**						
13.	Negative Numbers, Integers & Their Properties	**NO**			**X**		**X**	**X**
14.	Rational Numbers & Their Properties	**NO**	**X**		**X**			
15.	Real Numbers, Their Subsets & Properties	**NO**	**X**	**X**	**X**		**X**	**X**
16.	**Other Numbers & Number Concepts**	**NO**						
17.	Binary Arithmetic and/or Other Number Bases	**NO**						
18.	Exponents, Roots & Radicals	**NO**	**X**		**X**	**X**	**X**	**X**
19.	Real exponents	**NO**		**X**	**X**		**X**	

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
20.	Complex Numbers & Their Properties	**NO**		**X**	**X**			**X**
21.	Number Theory	**NO**						**X**
22.	Systematic Counting	**NO**			**X**	**X**	**X**	
23.	Matrices	**NO**						
24.	**Estimation & Number Sense Concepts**	**NO**						
25.	Estimating Quantity & Size	**NO**					**X**	**X**
26.	Rounding & Significant Figures	**NO**						**X**
27.	Estimating Computations	**NO**				**X**		**X**
28.	Exponents & Orders of Magnitude	**NO**						
29.	**Measurement**	**NO**						
30.	**Measurement Units**	**NO**						
31.	Concept of measure (including non-standard units)	**NO**				**X**		**X**
32.	Standard units (including metric system)	**NO**						
33.	Use of appropriate instruments	**NO**					**X**	**X**
34.	Common measures (Length; area; volume; time; calendar; money; temp; mass; weight; angles)	**NO**				**X**		**X**
35.	Quotients and products of units (km/h, m/s, etc.)	**NO**						
36.	Dimensional analysis/ Cancellation of units	**NO**						

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
37.	**Computations & Properties of Length, Perimeter, Area & Volume**	**NO**				**X**		**X**
38.	Computations, formulas and properties of length and perimeter	**NO**	**X**		**X**	**X**	**X**	**X**
39.	Computations, formulas and properties of area	**NO**					**X**	**X**
40.	Computations, formulas and properties of surface area	**NO**				**X**	**X**	**X**
41.	Computations, formulas and properties of volumes	**NO**						
42.	**Estimation & Error**	**NO**						**X**
43.	Estimation of measurement and errors of measurement	**NO**						**X**
44.	Precision and accuracy of measurement	**NO**	**X**				**X**	**X**
45.	**Geometry: Position, Visualization & Shape**	**NO**						
46.	**1-D & 2-D Coordinate Geometry**	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
47.	Line and coordinate graphs	**YES**	**X**	**X**	**X**	**X**	**X**	
48.	Equations of lines in a plane	**NO**	**X**	**X**	**X**		**X**	
49.	Conic sections and their equations	**NO**	**X**					
50.	**2-D Geometry: Basics**	**YES**	**X**	**X**		**X**	**X**	**X**
51.	Points, lines, segments, half-lines, and rays	**NO**	**X**			**X**		**X**

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
52.	Angles	**NO**		**X**	**X**			**X**
53.	Parallelism and perpendicularity	**NO**	**X**			**X**		
54.	**2-D Geometry: Polygons & Circles**	**NO**	**X**			**X**	**X**	**X**
55.	Triangles and quadrilaterals: their classification and properties	**NO**	**X**	**X**				**X**
56.	Pythagorean Theorem and its applications	**NO**						**X**
57.	Other polygons and their properties	**YES**	**X**	**X**		**X**	**X**	**X**
58.	Circles and their properties	**NO**						
59.	**3-D Geometry**	**NO**			**X**	**X**		**X**
60.	3-Dimensional shapes and surfaces and their properties	**NO**	**X**		**X**			
61.	Planes and lines in space	**NO**	**X**		**X**	**X**		**X**
62.	Spatial perception and visualization	**NO**			**X**			
63.	Coordinate systems in three dimensions	**NO**			**X**			
64.	Equations of lines, planes and surfaces in space	**NO**			**X**	**X**	**X**	**X**
65.	**Vectors**	**NO**						
66.	**Simple Topology**	**NO**	**X**					**X**
67.	**Geometry: Symmetry, Congruence & Similarity**	**NO**						
68.	**Geometry: Transformations**	**NO**						

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
69.	Patterns, tessellations, friezes, stencils, etc	**NO**				**X**		**X**
70.	Symmetry	**NO**	**X**	**X**		**X**	**X**	**X**
71.	Transformations	**NO**						
72.	**Congruence & Similarity**	**NO**			**X**	**X**		**X**
73.	Congruence	**NO**				**X**		**X**
74.	Similarities (similar triangles and their properties; other similar figures and properties)	**NO**						
75.	**Constructions w/ Straightedge & Compass**	**NO**						
76.	**Proportionality**	**NO**						
77.	**Proportionality Concepts**	**NO**				**X**		
78.	Meaning of ratio and proportion	**NO**	**X**					
79.	Direct and inverse proportion	**NO**						
80.	**Proportionality Problems**	**NO**						**X**
81.	Solving proportional equations	**NO**	**X**					**X**
82.	Solving practical problems with proportionality	**NO**						**X**
83.	Scales (maps and plans)	**NO**						**X**
84.	Proportion based on similarity	**NO**						
85.	**Slope & Simple Trigonometry**	**YES**	**X**	**X**	**X**	**X**		**X**
86.	Slope and gradient in straight line graphs	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
87.	Trigonometry of right triangles	**NO**			**X**			**X**
88.	**Linear Interpolation &**	**NO**						

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
	Extrapolation							
89.	**Functions, Relations, & Equations**	**NO**						
90.	**Patterns, Relations & Functions**	**NO**	**X**					**X**
91.	Number patterns	**NO**	**X**					
92.	Relations and their properties	**YES**	**X**	**X**	**X**		**X**	**X**
93.	Functions and their properties	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
94.	Representation of relations and functions	**NO**	**X**					
95.	Families of functions (graphs and properties)	**NO**		**X**			**X**	
96.	Operations on functions	**NO**	**X**	**X**			**X**	
97.	Related functions (inverse, derivative, etc.)	**NO**	**X**	**X**		**X**	**X**	**X**
98.	Relationship of functions and equations	**YES**	**X**	**X**		**X**	**X**	
99.	Interpretation of function graphs	**NO**						
100.	Functions of several variables	**NO**					**X**	**X**
101.	Recursion	**NO**	**X**			**X**		**X**
102.	Linear Functions	**YES**	**X**	**X**		**X**	**X**	**X**
103.	Quadratic Functions	**NO**			**X**	**X**	**X**	**X**
104.	Logarithmic and Exponential Functions	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
105.	Trigonometric Functions	**NO**	**X**				**X**	
106.	**Equations & Formulas**	**NO**	**X**			**X**		**X**

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
107.	Representation of numerical situations by equations	**NO**	**X**					
108.	Informal solution of simple equations	**NO**	**X**					
109.	Evaluating expressions	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
110.	Equivalent expressions (including factorization and simplification)	**YES**	**X**	**X**		**X**	**X**	**X**
111.	Linear equations and their formal (closed) solutions	**YES**	**X**	**X**	**X**	**X**	**X**	**X**
112.	Quadratic equations and their formal (closed) solutions	**NO**	**X**	**X**	**X**	**X**	**X**	
113.	Polynomial equations and their solutions	**NO**		**X**	**X**		**X**	
114.	Trigonometrical equations and identities	**NO**	**X**					**X**
115.	Logarithmic and exponential equations and their solutions	**NO**	**X**			**X**	**X**	**X**
116.	Solution of equations reducing to quadratics, radical equations, absolute value equations, etc.	**NO**						
117.	Other solution methods for equations (e.g., successive approximation)	**YES**	**X**	**X**	**X**	**X**	**X**	
118.	Inequalities and/or their graphical representation	**YES**	**X**	**X**	**X**		**X**	**X**
119.	Systems of equations and their solutions (including matrix solutions)	**NO**	**X**	**X**				**X**

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
120.	Systems of inequalities	**YES**	**X**	**X**		**X**	**X**	**X**
121.	Substituting into or rearranging formulas	**NO**			**X**		**X**	
122.	General equation of the second degree and its interpretation	**NO**						
123.	**Trigonometry and Analytic Geometry**	**NO**		**X**	**X**	**X**	**X**	
124.	Angle measures: radians and degrees	**NO**	**X**	**X**	**X**	**X**	**X**	
125.	Law of sines and cosines	**NO**	**X**		**X**	**X**	**X**	
126.	Unit circle and trigonometric functions	**NO**			**X**		**X**	
127.	Parametric equations	**NO**					**X**	
128.	Polar coordinates	**NO**			**X**		**X**	
129.	Polar equations and their graphs	**NO**						
130.	**Data Representation, Probability, & Statistics**	**NO**	**X**					
131.	**Data Representation & Analysis**	**NO**	**X**		**X**			**X**
132.	Collecting data from experiments and simple surveys	**YES**	**X**		**X**	**X**	**X**	**X**
133.	Representing data	**YES**	**X**		**X**	**X**	**X**	**X**
134.	Interpreting tables, charts, plots, graphs	**NO**						
135.	Kinds of scales (nominal, ordinal, interval, ratio)	**NO**			**X**	**X**		**X**
136.	Measures of central tendency	**YES**	**X**		**X**	**X**		**X**

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
137.	Measures of dispersion	**NO**	**X**					**X**
138.	Sampling, randomness, and bias related to data samples	**NO**			**X**		**X**	**X**
139.	Prediction and inferences from data	**NO**						**X**
140.	Fitting lines and curves to data	**NO**	**X**		**X**			**X**
141.	Correlations and other measures of relations	**NO**	**X**					**X**
142.	Use and misuse of statistics	**NO**						
143.	**Uncertainty & Probability**	**NO**	**X**		**X**	**X**		**X**
144.	Informal likelihoods and the vocabulary of likelihoods	**YES**	**X**	**X**		**X**	**X**	**X**
145.	Numerical probability and probability models	**NO**	**X**	**X**	**X**	**X**	**X**	
146.	Counting principles	**NO**				**X**	**X**	
147.	Mutually exclusive events	**NO**	**X**		**X**	**X**	**X**	**X**
148.	Conditional probability and independent events	**NO**			**X**		**X**	
149.	Bayes' Theorem	**NO**						
150.	Contingency tables	**NO**					**X**	
151.	Probability distributions for discrete random variables	**NO**					**X**	**X**
152.	Probability distributions for continuous random variables	**NO**			**X**			
153.	Expectation and the algebra of expectations	**NO**			**X**		**X**	**X**
154.	Sampling (distributions and	**NO**					**X**	

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
	populations)							
155.	Estimation of population parameters	**NO**					**X**	
156.	Hypothesis testing	**NO**			**X**		**X**	
157.	Confidence intervals	**NO**			**X**			
158.	Bivariate distributions	**NO**						
159.	Markov processes	**NO**						
160.	Monte Carlo methods and computer simulations	**NO**						
161.	**Elementary Analysis**	**NO**						
162.	**Infinite Processes**	**NO**	**X**		**X**		**X**	**X**
163.	Arithmetic and geometric sequences	**NO**	**X**		**X**		**X**	
164.	Arithmetic and geometric series	**NO**			**X**			
165.	Binomial Theorem	**NO**	**X**				**X**	**X**
166.	Other sequences and series	**NO**	**X**		**X**		**X**	
167.	Limits and convergence of series	**NO**					**X**	
168.	Limits and convergence of functions	**NO**						
169.	Continuity	**NO**						
170.	**Change**	**NO**						
171.	Growth and decay	**NO**					**X**	
172.	Differentiation	**NO**					**X**	
173.	Integration	**NO**						
174.	Differential equations	**NO**						

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
175.	Partial differentiation	**NO**						
176.	**Validation & Structure**	**NO**						
177.	**Validation & Justification**	**NO**	**X**	**X**				
178.	Logical connectives	**NO**						
179.	Quantifiers ("for all", "there exists")	**NO**						
180.	Boolean algebra and truth tables	**NO**		**X**			**X**	
181.	Conditional statements; equivalence of statements (including converse, contrapositive, and inverse)	**NO**					**X**	
182.	Inference schemes (e.g., *modus ponens, modus tollens*)	**NO**	**X**				**X**	
183.	Direct deductive proofs	**NO**		**X**			**X**	
184.	Indirect proofs and proof by contradiction	**NO**			**X**		**X**	
185.	Proof by mathematical induction	**NO**	**X**		**X**			
186.	Consistency and independence of axiom systems	**NO**						
187.	**Structuring and Abstracting**	**NO**		**X**			**X**	
188.	Sets, set notation, and set combinations	**NO**						
189.	Equivalence relations, partitions, and classes	**NO**						
190.	Groups	**NO**						
191.	Fields	**NO**						

Grade Spans 10-12								
Original	**Text**	**Core >66%**	**Economy 1 ***	**Economy 2 ***	**Economy 3 ***	**Economy 4 ***	**Economy 5 ***	**Economy 6**
192.	Linear (vectors) spaces	**NO**						
193.	Subgroups, subspaces, etc.	**NO**						
194.	Other axiomatic systems	**NO**						
195.	Isomorphism	**NO**						
196.	Homomorphism	**NO**						
197.	**Other Content**	**NO**					**X**	
198.	**Informatics (operation of computers, flow charts, learning a programming language, programs, algorithms with applications to the computer, complexity)**	**NO**	**X**		**X**		**X**	
199.	**History and nature of mathematics**	**NO**					**X**	
200.	**Special application of mathematics (kinematics, Newtonian mechanics, population growth, networks, linear programming, critical path analysis, examples from economics)**	**NO**						
201.	**Problem solving heuristics**	**NO**						
202.	**Non-mathematical science content**	**NO**	**X**			**X**		
203.	**Non-mathematical content other than science**	**NO**						

Grade Spans 10-12							
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**
1.	**Numbers**	**NO**					
2.	**Whole Numbers**	**NO**					
3.	Meaning	**NO**	**X**				
4.	Operations	**NO**					
5.	Properties of Operations	**NO**					
6.	**Fractions & Decimals**	**NO**					
7.	Common Fractions	**NO**					
8.	Decimal Fractions	**NO**					**X**
9.	Relationships of Common & Decimal Fractions	**NO**					
10.	Percentages	**NO**					**X**
11.	Properties of Common & Decimal Fractions	**NO**					
12.	**Integer, Rational & Real Numbers**	**NO**					
13.	Negative Numbers, Integers & Their Properties	**NO**			**X**		
14.	Rational Numbers & Their Properties	**NO**		**X**	**X**		
15.	Real Numbers, Their Subsets & Properties	**NO**	**X**		**X**		**X**
16.	**Other Numbers & Number Concepts**	**NO**					
17.	Binary Arithmetic and/or Other Number Bases	**NO**					
18.	Exponents, Roots & Radicals	**NO**		**X**	**X**		**X**
19.	Real exponents	**NO**		**X**			**X**
20.	Complex Numbers & Their Properties	**NO**	**X**				
21.	Number Theory	**NO**	**X**	**X**	**X**		**X**
22.	Systematic Counting	**NO**	**X**				
23.	Matrices	**NO**					
24.	**Estimation & Number Sense Concepts**	**NO**					

Grade Spans 10-12							
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**
25.	Estimating Quantity & Size	**NO**	**X**		**X**		**X**
26.	Rounding & Significant Figures	**NO**			**X**		
27.	Estimating Computations	**NO**					**X**
28.	Exponents & Orders of Magnitude	**NO**		**X**			
29.	**Measurement**	**NO**					
30.	**Measurement Units**	**NO**					
31.	Concept of measure (including non-standard units)	**NO**		**X**			
32.	Standard units (including metric system)	**NO**					
33.	Use of appropriate instruments	**NO**					
34.	Common measures (Length; area; volume; time; calendar; money; temp; mass; weight; angles)	**NO**		**X**			
35.	Quotients and products of units (km/h, m/s, etc.)	**NO**					
36.	Dimensional analysis / Cancellation of Units	**NO**					
37.	**Computations & Properties of Length, Perimeter, Area & Volume**	**NO**	**X**	**X**		**X**	
38.	Computations, formulas and properties of length and perimeter	**NO**	**X**	**X**			
39.	Computations, formulas and properties of area	**NO**				**X**	
40.	Computations, formulas and properties of surface area	**NO**		**X**		**X**	
41.	Computations, formulas and properties of volumes	**NO**					
42.	**Estimation & Error**	**NO**		**X**	**X**		

Grade Spans 10-12							
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**
43.	Estimation of measurement and errors of measurement	**NO**		**X**			
44.	Precision and accuracy of measurement	**NO**					
45.	**Geometry: Position, Visualization & Shape**	**NO**					**X**
46.	**1-D & 2-D Coordinate Geometry**	**YES**	**X**	**X**		**X**	**X**
47.	Line and coordinate graphs	**YES**	**X**	**X**		**X**	**X**
48.	Equations of lines in a plane	**NO**		**X**			**X**
49.	Conic sections and their equations	**NO**					
50.	**2-D Geometry: Basics**	**YES**	**X**	**X**		**X**	**X**
51.	Points, lines, segments, half-lines, and rays	**NO**	**X**	**X**		**X**	**X**
52.	Angles	**NO**	**X**			**X**	**X**
53.	Parallelism and perpendicularity	**NO**				**X**	**X**
54.	**2-D Geometry: Polygons & Circles**	**NO**		**X**		**X**	**X**
55.	Triangles and quadrilaterals: their classification and properties	**NO**		**X**		**X**	**X**
56.	Pythagorean Theorem and its applications	**NO**		**X**			**X**
57.	Other polygons and their properties	**YES**	**X**	**X**		**X**	**X**
58.	Circles and their properties	**NO**					
59.	**3-D Geometry**	**NO**	**X**	**X**		**X**	
60.	3-Dimensional shapes and surfaces and their properties	**NO**	**X**			**X**	
61.	Planes and lines in space	**NO**	**X**			**X**	
62.	Spatial perception and visualization	**NO**	**X**			**X**	
63.	Coordinate systems in three dimensions	**NO**					
64.	Equations of lines, planes and surfaces in space	**NO**				**X**	
65.	**Vectors**	**NO**					

Grade Spans 10-12							
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**
66.	**Simple Topology**	**NO**					
67.	**Geometry: Symmetry, Congruence & Similarity**	**NO**					
68.	**Geometry: Transformations**	**NO**					
69.	Patterns, tessellations, friezes, stencils, etc	**NO**		**X**			**X**
70.	Symmetry	**NO**	**X**	**X**			
71.	Transformations	**NO**					
72.	**Congruence & Similarity**	**NO**	**X**				
73.	Congruence	**NO**	**X**	**X**			
74.	Similarities (similar triangles and their properties; other similar figures and properties)	**NO**	**X**				
75.	**Constructions w/ Straightedge & Compass**	**NO**					
76.	**Proportionality**	**NO**					
77.	**Proportionality Concepts**	**NO**	**X**			**X**	
78.	Meaning of ratio and proportion	**NO**	**X**	**X**			**X**
79.	Direct and inverse proportion	**NO**					
80.	**Proportionality Problems**	**NO**	**X**	**X**			
81.	Solving proportional equations	**NO**		**X**			
82.	Solving practical problems with proportionality	**NO**	**X**	**X**			
83.	Scales (maps and plans)	**NO**		**X**			
84.	Proportion based on similarity	**NO**					
85.	**Slope & Simple Trigonometry**	**YES**	**X**	**X**		**X**	**X**
86.	Slope and gradient in straight line graphs	**YES**	**X**	**X**	**X**	**X**	**X**
87.	Trigonometry of right triangles	**NO**		**X**			
88.	**Linear Interpolation & Extrapolation**	**NO**					

Grade Spans 10-12							
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**
89.	**Functions, Relations, & Equations**	**NO**					
90.	**Patterns, Relations & Functions**	**NO**	**X**		**X**	**X**	**X**
91.	Number patterns	**NO**			**X**		**X**
92.	Relations and their properties	**YES**	**X**	**X**	**X**	**X**	**X**
93.	Functions and their properties	**YES**	**X**	**X**	**X**	**X**	**X**
94.	Representation of relations and functions	**NO**	**X**	**X**		**X**	**X**
95.	Families of functions (graphs and properties)	**NO**					**X**
96.	Operations on functions	**NO**	**X**	**X**			**X**
97.	Related functions (inverse, derivative, etc.)	**NO**	**X**	**X**			**X**
98.	Relationship of functions and equations	**YES**	**X**	**X**	**X**	**X**	**X**
99.	Interpretation of function graphs	**NO**					
100.	Functions of several variables	**NO**		**X**			**X**
101.	Recursion	**NO**	**X**	**X**		**X**	**X**
102.	Linear Functions	**YES**	**X**	**X**		**X**	**X**
103.	Quadratic Functions	**NO**		**X**		**X**	**X**
104.	Logarithmic and Exponential Functions	**YES**	**X**	**X**		**X**	**X**
105.	Trigonometric Functions	**NO**	**X**				
106.	**Equations & Formulas**	**NO**	**X**				**X**
107.	Representation of numerical situations by equations	**NO**					
108.	Informal solution of simple equations	**NO**	**X**				**X**
109.	Evaluating expressions	**YES**	**X**	**X**			**X**
110.	Equivalent expressions (including factorization and simplification)	**YES**	**X**	**X**	**X**	**X**	**X**
111.	Linear equations and their formal (closed) solutions	**YES**	**X**	**X**	**X**	**X**	**X**

Grade Spans 10-12							
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**
112.	Quadratic equations and their formal (closed) solutions	**NO**	**X**	**X**			**X**
113.	Polynomial equations and their solutions	**NO**		**X**		**X**	**X**
114.	Trigonometrical equations and identities	**NO**		**X**		**X**	**X**
115.	Logarithmic and exponential equations and their solutions	**NO**	**X**	**X**			**X**
116.	Solution of equations reducing to quadratics, radical equations, absolute value equations, etc.	**NO**		**X**		**X**	
117.	Other solution methods for equations (e.g., successive approximation)	**YES**	**X**		**X**	**X**	**X**
118.	Inequalities and/or their graphical representation	**YES**	**X**	**X**		**X**	**X**
119.	Systems of equations and their solutions (including matrix solutions)	**NO**	**X**			**X**	**X**
120.	Systems of inequalities	**YES**	**X**	**X**		**X**	
121.	Substituting into or rearranging formulas	**NO**		**X**		**X**	**X**
122.	General equation of the second degree and its interpretation	**NO**					
123.	**Trigonometry and Analytic Geometry**	**NO**	**X**			**X**	**X**
124.	Angle measures: radians and degrees	**NO**		**X**			**X**
125.	Law of sines and cosines	**NO**	**X**			**X**	**X**
126.	Unit circle and trigonometric functions	**NO**					
127.	Parametric equations	**NO**					
128.	Polar coordinates	**NO**					
129.	Polar equations and their graphs	**NO**					
130.	**Data Representation, Probability, & Statistics**	**NO**	**X**	**X**			
131.	**Data Representation & Analysis**	**NO**		**X**		**X**	**X**

Grade Spans 10-12							
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**
132.	Collecting data from experiments and simple surveys	**YES**	**X**		**X**	**X**	**X**
133.	Representing data	**YES**	**X**	**X**	**X**		**X**
134.	Interpreting tables, charts, plots, graphs	**NO**	**X**				
135.	Kinds of scales (nominal, ordinal, interval, ratio)	**NO**	**X**	**X**	**X**	**X**	
136.	Measures of central tendency	**YES**	**X**	**X**	**X**	**X**	**X**
137.	Measures of dispersion	**NO**		**X**	**X**	**X**	**X**
138.	Sampling, randomness, and bias related to data samples	**NO**		**X**	**X**	**X**	**X**
139.	Prediction and inferences from data	**NO**		**X**		**X**	
140.	Fitting lines and curves to data	**NO**		**X**		**X**	
141.	Correlations and other measures of relations	**NO**		**X**		**X**	
142.	Use and misuse of statistics	**NO**	**X**				
143.	**Uncertainty & Probability**	**NO**	**X**		**X**	**X**	
144.	Informal likelihoods and the vocabulary of likelihoods	**YES**	**X**	**X**	**X**	**X**	
145.	Numerical probability and probability models	**NO**		**X**		**X**	**X**
146.	Counting principles	**NO**				**X**	
147.	Mutually exclusive events	**NO**					
148.	Conditional probability and independent events	**NO**		**X**			
149.	Bayes' Theorem	**NO**		**X**			
150.	Contingency tables	**NO**		**X**		**X**	**X**
151.	Probability distributions for discrete random variables	**NO**		**X**			**X**
152.	Probability distributions for continuous random variables	**NO**					

Grade Spans 10-12							
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**
153.	Expectation and the algebra of expectations	**NO**		**X**		**X**	
154.	Sampling (distributions and populations)	**NO**		**X**		**X**	
155.	Estimation of population parameters	**NO**					
156.	Hypothesis testing	**NO**		**X**			
157.	Confidence intervals	**NO**					
158.	Bivariate distributions	**NO**		**X**			
159.	Markov processes	**NO**					
160.	Monte Carlo methods and computer simulations	**NO**					
161.	**Elementary Analysis**	**NO**					
162.	**Infinite Processes**	**NO**		**X**	**X**	**X**	**X**
163.	Arithmetic and geometric sequences	**NO**		**X**	**X**		**X**
164.	Arithmetic and geometric series	**NO**					**X**
165.	Binomial Theorem	**NO**					
166.	Other sequences and series	**NO**					
167.	Limits and convergence of series	**NO**		**X**			
168.	Limits and convergence of functions	**NO**		**X**			
169.	Continuity	**NO**					
170.	**Change**	**NO**					**X**
171.	Growth and decay	**NO**		**X**			
172.	Differentiation	**NO**		**X**			
173.	Integration	**NO**		**X**			
174.	Differential equations	**NO**					
175.	Partial differentiation	**NO**	**X**				
176.	**Validation & Structure**	**NO**					
177.	**Validation & Justification**	**NO**	**X**				**X**

Grade Spans 10-12							
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**
178.	Logical connectives	**NO**	**X**				
179.	Quantifiers ("for all", "there exists")	**NO**	**X**				
180.	Boolean algebra and truth tables	**NO**	**X**				**X**
181.	Conditional statements; equivalence of statements (including converse, contrapositive, and inverse)	**NO**	**X**				
182.	Inference schemes (e.g., *modus ponens*, *modus tollens*)	**NO**			**X**		**X**
183.	Direct deductive proofs	**NO**					
184.	Indirect proofs and proof by contradiction	**NO**					
185.	Proof by mathematical induction	**NO**					
186.	Consistency and independence of axiom systems	**NO**					
187.	**Structuring and Abstracting**	**NO**	**X**		**X**	**X**	
188.	Sets, set notation, and set combinations	**NO**				**X**	
189.	Equivalence relations, partitions, and classes	**NO**					
190.	Groups	**NO**					
191.	Fields	**NO**					
192.	Linear (vectors) spaces	**NO**				**X**	
193.	Subgroups, subspaces, etc.	**NO**					
194.	Other axiomatic systems	**NO**					
195.	Isomorphism	**NO**					
196.	Homomorphism	**NO**					
197.	**Other Content**	**NO**				**X**	**X**

Grade Spans 10-12							
Original	**Text**	**Core >66%**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**	**Economy 11**
198.	**Informatics (operation of computers, flow charts, learning a programming language, programs, algorithms with applications to the computer, complexity)**	**NO**				**X**	
199.	**History and nature of mathematics**	**NO**		**X**		**X**	**X**
200.	**Special application of mathematics (kinematics, Newtonian mechanics, population growth, networks, linear programming, critical path analysis, examples from economics)**	**NO**					
201.	**Problem solving heuristics**	**NO**					**X**
202.	**Non-mathematical science content**	**NO**	**X**				
203.	**Non-mathematical content other than science**	**NO**					

APPENDIX E (CONTINUED): INDIVIDUAL ECONOMY PORTRAITS
SCIENCE

The following individual economy profiles show the specific topics addressed by each economy's standards in the corresponding grade spans. The third column, labeled "Core," denotes with the word "YES" the topics included in the set of common topics. Those topics not included in the set of common topics are denoted with the word "NO". Five economies marked with an asterisk (*) are examples of high performing economies on PISA and TIMSS.

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
1	**Earth Sciences**	**NO**					
2	**Earth Features**	**NO**	**X**		**X**		
3	Earth's composition	**NO**		**X**			
4	Landforms	**NO**		**X**			
5	Bodies of water	**NO**		**X**	**X**		
6	Atmosphere	**NO**		**X**	**X**		
7	Rocks, soil	**NO**		**X**	**X**		
8	Ice forms	**NO**					
9	**Earth Processes**	**NO**		**X**			
10	Weather & climate	**YES**	**X**	**X**	**X**		**X**
11	Physical & Chemical Cycles	**NO**		**X**			**X**
12	Constructive and Destructive Processes	**NO**		**X**	**X**		
13	Earth's history	**NO**		**X**	**X**		
14	**Earth and the Universe**	**NO**					
15	Earth, sun, moon	**NO**			**X**		**X**
16	Planets in the solar system	**NO**			**X**		
17	Beyond the solar system	**NO**			**X**		**X**
18	Evolution of the universe	**NO**					
19	Motion/location of celestial bodies	**NO**	**X**		**X**		**X**

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
20	**Life Sciences**	**NO**					
21	**Diversity, Organization and Structure of Living Things**	**NO**		**X**	**X**		
22	Plants	**YES**	**X**	**X**		**X**	**X**
23	Animals	**YES**	**X**	**X**	**X**	**X**	**X**
24	Other organisms	**NO**	**X**			**X**	
25	Systems, organs, tissues	**NO**	**X**	**X**	**X**	**X**	
26	Cells	**NO**			**X**	**X**	
27	**Life Processes and Systems Enabling Life Functions**	**NO**	**X**				
28	Energy handling, biochemistry of systems	**NO**				**X**	
29	Sensing and responding	**NO**			**X**		
30	Biochemical processes in cells	**NO**					
31	**Life Spirals, Genetic Continuity and Diversity**	**NO**					
32	Life cycles	**YES**		**X**	**X**	**X**	**X**
33	Reproduction	**NO**			**X**		
34	Variation and inheritance	**NO**			**X**		
35	Population genetics, biotechnology	**NO**					
36	Evolution, speciation, diversity	**NO**					
37	Biochemistry of genetics	**NO**					
38	Genetic engineering	**NO**					
39	**Interactions of Living Things**	**NO**		**X**			

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
40	Biomes & ecosystems	**NO**	**X**		**X**		
41	Habitats & niches	**NO**		**X**	**X**		**X**
42	Interdependence of life	**NO**					**X**
43	Food webs, adaptations to habitats	**NO**					
44	Competition among organisms	**NO**			**X**		
45	Animal behavior	**NO**			**X**		**X**
46	Needs of living things	**NO**		**X**		**X**	
47	**Human Biology and Health**	**YES**	**X**	**X**	**X**	**X**	**X**
48	Human Nutrition	**NO**	**X**		**X**		
49	Human Disease and health	**NO**					
50	**Physical Sciences**	**NO**					
51	**Matter**	**NO**	**X**		**X**		
52	Classification of matter	**YES**		**X**	**X**	**X**	**X**
53	Physical properties	**YES**	**X**	**X**	**X**	**X**	**X**
54	Chemical properties	**YES**	**X**	**X**	**X**		**X**
55	Acids, Bases, Salts	**NO**			**X**		
56	**Structure of Matter**	**NO**			**X**		
57	Atoms, ions, molecules	**NO**			**X**		
58	Formulas/Equations/Nomenclature, Stoichiometry	**NO**					
59	Macromolecules	**NO**			**X**		

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
60	Subatomic particles	**NO**			**X**		
61	**Energy and Physical Processes**	**NO**					
62	Energy types, conversions, sources	**NO**	**X**		**X**	**X**	
63	Work, Power, Simple machines	**NO**					
64	Heat and temperature	**YES**	**X**	**X**	**X**	**X**	**X**
65	Wave phenomena	**NO**					
66	Sound & vibration	**NO**			**X**		
67	Light	**YES**		**X**	**X**	**X**	**X**
68	Electricity	**NO**			**X**		**X**
69	Magnetism/electromagnetism	**YES**		**X**		**X**	**X**
70	**Physical Transformations**	**NO**					
71	Physical changes	**YES**	**X**		**X**		**X**
72	Explanations of physical changes	**NO**		**X**	**X**		**X**
73	Kinetic-molecular theory	**NO**			**X**		
74	Quantum theory & fundamental particles	**NO**					
75	**Chemical Transformations**	**NO**					
76	Chemical changes	**NO**	**X**				
77	Definition & evidence of chemical change	**NO**					
78	Types of reactions	**NO**					

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
79	Law of Conservation of Matter	**NO**					
80	Explanations of chemical changes	**NO**					
81	Determinants/trends of chemical reactivity	**NO**					
82	Rate of change and equilibria	**NO**			**X**		
83	Energy and chemical change	**NO**					
84	Calorimetry, exothermic/endothermic reactions	**NO**					
85	First law of thermodynamics	**NO**					
86	Second law of thermodynamics	**NO**					
87	Organic & biochemical changes	**NO**					
88	Nuclear chemistry	**NO**					
89	Electrochemistry	**NO**			**X**		
90	**Forces and Motion**	**NO**					
91	Types of forces	**NO**					**X**
92	Contact forces and forces acting at a distance	**NO**		**X**			
93	Pressure - force applied to a surface	**NO**			**X**		
94	Time, space and motion	**NO**		**X**	**X**		
95	Measurement of time/space/mass	**NO**		**X**			
96	Types of motion/describing motion	**NO**					
97	Frames of reference	**NO**					

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
98	Dynamics of motion	**NO**	**X**	**X**	**X**		
99	Relativity theory	**NO**					
100	Air/fluid behavior	**NO**		**X**	**X**		**X**
101	**Science, Technology and Mathematics**	**NO**			**X**		
102	Nature or Conceptions of Technology	**NO**	**X**	**X**	**X**	**X**	
103	Interactions of Science, Mathematics, & Technology	**NO**	**X**				
104	Mathematics, technology influence on science	**NO**					
105	Science applications in mathematics, technology	**NO**	**X**				
106	Interactions of Science, Technology and Society	**NO**	**X**		**X**		
107	Influence of science, technology on society	**NO**					
108	Influence of society on science, technology	**NO**					
109	**History of Science and Technology**	**NO**			**X**		
110	**Environmental and Resource Issues Related to Science**	**NO**	**X**		**X**		
111	Pollution - Causes and Treatment	**NO**	**X**		**X**		
112	Land, Water, Sea Resource Conservation	**YES**	**X**	**X**	**X**		
113	Material & Energy Resource Conservation	**NO**	**X**		**X**		
114	World Population	**NO**					
115	Food Production, Storage	**NO**			**X**		
116	Effects of Natural Disasters	**NO**			**X**		

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
117	**Nature of Science**	**NO**					
118	Nature of Scientific Knowledge	**NO**	**X**			**X**	**X**
119	The Scientific Enterprise	**NO**					**X**
120	**Science and Other Disciplines**	**NO**					
121	Science & Mathematics	**NO**					
122	Science and Other Disciplines	**NO**					

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
1	**Earth Sciences**	**NO**					
2	**Earth Features**	**NO**	**X**			**X**	
3	Earth's composition	**NO**		**X**			
4	Landforms	**NO**					
5	Bodies of water	**NO**		**X**		**X**	
6	Atmosphere	**NO**		**X**			
7	Rocks, soil	**NO**		**X**	**X**	**X**	
8	Ice forms	**NO**					
9	**Earth Processes**	**NO**					
10	Weather & climate	**YES**	**X**	**X**	**X**	**X**	

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
11	Physical & Chemical Cycles	**NO**		**X**			
12	Constructive and Destructive Processes	**NO**		**X**		**X**	
13	Earth's history	**NO**	**X**		**X**		
14	**Earth and the Universe**	**NO**				**X**	
15	Earth, sun, moon	**NO**	**X**	**X**	**X**	**X**	
16	Planets in the solar system	**NO**			**X**		
17	Beyond the solar system	**NO**					
18	Evolution of the universe	**NO**					
19	Motion/location of celestial bodies	**NO**		**X**			
20	**Life Sciences**	**NO**					
21	**Diversity, Organization and Structure of Living Things**	**NO**	**X**		**X**	**X**	**X**
22	Plants	**YES**	**X**		**X**	**X**	
23	Animals	**YES**	**X**		**X**	**X**	
24	Other organisms	**NO**	**X**			**X**	
25	Systems, organs, tissues	**NO**			**X**	**X**	
26	Cells	**NO**					
27	**Life Processes and Systems Enabling Life Functions**	**NO**		**X**	**X**	**X**	**X**
28	Energy handling, biochemistry of systems	**NO**	**X**	**X**	**X**	**X**	
29	Sensing and responding	**NO**			**X**	**X**	

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
30	Biochemical processes in cells	**NO**					
31	**Life Spirals, Genetic Continuity and Diversity**	**NO**					**X**
32	Life cycles	**YES**		**X**	**X**	**X**	
33	Reproduction	**NO**		**X**	**X**	**X**	
34	Variation and inheritance	**NO**			**X**	**X**	
35	Population genetics, biotechnology	**NO**					
36	Evolution, speciation, diversity	**NO**	**X**	**X**			
37	Biochemistry of genetics	**NO**					
38	Genetic engineering	**NO**					
39	**Interactions of Living Things**	**NO**				**X**	
40	Biomes & ecosystems	**NO**	**X**		**X**	**X**	**X**
41	Habitats & niches	**NO**	**X**		**X**	**X**	**X**
42	Interdependence of life	**NO**	**X**	**X**	**X**	**X**	**X**
43	Food webs, adaptations to habitats	**NO**	**X**	**X**			
44	Competition among organisms	**NO**					
45	Animal behavior	**NO**			**X**	**X**	
46	Needs of living things	**NO**	**X**	**X**	**X**	**X**	
47	**Human Biology and Health**	**YES**	**X**		**X**	**X**	
48	Human Nutrition	**NO**			**X**	**X**	
49	Human Disease and health	**NO**			**X**	**X**	
50	**Physical Sciences**	**NO**					

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
51	**Matter**	**NO**					
52	Classification of matter	**YES**	**X**	**X**	**X**	**X**	**X**
53	Physical properties	**YES**	**X**	**X**	**X**	**X**	**X**
54	Chemical properties	**YES**	**X**	**X**	**X**	**X**	**X**
55	Acids, Bases, Salts	**NO**					
56	**Structure of Matter**	**NO**					
57	Atoms, ions, molecules	**NO**					
58	Formulas/Equations/Nomenclature, Stoichiometry	**NO**					
59	Macromolecules	**NO**					
60	Subatomic particles	**NO**					
61	**Energy and Physical Processes**	**NO**	**X**				**X**
62	Energy types, conversions, sources	**NO**		**X**	**X**		
63	Work, Power, Simple machines	**NO**					
64	Heat and temperature	**YES**	**X**	**X**	**X**	**X**	
65	Wave phenomena	**NO**	**X**				
66	Sound & vibration	**NO**	**X**	**X**	**X**	**X**	
67	Light	**YES**	**X**	**X**	**X**	**X**	
68	Electricity	**NO**	**X**	**X**	**X**	**X**	
69	Magnetism/electromagnetism	**YES**	**X**	**X**	**X**	**X**	
70	**Physical Transformations**	**NO**	**X**				**X**

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
71	Physical changes	**YES**	**X**	**X**	**X**	**X**	
72	Explanations of physical changes	**NO**			**X**	**X**	
73	Kinetic-molecular theory	**NO**			**X**		
74	Quantum theory & fundamental particles	**NO**					
75	**Chemical Transformations**	**NO**			**X**		**X**
76	Chemical changes	**NO**	**X**			**X**	
77	Definition & evidence of chemical change	**NO**			**X**		
78	Types of reactions	**NO**			**X**		
79	Law of Conservation of Matter	**NO**					
80	Explanations of chemical changes	**NO**					
81	Determinants/trends of chemical reactivity	**NO**					
82	Rate of change and equilibria	**NO**					
83	Energy and chemical change	**NO**					
84	Calorimetry, exothermic/endothermic reactions	**NO**					
85	First law of thermodynamics	**NO**					
86	Second law of thermodynamics	**NO**					
87	Organic & biochemical changes	**NO**					
88	Nuclear chemistry	**NO**					

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
89	Electrochemistry	**NO**			**X**		
90	**Forces and Motion**	**NO**	**X**				**X**
91	Types of forces	**NO**	**X**	**X**		**X**	
92	Contact forces and forces acting at a distance	**NO**		**X**			
93	Pressure - force applied to a surface	**NO**					
94	Time, space and motion	**NO**	**X**	**X**	**X**		
95	Measurement of time/space/mass	**NO**			**X**		
96	Types of motion/describing motion	**NO**				**X**	
97	Frames of reference	**NO**				**X**	
98	Dynamics of motion	**NO**		**X**	**X**	**X**	
99	Relativity theory	**NO**					
100	Air/fluid behavior	**NO**					
101	**Science, Technology and Mathematics**	**NO**					
102	Nature or Conceptions of Technology	**NO**			**X**	**X**	
103	Interactions of Science, Mathematics, & Technology	**NO**				**X**	
104	Mathematics, technology influence on science	**NO**		**X**			
105	Science applications in mathematics, technology	**NO**	**X**	**X**		**X**	
106	Interactions of Science, Technology and Society	**NO**				**X**	
107	Influence of science, technology on society	**NO**		**X**	**X**	**X**	**X**

Grade Spans 1-4							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
108	Influence of society on science, technology	**NO**			**X**	**X**	**X**
109	**History of Science and Technology**	**NO**			**X**	**X**	
110	**Environmental and Resource Issues Related to Science**	**NO**	**X**			**X**	
111	Pollution - Causes and Treatment	**NO**		**X**			**X**
112	Land, Water, Sea Resource Conservation	**YES**	**X**	**X**	**X**	**X**	**X**
113	Material & Energy Resource Conservation	**NO**	**X**	**X**	**X**	**X**	**X**
114	World Population	**NO**		**X**			**X**
115	Food Production, Storage	**NO**		**X**		**X**	**X**
116	Effects of Natural Disasters	**NO**	**X**	**X**			
117	**Nature of Science**	**NO**					
118	Nature of Scientific Knowledge	**NO**	**X**			**X**	**X**
119	The Scientific Enterprise	**NO**	**X**			**X**	
120	**Science and Other Disciplines**	**NO**					
121	Science & Mathematics	**NO**			**X**		
122	Science and Other Disciplines	**NO**					

Grade Spans 5-6							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
1	**Earth Sciences**	**NO**					
2	**Earth Features**	**NO**			**X**		**X**
3	Earth's composition	**NO**			**X**		
4	Landforms	**NO**			**X**		
5	Bodies of water	**NO**			**X**		**X**
6	Atmosphere	**NO**		**X**	**X**	**X**	
7	Rocks, soil	**NO**			**X**		**X**
8	Ice forms	**NO**					
9	**Earth Processes**	**NO**					**X**
10	Weather & climate	**YES**	**X**	**X**	**X**		**X**
11	Physical & Chemical Cycles	**YES**		**X**	**X**	**X**	
12	Constructive and Destructive Processes	**NO**					**X**
13	Earth's history	**NO**					**X**
14	**Earth and the Universe**	**NO**	**X**		**X**		
15	Earth, sun, moon	**YES**	**X**	**X**	**X**	**X**	**X**
16	Planets in the solar system	**NO**		**X**			
17	Beyond the solar system	**NO**			**X**		
18	Evolution of the universe	**NO**		**X**			
19	Motion/location of celestial bodies	**NO**		**X**			
20	**Life Sciences**	**NO**					

Grade Spans 5-6							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
21	**Diversity, Organization and Structure of Living Things**	**NO**	**X**		**X**		**X**
22	Plants	**YES**	**X**	**X**		**X**	**X**
23	Animals	**NO**	**X**				**X**
24	Other organisms	**NO**	**X**	**X**			
25	Systems, organs, tissues	**YES**	**X**	**X**	**X**	**X**	**X**
26	Cells	**NO**		**X**		**X**	
27	**Life Processes and Systems Enabling Life Functions**	**NO**	**X**				**X**
28	Energy handling, biochemistry of systems	**NO**		**X**	**X**	**X**	**X**
29	Sensing and responding	**NO**		**X**	**X**	**X**	
30	Biochemical processes in cells	**NO**		**X**	**X**		
31	**Life Spirals, Genetic Continuity and Diversity**	**NO**					
32	Life cycles	**NO**	**X**			**X**	**X**
33	Reproduction	**NO**			**X**	**X**	**X**
34	Variation and inheritance	**NO**				**X**	
35	Population genetics, biotechnology	**NO**					
36	Evolution, speciation, diversity	**NO**				**X**	
37	Biochemistry of genetics	**NO**					
38	Genetic engineering	**NO**					
39	**Interactions of Living Things**	**NO**			**X**		**X**
40	Biomes & ecosystems	**NO**	**X**	**X**	**X**	**X**	

Grade Spans 5-6							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
41	Habitats & niches	**YES**		**X**	**X**	**X**	**X**
42	Interdependence of life	**NO**	**X**			**X**	
43	Food webs, adaptations to habitats	**NO**			**X**	**X**	**X**
44	Competition among organisms	**NO**		**X**	**X**	**X**	**X**
45	Animal behavior	**NO**			**X**	**X**	
46	Needs of living things	**YES**	**X**	**X**	**X**	**X**	**X**
47	**Human Biology and Health**	**YES**	**X**	**X**	**X**	**X**	**X**
48	Human Nutrition	**NO**	**X**	**X**	**X**		
49	Human Disease and health	**NO**		**X**			
50	**Physical Sciences**	**NO**					
51	**Matter**	**NO**					
52	Classification of matter	**YES**	**X**	**X**	**X**		**X**
53	Physical properties	**NO**			**X**	**X**	
54	Chemical properties	**NO**		**X**	**X**		
55	Acids, Bases, Salts	**NO**		**X**			
56	**Structure of Matter**	**NO**					
57	Atoms, ions, molecules	**NO**			**X**		
58	Formulas/Equations/Nomenclature, Stoichiometry	**NO**					
59	Macromolecules	**NO**			**X**		
60	Subatomic particles	**NO**			**X**		

Grade Spans 5-6							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
61	**Energy and Physical Processes**	**NO**					
62	Energy types, conversions, sources	**NO**	**X**	**X**		**X**	
63	Work, Power, Simple machines	**YES**	**X**	**X**		**X**	**X**
64	Heat and temperature	**YES**		**X**	**X**	**X**	**X**
65	Wave phenomena	**NO**			**X**		
66	Sound & vibration	**NO**	**X**				
67	Light	**NO**	**X**	**X**	**X**		
68	Electricity	**YES**	**X**	**X**	**X**	**X**	**X**
69	Magnetism/electromagnetism	**NO**		**X**	**X**		**X**
70	**Physical Transformations**	**NO**					
71	Physical changes	**YES**	**X**	**X**	**X**	**X**	**X**
72	Explanations of physical changes	**YES**		**X**	**X**	**X**	**X**
73	Kinetic-molecular theory	**NO**					
74	Quantum theory & fundamental particles	**NO**					
75	**Chemical Transformations**	**NO**					
76	Chemical changes	**NO**	**X**		**X**		**X**
77	Definition & evidence of chemical change	**NO**		**X**	**X**		
78	Types of reactions	**NO**		**X**	**X**		**X**
79	Law of Conservation of Matter	**NO**		**X**	**X**		**X**
80	Explanations of chemical changes	**NO**					
81	Determinants/trends of chemical reactivity	**NO**					

Grade Spans 5-6							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
82	Rate of change and equilibria	**NO**		**X**	**X**		
83	Energy and chemical change	**NO**					
84	Calorimetry, exothermic/endothermic reactions	**NO**			**X**		
85	First law of thermodynamics	**NO**			**X**		
86	Second law of thermodynamics	**NO**					
87	Organic & biochemical changes	**NO**			**X**		
88	Nuclear chemistry	**NO**					
89	Electrochemistry	**NO**				**X**	
90	**Forces and Motion**	**NO**					
91	Types of forces	**NO**				**X**	
92	Contact forces and forces acting at a distance	**NO**			**X**	**X**	
93	Pressure - force applied to a surface	**NO**			**X**		
94	Time, space and motion	**YES**			**X**	**X**	**X**
95	Measurement of time/space/mass	**NO**		**X**			
96	Types of motion/describing motion	**NO**		**X**			
97	Frames of reference	**NO**			**X**		
98	Dynamics of motion	**YES**	**X**	**X**	**X**	**X**	**X**
99	Relativity theory	**NO**					
100	Air/fluid behavior	**NO**			**X**		
101	**Science, Technology and Mathematics**	**NO**					

Grade Spans 5-6							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
102	Nature or Conceptions of Technology	**YES**	**X**	**X**	**X**	**X**	
103	Interactions of Science, Mathematics, & Technology	**NO**					
104	Mathematics, technology influence on science	**NO**					
105	Science applications in mathematics, technology	**NO**	**X**				
106	Interactions of Science, Technology and Society	**NO**	**X**		**X**		
107	Influence of science, technology on society	**NO**	**X**			**X**	
108	Influence of society on science, technology	**NO**	**X**				
109	**History of Science and Technology**	**NO**			**X**		
110	**Environmental and Resource Issues Related to Science**	**NO**		**X**			
111	Pollution - Causes and Treatment	**NO**	**X**	**X**	**X**	**X**	
112	Land, Water, Sea Resource Conservation	**NO**	**X**		**X**		
113	Material & Energy Resource Conservation	**YES**	**X**	**X**	**X**		
114	World Population	**NO**					
115	Food Production, Storage	**NO**					
116	Effects of Natural Disasters	**NO**			**X**		
117	**Nature of Science**	**NO**					
118	Nature of Scientific Knowledge	**NO**	**X**		**X**	**X**	
119	The Scientific Enterprise	**NO**	**X**		**X**		

Grade Spans 5-6							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
120	**Science and Other Disciplines**	**NO**					
121	Science & Mathematics	**NO**					
122	Science and Other Disciplines	**NO**					

Grade Spans 5-6						
Number	**Text**	**YES (>66%)**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**
1	**Earth Sciences**	**NO**				
2	**Earth Features**	**NO**	**X**		**X**	**X**
3	Earth's composition	**NO**				
4	Landforms	**NO**				
5	Bodies of water	**NO**	**X**			
6	Atmosphere	**NO**	**X**			
7	Rocks, soil	**NO**	**X**		**X**	
8	Ice forms	**NO**	**X**			
9	**Earth Processes**	**NO**			**X**	**X**
10	Weather & climate	**YES**	**X**	**X**	**X**	
11	Physical & Chemical Cycles	**YES**	**X**	**X**	**X**	
12	Constructive and Destructive Processes	**NO**			**X**	
13	Earth's history	**NO**	**X**	**X**	**X**	
14	**Earth and the Universe**	**NO**				**X**

Grade Spans 5-6						
Number	**Text**	**YES (>66%)**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**
15	Earth, sun, moon	**YES**		**X**	**X**	
16	Planets in the solar system	**NO**	**X**		**X**	
17	Beyond the solar system	**NO**				
18	Evolution of the universe	**NO**				
19	Motion/location of celestial bodies	**NO**		**X**	**X**	
20	**Life Sciences**	**NO**				
21	**Diversity, Organization and Structure of Living Things**	**NO**	**X**		**X**	**X**
22	Plants	**YES**	**X**	**X**		
23	Animals	**NO**	**X**	**X**	**X**	
24	Other organisms	**NO**	**X**	**X**	**X**	
25	Systems, organs, tissues	**YES**			**X**	
26	Cells	**NO**				
27	**Life Processes and Systems Enabling Life Functions**	**NO**	**X**	**X**		
28	Energy handling, biochemistry of systems	**NO**			**X**	
29	Sensing and responding	**NO**	**X**		**X**	
30	Biochemical processes in cells	**NO**				
31	**Life Spirals, Genetic Continuity and Diversity**	**NO**		**X**		
32	Life cycles	**NO**		**X**	**X**	**X**
33	Reproduction	**NO**				
34	Variation and inheritance	**NO**				

Grade Spans 5-6						
Number	**Text**	**YES (>66%)**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**
35	Population genetics, biotechnology	**NO**				
36	Evolution, speciation, diversity	**NO**	**X**	**X**	**X**	
37	Biochemistry of genetics	**NO**				
38	Genetic engineering	**NO**				
39	**Interactions of Living Things**	**NO**			**X**	**X**
40	Biomes & ecosystems	**NO**			**X**	
41	Habitats & niches	**YES**	**X**	**X**		
42	Interdependence of life	**NO**		**X**		
43	Food webs, adaptations to habitats	**NO**		**X**		
44	Competition among organisms	**NO**		**X**		
45	Animal behavior	**NO**		**X**		
46	Needs of living things	**YES**		**X**	**X**	
47	**Human Biology and Health**	**YES**	**X**	**X**	**X**	
48	Human Nutrition	**NO**		**X**	**X**	
49	Human Disease and health	**NO**		**X**	**X**	
50	**Physical Sciences**	**NO**				
51	**Matter**	**NO**			**X**	
52	Classification of matter	**YES**	**X**	**X**	**X**	
53	Physical properties	**NO**	**X**	**X**	**X**	**X**
54	Chemical properties	**NO**	**X**		**X**	**X**
55	Acids, Bases, Salts	**NO**		**X**		

Grade Spans 5-6						
Number	**Text**	**YES (>66%)**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**
56	**Structure of Matter**	**NO**	**X**			
57	Atoms, ions, molecules	**NO**				
58	Formulas/Equations/Nomenclature, Stoichiometry	**NO**				
59	Macromolecules	**NO**				
60	Subatomic particles	**NO**				
61	**Energy and Physical Processes**	**NO**		**X**	**X**	
62	Energy types, conversions, sources	**NO**		**X**	**X**	**X**
63	Work, Power, Simple machines	**YES**		**X**	**X**	
64	Heat and temperature	**YES**	**X**	**X**	**X**	**X**
65	Wave phenomena	**NO**	**X**			
66	Sound & vibration	**NO**	**X**		**X**	
67	Light	**NO**	**X**	**X**		
68	Electricity	**YES**	**X**	**X**	**X**	
69	Magnetism/electromagnetism	**NO**	**X**		**X**	
70	**Physical Transformations**	**NO**				
71	Physical changes	**YES**			**X**	**X**
72	Explanations of physical changes	**YES**		**X**	**X**	
73	Kinetic-molecular theory	**NO**				
74	Quantum theory & fundamental particles	**NO**				
75	**Chemical Transformations**	**NO**				
76	Chemical changes	**NO**			**X**	**X**

Grade Spans 5-6						
Number	**Text**	**YES (>66%)**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**
77	Definition & evidence of chemical change	**NO**				
78	Types of reactions	**NO**			**X**	
79	Law of Conservation of Matter	**NO**			**X**	
80	Explanations of chemical changes	**NO**				
81	Determinants/trends of chemical reactivity	**NO**				
82	Rate of change and equilibria	**NO**				
83	Energy and chemical change	**NO**				
84	Calorimetry, exothermic/endothermic reactions	**NO**				
85	First law of thermodynamics	**NO**				
86	Second law of thermodynamics	**NO**				
87	Organic & biochemical changes	**NO**				
88	Nuclear chemistry	**NO**				
89	Electrochemistry	**NO**				
90	**Forces and Motion**	**NO**		**X**	**X**	**X**
91	Types of forces	**NO**	**X**		**X**	
92	Contact forces and forces acting at a distance	**NO**		**X**	**X**	
93	Pressure - force applied to a surface	**NO**				
94	Time, space and motion	**YES**	**X**	**X**	**X**	
95	Measurement of time/space/mass	**NO**				
96	Types of motion/describing motion	**NO**		**X**	**X**	
97	Frames of reference	**NO**				

Grade Spans 5-6						
Number	**Text**	**YES (>66%)**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**
98	Dynamics of motion	**YES**	**X**	**X**	**X**	
99	Relativity theory	**NO**				
100	Air/fluid behavior	**NO**			**X**	
101	**Science, Technology and Mathematics**	**NO**				
102	Nature or Conceptions of Technology	**YES**	**X**	**X**	**X**	
103	Interactions of Science, Mathematics, & Technology	**NO**			**X**	
104	Mathematics, technology influence on science	**NO**				
105	Science applications in mathematics, technology	**NO**	**X**	**X**	**X**	
106	Interactions of Science, Technology and Society	**NO**			**X**	**X**
107	Influence of science, technology on society	**NO**			**X**	**X**
108	Influence of society on science, technology	**NO**			**X**	
109	**History of Science and Technology**	**NO**			**X**	
110	**Environmental and Resource Issues Related to Science**	**NO**	**X**	**X**	**X**	
111	Pollution - Causes and Treatment	**NO**		**X**		**X**
112	Land, Water, Sea Resource Conservation	**NO**	**X**	**X**		**X**
113	Material & Energy Resource Conservation	**YES**	**X**	**X**	**X**	**X**
114	World Population	**NO**				**X**
115	Food Production, Storage	**NO**	**X**	**X**	**X**	**X**

Grade Spans 5-6						
Number	**Text**	**YES (>66%)**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**
116	Effects of Natural Disasters	**NO**				
117	**Nature of Science**	**NO**				
118	Nature of Scientific Knowledge	**NO**	**X**		**X**	
119	The Scientific Enterprise	**NO**	**X**		**X**	
120	**Science and Other Disciplines**	**NO**				
121	Science & Mathematics	**NO**		**X**		
122	Science and Other Disciplines	**NO**				

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
1	**Earth Sciences**	**NO**					
2	**Earth Features**	**NO**	**X**	**X**	**X**		**X**
3	Earth's composition	**NO**		**X**	**X**		**X**
4	Landforms	**NO**		**X**	**X**		
5	Bodies of water	**NO**		**X**	**X**		
6	Atmosphere	**YES**		**X**	**X**		**X**
7	Rocks, soil	**NO**		**X**	**X**		**X**
8	Ice forms	**NO**		**X**			
9	**Earth Processes**	**NO**	**X**				**X**
10	Weather & climate	**YES**		**X**	**X**		**X**
11	Physical & Chemical Cycles	**YES**		**X**	**X**		**X**
12	Constructive and Destructive Processes	**NO**		**X**	**X**		**X**
13	Earth's history	**NO**		**X**	**X**		**X**
14	**Earth and the Universe**	**NO**		**X**			
15	Earth, sun, moon	**YES**	**X**	**X**	**X**		**X**
16	Planets in the solar system	**YES**	**X**	**X**			**X**
17	Beyond the solar system	**NO**		**X**			**X**
18	Evolution of the universe	**NO**		**X**			
19	Motion/location of celestial bodies	**NO**		**X**	**X**		**X**
20	**Life Sciences**	**NO**		**X**			
21	**Diversity, Organization and Structure of Living Things**	**YES**	**X**	**X**	**X**	**X**	**X**
22	Plants	**NO**			**X**		**X**
23	Animals	**NO**			**X**		**X**

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
24	Other organisms	**NO**			**X**	**X**	**X**
25	Systems, organs, tissues	**YES**		**X**	**X**	**X**	**X**
26	Cells	**YES**	**X**	**X**	**X**	**X**	**X**
27	**Life Processes and Systems Enabling Life Functions**	**NO**	**X**				
28	Energy handling, biochemistry of systems	**YES**		**X**	**X**	**X**	**X**
29	Sensing and responding	**NO**		**X**	**X**		**X**
30	Biochemical processes in cells	**NO**		**X**	**X**	**X**	**X**
31	**Life Spirals, Genetic Continuity and Diversity**	**NO**					
32	Life cycles	**YES**	**X**	**X**	**X**	**X**	**X**
33	Reproduction	**YES**		**X**	**X**	**X**	**X**
34	Variation and inheritance	**YES**	**X**	**X**		**X**	**X**
35	Population genetics, biotechnology	**NO**	**X**	**X**			
36	Evolution, speciation, diversity	**NO**		**X**	**X**	**X**	
37	Biochemistry of genetics	**YES**	**X**	**X**	**X**	**X**	**X**
38	Genetic engineering	**NO**					
39	**Interactions of Living Things**	**NO**			**X**		**X**
40	Biomes & ecosystems	**YES**	**X**	**X**		**X**	**X**
41	Habitats & niches	**YES**		**X**	**X**	**X**	**X**
42	Interdependence of life	**NO**		**X**	**X**		**X**
43	Food webs, adaptations to habitats	**NO**		**X**		**X**	**X**
44	Competition among organisms	**NO**				**X**	**X**
45	Animal behavior	**NO**			**X**		**X**
46	Needs of living things	**YES**	**X**	**X**	**X**	**X**	**X**
47	**Human Biology and Health**	**YES**	**X**	**X**	**X**	**X**	**X**

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
48	Human Nutrition	**NO**	**X**		**X**		**X**
49	Human Disease and health	**NO**		**X**	**X**		**X**
50	**Physical Sciences**	**NO**					
51	**Matter**	**NO**					**X**
52	Classification of matter	**YES**	**X**	**X**	**X**	**X**	**X**
53	Physical properties	**YES**	**X**	**X**	**X**	**X**	**X**
54	Chemical properties	**YES**	**X**	**X**	**X**	**X**	**X**
55	Acids, Bases, Salts	**NO**		**X**	**X**	**X**	
56	**Structure of Matter**	**NO**					**X**
57	Atoms, ions, molecules	**YES**		**X**	**X**	**X**	**X**
58	Formulas/Equations/Nomenclature, Stoichiometry	**NO**		**X**	**X**	**X**	**X**
59	Macromolecules	**NO**			**X**		
60	Subatomic particles	**NO**		**X**		**X**	**X**
61	**Energy and Physical Processes**	**NO**					**X**
62	Energy types, conversions, sources	**YES**	**X**	**X**	**X**	**X**	**X**
63	Work, Power, Simple machines	**YES**	**X**	**X**	**X**	**X**	**X**
64	Heat and temperature	**YES**		**X**	**X**	**X**	**X**
65	Wave phenomena	**NO**		**X**	**X**		**X**
66	Sound & vibration	**NO**		**X**	**X**		**X**
67	Light	**YES**		**X**	**X**	**X**	**X**
68	Electricity	**YES**		**X**	**X**	**X**	**X**
69	Magnetism/electromagnetism	**YES**		**X**	**X**	**X**	**X**
70	**Physical Transformations**	**NO**					**X**
71	Physical changes	**YES**		**X**	**X**	**X**	**X**

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
72	Explanations of physical changes	**NO**		**X**	**X**	**X**	**X**
73	Kinetic-molecular theory	**NO**			**X**		
74	Quantum theory & fundamental particles	**NO**					
75	**Chemical Transformations**	**NO**					**X**
76	Chemical changes	**YES**	**X**	**X**	**X**		**X**
77	Definition & evidence of chemical change	**YES**		**X**	**X**	**X**	**X**
78	Types of reactions	**YES**	**X**	**X**	**X**	**X**	**X**
79	Law of Conservation of Matter	**NO**		**X**			**X**
80	Explanations of chemical changes	**NO**					**X**
81	Determinants/trends of chemical reactivity	**NO**				**X**	
82	Rate of change and equilibria	**NO**		**X**	**X**		
83	Energy and chemical change	**NO**			**X**		
84	Calorimetry, exothermic/endothermic reactions	**NO**			**X**		
85	First law of thermodynamics	**NO**	**X**	**X**		**X**	**X**
86	Second law of thermodynamics	**NO**		**X**			
87	Organic & biochemical changes	**NO**			**X**		
88	Nuclear chemistry	**NO**					**X**
89	Electrochemistry	**NO**		**X**	**X**		**X**
90	**Forces and Motion**	**NO**					
91	Types of forces	**NO**					**X**
92	Contact forces and forces acting at a distance	**NO**	**X**	**X**	**X**	**X**	
93	Pressure - force applied to a surface	**NO**			**X**	**X**	
94	Time, space and motion	**NO**			**X**	**X**	
95	Measurement of time/space/mass	**NO**			**X**	**X**	**X**

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
96	Types of motion/describing motion	**NO**		**X**	**X**	**X**	**X**
97	Frames of reference	**NO**					**X**
98	Dynamics of motion	**YES**	**X**	**X**	**X**	**X**	**X**
99	Relativity theory	**NO**					
100	Air/fluid behavior	**NO**		**X**		**X**	**X**
101	**Science, Technology and Mathematics**	**NO**					
102	Nature or Conceptions of Technology	**YES**	**X**	**X**	**X**	**X**	**X**
103	Interactions of Science, Mathematics, & Technology	**NO**	**X**				
104	Mathematics, technology influence on science	**NO**	**X**	**X**			
105	Science applications in mathematics, technology	**YES**	**X**	**X**		**X**	**X**
106	Interactions of Science, Technology and Society	**NO**	**X**		**X**		
107	Influence of science, technology on society	**YES**	**X**	**X**		**X**	**X**
108	Influence of society on science, technology	**NO**	**X**	**X**		**X**	**X**
109	**History of Science and Technology**	**NO**		**X**	**X**	**X**	**X**
110	**Environmental and Resource Issues Related to Science**	**NO**	**X**				**X**
111	Pollution - Causes and Treatment	**YES**	**X**	**X**	**X**		**X**
112	Land, Water, Sea Resource Conservation	**YES**	**X**	**X**	**X**	**X**	**X**
113	Material & Energy Resource Conservation	**YES**	**X**	**X**	**X**	**X**	**X**
114	World Population	**NO**	**X**	**X**	**X**		
115	Food Production, Storage	**YES**	**X**	**X**	**X**		**X**

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 1***	**Economy 2***	**Economy 3***	**Economy 4***	**Economy 5***
116	Effects of Natural Disasters	**NO**	**X**	**X**			
117	**Nature of Science**	**NO**					
118	Nature of Scientific Knowledge	**YES**	**X**	**X**	**X**	**X**	**X**
119	The Scientific Enterprise	**YES**	**X**	**X**	**X**	**X**	**X**
120	**Science and Other Disciplines**	**NO**					
121	Science & Mathematics	**NO**					
122	Science and Other Disciplines	**NO**					**X**

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
1	**Earth Sciences**	**NO**					
2	**Earth Features**	**NO**			**X**	**X**	
3	Earth's composition	**NO**	**X**	**X**		**X**	
4	Landforms	**NO**	**X**	**X**			
5	Bodies of water	**NO**	**X**	**X**	**X**		
6	Atmosphere	**YES**	**X**	**X**	**X**	**X**	
7	Rocks, soil	**NO**		**X**	**X**	**X**	
8	Ice forms	**NO**				**X**	
9	**Earth Processes**	**NO**	**X**			**X**	
10	Weather & climate	**YES**	**X**	**X**	**X**	**X**	
11	Physical & Chemical Cycles	**YES**	**X**	**X**	**X**	**X**	
12	Constructive and Destructive Processes	**NO**		**X**		**X**	**X**
13	Earth's history	**NO**		**X**	**X**	**X**	**X**
14	**Earth and the Universe**	**NO**			**X**	**X**	

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
15	Earth, sun, moon	**YES**	**X**	**X**	**X**	**X**	**X**
16	Planets in the solar system	**YES**	**X**	**X**	**X**	**X**	
17	Beyond the solar system	**NO**	**X**		**X**	**X**	
18	Evolution of the universe	**NO**	**X**		**X**	**X**	**X**
19	Motion/location of celestial bodies	**NO**			**X**	**X**	
20	**Life Sciences**	**NO**					
21	**Diversity, Organization and Structure of Living Things**	**YES**	**X**		**X**	**X**	**X**
22	Plants	**NO**	**X**		**X**		
23	Animals	**NO**	**X**		**X**		
24	Other organisms	**NO**	**X**		**X**		
25	Systems, organs, tissues	**YES**	**X**	**X**	**X**	**X**	**X**
26	Cells	**YES**	**X**	**X**	**X**	**X**	**X**
27	**Life Processes and Systems Enabling Life Functions**	**NO**	**X**			**X**	
28	Energy handling, biochemistry of systems	**YES**		**X**	**X**	**X**	
29	Sensing and responding	**NO**		**X**	**X**	**X**	**X**
30	Biochemical processes in cells	**NO**			**X**	**X**	
31	**Life Spirals, Genetic Continuity and Diversity**	**NO**				**X**	
32	Life cycles	**YES**	**X**	**X**	**X**	**X**	
33	Reproduction	**YES**	**X**	**X**	**X**	**X**	
34	Variation and inheritance	**YES**	**X**	**X**	**X**		**X**
35	Population genetics, biotechnology	**NO**	**X**		**X**	**X**	
36	Evolution, speciation, diversity	**NO**	**X**	**X**	**X**		**X**

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
37	Biochemistry of genetics	**YES**	**X**			**X**	
38	Genetic engineering	**NO**					
39	**Interactions of Living Things**	**NO**	**X**	**X**			
40	Biomes & ecosystems	**YES**	**X**		**X**	**X**	
41	Habitats & niches	**YES**	**X**	**X**	**X**	**X**	**X**
42	Interdependence of life	**NO**	**X**		**X**	**X**	**X**
43	Food webs, adaptations to habitats	**NO**		**X**	**X**	**X**	**X**
44	Competition among organisms	**NO**		**X**	**X**	**X**	
45	Animal behavior	**NO**			**X**		
46	Needs of living things	**YES**	**X**	**X**	**X**	**X**	
47	**Human Biology and Health**	**YES**	**X**		**X**	**X**	
48	Human Nutrition	**NO**			**X**		
49	Human Disease and health	**NO**			**X**		
50	**Physical Sciences**	**NO**	**X**				
51	**Matter**	**NO**	**X**		**X**	**X**	
52	Classification of matter	**YES**	**X**	**X**	**X**	**X**	
53	Physical properties	**YES**	**X**	**X**	**X**	**X**	**X**
54	Chemical properties	**YES**	**X**	**X**	**X**	**X**	**X**
55	Acids, Bases, Salts	**NO**		**X**	**X**	**X**	
56	**Structure of Matter**	**NO**	**X**		**X**	**X**	
57	Atoms, ions, molecules	**YES**	**X**	**X**	**X**	**X**	
58	Formulas/Equations/Nomenclature, Stoichiometry	**NO**			**X**	**X**	
59	Macromolecules	**NO**	**X**				
60	Subatomic particles	**NO**	**X**			**X**	

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
61	**Energy and Physical Processes**	**NO**	**X**				
62	Energy types, conversions, sources	**YES**		**X**	**X**	**X**	**X**
63	Work, Power, Simple machines	**YES**			**X**	**X**	
64	Heat and temperature	**YES**		**X**	**X**	**X**	**X**
65	Wave phenomena	**NO**	**X**		**X**	**X**	**X**
66	Sound & vibration	**NO**	**X**	**X**	**X**		**X**
67	Light	**YES**	**X**		**X**	**X**	**X**
68	Electricity	**YES**	**X**		**X**	**X**	**X**
69	Magnetism/electromagnetism	**YES**		**X**	**X**	**X**	**X**
70	**Physical Transformations**	**NO**	**X**				**X**
71	Physical changes	**YES**		**X**	**X**	**X**	**X**
72	Explanations of physical changes	**NO**			**X**	**X**	**X**
73	Kinetic-molecular theory	**NO**		**X**	**X**		**X**
74	Quantum theory & fundamental particles	**NO**					
75	**Chemical Transformations**	**NO**	**X**		**X**		**X**
76	Chemical changes	**YES**	**X**		**X**	**X**	**X**
77	Definition & evidence of chemical change	**YES**		**X**	**X**	**X**	
78	Types of reactions	**YES**			**X**	**X**	
79	Law of Conservation of Matter	**NO**					**X**
80	Explanations of chemical changes	**NO**	**X**		**X**		**X**
81	Determinants/trends of chemical reactivity	**NO**					
82	Rate of change and equilibria	**NO**	**X**		**X**	**X**	
83	Energy and chemical change	**NO**	**X**				
84	Calorimetry, exothermic/endothermic reactions	**NO**					

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
85	First law of thermodynamics	**NO**		**X**		**X**	**X**
86	Second law of thermodynamics	**NO**					
87	Organic & biochemical changes	**NO**				**X**	
88	Nuclear chemistry	**NO**		**X**			
89	Electrochemistry	**NO**	**X**				
90	**Forces and Motion**	**NO**	**X**			**X**	
91	Types of forces	**NO**	**X**		**X**		**X**
92	Contact forces and forces acting at a distance	**NO**		**X**	**X**		**X**
93	Pressure - force applied to a surface	**NO**			**X**	**X**	
94	Time, space and motion	**NO**	**X**		**X**		
95	Measurement of time/space/mass	**NO**		**X**	**X**		
96	Types of motion/describing motion	**NO**		**X**		**X**	
97	Frames of reference	**NO**					
98	Dynamics of motion	**YES**	**X**	**X**	**X**	**X**	**X**
99	Relativity theory	**NO**					
100	Air/fluid behavior	**NO**			**X**	**X**	
101	**Science, Technology and Mathematics**	**NO**					
102	Nature or Conceptions of Technology	**YES**	**X**		**X**	**X**	
103	Interactions of Science, Mathematics, & Technology	**NO**			**X**	**X**	
104	Mathematics, technology influence on science	**NO**				**X**	
105	Science applications in mathematics, technology	**YES**	**X**		**X**	**X**	
106	Interactions of Science, Technology and Society	**NO**	**X**		**X**	**X**	

Grade Spans 7-10							
Number	**Text**	**Core >66%**	**Economy 6**	**Economy 7**	**Economy 8**	**Economy 9**	**Economy 10**
107	Influence of science, technology on society	**YES**	**X**	**X**	**X**	**X**	**X**
108	Influence of society on science, technology	**NO**			**X**	**X**	**X**
109	**History of Science and Technology**	**NO**			**X**	**X**	**X**
110	**Environmental and Resource Issues Related to Science**	**NO**	**X**			**X**	
111	Pollution - Causes and Treatment	**YES**	**X**	**X**	**X**		**X**
112	Land, Water, Sea Resource Conservation	**YES**	**X**	**X**	**X**		**X**
113	Material & Energy Resource Conservation	**YES**	**X**	**X**	**X**	**X**	**X**
114	World Population	**NO**	**X**	**X**	**X**		**X**
115	Food Production, Storage	**YES**	**X**	**X**		**X**	**X**
116	Effects of Natural Disasters	**NO**	**X**			**X**	
117	**Nature of Science**	**NO**					
118	Nature of Scientific Knowledge	**YES**	**X**		**X**	**X**	**X**
119	The Scientific Enterprise	**YES**	**X**		**X**	**X**	**X**
120	**Science and Other Disciplines**	**NO**					
121	Science & Mathematics	**NO**			**X**	**X**	
122	Science and Other Disciplines	**NO**			**X**	**X**	

Grade Spans 10-12: Biology						
Number	**Text**	**Economy 1**	**Economy 2**	**Economy 3**	**Economy 4**	**Economy 5**
1.	**Earth Sciences**					
2.	**Earth Features**					
3.	Earth's composition					
4.	Landforms				**X**	
5.	Bodies of water					
6.	Atmosphere					
7.	Rocks, soil					
8.	Ice forms					
9.	**Earth Processes**					
10.	Weather & climate			**X**	**X**	
11.	Physical & Chemical Cycles	**X**				
12.	Constructive and Destructive Processes					
13.	Earth's history				**X**	
14.	**Earth and the Universe**					
15.	Earth, sun, moon	**X**				
16.	Planets in the solar system					
17.	Beyond the solar system					
18.	Evolution of the universe					
19.	Motion/location of celestial bodies					
20.	**Life Sciences**	**X**				**X**
21.	**Diversity, Organization and Structure of Living Things**	**X**	**X**	**X**	**X**	
22.	Plants	**X**	**X**	**X**	**X**	**X**

Grade Spans 10-12: Biology						
Number	**Text**	**Economy 1**	**Economy 2**	**Economy 3**	**Economy 4**	**Economy 5**
23.	Animals	X	X	X	X	X
24.	Other organisms	X	X	X	X	X
25.	Systems, organs, tissues	X	X	X	X	X
26.	Cells	X	X	X	X	X
27.	**Life Processes and Systems Enabling Life Functions**	X		X		
28.	Energy handling, biochemistry of systems	X	X	X	X	X
29.	Sensing and responding	X	X	X	X	X
30.	Biochemical processes in cells	X	X	X	X	X
31.	**Life Spirals, Genetic Continuity and Diversity**					X
32.	Life cycles	X	X	X	X	X
33.	Reproduction	X	X	X	X	X
34.	Variation and inheritance	X	X	X	X	X
35.	Population genetics, biotechnology	X		X	X	X
36.	Evolution, speciation, diversity	X	X	X	X	X
37.	Biochemistry of genetics	X	X	X	X	X
38.	Genetic engineering	X	X	X	X	X
39.	**Interactions of Living Things**			X		X
40.	Biomes & ecosystems	X	X	X	X	X
41.	Habitats & niches	X	X	X	X	X
42.	Interdependence of life	X	X	X		X

Grade Spans 10-12: Biology						
Number	**Text**	**Economy 1**	**Economy 2**	**Economy 3**	**Economy 4**	**Economy 5**
43.	Food webs, adaptations to habitats	**X**	**X**	**X**	**X**	**X**
44.	Competition among organisms	**X**	**X**	**X**	**X**	**X**
45.	Animal behavior				**X**	
46.	Needs of living things	**X**	**X**	**X**	**X**	**X**
47.	**Human Biology and Health**	**X**	**X**	**X**	**X**	
48.	Human Nutrition	**X**	**X**	**X**	**X**	
49.	Human Disease and health	**X**	**X**	**X**	**X**	**X**
50.	**Physical Sciences**					
51.	**Matter**					
52.	Classification of matter					
53.	Physical properties					
54.	Chemical properties					
55.	Acids, Bases, Salts					
56.	**Structure of Matter**					
57.	Atoms, ions, molecules					
58.	Formulas/Equations/Nomenclature, Stoichiometry					
59.	Macromolecules					
60.	Subatomic particles					
61.	**Energy and Physical Processes**					
62.	Energy types, conversions, sources					
63.	Work, Power, Simple machines					
64.	Heat and temperature					

Grade Spans 10-12: Biology						
Number	**Text**	**Economy 1**	**Economy 2**	**Economy 3**	**Economy 4**	**Economy 5**
65.	Wave phenomena					
66.	Sound & vibration					
67.	Light					
68.	Electricity					
69.	Magnetism/electromagnetism					
70.	**Physical Transformations**					
71.	Physical changes					
72.	Explanations of physical changes					
73.	Kinetic-molecular theory					
74.	Quantum theory & fundamental particles					
75.	**Chemical Transformations**					
76.	Chemical changes					
77.	Definition & evidence of chemical change					
78.	Types of reactions					
79.	Law of Conservation of Matter					
80.	Explanations of chemical changes					
81.	Determinants/trends of chemical reactivity					
82.	Rate of change and equilibria				**X**	
83.	Energy and chemical change					

Grade Spans 10-12: Biology						
Number	**Text**	**Economy 1**	**Economy 2**	**Economy 3**	**Economy 4**	**Economy 5**
84.	Calorimetry, exothermic/endothermic reactions					
85.	First law of thermodynamics					
86.	Second law of thermodynamics					
87.	Organic & biochemical changes	**X**				
88.	Nuclear chemistry					
89.	Electrochemistry					
90.	**Forces and Motion**					
91.	Types of forces					
92.	Contact forces and forces acting at a distance					
93.	Pressure - force applied to a surface					
94.	Time, space and motion					
95.	Measurement of time/space/mass			**X**		
96.	Types of motion/describing motion					
97.	Frames of reference					
98.	Dynamics of motion					
99.	Relativity theory					
100.	Air/fluid behavior					
101.	**Science, Technology and Mathematics**					
102.	Nature or Conceptions of Technology	**X**		**X**	**X**	

Grade Spans 10-12: Biology						
Number	**Text**	**Economy 1**	**Economy 2**	**Economy 3**	**Economy 4**	**Economy 5**
103.	Interactions of Science, Mathematics, & Technology					
104.	Mathematics, technology influence on science	X			X	
105.	Science applications in mathematics, technology	X			X	
106.	Interactions of Science, Technology and Society			X		
107.	Influence of science, technology on society	X		X	X	
108.	Influence of society on science, technology	X			X	
109.	**History of Science and Technology**	X	X	X	X	
110.	**Environmental and Resource Issues Related to Science**	X		X	X	X
111.	Pollution - Causes and Treatment	X	X	X	X	
112.	Land, Water, Sea Resource Conservation	X	X	X	X	
113.	Material & Energy Resource Conservation	X	X			
114.	World Population	X	X		X	
115.	Food Production, Storage	X	X	X	X	
116.	Effects of Natural Disasters		X		X	

Grade Spans 10-12: Biology						
Number	**Text**	**Economy 1**	**Economy 2**	**Economy 3**	**Economy 4**	**Economy 5**
117.	**Nature of Science**					
118.	Nature of Scientific Knowledge	**X**		**X**	**X**	**X**
119.	The Scientific Enterprise	**X**	**X**	**X**	**X**	
120.	**Science and Other Disciplines**					
121.	Science & Mathematics					
122.	Science and Other Disciplines					

APPENDIX F: PERFORMANCE SKILL DATA MATHEMATICS

In addition to the content, Achieve also analyzed the performance, or cognitive skill, expectations of the standards from the 12 economies in this study. Our goal was to determine the balance of basic skills, such as recall and advanced skills, such as applying advanced mathematical reasoning, across all economies.

Level of Cognitive Demand	1-6 Average	7-9 Average	10-12 Average	Low end of range	High end of range
Recall	36%	42%	33%	33%	42%
Representing	8%	7%	4%	4%	7%
Recognizing equivalents	9%	6%	3%	3%	6%
Recalling mathematical objects and properties	11%	18%	13%	11%	18%
Using vocabulary and notation	8%	11%	12%	8%	12%
Using Routine Procedures and Tools to Solve Problems	46%	37%	40%	37%	40%
Using equipment	0%	0%	0%	0%	0%
Using instruments, for example, measuring instruments	3%	2%	0%	0%	2%
Using computational devices	0%	3%	1%	0%	3%
Performing routine procedures	0%	0%	0%	0%	0%
Counting	3%	0%	1%	0%	1%
Computing	17%	12%	8%	8%	12%
Graphing	0%	2%	5%	0%	5%
Transforming	1%	5%	9%	1%	9%
Measuring	5%	2%	0%	0%	2%
Solving	6%	4%	5%	4%	5%
Predicting	2%	1%	2%	1%	2%
Relating representations	2%	3%	7%	2%	7%
Describing/discussing	7%	3%	2%	2%	3%
Using More Complex Procedures and Conceptual Understandings to Solve Problems	14%	9%	11%	9%	11%
Using more complex procedures	0%	0%	0%	0%	0%

Level of Cognitive Demand	1-6 Average	7-9 Average	10-12 Average	Low end of range	High end of range
Estimating	5%	2%	1%	1%	2%
Using data	3%	4%	5%	3%	5%
Comparing	5%	2%	2%	2%	2%
Classifying	1%	1%	2%	1%	2%
Formulating Problems and Strategizing/Critiquing Solution Methods	4%	9%	13%	4%	13%
Formulating and clarifying problems and situations	2%	7%	11%	2%	11%
Developing strategy	1%	0%	1%	0%	1%
Verifying	1%	1%	1%	1%	1%
Developing notation and vocabulary	0%	0%	0%	0%	0%
Critiquing	0%	1%	1%	0%	1%
Applying Advanced Reasoning Skills	1%	3%	4%	1%	4%
Developing algorithms	0%	0%	1%	0%	1%
Generalizing	0%	1%	1%	0%	1%
Conjecturing	0%	0%	1%	0%	1%
Justifying and proving	0%	2%	1%	0%	2%
Axiomatizing	0%	0%	0%	0%	0%
	100%	100%	100%		

APPENDIX F (CONTINUED): PERFORMANCE SKILL DATA SCIENCE

Science performance expectations can be viewed as falling into two major categories – Science Inquiry and Science Knowledge. The Science Inquiry category is concerned with the skills essential for learning how to conduct research, whereas the Science Knowledge category includes the various kinds of performances involved in learning science content.

Level of Cognitive Demand	1-4 Average	5-6 Average	7-10 Average	Biology Average	Low End of Range	High End of Range
ACQUIRING SCIENCE KNOWLEDGE						
Recalling simple information	31%	30%	31%	26%	26%	31%
Accessing information	2%	3%	2%	2%	2%	3%
ACQUIRING KNOWLEDGE	33%	33%	32%	28%	28%	33%
INTERPRETING SCIENCE KNOWLEDGE						
Comprehending complex information	19%	18%	25%	31%	18%	31%
Organizing and representing data	4%	3%	3%	4%	3%	4%
Interpreting data	2%	2%	2%	1%	1%	2%
Processing and sharing information	4%	4%	1%	3%	1%	4%
INTERPRETING KNOWLEDGE	29%	27%	31%	40%	27%	40%
APPLYING SCIENCE KNOWLEDGE						
Applying scientific principles to solve quantitative problems	1%	0%	2%	1%	0%	2%
Applying scientific principles to develop explanations	1%	2%	3%	1%	1%	3%
Using science and technology principles to solve practical problems	2%	2%	1%	0%	0%	2%
	4%	4%	6%	3%	3%	6%

Level of Cognitive Demand	1-4 Average	5-6 Average	7-10 Average	Biology Average	Low End of Range	High End of Range
APPLYING KNOWLEDGE						
ANALYZING SCIENCE KNOWLEDGE						
Understanding thematic information	0%	0%	1%	5%	0%	5%
Constructing, interpreting, and applying models	3%	3%	2%	2%	2%	3%
Making decisions	1%	2%	1%	1%	1%	2%
Engaging in reasoned debate	0%	1%	1%	4%	0%	4%
ANALYZING KNOWLEDGE	4%	6%	6%	11%	4%	11%
CONSTRUCTING SCIENCE KNOWLEDGE						
Abstracting and deducing scientific principles	3%	4%	2%	0%	0%	4%
CONSTRUCTING KNOWLEDGE	3%	4%	2%	0%	0%	4%
SCIENTIFIC INQUIRY (RESEARCH)						
BASIC SKILLS						
Using apparatus, equipment, and computers	5%	5%	4%	1%	1%	5%
Conducting routine experimental operations	7%	8%	7%	5%	5%	8%
Gathering data	9%	7%	6%	4%	4%	9%
BASIC INQUIRY SKILLS	21%	20%	17%	11%	11%	21%
ADVANCED SKILLS						
Identifying questions to investigate	1%	2%	2%	1%	1%	2%
Designing investigations	1%	2%	2%	3%	1%	3%
Conducting investigations	1%	1%	1%	1%	1%	1%
Interpreting investigational data	1%	1%	0%	1%	0%	1%
Formulating conclusions from investigational data	1%	1%	1%	1%	1%	1%

Level of Cognitive Demand	1-4 Average	5-6 Average	7-10 Average	Biology Average	Low End of Range	High End of Range
ADVANCED INQUIRY SKILLS	6%	7%	6%	8%	6%	8%

APPENDIX G: THE CODING FRAMEWORK

The strands (large categories) and codes (numbered statements) for content and performance skills were developed at Michigan State University with participation of subject matter experts from many countries, as part of the Survey of Mathematics and Science Survey (SMSO). The frameworks (mathematics and science) were later adapted for use in the Third International Mathematics and Science Study (TIMSS)[13], initiated by the International Association for the Evaluation of Education Achievement (IEA) in 1995.

The frameworks were designed to represent the aggregate of possible content and performance skills taught in the 40 plus economies that participated in their development. Furthermore, the tool has been used to analyze educational materials internationally and has undergone refinement throughout that process. Since 1998, Achieve has used this procedure to analyze curricular documents for a variety of projects. The framework's versatility accommodates diverse research undertakings that have fulfilled a range of objectives, from comparison of standards to the writing of more rigorous standards to characterizing high school exit exams and college entrance exams.

The Coding Process

Several checks and balances were put into place to assure inter-rater reliability in coding. The first step was to code a set of standards together in order to norm coding practices. Thereafter, a single coder from a team content of experts in mathematics and science coded a set of standards, obtaining input from others as questions arose. A trained expert from Michigan State University regularly reviewed both samples of the coding from each coder and the distribution of codes to search of patterns of bias, reconciling any differences in judgment in order to attain consensus. Finally, content area experts from each economy were invited to review the coding and submit questions and disagreements. Achieve's coding team and Michigan State University experts reviewed these comments, making final decisions about any changes in the coding.

Achieve generally analyzed only the segments of the standards containing content and the performance expectations embedded in those content statements. Coders coded only what was obvious and evident in the printed content statement. In some economies' standards, explanatory notes expanding on the intent of the standard are included and were considered as supplementary information, but not necessarily coded. Coders avoided interpretation and inference about what a student might have to do to fulfill the standard, only selecting codes that applied directly to the language in the standard or codes based on additional information in the explanatory notes.

[13] TIMSS is now Trends in International Mathematics and Science Study

Most single standard statements were coded with up to five content codes and up to five performance codes in order to capture the full range of the material covered by each standard. In some rare cases, coders applied up to eight content or performance codes to assure complete coverage of the included material.

Content Analysis

Achieve analyzed the topics covered by each economy to determine the overlapping topics between economies. Topics addressed by 67 percent or more of the participating economies in their standards at the each grade span constitute the common set of topics.

At each grade span for both mathematics and science, Achieve also conducted a calculation of the degree of overlap between each economy's content standards and the common set of topics. The overlap between the economy's standards and the common set of topics is represented by the percentage of the total number of topics from the framework addressed in that economy's standards that belong to the common set of topics at that grade span.

Performance Analysis

All performance demands written into the content standards were coded; if a standard contained multiple discrete performance demands, each one was taken into consideration and counted. Therefore, the analysis for performance skills depicts the relative emphasis on a certain skill or category of cognitive demand, as opposed to simple coverage or omission of individual skills.

APPENDIX H: PERFORMANCE SKILL HIERARCHIES
MATHEMATICS

Performance expectations from the coding taxonomy have been grouped into a hierarchy of levels approximating increasing levels of cognitive demand. The levels, in increasing order of cognitive demand are:

6. Recall
7. Using routine procedures and tools to solve problems
8. Using more complex procedures and conceptual understanding to solve problems
9. Formulating problems and strategizing/critiquing solution methods
10. Applying advanced reasoning skills

Performance Levels	
Level 1. Recall	
2.1	Knowing
2.1.1	Representing
2.1.2	Recognizing equivalents
2.1.3	Recalling mathematical objects and properties
2.5.1	Using vocabulary and notation
Level 2. Using Routine Procedures & Tools	
2.2.1	Using equipment
2.2.1.1	Using instruments, for example, measuring instruments
2.2.1.2	Using computational devices
2.2.2	Performing routine procedures
2.2.2.1	Counting
2.2.2.2	Computing
2.2.2.3	Graphing
2.2.2.4	Transforming

Performance Levels	
2.2.2.5	Measuring
2.3.3	Solving
2.3.4	Predicting
2.5.2	Relating representations
2.5.3	Describing/discussing
Level 3. Using More Complex Procedures	
2.2.3	Using more complex procedures
2.2.3.1	Estimating
2.2.3.2	Using data
2.2.3.3	Comparing
2.2.3.4	Classifying
Level 4. Formulating, Strategizing & Critiquing	
2.3.1	Formulating and clarifying problems and situations
2.3.2	Developing strategy
2.3.5	Verifying
2.4.1	Developing notation and vocabulary
2.5.4	Critiquing
Level 5. Advanced Reasoning	
2.4.2	Developing algorithms
2.4.3	Generalizing
2.4.4	Conjecturing
2.4.5	Justifying and proving
2.4.6	Axiomatizing

APPENDIX H (CONTINUED): PERFORMANCE SKILL CATEGORIES
SCIENCE

The **performance expectations included in the KNOWLEDGE category** have been grouped into levels of generally increasing cognitive demand, or rigor. These levels (or categories) of performance expectations are neither discrete nor strictly hierarchical, although there is a general increase in cognitive demand from Level 1 to Level 5. The levels are as follows:

6. Acquiring Knowledge
7. Explaining Knowledge
8. Applying Knowledge
9. Analyzing Knowledge
10. Constructing Knowledge

The **performance expectations included in the inquiry or RESEARCH category** are unique to science in that they reflect the empirical nature of science and the methodologies scientists employ in pursuit of new knowledge. (These skills are distinct from those delineated in the Science Knowledge category, described below, although there is certainly overlap. Evidence-based reasoning, for example, is characteristic of both categories.) Inquiry skills are divided into two sub-categories:

3. Basic Inquiry Skills
4. Advanced Inquiry Skills

SCIENTIFIC KNOWLEDGE	SCIENTIFIC INQUIRY (RESEARCH) SKILLS
ACQUIRING KNOWLEDGE 2.1.1 Recalling simple information 2.5.1 Accessing information	**BASIC SKILLS** 2.3.3 Gathering data 2.3.1 Using apparatus, equipment, and computers 2.3.2 Conducting routine experimental operations

SCIENTIFIC KNOWLEDGE	SCIENTIFIC INQUIRY (RESEARCH) SKILLS
INTERPRETING KNOWLEDGE 2.1.2 Comprehending complex information 2.3.4 Organizing and representing data 2.3.5 Interpreting data 2.5.2 Processing and sharing information	**ADVANCED SKILLS** 2.4.1 Identifying questions to investigate 2.4.2 Designing investigations 2.4.3 Conducting investigations 2.4.4 Interpreting investigational data 2.4.5 Formulating conclusions from investigational data
APPLYING KNOWLEDGE 2.2.2 Applying scientific principles to solve quantitative problems 2.2.3 Applying scientific principles to develop explanations 2.2.6 Using science and technology principles to solve practical problems	
ANALYZING KNOWLEDGE 2.1.3 Understanding thematic information 2.2.4 Constructing, interpreting, and applying models 2.2.5 Making decisions 2.5.3 Engaging in reasoned debate	
CONSTRUCTING KNOWLEDGE 2.2.1 Abstracting and deducing scientific principles	

APPENDIX I: BIOGRAPHIES OF ACHIEVE CONSULTANTS

JOSEPH ACCONGIO

Joseph Accongio is a consultant and the former principal/superintendent of the Charter School of Science and Technology in Rochester, N.Y. He was also the school's Director of Program Development and primary charter recipient. He has been principal of both the Nathaniel Rochester Community School and Thomas Jefferson Middle School, as well as the House Administrator of the Discovery Magnet. In addition, Dr. Accongio was a curriculum coordinator/science teacher, a chemistry teacher, and a biology teacher in the Rochester City School District. Dr. Accongio spent a year as Director of School Services with the Children's Television Workshop, creators of *Sesame Street*, *3-2-1 Contact*, and *Square One TV*. He developed a series of teachers' guides for the science and mathematics shows and conducted numerous workshops on utilizing these popular shows in the classroom. Dr. Accongio also co-authored a monograph on science assessment entitled "Classroom Assessment—Key to Reform in Science Education." He received a doctorate in curriculum planning from the State University of New York (SUNY) at Buffalo, a master's degree in education from SUNY at Brockport, and a bachelor's degree in general sciences from the University of Rochester.

MELANIE ALKIRE

Melanie Alkire is currently a mathematics consultant with Achieve, Inc. and a site visitor and higher level mathematics assistant examiner for International Baccalaureate North America. Beginning in 1994, Ms. Alkire contributed to the design and implementation of the Oregon University System's framework of standards and assessments for admission to the seven public university campuses called PASS (Proficiency-based Admissions Standards System). In this project she served as Lead Teacher, Assessment Moderator and Site Coordinator, and was also involved in the writing and implementation of proficiencies in mathematics, as well as project evaluation and training and professional development of mathematics faculty and high school teachers. She retired in 2005 from Portland Public Schools where she served as a mathematics teacher, department chair, International Studies Coordinator, and International Baccalaureate Coordinator. Ms. Alkire received an AB in Mathematics/Education from Northwest Nazarene University and a MAT in Mathematics/Education from Lewis and Clark College.

SUSAN K. EDDINS

Susan K. Eddins taught students in kindergarten through college for over 30 years. She is the recipient of several honors for her teaching, including the Presidential Award for Excellence in Mathematics Teaching, and she is a National Board Certified Teacher in Adolescent and Young Adult Mathematics. Ms. Eddins is now retired having been a faculty member, an Instructional Facilitator, and the Curriculum and Assessment Leader in mathematics at the Illinois Mathematics and Science Academy, where she taught since the school's inception in 1986. She has served in leadership capacities in several professional organizations, notably as a member of the Board of Directors of the National Council of Teachers of Mathematics (NCTM). Ms. Eddins was a member of the 9–12 writing group for NCTM's *Principles and Standards for School Mathematics*. She is co-author of a chapter in NCTM's *Windows of Opportunity* and is a co-author of *UCSMP Algebra*. She is a past panel

member and editor of NCTM's *Student Math Notes* and has authored several articles in refereed journals. More recently, in addition to numerous workshops and presentations, her most extensive work has been in the area of standards development, standards review, and alignment of standards to assessments. For Achieve, she has reviewed academic standards or assessments from Alaska, Illinois, Indiana, Minnesota, New Jersey, Oregon, Pennsylvania, Texas and Washington. Ms. Eddins holds bachelor's and master's degrees in mathematics.

LAWRENCE NEAL

Lawrence Neal **has been a science teacher at East High School in Rochester, N.Y., for 9 years. He has taught middle school science and chemistry from the general level up to the AP level. During 2001-2002, Mr. Neal was one of a small group of chemistry teachers who assisted in the statewide implementation of New York State Education Department's new Core Curriculum. He is currently a participant in the College Board's 6 – 12 Science Standards Project. Mr. Neal is also a member of the Rochester City School District's Inquiry Institute, which is bringing hands-on inquiry-based science education to Rochester's classrooms from Grades K – 12. Prior to teaching, Mr. Neal retired from a 20-year career in the United States Navy as a commander. He had been active in carrier-based aviation, both as a pilot and a shipboard air operations officer. During this career, Mr. Neal developed and implemented standards-based training initiatives at the squadron, ship, and naval industrial facility levels. Mr. Neal received a bachelor's degree in General Science (Chemistry) from the University of Rochester, a master's degree in International Studies from Old Dominion University, and his teaching certification in Chemistry and General Science (7 – 12) from the State University of New York at Brockport.**

SUSAN PIMENTEL

Susan Pimentel, co-founder of StandardsWork™, a nonprofit education consultancy, specializes in standards-driven education reform. After earning a Bachelor of Science in early childhood education and a law degree from Cornell University, she served as senior policy advisor to Maryland Governor William Donald Schaefer, and subsequently as special counsel to former Superintendent John Murphy in Prince George's County, MD. For more than two decades, Sue's work has focused on helping communities, districts and states to work together to advance meaningful and enduring education reform, and champion proven tools for increasing academic rigor. She has also been involved in several national efforts, including determining the content for a new national teacher test and various work with KIPP charter schools. Recently, Sue has worked as a Senior Policy Consultant to the ADP, including shaping the analysis and final report of *Do Graduation Tests Measure Up? A Closer Look at State High School Exit Exams.* Currently, she serves as primary consultant to a multi-state adult education reform effort under the auspices of the AIR and the Office of Vocational and Adult Education; standards expert and writer on adolescent literacy for the Carnegie Corporation; and coach to educators at all levels in the state of Arizona on standards and assessment issues. In addition, Sue is in her second year of facilitating the development and implementation of content standards in the District of Columbia Public Schools.

MARY LYNN RAITH

Mary Lynn Raith received her B.S in mathematics from Indiana University at Pittsburgh and her M.Ed. in mathematics education from the University of Pittsburgh. She is recently retired from the position of Mathematics Specialist in the Division of Instructional Support of the Pittsburgh Public Schools. As such, her responsibilities included leadership roles in curriculum development, textbook selection, design of alternative assessments, in-service program design and implementation, and coordination of mathematics programs across levels and schools. Ms. Raith was also the Co-Director of the Pittsburgh Reform in Mathematics Education project (PRIME), a K – 12 professional development system. She has also been involved with a number of national projects, including the development of both the New Standards Reference Examination and the Portfolio project for the middle grades, the Assessment Communities of Teachers project (ACT), and the Alternative Assessment in Mathematics project (A^2IM). She has also worked extensively with both NCTM and NCEE on its America's Choice school design and has presented at numerous national conferences.

DMITRI SEALS

Dmitri Seals joined Achieve after three years of work at Maya Angelou Public Charter School in Washington, DC. As a teacher there, he served as co-chair of the math department and led curriculum development for six high-school math courses. He also founded the school's math tutoring center, its debate team, and its annual speaking competition. Starting in 2002, he served as the founding president of the Coaches Association for the District of Columbia Urban Debate League; he led his team to the league's city championships in 2005. He graduated from Brown University in 2002, with a concentration in the Politics of Media and Education. During college, he served as the only student member of the Brown Executive Committee on College Curriculum, and he co-founded a year-long Committee on Diversity in Education in 2001. In addition to his work at Achieve, he continues to lead the Math Lab and debate team at Maya Angelou Public Charter School. He also writes profiles of social entrepreneurs for the Ashoka Foundation.

CARY SNEIDER

Cary Sneider is Vice President for Educator Programs at the Museum of Science in Boston, where his current objective is to help schools implement state standards in technology and engineering. Dr. Sneider's interests have focused on helping students unravel their misconceptions in science and on new ways to link science centers and schools to promote student inquiry. His publications include teachers' guides, articles about the instructional uses of computers, and research studies on how children acquire science concepts and skills. In 1997, he received the Distinguished Informal Science Education award from NSTA and in 2003 was named National Associate of the National Academy of Sciences.

KATHLEEN WIGHT

Kathleen Wight joined the Third International Mathematics and Science Study (TIMSS) research group in May of 1997. Since that time she has done extensive document analysis of mathematics and science curriculum standards, textbooks, and assessments using the TIMSS content and performance expectation framework. Her responsibilities have included: hiring, training, and supervising personnel to assist in the document analysis process; checking data

analyses to ensure data integrity; analyzing output from the data collection and coding process; writing reports; presenting results of analyses; reviewing and preparing test items for three grade bands (elementary, MS, and HS); and compiling the associated test forms. Kathleen earned a Bachelor of Arts in Statistics from the University of Michigan (1971), and a Master of Science in Environmental Engineering from Michigan State University (1997). She worked for 18 years with Michigan Bell Telephone Company, later Ameritech, SBC, and now AT&T.

EXAMPLES

[i] **New Zealand**, Level Three, Statistics, Statistical Investigation (thinking)
Conduct investigations using the statistical enquiry cycle by:

- gathering, sorting, and displaying multivariate category data, discrete numeric data and simple time-series data to answer questions;
- identifying patterns and trends in context, within and between data sets;
- communicating findings, using data displays.

[ii] **China** – Statistics and Probability expectations for the Second Stage of Schooling (Grades 4-6). Through rich real examples, understand the meanings of mean, median and mode. Able to obtain the mean, median and mode of data, and to explain their meanings from the practical point of view. According to concrete problems, able to select appropriate statistics to reflect the different characteristics of data.

[iii] **Australia** – Year 5, Measurement, chance and data. Design chance experiments to collect data and make predictions based on that data.

[iv] **Korea**, First Grade of Lower Secondary, B Variables and Expressions, 2 Linear Equations

- Understand the meaning of a linear equation and its solution.
- Understand the property of equality, and know how to apply it.
- Solve linear equations.

[v] **China** – Equation and Inequality expectations in the Third Stage of Schooling (Grades 7-9) / ii Equation and Inequality / (i) Equation and System of Equations / (c) Able to solve equation of first degree in one unknown, simple system of equations of first degree in two unknowns, as well as to simplify these into fraction equations of first degree in one unknown.

[vi] **China** – Third State of Schooling, Number, 1.iii.b / (b) Able to draw the graph of inverse proportion function. Explore and understand the property of $y = k/x$ ($k \neq 0$) based on explication of this expression and graph of first degree function. (i.e., variation of graph when $k>0$ or $k<0$).

[vii] **Hong Kong** – Key Stage 4, 4.4.1 / formulate and solve quadratic equations by factor method and formula

- solve the equation $ax^2 + bx + c = 0$ by plotting the graph $y = ax^2 + bx + c$ and reading the x-intercepts;
- be aware of the approximate nature of the graphical method;
- choose the most appropriate strategy to solve quadratic equations;
- recognize the conditions for the nature of roots;
- understand the hierarchy of real-number system and be aware of the characteristics of rational numbers when expressed in decimals.

[viii] **Chinese Taipei** – The First Year, iii.5 / Polynomial Equations - Including the introduction of basic algebra, Bolzano's Theorem and coefficient polynomial equation imaginary root pair theorem.

[ix] **Japan** – Mathematics C, 2. Algebraic expressions and curves
b) Parametric representations and polar coordinates
(i) Parametric representations of curves
(ii) Polar coordinates and polar equations

[x] **Primary Grades**

Level 1: **Japan**, Grade 5, Numbers and calculations, 4a

- In simple cases, to notice fractions of the same size.

Level 2: **Korea**, First Grade, Numbers and Operations, 2.1

- Understand the situations for, and the meaning of, addition and subtraction.

Level 3: **China**, Statistics, i.i

- Able to compare, order and classify objects in accordance with specified standards or standards of one's choice (e.g. quantity, shapes, color). Experience consistency of results of these activities when standards are the same, whereas in the case of different standards experience variety of results instead.

Level 4: **Chinese Taipei**, 6-n-10

- Utilize the common relationships between figures and quantity to properly list mathematical statements in order to solve problems and examine the rationality of the answers

Level 5: While a very small number of standards are coded as Level 5 (among other levels), the sample is too small to warrant inclusion.

[xi] **Lower Secondary**

Level 1: **Alberta CA**, Grade 8, 1.6.6

- Express a given positive mixed number as an improper fraction and a given positive improper fraction as a mixed number.

Level 2: **China**, Year Three, Numbers and Expressions, Real Number

- [Familiar with the fact] that power and root are both inverse operations. Able to use the square root operation to evaluate the square root of a non-negative number. Able to use the cube root operation to evaluate the cube root of a number. Able to use a calculator to evaluate square root and cube root.

Level 3: **Malaysia**, Grade 9, Unit 4: Statistics II, i, iii, iv

- i. Obtain and interpret information from pie charts.
- iii. Solve problems involving pie charts.
- iv. Determine suitable representation of data.

Level 4: **Singapore**, O Level, Numbers and Algebra, Algebraic representation and formulae, bullet 4

- Translation of simple real-world situations into algebraic expressions.

Level 5: **Hong Kong**, Key Stage 3, Learning Geometry through a Deductive Approach, Simple Introduction to Deductive Geometry

- Develop an intuitive idea of deductive reasoning by presenting proofs of geometric problems relating with angles and lines

[xii] **Upper Secondary**

Level 1 – **NAEP**: Geometry, 1d

- d) Draw or sketch from a written description plane figures (e.g., isosceles triangles, regular polygons, curved figures) and planar images of three-dimensional figures (e.g., polyhedra, spheres, and hemispheres).

Level 2: **Finland**, 6, Mathematical Models II, Objective 2

- know how to solve linear programming problems relating to practical situations;

Level 3: **Thailand**, Numbers and Operations, Standard M 1.3.1

- Use estimation in computing and solving problems: find the approximate values of radicals and exponents by using appropriate strategies.

Level 4: **Japan**, Mathematics I, Quadratic Functions, 2a

- Quadratic functions: To enable students to understand quadratic functions, and to recognize the usefulness of representing the variations in numbers and quantities by using functions. To enable students to apply them to consideration of concrete phenomena and solving quadratic inequalities. a) Quadratic functions and their graphs

Level 5: **Malaysia**, Grade 10, Learning Area 5: The Straight Line, Objective 2.i.

- Understand the concept of gradient of a straight line in Cartesian coordinates - Derive the formula for the gradient of a straight line.

[xiii] **Basic Inquiry Skills**

Japan Lower Secondary: observe a magnetic field caused by a magnet and electric current, to understand that a magnetic field is expressed by means of magnetic line of force, and to know that a magnetic field is produced around a coil.

Japan Elementary: Using weights and exploring the movement of objects by changing weights and speed of moving weights, and thus, enabling children to develop ideas about regularity in the movement of objects.

Hong Kong S4-6 Chemistry: demonstrate how to prepare solutions of a required concentration by dissolving a solid or diluting a concentrated solution.

[xiv] **Advanced Inquiry Skills**

Canada 7-9: ask questions about relationships between and among observable variables and plan investigations to address those questions.

Canada Earth & Space Science: design an experiment and identify specific variables (e.g., propose and test the variables that will change the eccentricity of an ellipse, using the string-and-pin method of drawing ellipses).

Canada Physics: carry out procedures controlling the major variables and adapting or extending procedures where required (e.g., control the major variables when conducting experiments to determine the relationships between kinetic and potential energies).

Canada Physics: interpret patterns and trends in data, and infer or calculate linear and nonlinear relationships among variables (e.g., interpret trends in experimental data while verifying the inverse-square law).

Canada 7-9: state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea (e.g., explain how the evidence of convection currents in fluids supports the particle model of matter).

[xv] **Acquiring Knowledge**

Hong Kong: Physics Curriculum and Assessment Guide (Secondary 4 - 6): describe the meaning of inertia and its relationship to mass.

Canada 10-12 Life Science: select and integrate information from various print and electronic sources or from several parts of the same source (e.g., collect information on human reproductive technology from a variety of sources).

[xvi] **Explaining Knowledge**

Chinese Taipei Grades 7-9: explain the difference between atoms and molecules in components and their properties.

Singapore Biology Higher 2 Syllabus 9747: Outline the roles and functions of membranes within cells and at the surface of cells.

Finland Elementary Science: interpret physical maps, thematic maps, photographs, and statistics, and utilize news sources and information from data networks.

Canada Chemistry: communicate questions, ideas, and intentions, and receive, interpret, understand, support, and respond to the ideas of others (e.g., discuss, as a team, the procedures used in the synthesis of ASA in the laboratory).

[xvii] **Applying Knowledge**

Hong Kong: Chemistry Curriculum and Assessment Guide (Secondary 4 - 6): perform calculations related to formula masses and relative molecular masses of compounds.

Canada Chemistry: identify limitations of a given classification system and identify alternative ways of classifying to accommodate anomalies (e.g., identify the limitations of using electronegativity values to determine the polar nature of a specific covalent bond).

Canada Chemistry: identify and correct practical problems in the way a technological device or system functions (e.g., identify problems such as the determination of correct masses in stoichiometric experimentations).

[xviii] **Analyzing Knowledge**

Hong Kong: Biology Curriculum and Assessment Guide (Secondary 4 - 6): relate the use of microorganisms to pollution control.

Chinese Taipei: Required Physics: Use molecular dynamics model to explain that pressure is caused by the moving molecules of gases heating the surface of containers.

Canada Physics: propose courses of action on social issues related to science and technology, taking into account an array of perspectives, including that of sustainability (e.g., propose a course of action that addresses the issue of eliminating speed limits on four-lane highways).

Canada Grade 10 Science: defend a decision or judgment and demonstrate that relevant arguments can arise from different perspectives (e.g., present a brief for a public hearing and summarize the briefs of others on an issue related to a local environmental problem).

[xix] **Constructing Knowledge**

Singapore Chemistry: deduce the type of bonding present from given information.