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.*