Briefing on the Technology and Engineering Literacy (TEL) Assessment and Achievement Levels Setting

In the spring of 2014, the first-ever NAEP TEL assessment was administered via computer to a nationally representative sample of 20,000 8th grade students. The assessment was designed to measure how well students can apply their understanding of technology and engineering principles to real-life situations. Results will be available at the national level only and will be released as The Nation's Report Card in early 2016. The NAEP TEL Framework, which guides development activities, focuses on the level of knowledge and competencies about technology and engineering needed by all students and citizens to function in a technological society.

TEL measures students' knowledge and skills in three interconnected areas: Technology and Society, Design and Systems, and Information and Communications Technology. There are three cross-cutting practices as well: Understanding Technological Principles, Developing Solutions and Achieving Goals, and Communicating and Collaborating. An innovative component of the assessment is the incorporation of interactive scenario-based tasks.

By law, the Governing Board is charged with setting achievement levels for each grade and subject tested by NAEP. On July 1, 2014, the Governing Board awarded a contract to NCS Pearson to develop achievement levels for the NAEP TEL assessment at grade 8. The achievement levels setting process is being carried out according to the Governing Board policy on Developing Student Performance Levels for NAEP. Over the past year, COSDAM has received project updates at each quarterly Board meeting.

Pearson has conducted two pilot studies to try out the achievement levels setting procedures, one in March 2015 and one in June 2015. The operational achievement levels setting meeting will take place from late September to early October 2015. The results from the operational achievement levels setting will be presented to the Board for action during the November 19-21, 2015 Governing Board meeting.

This session is intended to provide context for the planned Board achievement levels action in November. Presenters at the August TEL achievement levels briefing will include:

- Cary Sneider, ADC Vice Chair, will introduce the TEL Framework (see attached).
- Bill Ward, NCES staff, will provide a demonstration of a TEL scenario-based task.
- Lou Fabrizio, COSDAM Chair, will describe the Board policy on achievement levels setting (see attached).
- Sharyn Rosenberg, Governing Board staff, will provide an overview of the TEL achievement levels setting project, including the methodology, key activities and participants, and a description of the information that will be provided for the November 2015 Board discussion and action.

2014 Abridged
Technology and Engineering Literacy Framework

FOR THE 2014 NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

NATIONAL ASSESSMENT GOVERNING BOARD
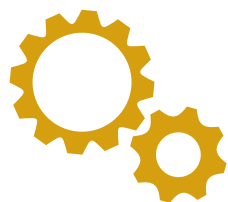
Introduction

We live in a world that is, to a large extent, shaped by technology: The computers and smartphones we use, the cars and planes we travel in, the homes and offices we inhabit; our food, clothes, entertainment, and medical care—all are created and driven by technology. Technology is also at the root of critical challenges we face as a society, such as the quest to link experts throughout the world, the search for sustainable energy, the ability to deal with global pandemics, and the development of environmentally friendly agriculture to feed a growing world population.

Until now, however, technology has not been a focus of instruction and assessment in our educational system, particularly at the elementary and secondary levels. Because of the growing importance of technology and engineering in the educational landscape, and to support America's ability to contribute to and compete in a global economy, the National Assessment Governing Board initiated development of the first NAEP Technology and Engineering Literacy Assessment. Relating to national efforts in science, technology, engineering, and mathematics (STEM) fields, the 2014 NAEP Technology and Engineering Literacy Assessment measures the "T" and "E" in STEM, augmenting long-standing NAEP assessments in science and mathematics.

NAEP Technology and Engineering Literacy (TEL) Assessment

The National Assessment of Educational Progress (NAEP), otherwise known as The Nation's Report Card, informs the public about the academic achievement of elementary and secondary students in the United States. Report cards communicate the findings of NAEP, a continuing and nationally representative measure of achievement in various subjects over time. For more than 35 years, NAEP has assessed achievement by testing samples of students most often in the 4th, 8th, and 12th grades. The results have become an important source of information on what U.S. students know and are able to do in a range of subject areas.

To create the new assessment, the National Assessment Governing Board sought a framework of technological literacy knowledge and skills that identifies the understandings and applications of technology principles that are important for all students. The framework defines "literacy" as the level of knowledge and competencies needed by all students and citizens. More than testing students for their ability to "do" engineering or produce technology, then, the assessment is designed to gauge how well students can apply their understanding of technology principles to real-life situations. At grade 4, for example, all students are expected to identify types of technologies in their world, design and test a simple model, explain how technologies can result in positive and negative effects, and use common technologies to achieve goals in school and in everyday life. By grade 12, students are expected

to select and use a variety of tools and media to conduct research, evaluate how well a solution meets specified criteria, and develop a plan to address a complex global issue. To learn more, see a video clip ("ecosystems") in the interactive framework of a sample scenario for grade 8 showing a student investigation of how organisms in an ecosystem are affected by a pollutant.

Technological literacy at grades 4, 8, and 12 is a pathway promoting further study and occupational pursuits.

The Governing Board assembled a broad array of individuals and organizations to create a test of students' abilities to grasp and apply technology principles. The resulting framework is the culmination of a long, complex process that drew on the contributions of thousands of individuals and organizations including technology experts, engineers, teachers, researchers, business leaders, testing experts, and policymakers.

The 2014 NAEP Technology and Engineering Literacy Assessment will provide important results and information that can be used to determine whether our nation's students have the essential knowledge and skills needed in the technology and engineering areas. Policymakers, educators, and the public can use data from the initial assessments as tools for monitoring certain aspects of student achievement in technology and engineering literacy over time.

Definitions of technology, engineering, and technology and engineering literacy

Any assessment of students' technology and engineering literacy must start with a clear idea of exactly what technology and engineering literacy means. That in turn requires clear definitions of technology and engineering.

"Technology" is any modification of the natural world done to fulfill human needs or desires.

This definition sees technology as encompassing the entire human-made world, from paper to the Internet. Technology also includes the entire infrastructure needed to design, manufacture, operate, and repair technological artifacts, from corporate headquarters and engineering schools to manufacturing plants and media outlets.

"Engineering" is a systematic and often iterative approach to designing objects, processes, and systems to meet human needs and wants.

This framework defines technology and engineering literacy in a broad fashion:

"Technology and engineering literacy" is the capacity to use, understand, and evaluate technology as well as to understand technological principles and strategies needed to develop solutions and achieve goals.

Thus—as with scientific, mathematical, and language literacy—technology and engineering literacy involves the mastery of a set of tools needed to participate intelligently and thoughtfully in society.

Three areas of technology and engineering literacy

Recognizing that it is not possible to assess every aspect of technology and engineering literacy, the TEL assessment framework targets the nature, processes, and uses of technology and engineering that are essential for 21st-century citizens. The assessment objectives are organized into three major areas: Technology and Society; Design and Systems; and Information and Communication Technology (ICT). Each broad category is further broken down into discrete areas to be assessed.

must understand technological systems and the engineering design process and be able to use various information and communication technologies to research the problem and develop possible solutions.

Design and Systems

Information and Communication Technology

Technology and Society
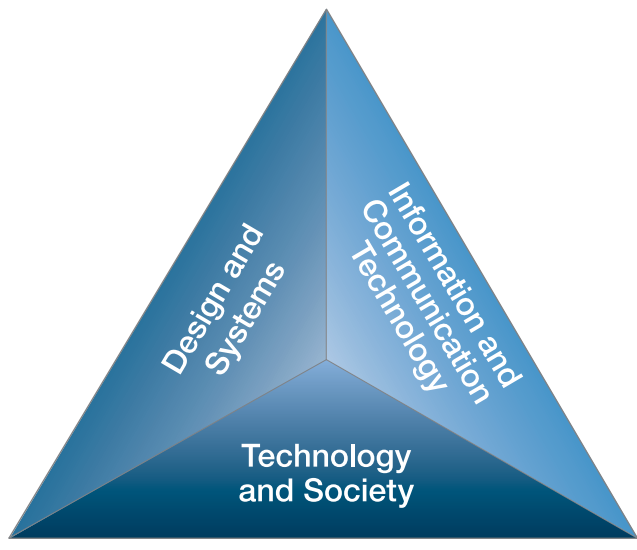
The interconnected relationship among these three major assessment areas can be illustrated as a three-sided pyramid in which each side supports the other two. For example, in order to address an issue related to technology and society, such as clean water, energy needs, or information research, a person who is literate in technology and engineering
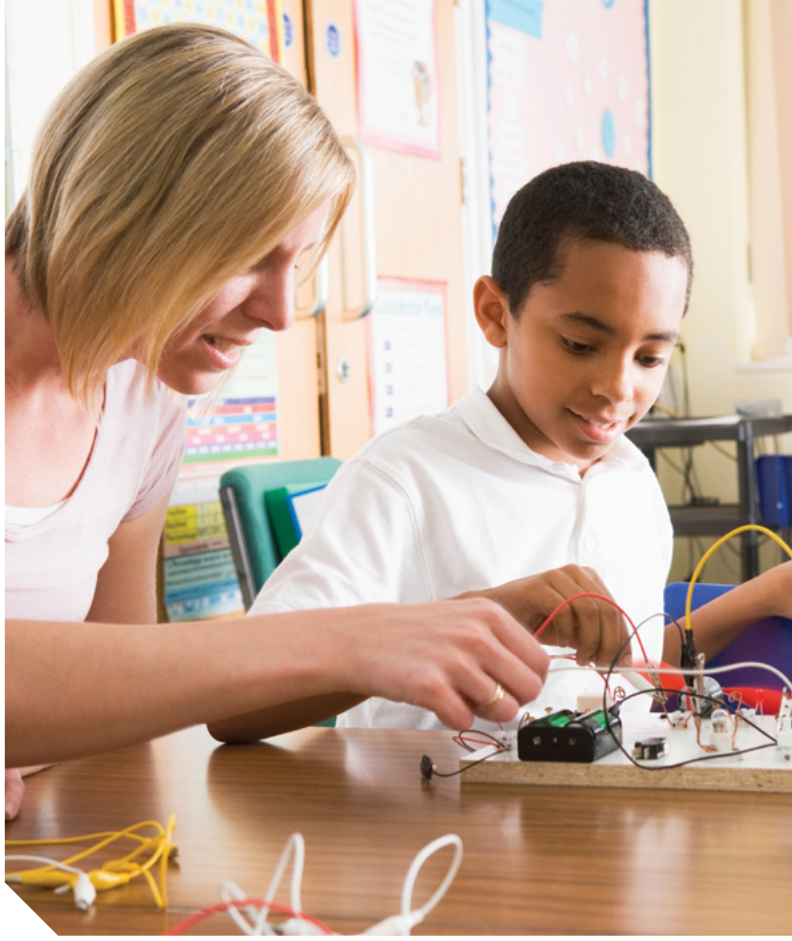
Area 1. Technology and Society

deals with the effects that technology has on society and on the natural world and with the sorts of ethical questions that arise from those effects.

The four sub-areas in which students are assessed include:

A. *Interaction of Technology and Humans* concerns the ways in which society drives the improvement and creation of new technologies and how technologies serve society as well as change it. **Fourth graders** are expected to know that people's needs and desires determine which technologies are developed or improved. For example, cellphones were invented, produced, and sold because people found it useful to be able to communicate with others wherever they were. **Eighth graders** are expected to understand how technologies and societies coevolve over significant periods of time. For example, the need to move goods and people across distances prompted the development of a long series of transportation systems from horses and wagons to cars and airplanes. **By 12th grade**, students are expected to realize that the interplay between culture and technology is dynamic, with some changes happening slowly and others very rapidly. They should be able to use various principles of technology design—such as the concepts of trade-offs and unintended consequences—to analyze complex issues at the interface of technology and society and to consider the implications of alternative solutions.

B. *Effects of Technology on the Natural World* is about the positive and negative ways that technologies affect the natural world. **Fourth graders** are expected to know that sometimes technology can cause environmental harm. For example, litter from food packages and plastic forks and spoons discarded on city streets can travel through storm drains to rivers and oceans where they can harm or kill wildlife. **Eighth graders** are expected to recognize that technology and engineering decisions often involve weighing competing priorities, so that there are no perfect solutions. For example, dams built to control floods and produce electricity have left wilderness areas underwater and affected the ability of certain fish to spawn. **By 12th grade**, students should have had a variety of experiences in which technologies were used to reduce the environmental impacts of other technologies, such as the use of environmental monitoring equipment.

C. *Effects of Technology on the World of Information and Knowledge* focuses on the rapidly expanding and changing ways that information and communication technologies enable data to be stored, organized, and accessed and on how those changes bring about benefits and challenges for society. **Fourth graders** should know that information technology provides access to vast amounts of information, that it can also be used to modify and display data, and that communication technologies make it possible to communicate across great distances using writing, voice, and images. **Eighth graders** should be aware of the rapid progress in development of ICT, should know how information technologies can be used

to analyze, display, and communicate data, and should be able to collaborate with other students to develop and modify a knowledge product. **By 12th grade**, students should have a full grasp of the types of data, expertise, and knowledge available online and should be aware of intelligent information technologies and the uses of simulation and modeling.

D. *Ethics, Equity, and Responsibility* concerns the profound effects that technologies have on people, how those effects can widen or narrow disparities, and the responsibility that people have for the societal consequences of their technological decisions. **Fourth graders** should recognize that tools and machines can be helpful or harmful. For example, cars are very helpful for going from one place to another quickly, but their use can lead to accidents in which people are seriously injured. **Eighth graders** should be able to recognize that the potential for misusing technologies always exists and that the possible consequences of such misuse must be taken into account when making decisions. **By 12th grade**, students should be able to take into account both intended and unintended consequences in making technological decisions.

Area 2. Design and Systems covers the nature of technology, the engineering design process by which technologies are developed, and basic principles of dealing with everyday technologies, including maintenance and troubleshooting.

The four sub-areas in which students are assessed include:

A. *Nature of Technology* offers a broad definition of technology as consisting of all the products, processes, and systems created by people to meet human needs and desires. **Fourth graders** are expected to distinguish natural and human-made materials, to be familiar with simple tools, and to recognize the vast array of technologies around them. **Eighth graders** should know how technologies are created through invention and innovation, should recognize that sometimes a technology developed for one purpose is later adapted to other purposes, and should understand that technologies are constrained by natural laws. **By 12th grade**, students should have an in-depth understanding of the ways in which technology coevolves with science, mathematics, and other fields; should be able to apply the concept of trade-offs to resolve competing values; and should be able to identify the most important resources needed to carry out a task.

B. *Engineering Design* is a systematic approach to creating solutions to technological problems and finding ways to meet people's needs and desires. **Fourth graders** should know that engineering design is a purposeful method of solving problems and achieving results. **Eighth graders** should be

able to carry out a full engineering design process to solve a problem of moderate difficulty. **By 12th grade**, students should be able to meet a complex challenge, weigh alternative solutions, and use the concept of trade-offs to balance competing values.

C. *Systems Thinking* is a way of thinking about devices and situations so as to better understand interactions among components, root causes of problems, and the consequences of various solutions. **Fourth graders** should know that a system is a collection of interacting parts that make up a whole, that systems require energy, and that systems can be either living or nonliving. **Eighth graders** should be able to analyze a technological system in terms of goals, inputs, processes, outputs, feedback, and control, and they should be able to trace the life cycle of a product from raw materials to eventual disposal. **By 12th grade**, students should be aware that technological systems are the product of goal-directed designs and that the building blocks of any technology consist of systems that are embedded within larger technological, social, and environmental systems. They should also be aware that the stability of a system is influenced by all of its components, especially those in a feedback loop.

D. *Maintenance and Troubleshooting* is the set of methods used to prevent technological devices and systems from breaking down and to diagnose and fix them when they fail. **Fourth graders** should know that it is important to care for tools and machines so they can be used when they are needed. Students should also know that if something does not work as expected, it is possible

to find out what the problem is in order to decide if the item should be replaced or how to fix it. **Eighth graders** should be familiar with the concept of maintenance and should understand that failure to maintain a device can lead to a malfunction. They should also be able to carry out troubleshooting, at least in simple situations. **By 12th grade**, students should know that many devices are designed to operate with high efficiency only if they are checked periodically and properly maintained. They should also have developed the capability to troubleshoot devices and systems, including those that they may have little experience with.

> ## Area 3. Information and Communication Technology includes
> computers and software learning tools, networking systems and protocols, hand-held digital devices, and other technologies for accessing, creating, and communicating information and for facilitating creative expression.

The five sub-areas in which students are assessed include:

A. *Construction and Exchange of Ideas and Solutions* concerns an essential set of skills needed for using ICT and media to communicate ideas and collaborate with others. **Fourth graders** should understand what is expected from members working as part of a team and should realize that teams are better than individuals at solving many kinds of problems. **Eighth graders** should know that communicating always involves understanding the audience—the people for whom the message is intended. They should also

be able to use feedback from others, and provide constructive criticism. **By 12th grade**, students are expected to have developed a number of effective strategies for collaborating with others and improving their teamwork. They should be able to synthesize information from different sources and communicate with multiple audiences.

B. *Information Research* includes the capability to employ technologies and media to find, evaluate, analyze, organize, and synthesize information from different sources. **Fourth graders** should be aware of a number of digital and network tools that can be used for finding information, and they should be able to use these tools to collect, organize, and display data in response to specific questions and to help solve problems. **Eighth graders** should be aware of digital and network tools and be able to use them efficiently. They should be aware that some of the information they retrieve may be distorted, exaggerated, or otherwise misrepresented, and they should be able to identify cases where the information is suspect. **By 12th grade**, students should be able to use advanced search methods and select the best digital tools and resources for various purposes. They should also be able to evaluate information for timeliness and accuracy.

C. *Investigation of Problems* concerns the use of information and communication technology to define and solve problems in core school subjects and in practical situations. **Fourth graders** should be able to use a variety of information and communication technologies to investigate a local or otherwise familiar issue and to generate,

present, and advocate for possible solutions. **Eighth graders** should be able to use digital tools to identify and research a global issue and to identify and compare different possible solutions. **By 12th grade**, students should be able to use digital tools to research global issues and to fully investigate the pros and cons of different approaches. They should be able to design and conduct complex investigations in various subject areas using a variety of digital tools to collect, analyze, and display information and be able to explain the rationale for the approaches they used in designing the investigation as well as the implications of the results.

D. *Acknowledgment of Ideas and Information* involves respect for the intellectual property of others and knowledge of how to credit others' contributions appropriately, paying special attention to the misuse of information enabled by rapid technological advances. **Fourth graders** should understand that it is permissible to use others' ideas as long as appropriate credit is given. They should also know that copyrighted materials cannot be shared freely. **Eighth graders** should be aware of general principles concerning the use of other people's ideas and know that these principles are the basis for such things as school rules and federal laws governing such use. They should know about the limits of fair use of verbatim quotes and how to cite sources. **By 12th grade**, students should understand the fundamental reasons for intellectual property laws and should know acceptable practices for citing sources when incorporating ideas, quotes, and images into their own work.

E. *Selection and Use of Digital Tools* includes both knowledge and skills for choosing appropriate tools and using a wide variety of electronic devices, including networked computing and communication technology and media. **Fourth graders** should know that different digital tools have different purposes and they should also be able to use a variety of digital tools that are appropriate for their age level. **Eighth graders** should be familiar with different types of digital tools and be able to move easily from one type of tool to another—for example, creating a document or image with one tool and then using a second tool to communicate the result to someone at a distant location. **By 12th grade**, students should be competent in the use of a broad variety of digital tools and be able to explain why some tools are more effective than others that were designed to serve the same purpose, based on the features of the individual tools.

Although these elements are central to the design of the NAEP Technology and Engineering Literacy Assessment, they are not sufficient to describe the kinds of reasoning to be expected from students, the context or subject matter that will be used to construct test items, or the overall shape of the entire assessment. The assessment targets and the subareas within each describing what students should be able to do foreshadow the crosscutting practices—ways of thinking and reasoning—for which the TEL assessment is designed.

# Practices and contexts for technology and engineering literacy

In all three areas of technology and engineering literacy, students are expected to be able to apply particular ways of thinking and reasoning when approaching a problem, and they are expected to do so in various contexts.

The practices can be grouped into three broad categories: Understanding Technological Principles; Developing Solutions and Achieving Goals; and Communicating and Collaborating.

Understanding Technological Principles focuses on students' knowledge and understanding of technology and their capability to think and reason with that knowledge.

Developing Solutions and Achieving Goals refers to students' systematic application of technological knowledge, tools, and skills to address problems and achieve goals presented in societal, design, curriculum, and realistic contexts.
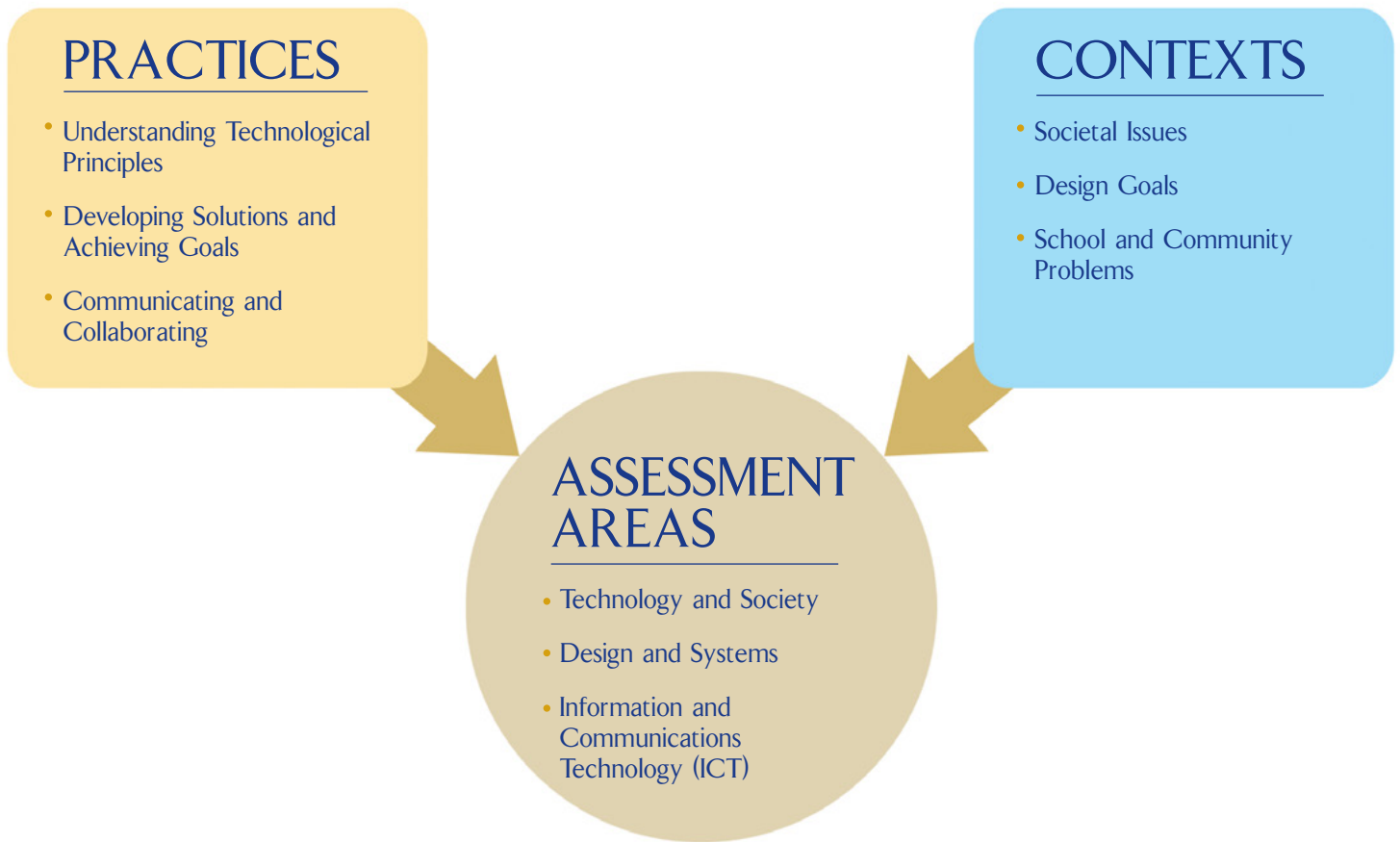
Communicating and Collaborating centers on students' capabilities to use contemporary technologies to communicate for a variety of purposes and in a variety of ways, working individually or in teams.
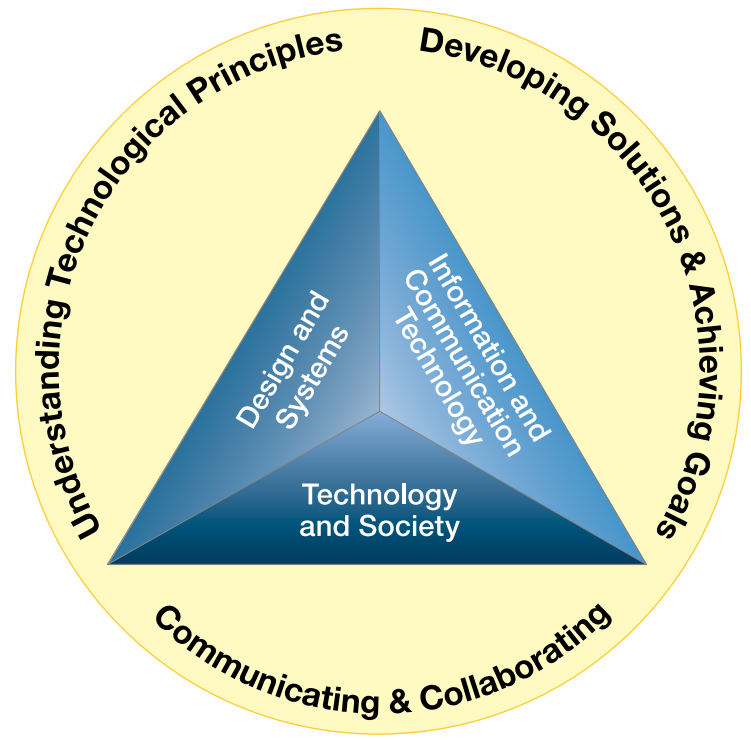
These practices are applied across all three major assessment areas. For example, communicating effectively and collaborating with others are necessary skills for understanding the effects of technology on the natural world, designing an engineering solution to a technological problem, and achieving a goal using information and communication technologies.

As crucial to the assessment as the practices are the contexts—the situations and types of problems in which assessment tasks and items will be set.

PRACTICES

- Understanding Technological Principles

- Developing Solutions and Achieving Goals

- Communicating and Collaborating

CONTEXTS

- Societal Issues

- Design Goals

- School and Community Problems

ASSESSMENT AREAS

- Technology and Society

- Design and Systems

- Information and Communications Technology (ICT)

Elements of the NAEP Technology and Engineering Literacy Assessment

The practices expected of students are general, crosscutting reasoning processes that students must use in order to show that they understand and can use their technological knowledge and skills. The contexts in which technology and engineering literacy tasks and items appear will include typical issues, problems, and goals that students might encounter in school or practical situations. Together, the assessment targets, practices, and contexts provide a structure for the generation of tasks and items.

Below are examples of the types of tasks and items that result when these three elements are combined. The table shows how the three practices—Understanding Technological Principles, Developing Solutions and Achieving Goals, and Communicating and Collaborating—can be used to classify the general types of thinking and reasoning intended by the assessment targets in the three major assessment areas of Technology and Society, Design and Systems, and Information and Communication Technology.

Classification of types of assessment targets in the three major assessment areas according to the practices for technology and engineering literacy

	Technology and Society	Design and Systems	Information and Communication Technology
Understanding Technological Principles	**Analyze** advantages and disadvantages of an existing technology **Explain** costs and benefits **Compare** effects of two technologies on individuals **Propose** solutions and alternatives **Predict** consequences of a technology **Select** among alternatives	**Describe** features of a system or process **Identify** examples of a system or process **Explain** the properties of different materials that determine which is suitable to use for a given application or product **Analyze** a need **Classify** the elements of a system	**Describe** features and functions of ICT tools **Explain** how parts of a whole interact **Analyze** and compare relevant features **Critique** a process or outcome **Evaluate** examples of effective resolution of opposing points of view **Justify** tool choice for a given purpose
Developing Solutions and Achieving Goals	**Select** appropriate technology to solve a societal problem **Develop** a plan to investigate an issue **Gather and Organize** data and information **Analyze and Compare** advantages and disadvantages of a proposed solution **Investigate** environmental and economic impacts of a proposed solution **Evaluate** trade-offs and impacts of a proposed solution	**Design and Build** a product using appropriate processes and materials **Develop** forecasting techniques **Construct and Test** a model or prototype **Produce** an alternative design or product **Evaluate** trade-offs **Determine** how to meet a need by choosing resources required to meet or satisfy that need **Plan** for durability **Troubleshoot** malfunctions	**Select and Use** appropriate tools to achieve a goal **Search** media and digital resources **Evaluate** credibility and solutions **Propose and Implement** strategies **Predict** outcomes of a proposed approach **Plan** research and presentations **Organize** data and information **Transform** from one representational form to another **Conduct** experiments using digital tools and simulations
Communicating and Collaborating	**Present** innovative, sustainable solutions **Represent** alternative analyses and solutions **Display** positive and negative consequences using data and media **Compose** a multimedia presentation **Produce** an accurate timeline of a technological development **Delegate** team assignments **Exchange** data and information with virtual peers and experts	**Display** design ideas using models and blueprints **Use** a variety of media and formats to communicate data, information, and ideas **Exhibit** design of a prototype **Represent** data in graphs, tables, and models **Organize, Monitor, and Evaluate** the effectiveness of design teams **Request** input from virtual experts and peers **Provide and Integrate** feedback	**Plan** delegation of tasks among team members **Provide and Integrate** feedback from virtual peers and experts to make changes in a presentation **Critique** presentations **Express** historical issues in a multimedia presentation **Argue** from an opposing point of view **Explain** to a specified audience how something works **Address** multiple audiences **Synthesize** data and points of view
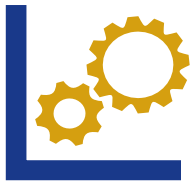
Content and design

To identify what students know and can do with regard to technology and engineering, the NAEP TEL framework calls for the assessment to be totally computer-based. In 2014 the NAEP TEL assessment will be conducted at grade 8 with a national sample of students in public and private schools. The assessment will include tasks and items sampled from the domain of technology and engineering literacy achievement identified by the intersection of the three major areas of technology and engineering literacy and the crosscutting practices at grades 4, 8, and 12—grades that will participate in the TEL assessment in future years.

Allowing students to demonstrate the wide range of knowledge and skills detailed in the NAEP Technology and Engineering Literacy Assessment targets will require a departure from the typical assessment designs used in other NAEP content areas. Thus students will be asked to perform a variety of actions using a diverse set of tools in the process of solving problems and meeting goals within rich, complex scenarios that reflect realistic situations. Consequently, this assessment will rely primarily on scenario-based assessment sets that test students through their interaction with multimedia tasks that include conventional item types, such as selected-response items, and also monitor student actions as they manipulate components of the systems and models that are presented as part of the task.

Because of their capability to replicate authentic situations examinees may encounter in their lives, scenarios have the potential to provide a level of authenticity other types of assessment tasks cannot provide. At the same time, the choice to use these complex tasks reduces the number of measures that can be included in any one test and causes many of the measures to be interdependent because they are related to the same scenario. To counteract this interdependency and ensure reliability, the NAEP assessment of technology and engineering literacy will also include sets of discrete items that produce independent measures.

Scenario-Based Assessment Sets

There will be two types of scenario-based assessment sets, one long and one short. The long scenarios will take students approximately 25 minutes. The short scenarios will take students about 12 to 15 minutes to respond. The two types of scenarios have common characteristics, but they differ in the complexity of the scenario and the number of embedded assessment tasks and items to which a student is asked to respond.

A set of sample video clips demonstrates the types of interactivity and functionality of tools that students might be expected to use as they respond to short and long scenarios that will be developed for the NAEP Technology and Engineering Literacy Assessment.

Discrete Item Sets

Discrete item sets will include conventional selected-response items and short constructed-response items. The discrete item sets will comprise approximately 10-15 stand-alone items in either selected- or constructed-response format to be completed within a 25-minute block. Each discrete item would provide a stimulus that presents enough information to answer the particular question posed in the stem of the item. Items in discrete sets will be selected-response items (for example, multiple choice) or short constructed-response items in which a student writes a text-based response.
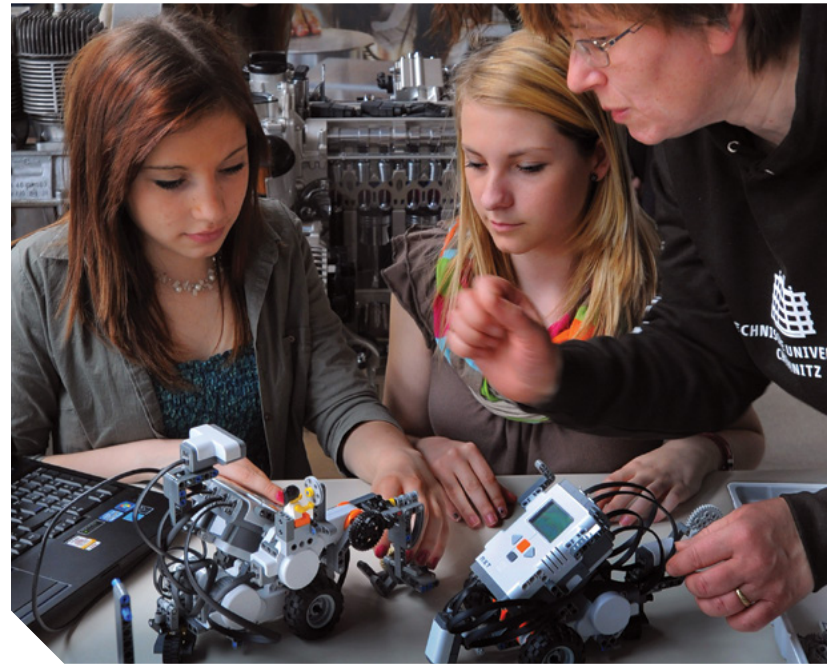
Background variables

Background data on students, teachers, and schools are needed to fulfill the statutory requirement that NAEP include information, whenever feasible, for various subgroups of students at the national level including gender, race/ethnicity, eligibility for free or reduced-price lunch, English language learners, and students with disabilities. Therefore, students, teachers, and school administrators participating in NAEP are asked to respond to questionnaires designed to gather demographic information. Information is also gathered from non-NAEP sources, such as state, district, or school records. For the 2014 NAEP Technology and Engineering Literacy Assessment, only student and school information will be collected as many students will not have taken a separate course in technology and engineering literacy taught by a specific teacher.

In addition to demographic information, background questionnaires include questions about variables related to opportunities to learn and achievement in technology and engineering literacy. The variables are selected to be of topical interest, to be timely, and to be directly related to academic achievement and current trends and issues in technology and engineering literacy. Questions do not solicit information about personal topics or information irrelevant to the collection of data on technology and engineering literacy achievement.
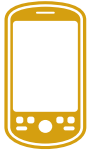
Achievement levels

The Governing Board uses student achievement levels of *Basic, Proficient,* and *Advanced* to report results of NAEP assessments. The achievement levels represent an informed judgment of "how good is good enough" in the various subjects that are assessed. Technology and engineering literacy achievement levels specific to the *2014 NAEP Technology and Engineering Literacy Framework* will be developed to elaborate the generic policy definitions of *Basic, Proficient,* and *Advanced* achievement. Preliminary achievement level definitions have been developed for each of the three areas to be reported separately in the assessment and they will be used to guide item development and initial stages of standard setting for the 2014 NAEP Technology and Engineering Literacy Assessment.

The preliminary achievement level definitions will be revised when actual student responses have been collected and analyzed. The Governing Board will convene panels of experts to examine the preliminary achievement level definitions and to recommend final achievement level definitions for each grade level.
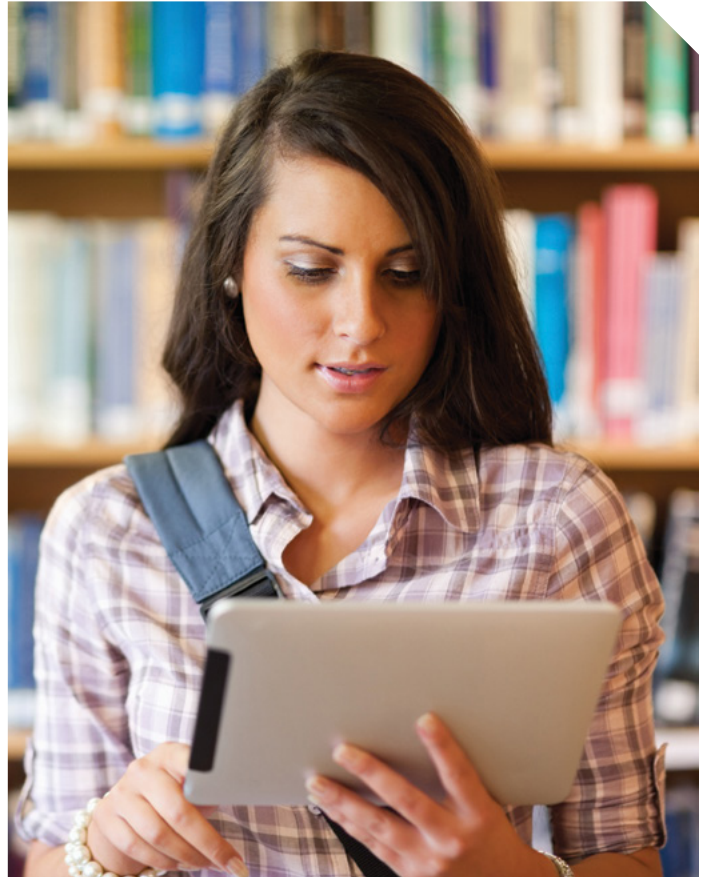
Conclusion

For generations students have been taught about technology and have been instructed in the use of various technological devices, but there has been no way to know exactly what students understand about technologies and their effective uses. The exploding growth in the world of technology led the Governing Board to sponsor the development of a framework for a NAEP Technology and Engineering Literacy Assessment. The Governing Board hopes that this *NAEP Technology and Engineering Literacy Framework* will serve as a significant national measure of what students know and can do in technology and engineering, and support improvements in student achievement.

To view the complete *2014 NAEP Technology and Engineering Literacy Framework*, or to view an interactive version of the framework, please visit www.nagb.org/publications/frameworks.htm or call us at (202) 357-6938.
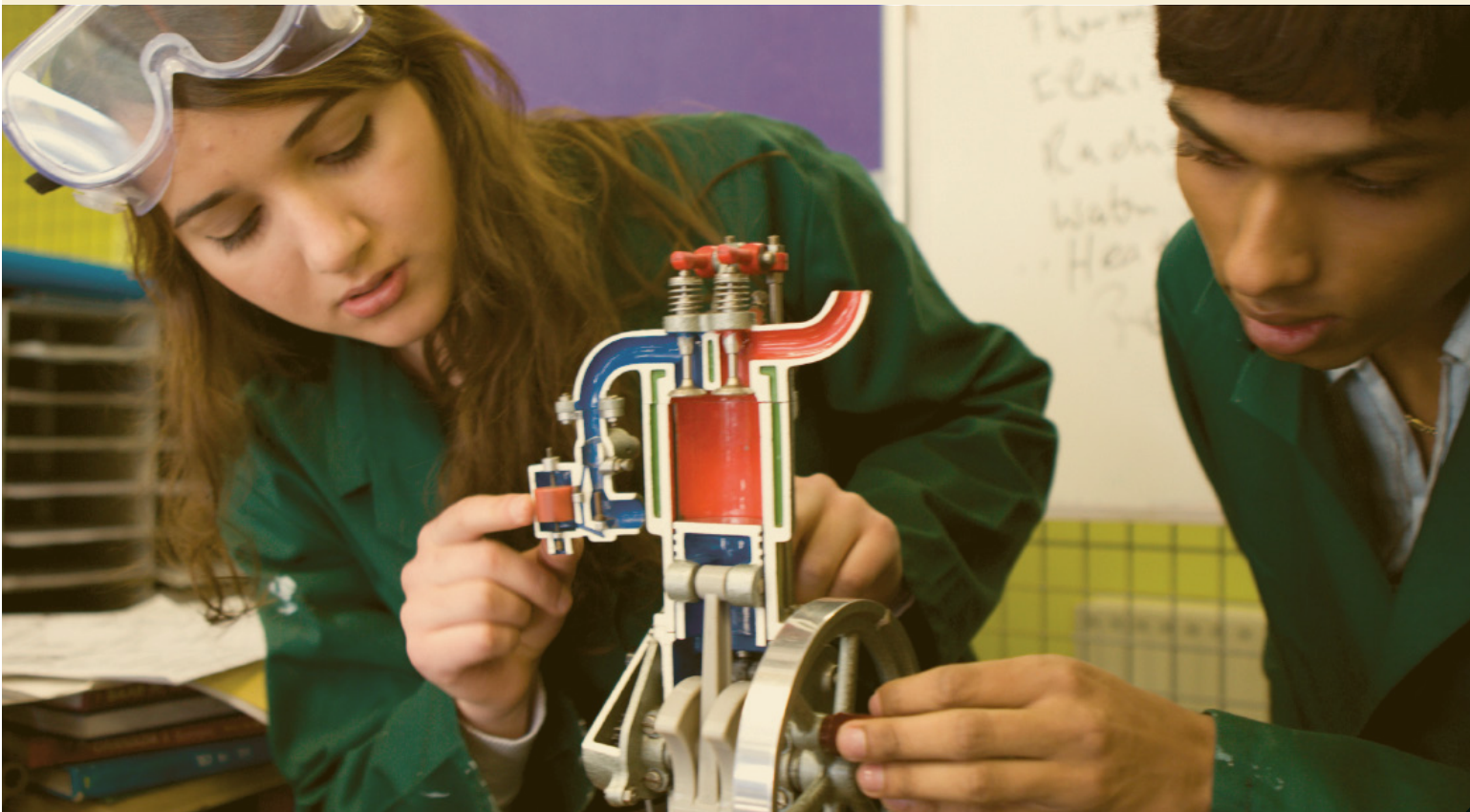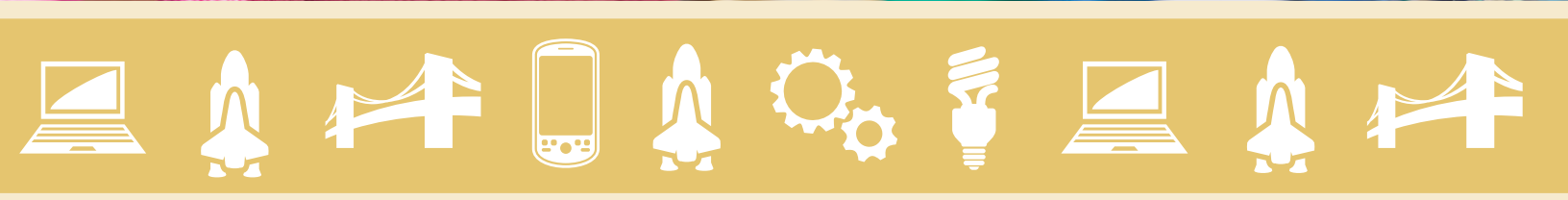
For more information on the National Assessment
Governing Board, please visit www.nagb.org
or call us at (202) 357-6938.

National Assessment Governing Board

Developing Student Performance Levels for the National Assessment of Educational Progress

Policy Statement

Foreword
A policy on setting achievement levels on the National Assessment of Educational Progress (NAEP) was first adopted in 1990 and amended several times thereafter. The present policy, adopted in 1995, contained introductory and explanatory text, principles, and guidelines. Since 1995, there have been several changes to the NAEP authorizing legislation (currently, the NAEP Authorization Act: P.L. 110-279). In addition, related legislation has been enacted, including the No Child Left Act of 2001. Consequently, introductory and other explanatory text in the original version of this policy, no longer germane, has been deleted or revised to conform to current legislation. The Principles and Guidelines remain in their original form except for Principle 4, from which the reference to the now decommissioned Advisory Council on Education Statistics has been deleted. (Foreword added August 2007.)

Principles for Setting Achievement Levels

Principle 1
The level setting process shall produce for each content area, three threshold points at each grade level assessed, demarcating entry into three categories: *Basic, Proficient, and Advanced.*

> *Proficient.*   *This level represents solid academic performance for each grade assessed. Students reaching this level have demonstrated competency over challenging subject matter, including subject-matter knowledge, application of such knowledge to real world situations, and analytical skills appropriate to the subject matter.*

> *Basic.*   *This level denotes partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at each grade.*
>
> *Advanced.*   *This level signifies superior performance beyond proficient.*

Principle 2

Developing achievement levels shall be a widely inclusive activity of the Board, utilizing a national consensus approach, and providing for the active participation of teachers, other educators (including curriculum specialists and school administrators at the local and state levels), and non-educators including parents, members of the general public, and specialists in the particular content area.

The development of achievement levels shall be conducted in two phases. In phase 1, the assessment framework development process shall yield preliminary descriptions of the achievement levels *(Basic, Proficient, and Advanced),* which shall subsequently be used in phase 2 to develop the numerical standards (cut scores) and to identify appropriate examples of assessment exercises that typify performance at each level. The levels will be updated as appropriate, typically when the assessment frameworks are updated.

Principle 3

The Governing Board shall incorporate the student performance levels into all significant elements of NAEP, including the subject area framework development process, exercise development and selection, and the methodology of the assessment. The achievement levels shall be used to report the results of the NAEP assessments so long as such levels are reasonable, valid and informative to the public.

Principle 4

In carrying out its statutory mandate, the Governing Board will *exercise its policy judgment in setting the levels.* The Board shall continually seek better means of setting achievement levels. In so doing, the Board may seek technical advice as appropriate from a variety of sources, including external evaluations provided by the Secretary, the Commissioner, and other experts. Proposed achievement levels shall be reviewed by a broad constituency, including consumers of NAEP data, such as policymakers, professional groups, the states and territories. In carrying out its responsibilities, the Board will ordinarily engage the services of a contractor who will prepare recommendations for the Board's consideration on the levels, the descriptions, and the exemplar exercises.

Guidelines for Setting Achievement Levels

Each guideline presented below is accompanied by a rationale and a summary of the implementation practices and procedures to be followed in carrying out the principle. It should be understood that the full implementation of this policy will require the

contractor, through Governing Board staff, to provide assurances to the Board that all aspects of the practices and procedures for which they are responsible have been completed successfully. These assurances will be in writing, and may require supporting documentation prepared by the contractor and/or Governing Board staff.

Summary of Guidelines

Guideline 1

The level setting process shall produce for each content area, three threshold points at each grade level assessed, demarcating entry into three categories: *Basic, Proficient, and Advanced.*

Guideline 2

The level setting process shall be a widely inclusive activity of the Board, carried out by a broadly representative body of teachers, other educators (including curriculum specialists and local and state administrators), and non-educators including parents, concerned members of the general public, and specialists in the particular content area; this process and resulting products shall be reviewed by a broad constituency.

Guideline 3

The level-setting process shall result in achievement level cut scores for each grade and level, expanded descriptions of the content expected at each level based on the preliminary descriptions provided through the national consensus process, and exemplar exercises that are representative of the performance of examinees at each of the levels and of the cognitive expectations for each level described.

Guideline 4

In carrying out its statutory mandate, the Board will *exercise its policy judgment in setting the levels.* However, in so doing, they will seek technical advice from a variety of sources, but especially from the contractor who will prepare the recommendations on the levels, the descriptions, and the exemplar exercises, as well as from consumers of NAEP data, including policymakers, professional groups, the states, and territories.

Guideline 5

The achievement levels shall be the initial and primary means of reporting the results of the National Assessment of Educational Progress at both the national and state levels.

Guideline 6

The level-setting process shall be managed in a technically sound, efficient, cost-effective manner, and shall be completed in a timely fashion.

Guideline 1

The level setting process shall produce for each content area, three threshold points at each grade level assessed, demarcating entry into three categories: *Basic, Proficient, and Advanced.*

Rationale

The Board is committed to describing the full range of performance on the NAEP scale, for students whose performance is in the mid-range, as well as for those whose performance is below and above the middle. It is highly desirable to endorse realistic expectations for all students to achieve no matter what their present performance might be. Three benchmarks on the NAEP scale suggest realistic expectations for students in all regions of the performance distribution. Likewise, the Board is committed to preserving trend results in NAEP. Three achievement levels accommodate growth (and possible declines) in all ranges of the performance distribution.

Practices and Procedures

Policy Definitions

The following policy definitions will be applied to all grades, 4, 8, and 12, and all content areas in which the levels are set. It is the Board's view that the level of performance referred to in the policy definitions is what students *should be able to know and do,* and not simply the current academic achievement of students or that which today's U.S. schools expect.

Proficient.   *This level represents solid academic performance for each grade assessed. Students reaching this level have demonstrated competency over challenging subject matter, including subject-matter knowledge, application of such knowledge to real world situations, and analytical skills appropriate to the subject matter.*

Basic.   *This level denotes partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at each grade.*

Advanced.   *This level signifies superior performance beyond proficient.*

From Policy Definitions to Content Descriptions

In the course of applying the policy definitions to the level-setting process, it will be necessary to articulate them in terms of the specific content and sequence (now called descriptions) appropriate for the grades in which the levels are being set. This will be completed on a preliminary basis through the process which develops the assessment

frameworks. These preliminary descriptions will be used to initially guide the work of deriving the advice that will assist the Board in setting the levels. Throughout the process of obtaining such advice, however, these descriptions may be refined, expanded, and edited to more clearly reflect the specific advice on the levels.

Training of Judges

In training the judges for the level-setting activity, it is necessary that all arrive at a common conceptualization of *Basic, Proficient, and Advanced* based on the policy definitions of the Board. Such conceptualizations must be within the scope of the assessment framework under consideration and capable of being applied at the individual item level (Reid, 1991.)

Judges must also be trained in the specific model that will be used to generate the rating data. At the very least, they need to understand the purposes for setting the levels, the significance of such an activity, the NAEP assessment framework for the subject area under discussion, elements that make particular exercises more or less difficult, and the rating task itself.

Judges shall be trained by individuals who are both knowledgeable in the subject matter area and are experienced, capable trainers in a large-group setting. Presentations shall be prepared, rehearsed, and piloted before implementation.

Judges shall be provided comprehensive, user-friendly training materials, adequate time to complete the task, and the appropriate atmosphere in which to work, one that is quiet, pleasant, and conducive to reaching the goals of the level-setting activity. It is also required that judges take the assessment under the same NAEP-like conditions as students, that is, using the NAEP student booklets, having all manipulatives and ancillary materials, and timed.

Guideline 2

The level setting process shall be a widely *inclusive* activity of the Board, carried out by a broadly representative body of teachers, other educators (including curriculum specialists and local and state administrators), and non-educators including parents, concerned members of the general public, employers, scholars, and specialists in the particular content area. This process and resulting products shall be reviewed by a broad constituency.

Rationale

The spirit of the legislative mandate of the Board is one of moving toward a national consensus on policy issues affecting NAEP. The Board has historically involved broad audiences in its deliberations. The achievement levels are no different. Further, the Board views the level-setting activity as an extension of the widely inclusive effort to derive the assessment frameworks and scope and sequence of each assessment. Finally, the magnitude of the decisions regarding *what students should know and be able to do is*

simply too important a decision to seek involvement from professionals alone; it must have the benefit of the collective wisdom of a broadly representative body, educators and non-educators alike.

Practices and Procedures

Sample of Judges

The panel of judges will be composed of both educators and non-educators. About two-thirds of the panel will represent teachers and other educators; one-third will represent the public, non-educator sector, for example, scholars, employers, parents, and professionals in occupations related to the content area. They will be drawn from a national sampling frame and will be broadly representative of various geographic regions (Northeast, Southeast, Central, West, and the territories) types of communities (urban, suburban, rural), ethnicities, and genders.

Individual panel members shall have expertise in the specific content area in which the levels are being developed, expertise in the education of students at the grades under consideration, and a general knowledge of assessment, curriculum, and student performance. The composition of the panels should be such that they meet the requirements of the *Standards (1985).*

The size of the panels should be responsive to what the research demonstrates regarding numbers of judges involved (see Jaeger, 1991). While it may not be practical or beyond the resources available, every effort should be made to empanel a sufficient number of judges to reduce the standard error of the cut score. While there is no absolute criterion on the magnitude of the standard error of the cut score, a useful rule of thumb is that it should not exceed the *combined* error associated with the standard error of measurement on the assessment and the error due to sampling from the population of examinees.

Review Procedures

Throughout the process and particularly at critical junctures, groups that have a legitimate interest in the process will be involved. During the planning process interested groups and individuals will be encouraged to participate and share their experiences in the area of setting standards. These groups might include professional societies, *ad hoc* advisory groups, standing advisory committees to the Governing Board or its contractor(s) and NCES and its contractor(s) and grantees. Documents (such as the Design Document and Interim Reports) will be disseminated in sufficient time to allow for a thoughtful response from those who wish to provide one.

Proposed levels will be widely distributed to major professional organizations, state and local assessment and curriculum personnel, business leaders, government officials, the Planning and Steering Committees of the framework development process, the Exercise Development panels, and other groups who may request them.

When it is deemed useful by the Board, public hearings and forums will be conducted in Washington, D.C. and other parts of the country to encourage review and input on a broad regional and geographic basis.

Guideline 3

The resulting products of the level-setting process shall be (1) achievement level scores marking the threshold score for each grade and level, (2) expanded descriptions of the content expected at each level based on the preliminary descriptions provided through the national consensus process, and (3) exemplar exercises that are representative of the performance of examinees at each of the levels and of the cognitive expectations for each level described. These three products form the basis for reporting the results of all future NAEP assessments.

Rationale

The NAEP scale, while useful for aggregating large amounts of information about student performance in a single number, requires contextual information about the specific content and the sequencing of that content across particular grades, in order to be truly beneficial to users of NAEP data. In order to make the NAEP data more useful, descriptions of each level which articulate content expectations and exemplar exercises taken from the public release pool of the most current NAEP assessment must accompany the benchmarks or cut scores for each level. The descriptions and exemplars are intended to be illustrative of the kind of content that is represented in the levels, as well as an aid in the interpretation of the NAEP data.

Practices and Procedures

Methodology

The methodology to be used in generating the levels will depend upon the specific assessment formats for the content area in which the levels are being set. Historically, in the case of multiple choice exercises and short constructed response formats, a modified Angoff (1971) procedure has been employed. In the case of extended constructed response formats, a paper-selection procedure has been employed. Neither of these is without its disadvantages. As the assessment formats of future assessments become more complex and employ more performance-type exercises, it is quite likely that alternate procedures will be needed. The Board will decide these on a case-by-case basis, looking for advice from those who have had experience in dealing with these alternative assessment formats. In any case, the design for carrying out the process must be carefully crafted, must be appropriate to the content area and philosophy of the assessment framework, and must have a solid research base.

The procedures will generally be piloted prior to full implementation. The purpose of the pilot would be to test out the materials used with the judges, the training procedures, the feedback information given to the judges during the process, and the

software used to complete the initial analyses. Procedures would be revised based on the pilot experience and evaluation evidence.

Whatever methodology is used, all aspects of the procedures will be documented for the purposes of providing evidence of procedural validity for the levels being recommended. This evidence will be made available to the Board at the time of deliberations about the levels being set.

Quality Control Procedures

While there are numerous points in a complex process for mistakes to occur, there are at least three important junctures where quality control measures need to be in place. First, is the point of data entry. Ideally, judges' ratings should be scanned to reduce manual errors of entry. However, if the ratings are entered manually, then they shall be entered and 100% verified using a double-entry, cross-checking procedure. Second, software programs designed to complete initial analyses on the rating data must be run with simulated data to de-bug, and provide assurances of quality control. The programs should detect logical errors and other kinds of problems that could result in incorrect results being generated. Finally, the production of cut scores on the NAEP scale is the final responsibility of the NAEP operations contractor. Only final cut scores, mapped onto the properly weighted and equated scale, received in writing from the operations contractor, will be officially communicated to the Board, or others who have a legitimate need to know. *Once the accuracy of the data has been ensured by the level-setting and operations contractors, the Board shall make a policy determination and set the final achievement levels, informed by the technical process of the level-setting activity.*

Descriptions of the Levels

The preliminary descriptions developed through the framework development process will be the starting point for developing recommendations for the levels under consideration. The preliminary descriptions are *working descriptions* for the panels while doing the ratings. These may be expanded and revised accordingly as these panels conduct the ratings, examine empirical performance data, and work to develop their final recommendations on the levels. The recommended descriptions will be articulated in terms of what students *should know and should be able to do.* They shall be coherent within grade, and consistent across grades, and will reference performance within the three regions created by the cut scores. No descriptions will be done for content below the *Basic* level.

Exemplar Exercises

The exemplars chosen from the released pool of exercises for the current NAEP assessment will reflect as much as possible performance both in the *Basic, Proficient, and Advanced* regions of the scale, as well as at the threshold scores. Exemplars will be selected to meet the rp = .50 criterion, and will demonstrate the range of performance possible within the regions. They will likewise reflect the content found in the final descriptions and the range of item formats on the assessment. Evidence will be provided for the degree of congruence between the content of the exemplars and that of the descriptions. There will be at least three exemplars per level per grade identified.

Guideline 4

In carrying out its statutory mandate, the Board will *exercise its policy judgment in setting the levels.* However, in so doing, they will seek technical advice from a variety of sources, but especially from the contractor, who will prepare the recommendations on the levels, the descriptions, and the exemplar exercises, as well as from consumers of NAEP data, including policymakers, professional groups, the states and territories.

Rationale

Setting achievement levels is both an *art* and a *science.* As an *art,* it requires judgment. It is the Board's best policy judgment what the levels should be. However, as a *science,* it requires solid technical advice based on a sound technical process. The Board is committed to seeking such technical advice from a variety of sources.

Practices and Procedures

Technical Advice throughout the Process

The Board seeks to involve persons who have had experience in standard-setting at the state level, and from those who are users of the NAEP results. Regular presentations will be given to standing committees who advise on NAEP matters such as the Education and Information Advisory Committee (EIAC) of the CCSSO, and the NAEP NETWORK. Their counsel will be sought on matters of substance as the work of the Board progresses. The EIAC and other similar constituencies may also be invited to send a representative to all standing technical advisory committees of the Board's contractor(s) which deal with the level-setting process.

The Board will also seek advice from the technical community throughout the level-setting process. Efforts will be made to ensure that presentations are made regularly to such groups as the American Educational Research Association (AERA), the National Council for Measurement in Education (NCME), and the professional groups in the content areas such as the International Reading Association (IRA), the National Science Teachers Association (NSTA), and other similar organizations. The Board will seek to engage technical groups available to them, including the Technical Review Panel, the National Academy of Education, their own contractor(s), and NCES and its contractor(s), in constructive research studies focused on providing information on the technical aspects of NAEP related to level-setting (e.g., scaling, weighting, mapping ratings to the scale, etc.)

Validity and Reliability Evidence

The Board will examine and consider all evidence of reliability and validity available. These data would include, but need not be limited to, procedural evidence such as the selection and training of judges and the materials and methods used in the process, reliability evidence such as intra-judge and inter-judge consistency data, and finally, internal and external validity data. Such data will help to inform *the Board's policy decision as they set the levels.*

Procedural evidence, while informative, is not necessarily sufficient evidence for demonstrating the validity of the levels. Therefore, the conduct of the achievement level-setting process shall be implemented so that a series of both internal and external validation studies shall be conducted simultaneously. To the extent possible, in order to realize maximum efficiencies in the use of resources, validation studies shall be included in the design of the level-setting data collection activities. Such studies may include, but shall not be limited to, convergent and divergent validation efforts, for example, conducting alternate standard-setting methods or conducting cross-validation level-setting activities, as well as exploring alternate methods for refining and expanding the preliminary achievement levels definitions, and empirically examining various technical decision rules used throughout the process.

As part of the validation task, additional evidence as to the suitability and appropriateness of identifying the subject area content of the recommended achievement levels ranges and cut-scores will be gathered. This evidence may include, but need not be limited to, data resulting from behaviorally anchoring the ranges and/or cut-scores, or data resulting from some other alternative procedures that employ a more global approach other than the item content of the particular assessment. The results of these studies will provide a clear indication of what students know and can do at the levels.

The results from these validation efforts shall be made available to the Board in a timely manner so that the Board has access to as much validation data as possible as it considers the recommendations regarding the final levels. Kane (1993) suggests that an "interpretive argument would specify the network of inferences leading from the score to the conclusions drawn about examinees and the decisions made about examinees, as well as the assumptions that support these inferences." An interpretative argument which articulates the rationale for interpreting the levels shall accompany the presentation of proposed levels to the Board.

Again, to maximize the efficient use of resources and to minimize duplication of effort, it is highly desirable for contractors to coordinate the design of such studies with other agencies responsible for evaluating the level-setting activities.

Guideline 5
The achievement levels shall be the initial and primary means of reporting the results of the National Assessment of Educational Progress at both the national and state levels.

Rationale
In an effort to improve the form and use of NAEP the Board seeks to make the results of NAEP more accessible and understandable to the general public and to policy makers. The Board also supports the movement from norms-based assessments to standards-based assessments. Reporting the results of NAEP using the achievement levels accomplishes these ends to a greater degree than heretofore possible.

Practices and Procedures

Reporting What Students Know and Can Do

The purpose of most NAEP reports, but particularly those published under the auspices of the National Center for Education Statistics, is to report to the American public and others on the performance of students—that is, to report on *what students know and can do.* The purpose of the achievement levels is to identify for the American public what students *should know and should be able to do,* and to report the actual performance of students in relation to the achievement levels. Therefore, NAEP reports incorporate elements of both of these aspects of performance.

Clarity of interpretation of the NAEP data can be achieved by ensuring that the descriptions of performance for the levels and the exemplar exercises reflect what the empirical data show for a given assessment. This may be achieved by the modified procedures of *scale anchoring* [1] or by new procedures developed specifically for the purposes of providing elements of the content of the frameworks in the reporting mechanisms.

Reporting Student Performance

In describing student performance using the levels, terms such as *students performing at the Basic level* or *students performing at the Proficient level* are preferred over *Basic students* or *Proficient students.* The former implies that students have mastery of particular content represented by the levels, while the latter implies an inherent characteristic of individual students.

In reporting the results of NAEP, the application of the levels of *Basic, Proficient, and Advanced* applies to the three regions of the NAEP scale generated when the appropriate cut scores are mapped to the scale. However, three cut scores yield, in fact, four regions. The region referenced by content which falls below the *Basic* cut score will be identified by descriptors that are not value-laden.

Interpreting Student Performance

When interpreting student performance using the levels, one must diligently avoid over interpretations. For example, each of the NAEP subject areas are scaled independently of each other, even though each scale uses the same metric, i.e., scores ranging from 0 to 500. Because the metrics are identical, it does not follow that comparisons can be made across subjects. For example, a *Proficient* cut score of *235* in reading should not be interpreted to have the same meaning as a *Proficient* cut score of *235* in U.S. history. Neither should unwarranted comparisons be made in the same subject area from one assessment year to the next, unless the data for the two years have been equated and we have reason to believe that the scale itself has not changed from time 1 to time 2.

Guideline 6

The level-setting process shall be managed in a technically sound, efficient, cost-effective manner, and shall be completed in a timely fashion.

Rationale

Since a contractor(s) is conducting technical advisory and assistance work for the Board, it is critical that such work be performed to meet high quality standards, including efficiency, cost-effectiveness, timeliness, and adherence to sound measurement practices. *However, in the final analysis, it is the Governing Board that makes the policy decision regarding the levels, not the contractor.*

Practices and Procedures

The contractor(s) shall prepare a fully detailed Planning Document at the onset of the level-setting work. This document will guide the progress of the work, serve as a monitor, and be the basis for staff and Board supervision. The Planning Document will outline milestone events in the process, provide a chronology of tasks and subtasks, as well as a monthly chronology of all activities across all tasks, and detail all draft and final documents that will be produced, the audience for such reports, and the number of copies to be provided by the contractor.

Procedures adopted by a contractor(s) to carry out the level-setting process must encourage and support national involvement by the relevant and required publics. Such meetings will also be conducted in a physical environment which is conducive to work and planning. To the extent possible, current technology shall be used in all areas of the level-setting process to increase efficiency and to reduce error.

The contractor(s) shall work closely and in a professional manner with the NAEP operations contractor in striving to fulfill the requirements of the level-setting process by (1) making all requests for information and data in a timely manner, (2) providing all requested information and data in a timely manner, (3) adhering to all predetermined deadlines so as not to impede the work of the operations contractor, and (4) advising the operations contractor of all unusual findings in the data so that a concerted effort can be mounted to resolve the problem or issue at hand.

The contractor(s) shall develop the initial level-setting design adhering to sound measurement principles and ensure that the various components of the design (e.g., selection of judges) are congruent with current standard-setting research. In the implementation of such designs, they shall employ state-of-the-art training strategies and measurement practices.

The contractor(s) shall produce documents in a timely manner and make oral presentations upon request. Presentations may include, but need not be limited to, the Board's quarterly meetings, relevant Board committees, and professional and lay groups.

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Endnotes

1. The traditional scale anchoring procedures anchored at the 200, 250, 300 350 points of the scale ($\pm$ 12.5 points), using a p $=$ *.65,* and a discrimination of .30 with the next lower level. The modified anchoring procedures (tried in reading for 1992) anchored at the achievement levels cut scores *($\pm$ 12.5),* using a p $=$ .65, and no discrimination criterion.

Technology and Engineering Literacy Achievement Levels Descriptions

Basic: Eighth grade students performing at the *Basic* level should be able to use common tools and media to achieve specified goals and identify major impacts. They should demonstrate an understanding that humans can develop solutions by creating and using technologies. They should be able to identify major positive and negative effects that technology can have on the natural and designed world. Students should be able to use systematic engineering design processes to solve a simple problem that responsibly addresses a human need or want. Students should distinguish components in selected technological systems and recognize that technologies require maintenance. They should select common information and communications technology tools and media for specified purposes, tasks, and audiences. Students should be able to find and evaluate sources, organize and display data and other information to address simple research tasks, give appropriate acknowledgement for use of the work of others, and use feedback from team members (assessed virtually).

Proficient: Eighth grade students performing at the *Proficient* level should be able to understand the interactions among parts within systems, systematically develop solutions, and contribute to teams (assessed virtually) using common and specialized tools to achieve goals. They should be able to explain how technology and society influence each other by comparing the benefits and limitations of the technologies' impacts. Students should be able to analyze the interactions among components in technological systems and consider how the behavior of a single part affects the whole. They should be able to diagnose the cause of a simple technological problem. They should be able to use a variety of technologies and work with others using systematic engineering design processes in which they iteratively plan, analyze, generate, and communicate solutions. Students should be able to select and use an appropriate range of tools and media for a variety of purposes, tasks, and audiences. They should be able to contribute to work of team collaborators (assessed virtually) and provide constructive feedback. Students should be able to find, evaluate, organize, and display data and information to answer research questions, solve problems, and achieve goals, appropriately citing use of the ideas, words, and images of others.

Advanced: Eighth grade students performing at the *Advanced* level should be able to draw upon multiple tools and media to address complex problems and goals and demonstrate their understanding of the potential impacts on society. They should be able to explain the complex relationships between technologies and society and the potential implications of technological decisions on society and the natural world. Given criteria and constraints, students should be able to use systematic engineering design processes to plan, design, and use evidence to evaluate and refine multiple possible solutions to a need or problem and justify their solutions. Students should be able to explain the relationships among components in technological systems, anticipate maintenance issues, identify root causes, and repair faults. They should be able to use a variety of common and specialized information technologies to achieve goals, and to produce and communicate solutions to complex problems. Students should be able to integrate the use of multiple tools and media, evaluate and use data and information, communicate with a range of audiences, and accomplish complex tasks. They should be able to use and explain the ethical and appropriate methods for citing use of multimedia sources and the ideas and work of others. Students should be able to contribute to collaborative tasks on a team (assessed virtually) and organize, monitor, and refine team processes.