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SCANS

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# WHAT WORK REQUIRES OF SCHOOLS



## A SCANS REPORT FOR AMERICA 2000

THE SECRETARY'S COMMISSION ON ACHIEVING NECESSARY SKILLS  
U.S. DEPARTMENT OF LABOR



## FIGURE B

## FIVE COMPETENCIES

**Resources:** Identifies, organizes, plans, and allocates resources

- A. *Time*—Selects goal-relevant activities, ranks them, allocates time, and prepares and follows schedules
- B. *Money*—Uses or prepares budgets, makes forecasts, keeps records, and makes adjustments to meet objectives
- C. *Material and Facilities*—Acquires, stores, allocates, and uses materials or space efficiently
- D. *Human Resources*—Assesses skills and distributes work accordingly, evaluates performance and provides feedback

**Interpersonal:** Works with others

- A. *Participates as Member of a Team*—contributes to group effort
- B. *Teaches Others New Skills*
- C. *Serves Clients/Customers*—works to satisfy customers' expectations
- D. *Exercises Leadership*—communicates ideas to justify position, persuades and convinces others, responsibly challenges existing procedures and policies
- E. *Negotiates*—works toward agreements involving exchange of resources, resolves divergent interests
- F. *Works with Diversity*—works well with men and women from diverse backgrounds

**Information:** Acquires and uses information

- A. *Acquires and Evaluates Information*
- B. *Organizes and Maintains Information*
- C. *Interprets and Communicates Information*
- D. *Uses Computers to Process Information*

**Systems:** Understands complex inter-relationships

- A. *Understands Systems*—knows how social, organizational, and technological systems work and operates effectively with them
- B. *Monitors and Corrects Performance*—distinguishes trends, predicts impacts on system operations, diagnoses deviations in systems' performance and corrects malfunctions
- C. *Improves or Designs Systems*—suggests modifications to existing systems and develops new or alternative systems to improve performance

**Technology:** Works with a variety of technologies

- A. *Selects Technology*—chooses procedures, tools or equipment including computers and related technologies
- B. *Applies Technology to Task*—Understands overall intent and proper procedures for setup and operation of equipment
- C. *Maintains and Troubleshoots Equipment*—Prevents, identifies, or solves problems with equipment, including computers and other technologies

## FIGURE C

## A THREE-PART FOUNDATION

**Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens, and speaks

- A. *Reading*—locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
- B. *Writing*—communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
- C. *Arithmetic/Mathematics*—performs basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques
- D. *Listening*—receives, attends to, interprets, and responds to verbal messages and other cues
- E. *Speaking*—organizes ideas and communicates orally

**Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

- A. *Creative Thinking*—generates new ideas
- B. *Decision Making*—specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
- C. *Problem Solving*—recognizes problems and devises and implements plan of action
- D. *Seeing Things in the Mind's Eye*—organizes, and processes symbols, pictures, graphs, objects and other information
- E. *Knowing How to Learn*—uses efficient learning techniques to acquire and apply new knowledge and skills
- F. *Reasoning*—discovers a rule or principle underlying the relationship between two or more objects and applies it in solving a problem

**Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

- A. *Responsibility*—exerts a high level of effort and perseveres towards goal attainment
- B. *Self-Esteem*—believes in own self-worth and maintains a positive view of self
- C. *Sociability*—demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings
- D. *Self-Management*—assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
- E. *Integrity/Honesty*—chooses ethical courses of action

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**CONNECTICUT MASTERY TEST THIRD GENERATION BLUEPRINT**
**Grades 4, 6 and 8 Content Overview Effective Fall 2000**

<b>Content Standard</b>	<b>Strand</b>
<b>Number Sense</b>	1. Place Value 2. Pictorial Representations of Numbers 3. Equivalent Fractions, Decimals and Percents 4. Order, Magnitude and Rounding
<b>Operations</b>	5. Models for Operations 6. Basic Facts 7. Compute with Whole Numbers and Decimals 8. Compute with Fractions 9. Solve Word Problems
<b>Estimation and Approximation</b>	10. Numerical Estimation Strategies 11. Estimate Solutions to Problems
<b>Ratios, Proportions and Percents</b>	12. Ratios and Proportions 13. Compute with Percents
<b>Measurement</b>	14. Time 15. Approximate/Estimate Customary and Metric Measures 16. Customary and Metric Measures
<b>Spatial Relationships and Geometry</b>	17. Geometric Shapes and Properties 18. Spatial Relationships
<b>Probability and Statistics</b>	19. Tables, Graphs and Charts 20. Statistics and Data Analysis 21. Probability
<b>Patterns</b>	22. Patterns
<b>Algebra and Functions</b>	23. Algebraic Concepts
<b>Discrete Mathematics</b>	24. Classification and Logical Reasoning
<b>Integrated Understandings</b>	25. Mathematical Applications

## GRADE 4

Content Standard	Strand	Concept or Skill
Number Sense	Place Value	1a. Solve problems involving 1 and 10, more or less.
		1b. Identify alternative forms of expressing whole numbers using expanded notation.
		1c. Identify alternative forms of expressing whole numbers using regrouping.
		1d. Use place value concepts to interpret the meaning of numbers.
	Pictorial Representations of Numbers	2a. Relate pictorial representations using base ten blocks to whole numbers and vice versa.
		2b. Identify, label and shade fractional parts of regions and sets using pictures.
	Equivalent Fractions, Decimals and Percents	Not tested at Grade 4.
	Order, Magnitude and Rounding	4a. Order whole numbers.
		4b. Describe magnitude of whole numbers.
		4c. Round whole numbers.
		4d. Identify points representing whole numbers on a number line and vice versa.
Operations	Models for Operation	5a. Relate multiplication and division facts to rectangular arrays and pictures.
		5b. Identify or write the appropriate operation or number sentence to solve a story problem.
		5c. Write story problems from addition and subtraction number sentences.
	Basic Facts	6a. Add and subtract facts to 18.
6b. Multiply and divide by 2,5 and 10.		

## GRADE 4, continued

<b>Content Standard</b>	<b>Strand</b>	<b>Concept or Skill</b>
	Compute with Whole Numbers and Decimals	7a. Add and subtract 1- and 2-digit numbers without regrouping. 7b. Add 1- and 2-digit numbers with regrouping.
	Compute with Fractions	Not tested at Grade 4.
	Solve Word Problems	9a. Solve simple story problems involving addition or subtraction. 9b. Solve simple story problems involving addition or subtraction with extraneous information.
<b>Estimation and Approximation</b>	Numerical Estimation Strategies	10a. Identify the best expression to find an estimate. 10b. Identify whether and why a particular strategy will result in an overestimate or an underestimate. 10c. Determine the reasonableness or unreasonableness of an estimate and explain why.
	Estimate Solutions to Problems	11a. Estimate a reasonable answer to a problem. 11b. Use estimation to make and defend decisions.
<b>Ratios, Proportions and Percents</b>	Ratios and Proportions	Not tested at Grade 4.
	Compute with Percents	Not tested at Grade 4.
<b>Measurement</b>	Time	14a. Tell time to the nearest hour, half-hour and quarter-hour using analog and digital clocks. 14b. Solve problems involving time, elapsed time and calendars. 14c. Interpret situations involving clocks and calendars.
	Approximate/Estimate Customary and Metric Measures	15. Estimate lengths and areas.

## GRADE 4, continued

Content Standard	Strand	Concept or Skill
	Customary and Metric Measures	16a. Measure or draw lengths to the nearest inch or centimeter. 16b. Identify appropriate customary or metric measure for a given situation.
Spatial Relationships and Geometry	Geometric Shapes and Properties	17a. Identify geometric shapes and figures, including the number of angles and sides of polygons. 17b. Draw geometric shapes and figures.
	Spatial Relationships	Not tested at Grade 4.
Probability and Statistics	Tables, Graphs and Charts	19a. Identify correct information from graphs, tables and charts. 19b. Create bar graphs and pictographs from data in tables and charts.
	Statistics and Data Analysis	Not tested at Grade 4.
	Probability	21. Solve problems involving elementary notions of probability.
Patterns	Patterns	22. Extend or complete patterns involving whole numbers and attributes and identify or state rules for given patterns.
		Not tested at Grade 4.
Algebra and Functions	Algebraic Concepts	
Discrete Mathematics	Classification and Logical Reasoning	24a. Identify objects that are the same or different by one attribute. 24b. Sort objects into two groups by a common attribute.
Integrated Understandings	Mathematical Applications	25. Solve extended numerical and statistical problems.

## GRADE 6

Content Standard	Strand	Concept or Skill
Number Sense	Place Value	1a. Solve problems involving 100 and 1,000, more or less.
		1b. Identify alternative forms of expressing whole numbers <10,000 using expanded notation.
		1c. Identify alternative forms of expressing whole numbers <10,000 using regrouping.
		1d. Use place value concepts to interpret the meaning of numbers.
	Pictorial Representations of Numbers	2a. Relate decimals (0.01 - 2.99) to pictorial representations and vice versa.
		2b. Relate fractions and mixed numbers to pictures and vice versa.
		2c. Construct pictorial representations of fractions, mixed numbers and decimals.
	Equivalent Fractions, Decimals and Percents	3a. Rename equivalent fractions.
		3b. Rename equivalent mixed numbers and improper fractions.
	Order, Magnitude and Rounding	4a. Order whole numbers less than 100,000.
		4b. Order fractions, mixed numbers and decimals.
		4c. Describe magnitude of whole numbers <100,000.
		4d. Describe magnitude of fractions, mixed numbers and decimals.
		4e. Round whole numbers.
4f. Round decimals.		
4g. Locate points on number lines and scales.		
Operations	Models for Operations	5a. Identify the appropriate operation or number sentence to solve a story problem.
		5b. Write story problems from multiplication and division number sentences.
	Basic Facts	6. Multiply and divide facts.

## GRADE 6, continued

Content Standard	Strand	Concept or Skill
	Compute with Whole Numbers and Decimals	7a. Add and subtract 2-, 3- and 4-digit whole numbers and money amounts less than \$100. 7b. Multiply and divide multiples of 10 and 100 by 10 and 100. 7c. Multiply and divide 2- and 3-digit whole numbers and money amounts less than \$10 by 1-digit numbers.
	Compute with Fractions	8. Add and subtract fractions and mixed numbers with like denominators.
	Solve Word Problems	9a. Solve 1-step problems involving whole numbers and money amounts. 9b. Solve 2-step problems involving whole numbers and money amounts. 9c. Solve 2-step problems and explain how the solution was arrived at.
Estimation and Approximation	Numerical Estimation Strategies	10a. Identify the best expression to find an estimate. 10b. Identify whether and why a particular strategy will result in an overestimate or an underestimate. 10c. Determine the reasonableness or unreasonableness of an answer or estimate.
	Estimate Solutions to Problems	11a. Estimate a reasonable answer to a problem and explain why it is reasonable. 11b. Use estimation to make and defend decisions.
Ratios, Proportions and Percents	Ratios and Proportions	Not tested at Grade 6.
	Compute with Percents	Not tested at Grade 6.
Measurement	Time	14a. Solve problems involving elapsed time. 14b. Solve problems involving the conversion of measures of time.
	Approximate/Estimate Customary and Metric Measures	15. Estimate lengths and areas.

## GRADE 6, continued

Content Standard	Strand	Concept or Skill
	Customary and Metric Measures	<p>16a. Solve problems involving the conversion of measures of length.</p> <p>16b. Measure lengths to the metric or customary unit specified.</p> <p>16c. Measure/determine perimeter and area.</p> <p>16d. Identify appropriate customary or metric units of measure for a given situation (length, capacity, mass).</p>
Spatial Relationships and Geometry	Geometric Shapes and Properties	<p>17a. Identify, draw, describe and classify geometric shapes and figures.</p> <p>17b. Describe and classify geometric shapes and figures.</p>
	Spatial Relationships	<p>18a. Identify or draw lines of symmetry.</p> <p>18b. Identify congruent figures.</p> <p>18c. Locate points on grids.</p>
	Tables, Graphs and Charts	<p>19a. Identify correct information from graphs, tables and charts.</p> <p>19b. Create bar graphs and pictographs from data in tables and charts.</p>
Probability and Statistics	Statistics and Data Analysis	20. Draw and justify reasonable conclusions from graphs, tables and charts.
	Probability	21. Solve problems involving elementary notions of probability and fairness, including justifying answers.
Patterns	Patterns	22. Extend or complete patterns involving numbers and attributes and identify or state rules for given patterns.
Algebra and Functions	Algebraic Concepts	23. Solve simple 1-step equations.
Discrete Mathematics	Classification and Logical Reasoning	24. Solve problems involving the organization of data.
Integrated Understandings	Mathematical Applications	25. Solve extended numerical, spatial and statistical problems.

## GRADE 8

Content Standard	Strand	Concept or Skill	
Number Sense	Place Value	1a. Solve problems involving 0.1 and 0.01, more or less.	
		1b. Identify alternative forms of expressing numbers using expanded notation.	
		1c. Identify alternative forms of expressing numbers using scientific notation.	
	Pictorial Representations of Numbers	2a. Relate fractions, decimals and percents to their pictorial representations and vice versa.	
		2b. Construct pictorial representations of fractions, decimals and percents.	
	Equivalent Fractions, Decimals and Percents	3a. Rename equivalent fractions and mixed numbers as equivalent decimals and vice versa.	
		3b. Rename fractions and decimals as equivalent percents and vice versa.	
	Order, Magnitude and Rounding	4a.	Order whole numbers or decimals.
			Order fractions and mixed numbers.
		4c.	Describe magnitude of whole numbers and decimals.
			Describe magnitude of fractions and mixed numbers.
		4e. Round whole numbers, fractions and decimals.	
		4f. Locate points on number lines and scales, including fractions, decimals and integers.	
	Operations	Models for Operations	5a. Identify the appropriate operation or number sentence to solve a story problem.
5b. Write story problems from equations.			
Basic Facts		Not tested at Grade 8.	

## GRADE 8, continued

Content Standard	Strand	Concept or Skill
	Compute with Whole Numbers and Decimals	<p>7a. Add and subtract 2-, 3- and 4-digit whole numbers and decimals.</p> <p>7b. Multiply and divide whole numbers and decimals by 10, 100 and 1,000.</p> <p>7c. Multiply and divide 2- and 3-digit whole numbers and money amounts and decimals by 1-digit numbers and decimals.</p>
	Compute with Fractions	<p>8a. Add and subtract fractions and mixed numbers with reasonable and appropriate denominators.</p> <p>8b. Multiply whole numbers and fractions by fractions and mixed numbers.</p>
	Solve Word Problems	<p>9a. Solve 1-step problems involving whole numbers, decimals and money amounts.</p> <p>9b. Solve 1-step problems involving fractions and mixed numbers.</p> <p>9c. Solve multi-step problems involving whole numbers, decimals, fractions and mixed numbers, including averaging.</p> <p>9d. Solve problems involving whole numbers, decimals, fractions and mixed numbers with extraneous information.</p> <p>9e. Solve multistep problems and explain how the solution was arrived at.</p>
Estimation and Approximation	Numerical Estimation Strategies	<p>10a. Identify the best expression to find an estimate.</p> <p>10b. Identify whether and why a particular strategy will result in an overestimate or an underestimate.</p> <p>10c. Determine the reasonableness or unreasonableness of an answer or estimate.</p>
	Estimate Solutions to Problems	<p>11a. Estimate a reasonable answer to a problem.</p> <p>11b. Use estimation to make and defend a decision.</p>

## GRADE 8, continued

Content Standard	Strand	Concept or Skill	
Ratios, Proportions and Percents	Ratios and Proportions	12a. Solve problems involving ratios.	
		12b. Solve problems involving proportions.	
	Compute with Percents	13a. Find percents of whole numbers or the percent a given number is of another number.	
		13b. Solve problems involving percents.	
Measurement	Time	Not tested at Grade 8.	
	Approximate/Estimate Customary and Metric Measures	15. Estimate lengths, areas and angle measures.	
	Customary and Metric Measures	16a. Solve problems involving the conversion of units of measure, including time.	
		16b. Measure/determine perimeter, area and volume.	
		16c. Identify appropriate customary or metric units of measure for a given situation.	
		17a. Identify and draw geometric shapes and figures.	
Spatial Relationships and Geometry	Geometric Shapes and Properties	17b. Describe and classify geometric shapes and figures.	
		18a. Identify or draw geometric transformations.	
	Spatial Relationships	18b. Identify, draw and describe lines of symmetry.	
		18c. Relate 2- and 3-dimensional representations.	
		18d. Identify and describe congruent and similar figures.	
		18e. Locate points on grids.	
		Tables, Graphs and Charts	19a. Identify correct information from graphs, tables and charts.
			19b. Create graphs from data in tables and charts.
Probability and Statistics			

## GRADE 8, continued

Content Standard	Strand	Concept or Skill
	Statistics and Data Analysis	20a. Draw and justify reasonable conclusions from graphs, tables and charts.
		20b. Solve problems involving means and medians of sets of data.
	Probability	21a. Solve problems involving elementary notions of probability and fairness, including justifying answers.
		21b. Solve problems involving expected outcomes or predictions.
Patterns	Patterns	22. Extend or complete patterns involving numbers and attributes and identify or state rules for given patterns.
Algebra and Functions	Algebraic Concepts	23a. Solve simple 1-step equations.
		23b. Use order of operations.
		23c. Evaluate expressions and use formulas.
		23d. Represent situations with algebraic expressions.
Discrete Mathematics	Classification and Logical Reasoning	24. Solve problems involving the organization of data.
Integrated Understandings	Mathematical Applications	25. Solve extended numerical, spatial statistical problems.

**CONNECTICUT ACADEMIC PERFORMANCE TEST (CAPT)  
SECOND GENERATION BLUEPRINT  
Content Framework Effective Spring 2001**

All CAPT mathematics items will be in a context and require students to **solve a problem**. In addition, all open-ended CAPT items will require students to show their work and explain their **reasoning**, thereby **communicating** their understanding of the relevant mathematics.

All CAPT items will be devised to measure one or more of the following aspects of mathematical content:

## **The Number and Quantity Strand**

### **1. Number Sense**

- Use integers, fractions, decimals, percents and scientific notation in real-world situations to count, measure, compare, order, scale, locate and label.
- Use a variety of representations (including graphs, tables, words, number lines, pictures, etc.) to present, interpret and communicate various kinds of numerical information.
- Demonstrate an understanding of order, magnitude and equivalent forms of numbers.

### **2. Operations**

- Identify appropriate operations (including addition, subtraction, multiplication, division, exponentiation and square roots) and use these operations in a variety of contexts.
- Select and use appropriate methods for computing (including mental mathematics, paper-and-pencil, and calculator methods).

### **3. Estimation and Approximation**

- Select and use estimation strategies in problem situations.
- Assess the reasonableness of answers to problems.

### **4. Ratios, Proportions and Percents**

- Use ratios, proportions and percents to solve problems.
- Use dimensional analysis to determine equivalent rates (for example, converting inches per minute to feet per hour).
- Use direct and inverse variation to solve numerical, geometric and algebraic problems.

## **The Measurement and Geometry Strand**

### **5. Measurement**

- Use the concepts of length, perimeter, area, volume, angle measure, capacity, weight and mass to solve problems, using both metric and customary units.
- Identify appropriate metric and customary measurement units and use appropriate measurement tools (including rulers and protractors).
- Estimate, make and use measurements in realistic situations.
- Use formulas and scales to determine measures.

**6. Spatial Relationships and Geometry**

- Interpret, describe and draw 2- and 3-dimensional objects.
- Use the concepts of rotation, reflection and translation to transform geometric figures.
- Describe and use fundamental concepts and properties of, and relationships among, points, lines, planes, angles and shapes (including incidence, parallelism, perpendicularity, and the Pythagorean Theorem).
- Use the concepts of congruence and similarity to solve realistic problems.
- Use coordinate representations of geometric figures.
- Solve problems using geometric models.

**The Statistics, Probability and Discrete Mathematics Strand****7. Probability and Statistics**

- Demonstrate an understanding of sampling and its role in statistical assertions.
- Describe, calculate and apply the concepts of mean, median, mode and range.
- Construct, read and interpret tables, charts and graphs of real-world data.
- Make and evaluate inferences from tables, charts, graphs and other representations of data.
- Use probability to make predictions and evaluate the likelihood of simple and compound events.
- Use simulations to determine experimental probabilities.
- Compare experimental and theoretical probabilities and make predictions based on these probabilities.

**8. Discrete Mathematics**

- Use systematic listing and counting strategies, including simple combinations and permutations, to solve problems.
- Use recursive processes, including iteration, to solve problems.

**The Algebra and Functions Strand****9. Patterns**

- Construct, describe, extend, and analyze a variety of numerical, geometric, and statistical patterns.
- Describe, analyze and generalize patterns using tables, rules, algebraic expressions and equations, and graphs.
- Make and justify predictions based on patterns.

**10. Algebra and Functions**

- Represent and analyze situations involving variable quantities with tables, graphs, verbal rules and equations, and translate among representations.
- Use variables, expressions, equations and inequalities, including formulas, to model situations and solve problems.
- Construct and use linear functions to model and solve real-world situations.
- Use the coordinate plane to represent functions.

## Scoring Rubric for Mathematics Open-Ended Items

Each score category contains a range of student responses which reflect the descriptions given below.

### Score 3

The student has demonstrated a full and complete understanding of all concepts and processes embodied in this application. The student has addressed the task in a mathematically sound manner. The response contains evidence of the student's competence in problem-solving and reasoning, computing and estimating, and communicating to the full extent that these processes apply to the specified task. The response may, however, contain minor arithmetic errors that do not detract from a demonstration of full understanding.

### Score 2

The student has demonstrated a reasonable understanding of the essential mathematical concepts and processes embodied in this application. The student's response contains most of the attributes of an appropriate response including a mathematically sound approach and evidence of competence with applicable mathematical processes, but contains flaws that do not diminish countervailing evidence that the student comprehends the essential mathematical ideas addressed by this task. Such flaws include errors ascribable to faulty reading, writing, or drawing skills; errors ascribable to insufficient, non-mathematical knowledge; and errors ascribable to negligent or inattentive execution of mathematical processes or algorithms.

### Score 1

The student has demonstrated a limited understanding of some of the concepts and process embodied in this application. The student's response contains some of the attributes of an appropriate response, but lacks convincing evidence that the student fully comprehends the essential mathematical ideas addressed by this task. Such deficits include evidence of insufficient mathematical knowledge; errors in fundamental mathematical procedures; and other omissions or anomalies that bring into question the extent of the student's ability to solve problems of this general type.

### Score 0

The student has demonstrated merely an acquaintance with the topic. The student's response is associated with the task in the item, but contains few attributes of an appropriate response. There are significant omissions or anomalies that indicate a basic lack of comprehension in regard to the mathematical ideas and procedures necessary to adequately address the specified task. No evidence is present to suggest that the student has the ability to solve problems of this general type.

## CAPT CALCULATOR USE POLICY

In setting this policy governing the use of calculators on the CAPT, the State Department of Education was guided by the following facts and beliefs:

### Facts

- Some CAPT mathematics items are unreasonable to do without at least a four-function calculator.
- All CAPT items can be completed with a four-function calculator.
- The additional time students may gain if they use a graphics calculator is offset by the fact that the State Department of Education will provide enough time for all students – regardless of the calculator they use – to reasonably complete the test.

### Beliefs

- Fairness is not necessarily achieved when everyone uses the same calculator, but rather when students are allowed to use the calculator with which they are most familiar and comfortable.
- Students are most likely to do their best work when they use their own calculator or one which the school has provided and which students have used in instructional settings prior to the test.

### Policy

It is the policy of the State Department of Education, therefore, that students will be allowed to use any calculator provided to them or any calculator of their choosing, including scientific and graphics calculators, on the CAPT.

### Additional Information

In implementing this policy, schools and school districts should be aware that:

- all four current National Science Foundation-funded secondary mathematics curriculum development projects integrate the graphics calculator into daily instruction and assessment;
- the College Board's new policy for the SATs also provides that, in an effort to assure true calculator equity, students will be allowed to use the calculator with which they are most familiar and comfortable; and
- nothing in this policy should be used to discourage the purchase and use of graphics calculators for ongoing mathematics instruction, and eventually by all students on all tests.

## Calculators and the Education of Youth

Calculators are widely used at home and in the workplace. Increased use of calculators in school will ensure that students' experiences in mathematics will match the realities of everyday life, develop their reasoning skills, and promote the understanding and application of mathematics. The National Council of Teachers of Mathematics therefore recommends the integration of the calculator into the school mathematics program at all grade levels in classwork, homework and evaluation.

Instruction with calculators will extend the understanding of mathematics and will allow all students access to rich, problem-solving experiences. This instruction must develop students' ability to know how and when to use a calculator. Skill in estimation and the ability to decide if the solution to a problem is reasonable are essential adjuncts to the effective use of the calculator.

Evaluation must be in alignment with normal, everyday use of calculators in the classroom. Testing instruments that measure students' understanding of mathematics and its applications must include calculator use. As the availability of calculators increases and the technology improves, testing instruments and evaluation practices must be continually upgraded to reflect these changes.

The National Council of Teachers of Mathematics recommends that all students use calculators to:

- explore and experiment with mathematical ideas such as patterns, numerical and algebraic properties, and functions;
- develop and reinforce skills such as estimation, computation, graphing and analyzing data;
- focus on problem-solving processes rather than the computations associated with problems;
- perform the tedious computations that often develop when working with real data in problem situations;
- gain access to mathematical ideas and experiences that go beyond those levels limited by traditional paper-and-pencil computation.

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The National Council of Teachers of Mathematics also recommends that every mathematics teacher at every level promote the use of calculators to enhance mathematics instruction by:

- modeling the use of calculators in a variety of situations;
- using calculators in computation, problem-solving, concept development, pattern recognition, data analysis and graphing;
- incorporating the use of calculators in testing mathematical skills and concepts;
- keeping current with the state-of-the-art technology appropriate for the grade level being taught;
- exploring and developing new ways to use calculators to support instruction and assessment.

The National Council of Teachers of Mathematics further recommends that:

- school districts conduct staff development programs that enhance teachers' understanding of the use of appropriate state-of-the-art calculators in the classroom;
- teacher preparation institutions develop preservice and in-service programs that use a variety of calculators, including graphing calculators, at all levels of the curriculum;
- educators responsible for selecting curriculum materials make choices that reflect and support the use of calculators in the classroom;
- publishers, authors, and test and competition writers integrate the use of calculators at all levels of mathematics;
- mathematics educators inform students, parents, administrators, and school boards about the research that shows the advantages of including calculators as an everyday tool for the student of mathematics.

Research and experience have clearly demonstrated the potential of calculators to enhance students' learning in mathematics. The cognitive gain in number sense, conceptual development, and visualization can empower and motivate students to engage in true mathematical problem solving at a level previously denied to all but the most talented. The calculator is an essential tool for all students of mathematics.

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