Vermont Grade Expectations
Grade One
Support Resource
April 2008

This document contains items keyed to the Vermont Grade Expectations for grade one and are designed to help clarify the Grade Expectations. While the items exemplify aspects of each GE, they may not illustrate all skills and/or concepts included in the GE. ***Furthermore, the items are not designed to be used as an assessment of the GE, but serve the purpose of exemplifying the concepts and skills within the GE***. ***Because this is not an assessment document, the items should not be copied and used for assessment purposes.*** The examples are provided to support teachers in understanding the essence of the GE, and are a suggested resource that could be used for the teaching and learning of a concept.

Appendix A contains web links when items were drawn from outside sources. Many of these sites contain additional materials which may be useful in the instructional setting. Appendix B contains the Depth of Knowledge descriptors based on Norman Webb's work, and Appendix C contains the answers and Depth of Knowledge classification for each item. In addition, each item is numbered sequentially in the upper left hand corner for ease of reference to the answers in Appendix C.

Number and Operations

Purpose: Number and operations remain a cornerstone for the study of mathematics in grades K – 12. Students use numbers to quantify sets, identify location, measure, quantify the probability of an event, analyze data, and describe and interpret real-world phenomena. Having students know basic facts and compute fluently (i.e., accurately and efficiently) continues to be an important goal in mathematics education. However, knowing basic facts should be incorporated into a rich mathematics curriculum that builds conceptual understanding of these facts.

Through the school years, the amount of time spent on numbers and their operations will decrease and the types of numbers studied will change. As students progress through the elementary grades and into middle school, they will need to develop an in-depth conceptual understanding of fractions, decimals, and percents prior to doing algorithmic computations with these numbers. Conceptual understanding of integers and meaningful computation with them are also goals for middle grade students. The study of irrational numbers and the real number system will begin in eighth grade and continue through high school. Imaginary and complex numbers are introduced in advanced mathematics. It is important for students to model and represent the different types of numbers they study in all grades.

Students cannot appreciate the power of numbers unless they also understand the operations upon those numbers. Students need to recognize which operation to apply to a given problem situation they encounter. They need to know what effect the various operations will have on different types of numbers. They need to know the relationships among the operations and their properties. A deep understanding of the operations and their properties will help students make sense of algorithms and lead to computational fluency. A firm understanding of numbers, as well as operations and their properties, will provide a good foundation for the study of algebra.

Standard 7.6: Arithmetic, Number and Operation Concepts
Grade 1

M1: 1 Demonstrates conceptual understanding of rational numbers with respect to whole numbers from 0 to 100 using place value (a grouping system wherein a digit's place in a number denotes its value; e.g., in 34, 3 represents 3 tens, or 30); by applying the concepts of equivalency in composing or decomposing numbers (e.g., 12 = 7 + 5); and in expanded notation (e.g., 41 = 4 tens + 1 one or 41 = 40 + 1**) using models, explanations, or other representations. Shows correct sequence of ordinal and cardinal numbers and compares cardinal numbers** and

positive fractional numbers (benchmark fractions: *a*/2, *a*/3, or *a*/4 where a is a whole number greater than 0 and less than or equal to the denominator) as part/whole relationships of benchmark fractions with models, diagrams, or written or verbal/scribed response

1 In what place is the orange cat?

a) fourth b) eleventh C) fifth d) tenth

Shows correct sequence of ordinal numbers.

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2 Circle each shape that shows one half.

Compares positive fractional numbers as part to whole relationship with models

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3 James has 4 marbles. ½ of James' marbles are brown. ½ of James' marbles are red. Draw and color James' marbles.

Explain how many marbles you colored red using words, numbers or pictures.

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4 There are 10 sticks in each bundle.

1) Write the number of sticks in group a.

2) Then write the number of sticks in group b.

a.  = _____

b.  = _____

Demonstrates conceptual understanding of rational numbers with respect to whole numbers by applying concepts of equivalency in composing numbers using models

M1: 2 **Demonstrates understanding of the relative magnitude of numbers** from 0 to 100 by ordering whole numbers; by comparing whole numbers to each other or to benchmark numbers (10, 25, 50); by showing the relationship between whole numbers (1 more, 1 less; 10 more, 10 less); or by connecting number words and numerals to the quantities they represent using models, representations, or number lines. Apply number parameters consistent with M1: 1.

5 Put the numbers in order from least to greatest?

47 61 18 93 5 64

Demonstrates understanding of the relative magnitude of numbers from 0 to 100 by ordering whole number

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6

Look at these number cards: 8 4

What is the smallest 2 digit number you can make with these numbers? What is the largest 2 digit number you can make with these numbers? Tell how you know.

Demonstrates understanding of the relative magnitude of numbers by comparing whole numbers to each other

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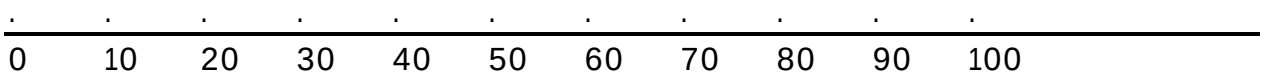
Demonstrates understanding of the relative magnitude of numbers by showing the relationship between whole numbers (10 more) using number line

7 Put an X where 10 more than 30 is on the number line.



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Demonstrates understanding of the relative magnitude of numbers by comparing numbers to benchmark numbers (10, 25, 50)

8 Look at these numbers:

10____25____50

Between which 2 numbers does 38 belong?

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9 Write the answers:

a. One more than thirty-eight

b. Ten more than sixty

c. One less than twenty-seven

d. Ten less than forty-six

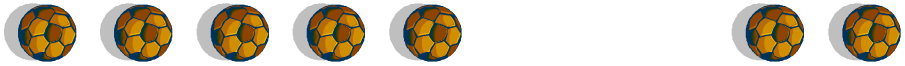
Demonstrates understanding of the relative magnitude of numbers by connecting number words to numeral; shows the relationship between whole numbers

Assessment for the California Mathematics Standards Grade 1

M1: 3 Demonstrates conceptual understanding of mathematical operations involving addition and subtraction by solving problems involving situations in which one adds to, takes from, puts together, and takes apart, or adds.

10 Which of the following is a model of 5+2?

a. 

b. 

c. 

Demonstrates conceptual understanding of mathematical operations involving addition by solving problems involving situations in which one adds to

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11 Solve this equation. Draw a model of your equation.

$9 = ? + 6.$

Demonstrates conceptual understanding of mathematical operations involving addition by solving problems involving situations in which one adds to.
(It is important to provide students with number sentences that are not always of the form a+b=c).

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12 Write a story for this number sentence:

$11 - 6 = 5$

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M1: 4 Accurately solves problems in <u>and out of context</u> involving addition and subtraction using whole numbers.

13 Tom has 4 soccer balls.

Accurately solves problems in context involving addition and subtraction using whole numbers.

Tom needs 10 soccer balls for his birthday party. Write an addition number sentence to show how many more balls Tom needs for his birthday party.

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14 Bobby counted 8 wheels on motorcycles.

How many motorcycles did Bobby see? Show or tell how you know.

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15 Show what number makes each number sentence true.

4 + __ = 7 **5 = 4 + __** **9 – 6 = __** **__ = 5 + 3**

10 – __ = 4 **6 = __ - 2** **19 + 6 = __**

Accurately solves problems out of context involving addition and subtraction.

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M1: 5 **Demonstrates understanding of monetary value** of coins and adds coins together to a value no greater than $1.00.

16 Jan has these 6 coins in her pocket. How much money does Jan have? Does Jan have enough money to buy a 40 cent candy bar?

Demonstrates understanding of monetary value of coins and adds coins together to a value no greater than $1.00.

Vermont Department of Education

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17 Sam has a jar of coins. He takes 6 coins out of the jar. He has nickels, dimes and pennies. Draw 6 coins Sam could take out of the jar and show the total value of the coins.

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M1: 6 **Mentally adds and subtracts** whole-number facts through ten **with accuracy**.

M1: 7 **Estimates and evaluates the reasonableness of solutions appropriate to grade level.**

18

Kim has 62 trading cards. Lou has 20 trading cards. About how many more cards does Kim have than Lou? Circle the closest answer.

80 60 40 20

Estimates and evaluates the reasonableness of solutions

Assessment for the California Mathematics Standards Grade 1

19 Amy has 16 rabbits. Tom has 32 rabbits. About how many rabbits do Amy and Tom have all together?

Amy says the number of rabbits they have all together is closer to 40. Tom says the number of rabbits they have altogether is closer to 50. Who is correct? Show or tell how you know.

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M1: 8 **Applies properties of numbers** (odd, even, composition/decomposition [5 is the same as 2 + 3]) and **operations** (commutative, identity) **to solve problems and to simplify computations involving whole numbers.**

Applies properties of numbers (composition) to solve problems

20 Jill has 2 beads in one hand and 3 beads in another hand. Andy has 4 beads in one hand and 1 bead in his other hand. Do Jill and Andy have the same number of beads? Use numbers or words to show how you know.

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21 Look at these dominoes. Tell whether each domino is even or odd. Explain how you know.

Applies properties of numbers (even, odd) to solve problems.

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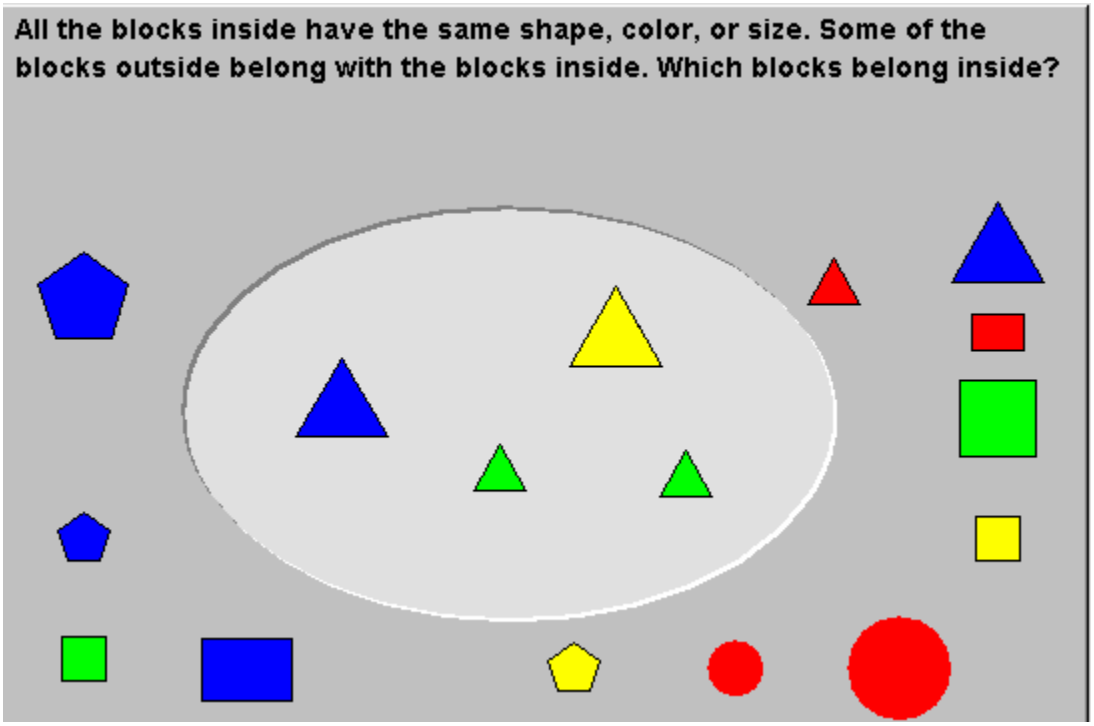
Geometry and Measurement

Purpose: Geometry and the related area of measurement help students represent, describe, and make sense of the world in which they live. Geometry is also a natural place for students to develop their reasoning and justification skills. We live in a three-dimensional world. To interpret, understand, and appreciate that world, students need to develop an understanding of space. In addition, success in mathematics depends, in part, on the development of spatial abilities. Spatial skills include making and interpreting drawings, forming mental images, and visualizing changes. Measurement is the process of assigning a numerical value to an attribute of an object. The study of measurement provides students with techniques and tools they will need to describe and analyze their world. It also provides an opportunity to make connections within mathematics and between mathematics and other curricular areas. High school students must develop more mature insights into the essential role of measurement as a link between the abstractness of mathematics and the concreteness of the real-world. In both areas, geometry and measurement, students need to investigate, experiment, and explore geometric properties using both technology and hands-on materials.

Standard 7.7: Geometry and Measurement Concepts

M1: 9 **Uses attributes, composition, or decomposition to sort or classify polygons (triangles, squares, rectangles, rhombi, trapezoids, and hexagons) or objects by a combination of two nonmeasurable or measurable attributes.**
Recognizes and names polygons and circles in their environment.

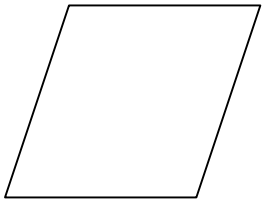
22



Uses attributes, to sort or classify polygons (triangles, squares, rectangles, rhombi, trapezoids, and hexagons) or objects by a combination of two nonmeasurable or measurable attributes

National Library of Virtual Manipulatives

23 Sam used 2 shapes to make a rhombus. Use your pattern blocks to find the 2 shapes Sam used. What 2 shapes did Sam use?



Uses composition to sort and classify polygons

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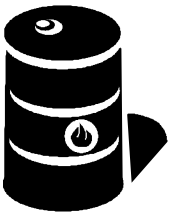
M1: 10 No **M1: 10** at this grade level

M1: 11 **Identifies objects in the environment** given an example of a three-dimensional shape (e.g., show a wooden cylinder and students identify common objects of the same shape).

24 Look at this cylinder.



Wooden Cylinder

Identifies objects in the environment given an example of a three-dimensional shape

Find an object in our classroom shaped like a cylinder.

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M1: 12 No **M1: 12** at this grade level

M1: 13 No **M1: 13** at this grade level

M1: 14 No **M1: 14** at this grade level

M1: 15 **Selects an appropriate tool with which to measure** length, temperature, weight, and volume, **and uses** nonstandard units for linear measurement and weight.

25 Measure the length of your desk using Unifix cubes.

Uses nonstandard units for linear measurement

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M1: 16 Determines elapsed and accrued time as it relates to <u>the patterns of</u> <u>days of the week, yesterday, today, tomorrow and tells time to the half hour.</u>

26

How David Gets to School

Determines elapsed time as it relates to the patterns of days of the week.

Today is Monday. David walks to school on Monday. Tomorrow David will take the bus to school. This pattern continues. How will David get to school on Friday?

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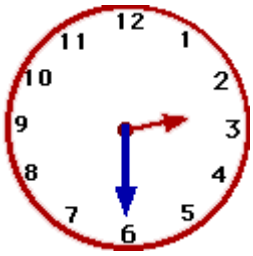
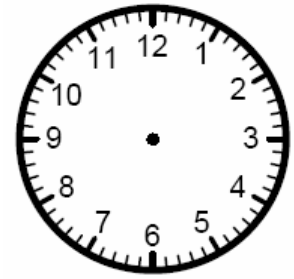
27 Look at this clock.



Tells time to the half hour.

What time is the clock showing?



Show half past 4 o'clock

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M1: 17 No **M1: 17** at this grade level

M1: 18 **Find and name locations with simple** relationships (i.e., near, far, above, below, next to, up, down, right, left).

28

a. Write the letter A above the rectangle.
b. Write the letter B below the rectangle.
c. Write the letter C in the rectangle.
d. Write the letter D to the right of the rectangle.

Assessment for the California Mathematics Standards Grade 1

Functions and Algebra

Purpose: Algebra is the language through which much of mathematics is communicated. Students in Kindergarten begin to explore algebraic concepts using informal representations (e.g., words, physical models, tables, graphs). In later years students progress to more abstract representations. The study of patterns is one of the central themes of algebraic thinking and leads to an understanding of relations and functions. Students at all grade-levels should recognize, describe, and generalize patterns and build mathematical models to describe, interpret, and predict the behavior of real-world phenomena. Algebraic processes are important tools that students can use throughout their lives.

Standard 7.8: Functions and Algebra Concepts

M1: 19 **Identifies and extends to specific cases a variety of patterns including** sequences of shapes, sounds, movement, colors, letters, and numbers by extending the pattern to the next one, two, or three elements.

29

Look at this repeating pattern. Draw the next three shapes in this repeating pattern.

Identifies and extends to specific cases a variety of patterns including sequences of shapes to the next three elements.

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Lucy wants to make a necklace with a bead pattern that repeats 2 times. She has 3 kinds of beads.

□ 0 ?

Draw a necklace Lucy could make with the 3 kinds of beads.

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M1: 20 **Demonstrates a conceptual understanding <u>of linear</u> <u>relationships (</u>$y = kx$<u>) as a constant rate of change</u>** qualitatively (growth—student growing taller) <u>and quantitatively (measurable growth—2 inches each year).</u>

30

Tom keeps pennies in a jar. Tom puts 3 pennies in the jar each day for 4 days. How many pennies does Tom have in the jar at the end of 4 days? Show or tell how you know.

Demonstrates a conceptual understanding of linear relationships ($y = kx$) as a constant rate of change

Vermont Department of Education

M1: 21 No **M1: 21** at this grade level

M1: 22 **Demonstrates conceptual understanding of equality** by showing equivalence between two expressions(4+1=5; 2+3=5) by **solving** one-step equations involving whole number addition or subtraction using models, verbal explanations, or written equations.

31

a) Look at this number sentence. The same number makes this number sentence true.

? + ? = 8

What **one** number makes this number sentence true?

b) Look at this number sentence.

$$\begin{array}{r} 21 \\ +\ ? \\ \hline 26 \end{array}$$

What number makes this number sentence true?

Demonstrates conceptual understanding of equality by showing equivalence between two expressions by solving one-step equations involving whole number addition or subtraction using written equations

c) Look at this number sentence.

? - 5 = 9

What number makes this number sentence true? Show or tell how you know.

Vermont Department of Education

Data, Statistics and Probability

Purpose: Collecting, organizing, and displaying data, as well as interpreting and analyzing information to make decisions and predictions, have become very important in our society. Statistical instruction should be carried out in a spirit of investigation and exploration so students can answer and formulate questions about data.

Probability should be studied in familiar contexts. Students need to investigate fairness, chances of winning, and uncertainty. Technology should be used as a tool throughout the investigation process.

Standard 7.9: Data, Statistics, and Probability Concepts

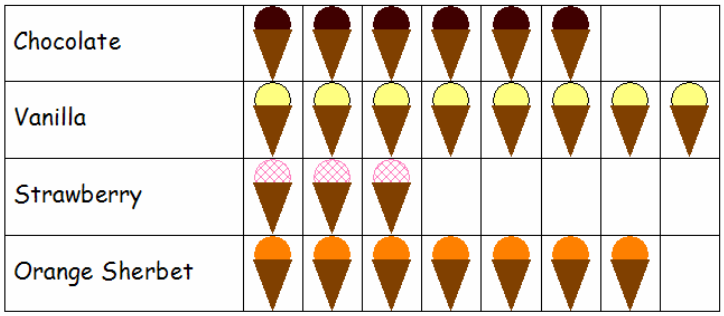
M1: 23 **Interprets a given representation** (models, tally charts, pictographs with one-to-one correspondence, and tables) through written or verbal/scribed response to answer questions related to the data, or to analyze the data to formulate conclusions.

(IMPORTANT: *Analyzes data consistent with concepts and skills in M1: 24.*)

32

We Scream for Ice Cream

Students in Mr. Max's class are planning an ice cream party. Each student voted for their favorite flavor, and the students made a chart of the results:



1. How many students are in Mr. Max's class? Explain how you know this.

2. If the class can buy only two different ice cream flavors for the party, which two should they buy? Why?

Interprets a given representation (pictograph with one-to-one correspondence) to answer questions related to the data, or to analyze data to formulate conclusions.

BALANCED ASSESSMENT

M1: 24 **Analyzes patterns, trends, or distributions in data in a variety of contexts using** "more," "less," or "equal."

33

Look at the "We Scream for Ice Cream" graph. Did more students vote for strawberry than chocolate? Explain how you know.

Analyzes distributions of data in a variety of contexts using "more", "less", or "equal"

M1: 25 **Organizes and displays data using** diagrams, models, or tally charts through written or verbal/scribed response to answer questions related to the data, to analyze the data to formulate conclusions.

(IMPORTANT: *Analyzes data consistent with concepts and skills in M1: 24.*)

34

The children in our school each have a favorite fruit. 10 children like apples. 20 children like bananas. 15 children like pears. 3 children like pineapples.

Make a tally chart or diagram that shows the number of children who like each fruit.

Which fruit do most children like best?

Which fruit do the fewest children like?

Organizes and displays data to using diagrams or tally charts to answer questions related to the data.

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M1: 26 No **M1: 26** at this grade level

M1: 27 **For a probability event in which the sample space may or may not contain equally likely outcomes**, uses experimental probability to describe the likelihood or chance of an event (using "more likely," "less likely").

35

Place 6 red marbles and 1 blue marble in a bag. Shake the bag and take 1 marble out of the bag without looking. Are you more likely to draw a blue marble than a red marble? Show or tell how you know.

For a probability event in which the sample space may or may not contain equally likely outcomes, uses experimental probability to describe the likelihood or chance of an event (using "more likely," "less likely")

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M1: 28 **In response to a teacher - or student-generated question or hypothesis**, collects appropriate data to answer the question or hypothesis being tested through written or verbal/scribed response.

(IMPORTANT: *Analyzes data consistent with concepts and skills in MK: 24.*)

36

Kim thinks the flavor of ice cream most students in our class like best is chocolate. Collect data from students in our class to find out if Kim is correct.

In response to a teacher - or student-generated question or hypothesis, collects appropriate data to answer the question or hypothesis being tested.

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M1: 29 No **M1: 29** at this grade level

Standard 2.5: Mathematical Dimensions,
Standard 7.10: Mathematical Problem Solving and Reasoning—Applications

M1: 30 **Demonstrate understanding of mathematical problem solving[2] and communication through:[3]**

- **Approach & Reasoning**—The reasoning, strategies, and skills used to solve the problem;
- **Connections**—Demonstration of observations, applications, extensions, and generalizations;
- **Solution**—All of the work that was done to solve the problem, including the answer;
- **Mathematical Language**—The use of mathematical language in communicating the solution;
- **Mathematical Representation**—The use of mathematical representation to communicate the solution; and
- **Documentation**—Presentation of the solution.

2 Problem-solving situations are mathematical problems that reflect the levels of mathematics in the Grade Level Expectations.
3 See *Vermont Elementary and Middle Level Mathematics Portfolio Scoring Guid*e for additional information.

APPENDIX A

Balanced Assessment. http://balancedassessment.concord.org/packetprim.html

California Department of Education. http://www.cde.ca.gov/ta/tg/sr/resources.asp

National Library of Virtual Manipulatives. http://nlvm.usu.edu/en/nav/vlibrary.html

Vermont Department of Education.

APPENDIX B:
Implied Cognitive Demand and Depth of Knowledge

A fundamental criterion used to develop the NECAP GLEs and GSEs is that the expectations should explicitly indicate cognitive demand (how content interacts with process) and that there should be a mix of cognitive demand levels at all grades. One should not assume that students at lower grades do less cognitively demanding work. The cognitive demand or depth of knowledge required by an expectation or an assessment item is related to the number and strength of connections of concepts and procedures that a student needs to make to produce a response, including the level of reasoning required along with self-monitoring. Furthermore, there are additional factors that influence cognitive demand including contextual requirements, language, the number and variety of representations, requirements for generalizations to new situations, and the opportunity to learn.

It is important to note that depth of knowledge is not synonymous with difficulty. As an example, solving a multi-step linear equation with variables on both sides may be a difficult task for middle school students; however, the task can be solved by applying a standard procedure making the task of low complexity.

The NECAP states (VT, NH, RI) believe that expectations and assessments should be aligned in terms of their cognitive complexity. That is, the cognitive complexities of the assessment items should match those of the standards (what students are expected to know and be able to do). To ensure this alignment, the NECAP states have adopted Norman L. Webb's (senior researcher with the Wisconsin Center for Educational Research) Depth of Knowledge classification system. Norman Webb's system is based on four levels of classification. The full descriptions of each level are given on pages 4 and 5. The levels can be summarized as follows.

Level 1	Recall
Level 2	Skill/Concept
Level 3	Strategic Thinking
Level 4	Extended Thinking

The NECAP states, together with a committee of educators, analyzed the GLEs and GSEs for their implied cognitive demand. All aspects of each expectation were analyzed and the implied cognitive demand levels were recorded. One of the charges of the NECAP test item review committees is to ensure that assessment items align not only with the expectations but also with their implied cognitive demands. The range of cognitive demands for each GLE and GSE is summarized in Table 1. It should be noted that the highest level listed for each GLE and GSE should be thought of as a "ceiling" not a "target". An important assessment goal is to write items that cover the range of the levels indicated and not just the highest level. If one assesses only at the "target" level, all GLEs with a level 3 (for example) as their "ceiling" would only be assessed at level 3. This would potentially have two negative impacts on the assessment: 1) The assessment as a whole would be too difficult, and 2) important information about student learning along the achievement continuum would be lost. To the extent possible, each GLE and

GSE should be assessed at the “ceiling” and at least one level below the “ceiling” in order to provide additional diagnostic information to educators.

Vermont Grade Expectations
Implied Cognitive Demand and Depth of Knowledge

	K	1st	2nd	3rd	4th	5th	6th	7th	8th	HS
Arithmetic, Numbers and Operations										
M1	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2	1,2
M2	1,2	1,2	1	2	2	2	2	2	2	
M3	2	2	1,2	2	2	2,3	2,3	2,3		
M4	1	1,2		1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
M5	1	1	1,2							
M6		1	1	1	1	1	1			
M7	2	2	2	2	2	2	2	2	2	2
M8		1,2	2	2,3	2,3	2,3	2,3	2,3	2,3	2,3
Geometry and Measurement Concepts										
M9	1	1	1,2,3	1, 2	1,2	1,2	1,2	1,2	1,2,3	1,2,3
M10								1,2	1,2,3	
M11		1	1,2	2	1,2	1,2	1,2	2,3		2,3
M12				2	2	1,2	1,2	1,2		
M13					2	2	1,2	1,2,3	1,2,3	1,2,3
M14			1,2	1,2	1,2	1,2	1,2,3	1,2,3	1,2,3	1,2,3
M15	1	1	1	1	1,2	1,2	1,2	1,2	1,2	1,2
M16	1	1	1	1	1	1				
M17								1,2	1,2	1,2
M18	1	1	2	2	2	2	2			
Functions and Algebra Concepts										
M19	1,2	1,2	2	2	2	2	2,3	2,3	2,3	2,3
M20	2	1,2	1,2	2	2	2	1,2	1,2,3	1,2,3	1,2,3
M21					1	1	1,2	1,2	1,2	1,2
M22	1,2	1,2	1	1,2	1,2	1,2	1,2	1,2	1,2,3	1,2,3

Data, Statistics, and Probability Concepts										
M23	2,3	2,3	1,2,3	1,2,3	1,2, 3	1,2,3	1,2,3	1,2,3	2,3	2,3
M24	2,3	2,3	2,3	2,3	2,3	2,3	2,3	2,3	2,3	1,2,3
M25	2,3	2,3	2,3	1,2	2,3	1,2	2,3	2,3	2,3	2,3
M26			2	2	2,3	2,3	2,3	2,3	2,3	1,2,3
M27		1,2	1,2	1,2	1,2	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
M28	3,4	3,4	3,4	3,4	3,4	3,4	3,4	3,4	3,4	3,4
M29				2,3	1,2,3	1,2,3	2,3	2,3	2,3	2,3
M30	3,4	3,4	3,4	3,4	3,4	3,4	3,4	3,4	3,4	3,4
Note: GEs assessed on the NECAP are shaded gray.										

Depth of Knowledge Descriptors for Mathematics
Norman L. Webb
March 28, 2002

Mathematics Depth of Knowledge Levels

Level 1 (Recall) includes the recall of information such as a fact, definition, term, or a simple procedure, as well as performing a simple algorithm or applying a formula. That is, in mathematics a one-step, well-defined, and straight algorithmic procedure should be included at this lowest level. Other key words that signify a Level 1 include "identify," "recall," "recognize," "use," and "measure." Verbs such as "describe" and "explain" could be classified at different levels depending on what is to be described and explained.

Level 2 (Skill/Concept) includes the engagement of some mental processing beyond a habitual response. A Level 2 assessment item requires students to make some decisions as to how to approach the problem or activity, whereas Level 1 requires students to demonstrate a rote response, perform a well-known algorithm, follow a set procedure (like a recipe), or perform a clearly defined series of steps. Keywords that generally distinguish a Level 2 item include "classify," "organize," "estimate," "make observations," "collect and display data," and "compare data." These actions imply more than one step. For example, to compare data requires first identifying characteristics of the objects or phenomenon and then grouping or ordering the objects. Some action verbs, such as "explain," "describe," or "interpret" could be classified at different levels depending on the object of the action. For example, if an item required students to explain how light affects mass by indicating there is a relationship between light and heat, this is considered a Level 2. Interpreting information from a simple graph, requiring reading information from the graph, also is a Level 2. Interpreting information from a complex graph that requires some decisions on what features of the graph need to be considered and how information from the graph can be aggregated is a Level 3. Caution is warranted in interpreting Level 2 as only skills because some reviewers will interpret skills very narrowly, as primarily numerical skills, and such interpretation excludes from this level other skills such as visualization skills and probability skills, which may be more complex simply because they are less common. Other Level 2 activities include explaining the purpose and use of experimental procedures; carrying out experimental procedures; making observations and collecting data; classifying, organizing, and comparing data; and organizing and displaying data in tables, graphs, and charts.

Mathematics Depth of Knowledge Levels continued

Level 3 (Strategic Thinking) requires reasoning, planning, using evidence, and a higher level of thinking than the previous two levels. In most instances, requiring students to explain their thinking is a Level 3. Activities that require students to make conjectures are also at this level. The cognitive demands at Level 3 are complex and abstract. The complexity does not result from the fact that there are multiple answers, a possibility for both Levels 1 and 2, but because the task requires more demanding reasoning. An activity, however, that has more than one possible answer and requires students to justify the response they give would most likely be a Level 3. Other Level 3 activities include drawing conclusions from observations; citing evidence and developing a logical argument for concepts; explaining phenomena in terms of concepts; and using concepts to solve problems.

Level 4 (Extended Thinking) requires complex reasoning, planning, developing, and thinking most likely over an extended period of time. The extended time period is not a distinguishing factor if the required work is only repetitive and does not require applying significant conceptual understanding and higher-order thinking. For example, if a student has to take the water temperature from a river each day for a month and then construct a graph, this would be classified as a Level 2. However, if the student is to conduct a river study that requires taking into consideration a number of variables, this would be a Level 4. At Level 4, the cognitive demands of the task should be high and the work should be very complex. Students should be required to make several connections—relate ideas *within* the content area or *among* content areas—and have to select one approach among many alternatives on how the situation should be solved, in order to be at this highest level. Level 4 activities include designing and conducting experiments; making connections between a finding and related concepts and phenomena; combining and synthesizing ideas into new concepts; and critiquing experimental designs.

References

New Hampshire, Rhode Island, and Vermont Department of Education. (2004). *Draft Tri-State New England (TSNE) Mathematics Test Specifications*. New Hampshire, Rhode Island, and Vermont Department of Education.

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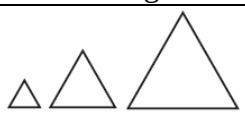
APPENDIX C:
Answers and DoK Codes for Examples

Item Number	Answer	Depth of Knowledge
1	(c) Fifth	1
2	1st and 3rd	1
3	2 brown, 2 red Answers will vary	2
4	33,26	2
5	5,18,47,62,64,93	1
6	48, 84	2
7	40	2
8	Between 25 and 50	2
9	39,70,26,36	1
10	B	1
11	3 ? ? ? ? ? ? ? ? ? = ? ? ? +? ? ? ? ? ?	2
12	Answers will vary	2
13	4+6=10	2
14	8	2
15	3,1,3,8,6,8,25	1
16	$.47 Yes	1
17	Answers will vary	1
18	40	1
19	50 – Tom – Answers will vary	2
20	Yes 2+3=4+1	2
21	Odd, Odd, Odd	1
22	Blue triangle	1
23	Two triangles	1
24	Answers will vary	1
25	Answers will vary	1
26	Bus	2
27	2:30 – 4:30	1
28	A above, B below, C inside, D to right	1
29	 Answers will vary	2
30	12	2
31	a) 4, b) 5, c) 14	2

32	24 – vanilla and orange sherbert Answers will vary	2
33	Answers will vary	3
34	Bananas - Pears	2
35	Blue less likely than red More blue than red in sample space	2
36	Answers will vary	3