SUNY College at Old Westbury
School of Education
Childhood Education Department

Multi-Subject Content Specialty Test (CST)

Mathematics Practice Questions
Childhood Education
Grades 1-6

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1. A bag contains a number of plastic disks that are either red, green, or blue. One-quarter of the disks are red, two-thirds of the disks are green. Which of the following is a possible value for the number of disks in the bag that are either red or green?

A. 18

B. 36

C. 42

D. 88

2. A third grade teacher is preparing to teach the following standard from the New York State P-12 Common Core Learning Standards for Mathematics.

Number & Operations –Fractions (3.NF)

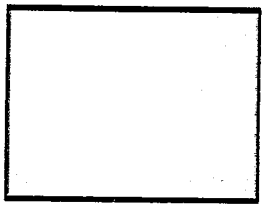
Develop understanding of fractions as numbers.

4. Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.

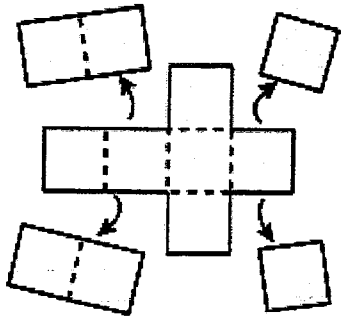
Which strategy is likely to be most effective as part of an introductory lesson designed to meet this standard?

A. Teaching that 1/3 is equivalent to 2/6 by showing how they represent the same point on a number line
B. Teaching that one-third is equivalent to two-sixths because 1/3 x 2/2 = 2/6 because that is the rules of fractions
C. Teaching that 1/3 is equivalent to 2/6 because 6 is the least common denominator of 2 and 3.
D. Teaching that 1/3 is equivalent to 2/6 by showing cross multiplication of $1 \times 6 = 2 \times 3$

3. Use the diagram below to answer the question that follows.



Step 1



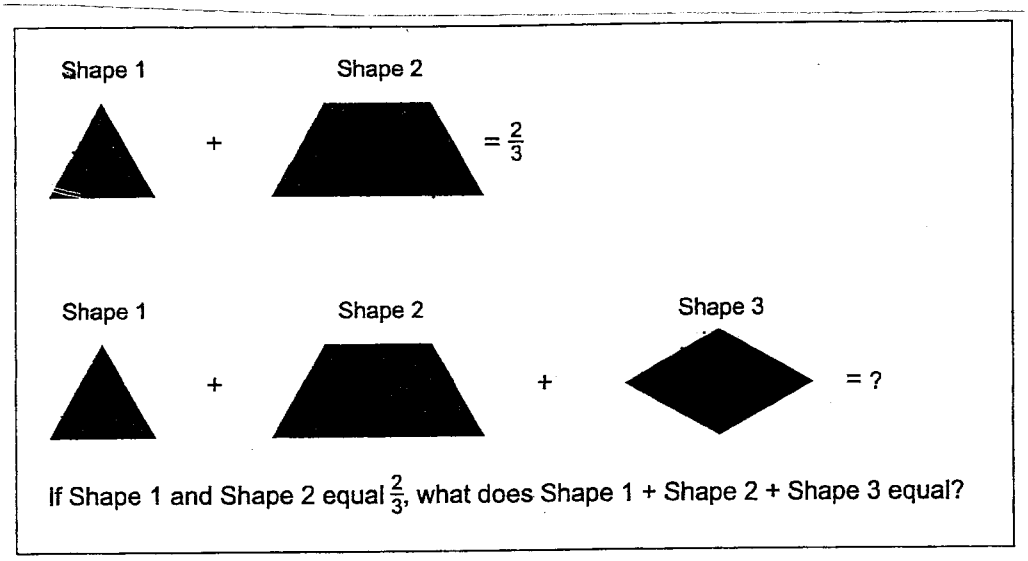
Step 2

Step 3

The steps for making a cube-shaped box by cutting and folding a rectangular piece of paper are shown in the diagram. If all the small squares shown in step 2 are congruent and the volume of the box produced in step 3 is 216 cubic units, what is the area of the rectangular sheet of paper in step 1?

A. 72 square unite
B. 144 square units
C. 432 square unit
D. 864 square units

4. A class is using manipulative tiles in the shape of equilateral triangles to explore fractions. One of the students makes up the problem illustrated below.



What is the solution to this problem?

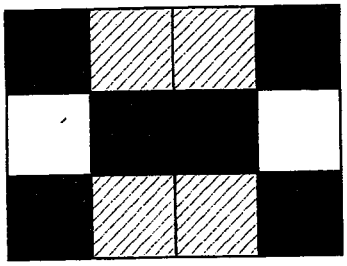
A. 5/6

B. 1

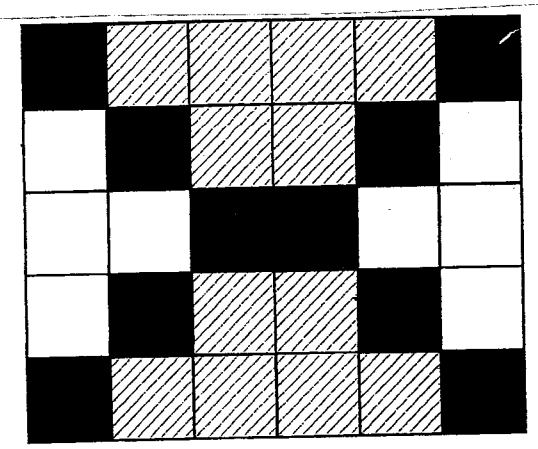
C. 1 1/3

D. 1 1/2

5. The first two elements of a pattern are shown in the diagram below.



1



2

If the pattern continues, how many black boxes will there be in the fifth element of the pattern?

A. 16

B. 18

C. 20

D. 22

6. Which of the following situations best illustrates the mathematical concept of a linear relationship – a relationship between two variables such that a change in one is accompanied by a proportional change in the other?

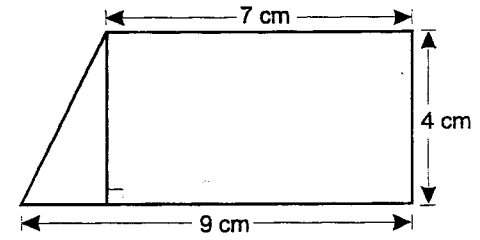
A. Joe's Pizza sells an 8-inch diameter pizza for $10.00, a 12-inch diameter pizza for $14.00, and a 16-inch diameter pizza for $16.00

B. College Painters estimates that two people could paint a house in ten days, four people could paint the same house in four days, and eight people could paint the house in one day.

C. A recycling center offers $22.00 for 100 pounds of scrap aluminum, $33.00 for 150 pounds, and $44.00 for 200pounds.

D. The world's population doubled in the 15 years from 1950 to 1975, doubled again in the 20 years from 1975 to 1995, and is expected to double once more in the 30 years from 1995 to 2025.

7. **Use the diagram below to answer the question that follows**



Which of the following expressions shows the correct procedure for determining the area of the shape shown above?

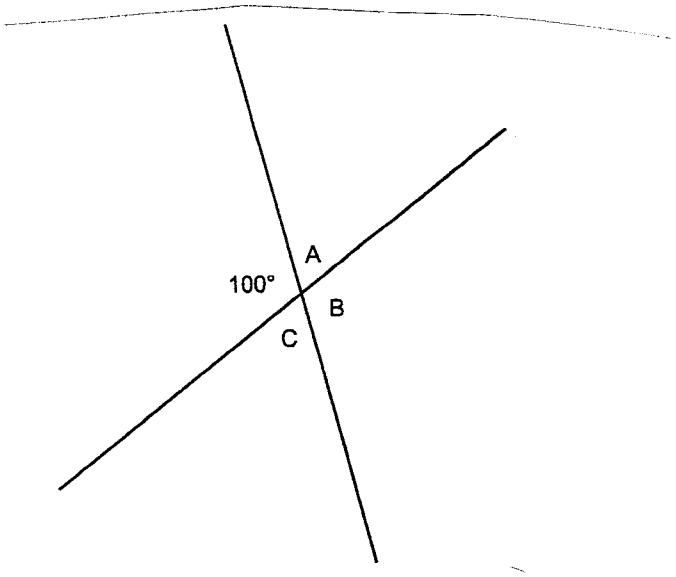
A. 1/2 (4 x 9)

B. 1/2 [(4 x 9) – (4 x 7)]

C. (4 x 7) + 1/2 (4 x 2)

D. (4 x 9) – 4 x 2)

8. Use the diagram below to answer the question that follows.



The diagram above shows the intersection of two straight lines. Based on the diagram, which of the following statements must be true?

A. The measure of angle *A* equals the measure of angle B

B. The measure of angle C equals 100°.

C. The measure of angle *B* equals 80°.

D. The measure of angle *A* equals the measure of angle *C*.

9. When two different prime numbers are multiplied, it is possible for the product to be:

A. an even number.

B. a perfect square.

C. an irrational number.

D. a negative integer.

10. Doubling the length of both the base and the height of a right triangle will cause the:

A. area to increase by a factor of two.
B. area to increase by a factor of four.
C. perimeter to increase by a factor of four.
D. perimeter to increase by a factor of eight.

11. A first grade class is playing a game involving the exchange of pennies for dimes and dimes for dollars. A die is rolled and that number of pennies is given to the roller. When a student has enough pennies, they may be exchanged for a dime. This process continues until the student has collected enough dimes to exchange for a dollar bill. Carrying out this type of activity is likely to be most effective for helping the students develop an understanding of:

A. the idea of multiplication as repeated addition.

B. fundamental aspects of the base-ten numeration system.

C. elementary concepts of factoring.

D. the history of the U.S. currency

12. An assignment asks students to gather data about their classmates. Which of the following is the most appropriate question students could ask their classmates that would provide data for a demonstration of the statistical concept of the mean?

A. How many pets does your family have?

B. What color eyes do you have?

C. Which do you enjoy more, winter or summer?

D. What is your favorite kind of animal?

13. In a first-grade classroom, a teacher displays a ball, a cone, and a box. The teacher asks the class to look at the three objects and describe the ways in which their shapes differ from one another. This activity would be most effective in fostering an understanding of which of the following geometric ideas?

A. symmetry

B. classification

C. congruence

D. transformation

14. A second-grade teacher plans a math activity using a set of wooden rods of various lengths. The teacher asks students to compare the lengths of 2 cm rods to 10 cm rods by asking them to see how many 2 cm rods placed end-to-end equal the length of the 10 cm rod. This activity would be most appropriate for introducing second graders to the concept of:

A. fractions.

B. proportions.

C. percentages.

D. natural numbers.

15. A polygon has three internal angles that add up to 180°. Exactly two of the polygon's internal angles and two of its sides are congruent. A polygon fitting this description must be:

A. an isosceles triangle.

B. a right triangle.

C. an equilateral triangle.

D. a scalene.

16. Use the table below to answer the question that follows.

Year	Population
0	50,000
1	51,000
2	52,020
n	?

The table gives the population of a town over a three-year period. If the population continues to increase at the same rate per year, which of the following equations could be used to predict the population, P(n), in the *n*th year?

A. $P(n) = 50{,}000 + 500n$

B. $P(n) = 50{,}000\ (0.02)^n$

C. $P(n) = 50{,}000 + 1{,}000n$

D. $P(n) = 50{,}000\ (1.02)^n$

17. A mathematical equation is given by $y - 5x + 2x^2 = x^2 + 6x + 3$. Which of the following is an equivalent representation?

A. $y = -x^2 - x + 3$

B. $y = -x^2 + 11x + 3$

C. $y = 3x^2 - x + 3$

D. $y = 3x^2 + 11x + 3$

18. Tony needs to arrive at school at 8:10 a.m. If it takes him 9 minutes to get out of bed and brush his teeth, 12 minutes to get dressed, 18 minutes to eat breakfast, and 23 minutes to walk to school, when will he have to get up?

Which of the following strategies would be most effective for solving this problem?

A. Modeling

B. Working backwards

C. Guessing and checking

D. Finding a pattern

19. Two numbers, *A* and *B*, are shown below in expanded notation.

$A = 7 \times 10^3 + 4 \times 10^2 + 5 \times 10^1$

$B = 3 \times 10^1 + 2 \times 10^0$

When *A* x *B* is calculated, what digit will be in the thousands place of the product?

A. 2

B. 3

C. 4

D. 8

20. Six grade students are using a graphing calculator to explore how changing the value of *m* in an equation of the form $y = mx$ changes the graph of the equation. The students view several graphs and are then asked to make a generalization about how the value of *m* affects the graph of the equation. This is an example of using:

A. A counterexample to evaluate a mathematical relationship.

B. An axiomatic system to generate a mathematical relationship.

C. Inductive reasoning to conjecture a mathematical relationship.

D. Deductive reasoning to prove a mathematical relationship.

OPEN-RESPONSE ITEM ASSIGNMENT #2

Use the information below to complete the exercise that follows.

An important learning standard for prekindergarten children is to sort and classify objects by properties such as color, size, and shape.

Using your knowledge of classification and child development, prepare a response in which you:

- describe how sorting and classifying objects is related to a fundamental concept in mathematics;
- summarize a learning experience that would help prekindergarten children learn to sort and classify objects based on their properties and characteristics; and
- explain why this experience fosters learning and development for prekindergarten children.

SAMPLE WEAK RESPONSE FOR OPEN-RESPONSE ITEM ASSIGNMENT #2

A child must understand that there are classifications for objects and categories used when describing them. Sorting and classifying objects regarding their color, size and shape is related to mathematics. The children will have to look at each object and look at their shapes and sizes. Shapes and sizes are related to mathematics. The children will need to know different sizes and be able to recognize certain shapes in order to be able to sort the objects correctly. Recognition will have to be taught and children will need to be able to recognize in order to sort.

A sorting and classifying learning experience that would help children learn to sort and classify objects would be providing different colored transportation vehicles. At first the children could sort them by color, since that's one of the first things they learn in preschool—not only because they're interested in colors but because recognizing colors is an important strategy used to describe objects. Later they could be broken down into other characteristics such as number of wheels, does it have a motor, how many people, etc.

Developing a child's understanding of classification is necessary to prepare them for their future education. Classification and sorting strategies are the fundamentals of math, science, and even English. When children are classifying they are learning about people, animals and objects in the world. By doing these types of activities children are learning more about their environment. We have some similarities to each other as well as some differences. By learning to classify, children can carry these concepts into other learning areas, such as learning about different cultures in social studies or animals in science.

FIRST SAMPLE STRONG RESPONSE FOR OPEN-RESPONSE ITEM ASSIGNMENT #2

Classification of shapes is directly related to being able to understand that different geometric objects have properties that may be similar or different -- such as triangles have three sides and three points, while squares have four of each. While sorting shapes of different sizes and colors, children are making sets of objects whose properties are alike in some way.

A good sorting and classifying activity for prekindergarteners would be to have a bin in the discovery area filled with a variety of natural materials -- such as leaves, rocks, and shells -- and provide sectioned trays and boxes that the children can use to sort the objects. They may choose to classify the objects by color, size, shape, texture, or any other property. As the children work, the teacher should ask them to talk about what they are doing: What's your idea? How do those go together? What is the same about these objects? Why are these different? The children then learn that objects have many attributes and that they can be sorted in different ways. To extend the activity, the teacher could make pictorial representations with the children during circle times to illustrate different ideas the children have had for sorting and classifying the objects.

This experience would foster learning and development because children of this age need concrete materials to help them begin to formulate important ideas about objects in the physical world, the variety of physical properties they may have, and the different ways those attributes can be described, organized, and generalized. As children talk about the activity among themselves and with the teacher, they are constructing a variety of concepts and developing language for discussing their ideas, such as *bigger than*, *smaller than*, *longer than*, *shorter than*, and *the same as*.

Performance Characteristics:

Purpose	The extent to which the response achieves the purpose of the assignment.
Subject Matter Knowledge	Accuracy and appropriateness in the application of subject matter knowledge.
Support	Quality and relevance of supporting details.
Rationale	Soundness of argument and degree of understanding of the subject matter.

Scoring Scale:

Score Point	Score Point Description
4	**The "4" response reflects a thorough knowledge and understanding of the subject matter.** • The purpose of the assignment is fully achieved. • There is a substantial, accurate, and appropriate application of subject matter knowledge. • The supporting evidence is sound; there are high-quality, relevant examples. • The response reflects an ably reasoned, comprehensive understanding of the topic.
3	**The "3" response reflects an adequate knowledge and understanding of the subject matter.** • The purpose of the assignment is largely achieved. • There is a generally accurate and appropriate application of subject matter knowledge. • The supporting evidence is adequate; there are some acceptable, relevant examples. • The response reflects an adequately reasoned understanding of the topic.
2	**The "2" response reflects a limited knowledge and understanding of the subject matter.** • The purpose of the assignment is partially achieved. • There is a limited, possibly inaccurate or inappropriate, application of subject matter knowledge. • The supporting evidence is limited; there are few relevant examples. • The response reflects a limited, poorly reasoned understanding of the topic.
1	**The "1" response reflects a weak knowledge and understanding of the subject matter.** • The purpose of the assignment is not achieved. • There is little or no appropriate or accurate application of subject matter knowledge. • The supporting evidence, if present, is weak; there are few or no relevant examples. • The response reflects little or no reasoning about or understanding of the topic.
U	**The response is unrelated to the assigned topic, illegible, primarily in a language other than English, not of sufficient length to score, or merely a repetition of the assignment.**
B	**There is no response to the assignment.**

Study Guide

Field 222: Multi-Subject: Teachers of Childhood (Grade 1–Grade 6)
Part Two: Mathematics

Sample Constructed-Response Item

Competency 0005
Analysis, Synthesis, and Application

Use the data provided to complete the task that follows.

Using the data provided, prepare a response of approximately 400–600 words in which you:

identify a significant mathematical strength related to the given standard that is demonstrated by the student, citing specific evidence from the exhibits to support your assessment;

identify a significant area of need related to the given standard that is demonstrated by the student, citing specific evidence from the exhibits to support your assessment; and

describe an instructional intervention that builds on the student's strengths and that would help the student improve in the identified area of need. Include a strategy for helping the student build a viable argument related to the given standard.

Background Information

Fourth-grade students have been developing an understanding of fractions. The class has reviewed representing numbers on a number line, worked with equivalent fractions in special cases, and compared fractions by reasoning about their size. The class is currently working on the following standard from the New York State P–12 Common Core Learning Standards for Mathematics.

Number & Operations—Fractions (4.NF)

Extend understanding of fraction equivalence and ordering.

5. Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as 1/2. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.

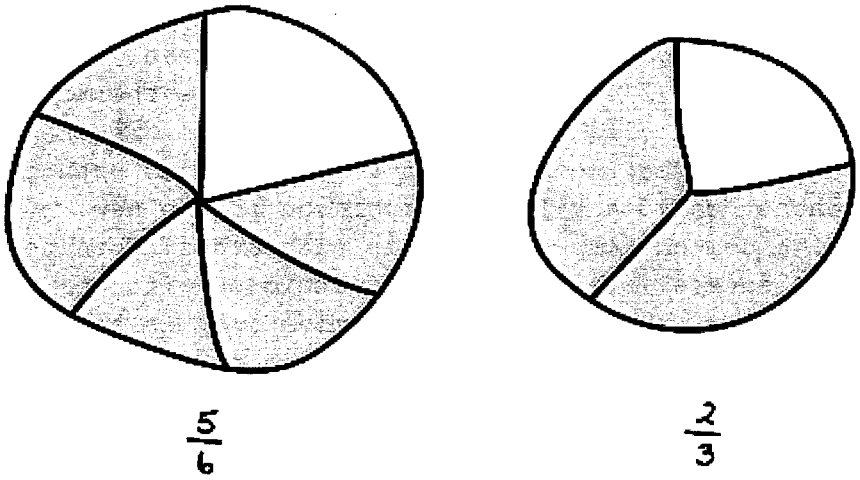
In particular, the teacher has planned a lesson experience in which students will use benchmarks to compare and order fractions. The students have worked with halves, fourths, eighths, thirds, sixths, and twelfths. The teacher has the students work in groups of two.

Teacher: Can you show me what you mean when you say, "you just need one more piece"?

Student: Well, if I think about a pie, I know I only need one more piece to make the whole.

Teacher: Can you show me what you are thinking of with a drawing?

Student: That's easy! I'll make two pies. One shows $\frac{5}{6}$ and one shows $\frac{2}{3}$.



Student: See, they both have one piece missing so they are both the same and they must be pretty close to one whole.

Sample Strong Response to the Constructed-Response Assignment

A strength that the student demonstrates is understanding that fractions with different numerators and denominators can be equivalent. This is shown by the statement, "we put 4/8 under 1/2 because we know they are equal" and later by "1/4 is the same as 2/8." The student could compare fractions that have the same denominators, showing an understanding of the meaning of the numerator. The statement "because you need one more piece to make it 1/2," although lacking in precise terminology, was accurately used to explain that 3/8 was less than 4/8.

A significant area of need is demonstrated in the student's lack of understanding that denominator determines piece size. When comparing fractions with different denominators, the student made no distinction between the size of the pieces that are being considered; he considered only the number of pieces. This is illustrated by the statement "2/3 is the same as 5/6 because you just need one more piece to make them both a whole." Although the student was able to draw both fractions as a pie and shade the correct number of pieces, he apparently did not discern that the missing piece in the pies were different in size, and that, in fact, the pies themselves were not the same size. He noted only that there was one piece missing from each and erroneously concluded that the fractions were equivalent.

Instructional intervention should start with the student using strips of

	The response is well supported by relevant examples and details and thoroughly demonstrates sound reasoning.
3	The "3" response reflects a general command of the relevant knowledge and skills: The response generally addresses all parts of the assignment. The response demonstrates the relevant knowledge and skills with general accuracy and effectiveness. The response is generally supported by some examples and/or details and generally demonstrates sound reasoning.
2	The "2" response reflects a partial command of the relevant knowledge and skills: The response addresses all parts of the assignment, but most only partially; or some parts are not addressed at all. The response demonstrates the relevant knowledge and skills with partial accuracy and effectiveness. The response is partially supported by some examples and/or details or demonstrates flawed reasoning.
1	The "1" response reflects little or no command of the relevant knowledge and skills: The response minimally addresses the assignment. The response demonstrates the relevant knowledge and skills with minimum accuracy and effectiveness. The response is minimally supported or demonstrates significantly flawed reasoning.
U	The response is unscorable because it is unrelated to the assigned topic or off-task, unreadable, written in a language other than English or contains an insufficient amount of original work to score.
B	No response.

ANSWER KEY SHEET
MATH

1. D
2. A
3. C
4. B
5. D
6. C
7. C
8. D
9. A
10. B
11. B
12. A
13. B
14. A
15. A
16. D
17. B
18. B
19. D
20. C

paper to fold and create fraction strips for a variety of fractions (thirds, fourths, sixths, eighths) and to compare 2/3 to 3/4 and to 5/6. The teacher would ask are they all equal? Which of the three is closest to one whole? Compare the amount left to make one whole. Are 1/3, 1/4, and 1/6 equal? Why not? What is the meaning of the denominator in a fraction? What does it tell you?

Using fraction strips, the student could then be asked to compare several fractions that have the same numerator but different denominators, such as 2/6 and 2/4, or 5/8 and 5/6. Because the student appears to have some understanding of equivalent fractions, the next step would be to do work converting 2/3 and 5/6 to fractions with common denominators. The teacher would ask for a comparison of the new fractions, written with common denominators, to each other. Then the student should compare several other pairs of fractions "with one piece missing" in the same manner, finding common denominators. As he works, he should explain his process and his thinking to the teacher.

Students using symbolic notation for fractions may get lost in the symbols and fail to remember that denominators define the size of the fractional part and numerators represent the number of this part. The use of a visual model (the strips) coupled with teacher questioning and student explanations, would help a student to understand key concepts, thus enabling him to build a viable argument regarding equivalent fractions, and allowing him to progress to new ideas.

Performance Characteristics for Constructed-Response Item

The following characteristics guide the scoring of responses to the constructed-response assignment.

Completeness	The degree to which the response addresses all parts of the assignment
Accuracy	The degree to which the response demonstrates the relevant knowledge and skills accurately and effectively
Depth of Support	The degree to which the response provides appropriate examples and details that demonstrate sound reasoning

Score Scale for Constructed-Response Item

A score will be assigned to the response to the constructed-response item according to the following score scale.

Score Point	Score Point Description
4	The "4" response reflects a thorough command of the relevant knowledge and skills: The response thoroughly addresses all parts of the assignment. The response demonstrates the relevant knowledge and skills with thorough accuracy and effectiveness.

Description of Class Activity

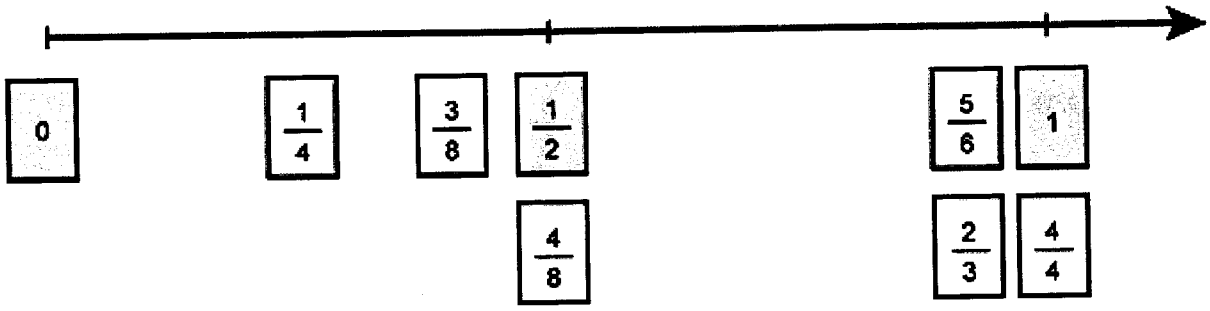
The teacher gives each pair of students a set of "benchmark cards." Each card is a shaded index card labeled with the number 0, $\frac{1}{2}$, or 1. The students place the benchmark cards in correct order from least to greatest along a number line drawn on a piece of cardboard.

Each pair of students also has a pack of "fraction cards." Each card is an unshaded index card labeled with a fraction (e.g., $\frac{6}{6}$, $\frac{1}{4}$, $\frac{2}{3}$, $\frac{3}{2}$, $\frac{5}{12}$, $\frac{4}{8}$). Each student takes a turn selecting a fraction card from the pack. A card that is equal to one of the benchmark cards is placed beneath the benchmark card. The remaining cards are placed between the benchmark cards in the correct order.

While working with their partner, students are encouraged to justify the placement of each card by reasoning about fraction equivalencies and relationships. The student placing the card must explain his or her reasoning while the student observing is encouraged to question and critique the partner's decisions. The teacher has emphasized that both partners will need to be prepared to justify the placement of fractions on the number line.

Excerpt of Interview with Student

As students work, the teacher moves among them and asks questions that require students to explain their reasoning about comparing and ordering fractions. The teacher stops to observe one group's work in progress and asks one of the students several questions. The group's work is shown below, followed by a short excerpt of the discussion between the teacher and the student.



Teacher: How did you and your partner decide where $\frac{3}{8}$ would go on your number line?

Student: Well, we put $\frac{4}{8}$ under $\frac{1}{2}$ because we know they are equal. So then we knew that $\frac{3}{8}$ must be less than one-half because you need one more piece to make it $\frac{1}{2}$. We also know that $\frac{3}{8}$ is larger than $\frac{1}{4}$ because $\frac{1}{4}$ is the same as $\frac{2}{8}$.

Teacher: How did you decide where to place $\frac{5}{6}$ and $\frac{2}{3}$ on your number line?

Student: We know that $\frac{5}{6}$ is more than one-half because it only takes $\frac{3}{6}$ to equal $\frac{1}{2}$. And $\frac{2}{3}$ is the same as $\frac{5}{6}$ because you just need one more piece to make them both a whole.

ANALYSIS FOR FIRST STRONG RESPONSE TO OPEN-RESPONSE ITEM ASSIGNMENT #2

This is an example of a strong response because it is characterized by the following:

Purpose: The candidate addresses the assignment fully by focusing on the developmental characteristics of prekindergarten children and on the relationship between sorting and classifying activities and mathematical concepts. Specific and appropriate examples are provided to illustrate each point the candidate makes.

Subject Matter Knowledge: In the first paragraph, the candidate relates sorting and classifying to distinct mathematical concepts: properties of objects and sets. Classification of shape is illustrated accurately with the example of triangular vs. square properties. The activity is structured to help children focus on different properties among the objects and yet it is open-ended for the children to determine their own sets, as expressed in the teacher's question, "What's your idea?" In the last paragraph, the candidate's understanding of the connections between a young child's play with concrete materials and how mathematical understanding and language develop is indicated by specific phrases such as "the different ways those attributes can be described, organized, and generalized."

Support: Support throughout this response is relevant and important to the candidate's discussion of both child development and mathematics. The candidate provides accurate examples, as in contrasting the properties of triangles and squares ("triangles have three sides and three points, while squares have four of each"). The learning experience is presented with substantial details about the materials the teacher would provide (e.g., leaves, rocks, and shells, as well as sectioned trays and boxes), and specific questions the teacher can ask to develop language and cognition.

Rationale: Each part of the candidate's response reveals sound reasoning and a depth of understanding of early childhood development. The first paragraph describes logical connections between sorting and classifying activities in prekindergarten and fundamental mathematical concepts. After describing a detailed sorting and classifying activity in the second paragraph, the candidate follows up with a discussion about the specific developmental reasons for doing the activity and the role it plays in the child's learning.

ANALYSIS FOR SECOND WEAK RESPONSE TO OPEN-RESPONSE ITEM ASSIGNMENT #2

This is an example of a weak response because it is characterized by the following:

Purpose: This response struggles to find a clear connection between sorting and classifying and a fundamental concept in mathematics, merely repeating that children need to be able to do this, and that "shapes and sizes are related to mathematics." The activity of sorting vehicles has potential for preschoolers, but the idea needs more development. While the final paragraph indicates the general significance of sorting and classifying across the curriculum and across the grades, it's unclear why the specific activity chosen (sorting transportation vehicles) promotes learning and development for prekindergarteners.

Subject Matter Knowledge: The response to each part of the assignment indicates that the candidate's knowledge is limited to broad generalities, such as "children will need to know different sizes" and "recognizing colors is an important strategy used to describe objects." In order to communicate a greater depth of subject matter knowledge, the candidate needs to provide an explanation of the specific meaning those generalities have when applied to prekindergarten learning and development. The essential subject matter knowledge this assignment requires is: what mathematical learning is going on when prekindergarteners sort and classify, what kind of activity would help prekindergarteners focus on the properties and characteristics of objects, and why that activity would foster learning and development at this age.

Support: This response lacks the relevant supporting details required to convey how the candidate's ideas relate to the specific aspects of this assignment. In the first paragraph, for example, the candidate might have been able to identify a specific mathematical concept if a specific material had been chosen, such as "a bin of assorted solid geometric blocks," and if a way children might classify them had been described, instead of using the general term "objects" and talking about being able to "recognize certain shapes." Similarly, if the idea of "different colored transportation vehicles" had included some examples (e.g., Tonka construction trucks, matchbox cars, oil company model tankers), the variety of ways a prekindergartener could classify these vehicles would have been more apparent. Supporting details help candidates communicate their ideas more clearly.

Rationale: Although several of the ideas expressed in this response are generally true, the candidate has been unable to show how the ideas are related to each other and how they connect to the focus of the assignment. Statements such as "shapes and sizes are related to mathematics" and "when children are classifying they are learning about people, animals, and objects in the world" are so broad that they apply to a variety of grades and learning situations. The response needs to be anchored in an understanding of why a particular classification activity is important for the learning and development of prekindergarteners, rather than describing how it might benefit them later on in their schooling.