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Mathematics Question Writing

Objective: Write, review, and finalize mathematics questions for specific content areas and specific groups of students.

Audience: Middle School and High School Teachers

Outline:

1. Discuss Question Writing
    a. What are you assessing?
    b. Guidelines for question writing
        i. Factors that may PREVENT test takers from answering the question correctly.
        ii. Factors that may ALLOW uniformed test takers to arrive at a correct response using methods that were not intended.
2. Choose Mathematics content area(s) and grade level for discussion
3. Discuss and document common misconceptions and common errors in the content area.
4. Write questions
5. Review questions
6. Revise questions

Item writing Guidelines with discussion and examples

1. Some factors internal to an item that may PREVENT test takers with the knowledge, abilities, and skills required from answering the item correctly.

2. Some factors internal to an item that may ALLOW uninformed test takers to arrive at the correct response using methods not intended to be measured by the item

Sample misconceptions

- Algebra: $\sqrt{x^2+y^2} = x^2 + y^2, \text{ for all } x, y$
- Algebra: A variable by itself cannot be combined with other like variables e.g., in $x + 3x + 2x$ students do not see x as $1x$
- Algebra: If $n > p$ then $nx > px$ for all x.

- Algebra: In solving equation, students use same operation on both sides instead of the inverse.
- Algebra: There is no difference between No Slope and 0 Slope.
- Algebra: Two fractional algebraic expressions can be compared by treating the numerator and the denominator separately
- Decimals/Percents:
  - 50% = .50
  - 4% = .4
  - 3125% = 0.3125
- Decimals: When ordering and comparing numbers, the decimal can be ignored: e.g. 5.62 > 36.2 because 562 > 362
- Fractions: To compare two ratios, compare numerators and compare denominators separately
- Geometry: Modifying the area of shape means the perimeter must have changed
- Geometry: Rearranging sub-pieces within a shape changes the area
- Geometry: The size of an angle is determined by the length of the legs
- Geometry: The size of an angle is determined by the size of the arc marking the angle
- Percent: Increasing an amount by a percentage, and then decreasing the new amount by the original percentage returns the answer to the original value.
- Percents: Can't have over 100% of something
- Statistics: Mean, Median, Mode cannot be the same number. Mean, Median, and Mode are always the same number.

Question Review

For each question:

1. Key the item, i.e., find the solution.

2. Write your estimation of how many examinees will get this item correct, choose one of 0.9 (i.e., 90% of the examinees will get the correct answer), 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1.

3. Write your analysis of each item:
   a. What are the key mathematical concepts being tested?
   b. What facts or Theorems are required to get the correct answer?
   c. What other mathematical skills are tested in this item?
   d. What features of the item make the item easier?
   e. What features of the item make the item harder?
   f. Is there are 'wrong way' to get the correct answer?

g. Do the distractors in a multiple choice item include common errors or misconceptions?
h. Are there any factors that PREVENT test takers from answering the question correctly?
i. Are there any factors that ALLOW uniformed test takers to arrive at a correct response using methods that were not intended?

4. Organize the items with regards to difficulty, i.e., categorize the items based on features that you think make the items more difficult.

5. Write THREE similar items that test the same mathematical concept and have the same estimated difficulty.