Developing M.S.A.- and H.S.A.-Style Questions from Textbook Problems

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How do teachers create questions to use in their classes that are similar to those that are on the Maryland School Assessment (M.S.A.) or Algebra/Data Analysis High School Assessment (H.S.A.)? Of course, the state offers wonderful curricular and assessment support at its web site (mdk12.org), but those are organized by state standard, not necessarily by local district curricula or teacher's plan book. Teachers need problems in line with the instruction that they are delivering today (or, if you are able to plan 'way' ahead, tomorrow). What source do all teachers have in the classroom that could be used to help find more problems? Well, the textbook of course. So, how do teachers take problems from a textbook and turn them into questions that are similar to Maryland School Assessment items?

First of all, consider the types of problems that appear on state assessments. There are four basic types of questions on the state assessments (not all question types are given at all grade levels): selected response items (the traditional multiple choice), student-produced response items (also called grid-in questions), brief constructed response items (where students write out complete responses to problems), and extended constructed response items (where students respond to more in-depth questions than brief constructed response items). Selected response and brief constructed items are on all assessments, student-produced response items begin in grade seven, and the extended constructed response items begin in grade five. The state has recently decided to eliminate the constructed response items from the high school level of assessments in order to decrease the amount of time required to process the scoring of these assessments, so brief and extended constructed response items will not appear on the Algebra/Data Analysis H.S.A. starting with the May 2009 administration. In addition, the state is creating assessments in line with the modified academic achievement standard for students with special needs accommodations for both M.S.A. and H.S.A. These assessments will use only selected response items with three answer choices. The items will also have simplified language and a lower level of cognitive demand, but will continue to test the same content standard. It is planned that the MOD H.S.A. will be ready in May of 2008 and the MOD M.S.A. will be ready in May 2009.

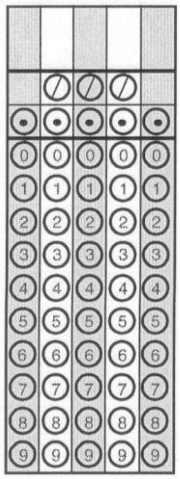
A key to understanding the Maryland state assessments is the importance placed on context at all grade levels. Also, teachers need to emphasize connections between classroom instruction, problems in textbooks, and state assessment items. In textbooks, problems are presented at both skill and contextual levels, as where questions on the state assessment focus on context whenever possible, stressing the importance of answering questions within the given context. Both textbook questions and state test items ask students to explain their answers and justify their responses, and both have the expectation that students will demonstrate their work. For state items, there are guidelines and structures that can be followed by anyone that will help prepare students for the type of questions they will experience. While understanding the mathematics is always the most important aspect of any instructional lesson, including the presentation of some

questions in the same way as they would appear on a state assessment can help students see the connections between the instruction in the classroom and the state assessment.

Selected response items are what traditionally are termed multiple choice questions. The problem is designed with a 'stem,' a few sentences with the information needed to solve the item and the question for students to answer, and four answer choices. The item assesses one mathematics indicator and often includes a real-world context. Some problems will also include a graphic, graph, or model if it is beneficial in solving the problem. Graphics are not included unless they are necessary (the graphic is often used in the place of wording in the stem), and the wording of the problem is as clear and concise as possible. No extra information is given. The answer choices are always ABCD (they did used to alternate between ABCD and FGHJ, but do not any longer). For all state assessments, there is one clear correct answer (no selecting the 'best' answer – except in estimation problems) and the distracters (wrong answers) are most often determined by only making a single error in the problem solving process. 'None of these' will not appear as an answer choice. It should take a student a little more than a minute to answer a selected response item.

To utilize a textbook problem as a selected response item, consider problems that are written clearly and concisely and do not include additional information that could mislead students. While having problems with additional information is important for students to see in instructional and some assessment environments, it is not something that students would see on a state assessment. The stem of the problem should be no more than three to four sentences, using clear and concise vocabulary, with the question students need to answer as the last sentence. There may be a graph or picture, but only if it provides vital information to the item (do not include graphics to make the problem 'look better'). Also, find a textbook problem that can give the correct number of wrong answers. While this may seem easy, many problems may have one or two easily-obtained incorrect answers, but finding a third which involves making only one error can be a challenge. Remember, wrong answers are not selected at random, but rather are mistakes that students could make in solving the problem. In addition, no answer, whether the correct answer or an incorrect one, should stand out among the others. For example, there should not be one single digit answer and three double digit answers (this gives visual weight to the single digit answer). When looking at answer choices, either all four should be comparable or there should be similarities between pairs of answers (two and two). Answer choices should also be in order – either ascending or descending. Many textbook problems will work as selected response items, but some will not. Again, pick ones that include context when possible. The other key for writing selected response items is getting four good answer choices – one correct answer and three 'good' distracters.

Student-produced response items, or grid-ins, are questions in which the student determines a numerical answer to the problem and fills in bubbles on their answer booklet to represent the correct answer (see graphic), somewhere between 0 and 99,999 (the maximum five-digit answer). One could view student-produced response items as selected response without the answer choices, but the best student-produced response items go beyond what selected response items can offer. Since the grid allows students to record their own answer for the item, solutions can be within a range of possible answer choices. For example, students could be asked for a number less than 10, and any number that a student enters that is less than 10 would be correct. This allows for a more open-ended item than is possible with selected response.



Again, context is important, and should be included when possible. Also, the actual question that a student is asked should be worded in a way that includes the label for the solution, such as "What is the distance, in miles, that Elmer must travel?" In this manner, the completely numerical solution is correct. A student should be able to solve a student-produced response item in about two minutes.

The other type of question on the state assessment is the constructed response item, both brief and extended, where students must write out complete solutions that are graded using a rubric. A brief constructed response item should be designed for a student to complete in between five and eight minutes; an extended constructed response item should be completed in ten to fifteen minutes. Obviously, an extended item should ask students for more than a brief item. In addition, there is a difference between constructed response items on the M.S.A. and the H.S.A. On the M.S.A., the item is broken into two pieces for scoring purposes – part a is worth a single point for the mathematical solution to the problem and part b grades the process the student used, or the connection/extension that the student is asked to do, and is scored using a rubric (see http://mdk12.org/assessments/k_8/index_d.html for more information). The difference between brief and extended responses for the M.S.A. is that students are asked to answer one question for a brief constructed response and two questions for an extended constructed response (these questions are bulleted under part b. For the H.S.A., the entire item, whether it is a brief constructed response item or an extended constructed response item, is scored using a rubric (see http://mdk12.org/assessments/high_school/index_b.html for more information). Again, constructed response items are being phased out of the H.S.A. starting in May of 2009.

Constructed response items are also often presented in context, and providing a contextual solution is part of the scoring rubric (see information on 'application' below). A constructed response item is an open-ended question that provides students with the opportunity to generate

and weave ideas into a short response. It can be used to assess understanding of factual knowledge, synthesizing ideas into an explanation, describing a model and identify its advantages and disadvantages, selecting evidence and support ideas, and analyzing a graph or diagram. An extended constructed response item can be used to measure a student's ability to analyze and respond to complex situations and gives the student the opportunity to generate an extended response to a question. Extended constructed response items allow for students to respond to multiple questions or to respond in greater depth on a topic.

To convert a textbook problem into a constructed response item, first look for a problem with a simple context that your students will understand. It is much easier to adapt the indicator and vocabulary in a problem than to try to create a new context. Limit the information in the problem to three simple and well-written sentences. Remember, you can use graphics, tables, figures, and diagrams to aid in student understanding of the problem (and sometimes cut the number of words needed). If you use a graphic, be sure to direct the students to use it, using something along the lines of "look at the diagram below." Just as in selected response and student-produced response items, do not include extraneous information in the problem, rather, focus the student's attention on the particular area of knowledge you want them to use to solve the problem (remember, you are trying to assess the student's knowledge, not trick them). The questions that students are asked to respond to are listed after the information in bulleted format.

Constructed response items are scored, at least in part, using a scoring rubric. For the M.S.A., there are three basic categories for the rubric: application, explanation/justification, and connection/extension. For the H.S.A., there are five basic categories: application, explanation, justification, representation, and analysis. Not all rubric categories appear in every constructed response item, but let's examine some characteristics and clarifying sentences for each of these categories.

Application concerns students using appropriate concepts and strategies applied to solve problem correctly. The solution should be written in the context of the problem. Appropriate units are used. The solution is checked for reasonableness in context of the problem.

Explanation uses words, symbols, or both to explain the processes used to solve the problem. Did the student:

- communicate the answer to the problem and how they arrived at that answer?
- show the steps used to solve the problem either in words or symbols?
- tell why he/she solved the problem as he/she did?
- write the solution in terms of the problem?

Also, would other people understand how the student solved the problem by reading the student's response?

Justification concerns using definitions, postulates, and theorems to determine validity of solution. Why did the student make the choices she/he did? Did the student use the vocabulary appropriate for the problem? Justification and explanation are intertwined, but justification requires students to show their knowledge of mathematical concepts underlying their explanation.

Connections (M.S.A.) are made within different topics of mathematics or to the world outside of mathematics. Students connect their understanding to another topic within mathematics.

Extensions (M.S.A.) are made within different topics of mathematics or to the world outside of mathematics. Change values in the problem and ask students what will happen to the value of the answer.

Representation (H.S.A.) is about the way data is presented and the appropriate display of information. Graphs should have title, axes should have scales and labels, data need to be graphed correctly. Equations have variables identified if not defined in problem. Charts and tables are labeled correctly and completed when necessary.

Analysis (H.S.A.) is about students show that they understand the problem, using appropriate strategies or processes needed to solve the problem. When students analyze a problem, they break it into its components and make sure they understand what the problem is asking and what approach they need to take in solving it. Students should be asking themselves: "Did I look at this problem as fully as I could?" Analysis is not always something that students specifically write on their paper.

Here are some additional guidelines/style details for M.S.A./H.S.A. item writing:

Answer	Do not use "complete" or "do." Use "answer."
Which of these . .	Don't use this, instead use "Which of the following . . ."
Explain	M.S.A., grade 3: "Explain how you found your answer. Use what you know about _____ in your explanation. Use words and/or numbers in your explanation." M.S.A., grade 5: "Explain how you found your answer. Use what you know about _____ in your explanation. Use words, numbers, and/or symbols in your explanation." H.S.A.: "Explain how you determined your answer. Use words, symbols, or both in your explanation."
Figures	Figures should be drawn to scale unless doing so will cue the students to the correct response. A note below the figure should accompany figures not drawn to scale. "Note: The figure is not drawn to scale"

Justify	M.S.A.: "Explain why your answer is correct." H.S.A.: "Use mathematics to justify your answer."

All state assessment items are linked to specific Voluntary State Curriculum or Core Learning Goal indicator(s) as well as judged for their level of cognitive demand (how difficult they are). When putting together items for practice assessments, balancing both indicator and cognitive demand should be done. There are three levels of cognitive demand:

Low/Easy – Recalling facts, solving simple step problems

Medium – Applying, explaining, solving multi-step problems

High/Challenging – Abstracting, justifying, drawing conclusions, making generalizations

The state balances levels of difficulty (easy, medium, and challenging) on all of their assessments. A teacher should try to balance both content standards and cognitive demand on any practice or assessment they develop.

As part of the item development process, it is helpful to have someone else read your sentences to be sure that you are clear and concise. Your goal is to tell students what they are to do and what is expected of them and to tell students where they are to write their response. Be sure to give students enough room on the paper to write their response, though you do not need to provide two separate booklets (as the state assessment would be – one for test questions and one for student responses).

In summary, one of the most important factors in developing state assessment items is to remember the importance of context and to keep the vocabulary basic and the sentence structure simple. Both the M.S.A. and the H.S.A. are designed to allow students to demonstrate their understanding of mathematics through application. This usually starts with a problem involving a context in which students create a mathematical model. Students solve the problem using their mathematical model, then connect their answer to the given context. Many textbook problems can be converted into M.S.A./H.S.A.-style problems, but not all can be, so be careful in your selection. Sometimes, it is better to find another problem than to fit a square peg into a round hole. Remember, clarity and simplicity is important. If a context is too complex, it may not be appropriate for an item.

Bibliography/Resources Utilized

Maryland State Department of Education online resources

Mathematics MSA Toolkit

http://mdk12.org/instruction/curriculum/mathematics/vsc_toolkit.html

Grade 6 Sample Items:

http://mdk12.org/assessments/k_8/sample_grade6_math.html

Grade 7 Sample Items:

http://mdk12.org/assessments/k_8/sample_grade7_math.html

Grade 8 Sample Items:

http://mdk12.org/assessments/k_8/sample_grade8_math.html

Maryland School Assessment rubrics:

http://mdk12.org/assessments/k_8/mathscoring_ecr.html

http://mdk12.org/assessments/k_8/mathscoring_bcr.html

Algebra/Data Analysis H.S.A. Toolkit

http://mdk12.org/instruction/curriculum/mathematics/clg_toolkit.html

Algebra/Data Analysis Sample Items (mini-assessments):

http://mdk12.org/assessments/high_school/index_d.html

Algebra/Data Analysis Public Release Items:

http://mdk12.org/assessments/high_school/index_b.html