Putting Research into Practice: Diagnostic Questions to Improve Classroom Instruction

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Overview
1. Diagnostic questions and formative assessment
2. Misconceptions and resources to find them
Q&A from audience
3. The DIMS project approach
4. Sample DIMS questions
Q&A from audience
5. Using diagnostic questions in the classroom
6. What we learned from the DIMS project
Q&A from audience
7. The DIMS logic model
8. Writing your own diagnostic questions
Q&A from audience

Send in your questions as the session goes along.

1. DIAGNOSTIC QUESTIONS AND FORMATIVE ASSESSMENT

Polling Question #1:
What is Formative Assessment?

(A) It has something to do with “formative evaluation”
(B) There are test products called formative assessments
(C) Use of frequent tests to motivate student learning
(D) On-going, every-day assessment to inform instruction
(E) I’m really not very sure.

Formative Assessment

A process “in which information about learning is evoked and then used to modify the teaching and learning activities in which teachers and students are engaged.”

Documenting, Diagnosing, Treating

2. MISCONCEPTIONS AND RESOURCES TO FIND THEM

Misconceptions
Incomplete schemata…
Incorrect notions…
Partial understandings…
…that (some) students predictably bring to all learning situations and which, if left unaddressed, could have a negative impact on future learning.

Misconceptions...
• Are hard to shift in students
• Are difficult to appreciate sometimes as subject-matter experts
• Here are some examples

Polling Question #2:
What do you think about this map?

(A) It’s just wrong.
(B) It provides another point of view.
(C) But where’s north now?
Austro-centric Map

- Reminds us that “north” is NOT synonymous with “up”
- We can intellectually reason about that
- Are still (mostly) left feeling that there’s something wrong with this map
- In other words, misconceptions are hard to shift …
- Telling someone the right answer may not be enough
- A shift to a more fruitful perspective is needed

Sources of Misconceptions

- Diagrams, Models, and Other Representations
- Abstractions, Generalizations, and Simplifications
- Language and Vocabulary
- Real-world Experiences and Perceptions
- Commonly Accepted “Facts”
- Common Sayings, Beliefs, and Myths
- Metaphors and Analogies

Math Example 1

An upside down triangle?

Question to consider:
What might be the sources of this misconception?

(A) Diagrams, Models, and Other Representations
(B) Abstractions, Generalizations, and Simplifications
(C) Language and Vocabulary
(D) Real-world Experiences and Perceptions
(E) Commonly Accepted “Facts”
(F) Common Sayings, Beliefs, and Myths
(G) Metaphors and Analogies

Math Example 2

A left angle?

Question to consider:
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Science Example 1

Question to consider:
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(G) Metaphors and Analogies

Science Example 2
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Question to consider:
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Resources

Science

Mathematics

Diagnostic Items in Mathematics and Science (DIMS) IES reference R305K040051

- A bank of multiple-choice items where both correct and incorrect responses are interpretable in ways that provide critical data on the current state of individual and whole-class understanding
- The interpretability of the answer choices comes from the use of student misconceptions to develop answer choices.
- Professional development to support teachers develop or refine their questioning strategies, and develop additional ways to support student learning of important concepts
The Diagnostic Items in Mathematics and Science Project

The DIMS questions are a vehicle:

- To help teachers identify student misconceptions
- To help teachers develop a classroom atmosphere that values participation, questioning and risk-taking
- To provide information to direct instruction and learning to where all students are currently at in their thinking

The Rationale for Diagnostic Items

Benchmark/Interim Assessment
- Quality control at end of an instructional sequence
- Monitoring assessment
- Identifies that remediation is required, but not what
- Requires new routines to utilize the information

Diagnostic/Formative Assessment
- Starts with the decisions teacher make daily
- Supports teachers “on-the-fly” decisions

4. SAMPLE DIMS QUESTIONS

Which of the shapes below contains a dotted line that is also a diagonal?

Polling Question #3: Reactions to the previous item

(A) A bad test item with more than one correct answer
(B) Allows me to distinguish between levels of understanding
(C) Confusing to students when they take state tests

Polling Question #3: Reactions to the previous item

(A) A bad test item with more than one correct answer
(B) Allows me to distinguish between levels of understanding
(C) Confusing to students when they take state tests
**Correct Answers are Interpretable**

**Version 1**
There are two flights per day from Newtown to Oldtown. The first flight leaves Newtown each day at 9:20 and arrives in Oldtown at 10:55. The second flight from Newtown leaves at 2:15. At what time does the second flight arrive in Oldtown? Show your work.

**Version 2**
There are two flights per day from Newtown to Oldtown. The first flight leaves Newtown each day at 9:05 and arrives in Oldtown at 10:55. The second flight from Newtown leaves at 2:15. At what time does the second flight arrive in Oldtown? Show your work.

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**Non-Parallel Answer Choices**

What is the median for the following data set?

38 74 22 44 96 22 19 53

A. 22
B. 38 and 44
C. 41
D. 46
E. 77
F. This data set has no median

**Sort Out Competing Good Ideas**

What can we do to preserve the ozone layer?

A. Reduce the amount of carbon dioxide produced by cars and factories
B. Reduce the greenhouse effect
C. Stop cutting down the rainforests
D. Limit the numbers of cars that can be used when the level of ozone is high
E. Properly dispose of air-conditioners and fridges

**Number of Answer Choices Can Vary**

Which of the following is NOT an animal?

A. Cow
B. Tree
C. Human
D. Shark
E. Mushroom
F. Worm
G. Snail
H. Bacteria

**Polling Question #8**

What is the MOST important distinction between these diagnostic questions and other MC questions

(A) Can be adapted for the needs of a particular class
(B) Can have more than one correct answer
(C) Use student misconceptions – cognitive models – to create answer choices
(D) Don’t have a standard number of answer choices
5. USING DIAGNOSTIC QUESTIONS IN THE CLASSROOM

Entrance or Exit Tickets

VIDEO CLIP
6. WHAT WE LEARNED FROM THE DIMS PROJECT

DIMS Pilots and RCT
- Teachers in NJ, PA, Boston MA and VT
- Teachers able to consistently incorporate DIMS items into their practice, with some variation across teachers (teachers used as few as 12 items in the course of a year to as many as 100).
- Teachers reported changes in how they thought about the content to be taught, and developed more of a formative assessment mind-set (using items as pre-assessments before new units or as quick checks during the unit to identify students who needed additional support)
- Most teachers by the end of the year had attempted to write their own diagnostic questions.

Impact on Students
- Teachers reported that students appreciated using the items, that discussing the items allowed them to share their ideas more freely and to see the benefit of doing so.
- In terms of the impact on student learning – as measured by test scores – we had positive results for the two math groups with treatment students scoring higher than the control students on the Vermont math state assessment, with more mixed results in science.
- We do have to be cautious with these results since they are based on fairly small numbers of students due to some difficulties in extracting the data from Vermont.

Changes in Teacher Thinking
“I never really thought much about misconceptions before DIMS. Listening to student thinking and ideas has been great.”

“I enjoyed the free ride these questions granted me into the minds of my students.”

“[I] had rarely examined their origins and rarely specifically targeted individual misconceptions. I find myself more willing to take the time to do so now.”

Impact on Teaching Practice
 “[DIMS questions] allowed me to speed up/skip over topics and become more time-efficient, [and] also allowed the opposite—slow down/reteach.”

“Using these questions gave me a better understanding of “where” to take my lessons, who needed more help and what level I could go to. This tool was helpful in finding problems and solutions in my teaching of a concept.”

“Having students ‘free write’ their reasons for answers [to a DIMS question] before instruction was helpful to them and shaped how I presented future material.”
A Student View

"I like the DIMS!! It’s like everybody gets to answer a question at once without blurting the answer. I think it is cool! I like it very much because you don’t have to call on people and everybody gets a chance to answer the question."

7. DIMS LOGIC MODEL

A Logic Model

- A way to illustrate the anticipated outcomes
- Provides a framework to examine existing research to see if anticipated outcomes are plausible

8. WRITING YOUR OWN DIAGNOSTIC QUESTIONS
Writing Multiple Choice Diagnostic Questions

- Question writing
  - Identify relevant content standards/concept
  - Identify relevant misconceptions
  - Generate incorrect answer choices from misconceptions
  - Develop the question
  - Ensure there is at least one correct answer

- Question review
  - Swap questions someone
  - Questions to ask:
    - Does this question get at a misconception?
    - Will the incorrect answers provide a teacher with helpful information?
    - Could a student get the correct answer with faulty reasoning?

- Pilot/try-out
- Further review and edit

Not a Solo Effort

Contact Information

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SUBMITTED Q&A