Assessing and Communicating Cognitively Demanding Learning Goals
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What is your innovative teaching strategy and how does it represent a novel approach?

Piloted integration of a cognitive demand framework[1] to:
- Align assessments, instructional activities with cognitively demanding course goals
- Communicate intended alignment to students

Reorganized evaluation categories
- 100-level/400-level course
  - 20/30% Standards-Based, Skills Mastery Quizzes (lower-level demands)
  - 30/40% Mathematical Reasoning Portfolio (procedures with connections)
  - 40/20% Problem-Solving Working Group (doing mathematics)
  - 10% Attendance and Participation

Technology supports facilitating change
- Moved quizzes outside of class with video support & retakes
- Canvas rubrics to explicitly assess Standards of Mathematical Practice

What were the student learning targets for your project?

Standards Based, Skills Mastery Quizzes
Skills Mastery Quizzes are focused on the lower-level demands of memorization and procedures without connections. By the end of this course, you should be proficient working with definitions, constructing a variety of visual representations, and performing common calculation methods.

Mathematical Reasoning Portfolio
The Mathematical Reasoning Portfolio targets the higher-level cognitive demand of procedures with connections. You will critique mathematical reasoning to investigate common errors and misconceptions in order to deepen your understanding of key concepts and principles. At the end of this course, you should be able to explain why an erroneous method is incorrect, instead of just saying "you can't do it that way."

What's wrong with the next reasoning that supposedly proves that the equation $x - 1 = 0$ has no solutions?

Starting with the equation $x - 1 = 0$, divide both sides by $x - 1$:
$$x - 1 = 0$$
$$(x - 1)/(x - 1) = 0/(x - 1)$$
$$1 = 0$$

Because the equation $1 = 0$ is false, the equation $x - 1 = 0$ is false for all values of x and therefore has no solutions.

Problem-Solving Working Groups
Problem-Solving Working Groups are designed to provide you opportunities to engage with higher-level, cognitively demanding doing mathematics tasks, where the key mathematical ideas of the problem are directly related to course content. Integrating content and problem solving (Cai & Lester, 2010) will help you (1) deepen your mathematical content knowledge of the current unit, (2) develop your problem-solving skills, and (3) increase your awareness of your problem-solving process and the habits of mind you employ. All these skills are necessary if you will be teaching mathematical problem solving in the future.

The theater you run charges $4 for child tickets and $12 for adult tickets.
1. What's a large amount of money you could make?
2. What's a small amount of money you could make?

Okay, your no-good kid brother is working the cash register. He told you he made:
- $2,550 on Friday
- $2,126 on Saturday
- $1,968 on Sunday

He's lying about at least one of those. Which ones? How do you know?

How do you know your innovation is working? How did the students respond?

Student Perceptions
- Maintained high SEOI scores and positive comments
- Students used to traditional instruction and assessments may be hesitant to change[2] and I have experienced this hesitancy in past courses.
- I am more effectively able to implement research-based strategies to support students in cognitively demanding work: make clear the benefits and purpose of active/inquiry instruction at the beginning of the course[2,3] and provide more scaffolding for students to manage their own learning[4].

Student Assessment Scores
- Standards-Based, Skills Mastery Quizzes: ~100% average scores
  - Students still successful even if class time is spent on other tasks
- Mathematical Reasoning Portfolio
  - Significant score increases in students' ability to "construct viable arguments and critique the reasoning of others" (Standard of Mathematical Practice 3)

Student Beliefs
- Problem-Solving Working Groups:
  - Informal observations of more engagement in productive failure

How broadly can your ideas be translated?

- Successful in both a 100-level and 400-level math course
- Incorporated similar ideas in math courses not designed for future teachers (e.g., MATH 260) and am planning to integrate this framework into those more general math courses in the future.
- While the cognitive demand framework is designed to focus on mathematical goals/tasks, it is grounded in the content neutral Bloom's Taxonomy of hierarchical learning objectives and could easily be replicated in other content areas.
- In fact, the authors of the Cognitive Demand Framework for Math Tasks also created a Cognitive Demand Framework for Science Tasks[5].

References

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