Evaluating Science Teachers' Formative Assessment Competency

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Research Questions

- What are the important dimensions (we call them facet dimensions) underlying teachers' competency of interpretation and action in formative assessment practice? What are the commonly seen facets within each dimension?
- What are the design guidelines for constructing reliable and valid measures for teachers' formative assessment skills and knowledge (FASK)?
- Can the FASK tasks reliably and validly measure teachers' formative assessment competency?

Rationale for The Project

- Research is near unanimous on the importance of formative assessment for student learning as it is an integral part of the learning experience and key to the instruction.
- Empirical studies have started to identify some problematic aspects or difficulties in teachers' assessment practices.
- Need for instruments to assess teachers' formative assessment practices other than self-report survey or time-consuming observation tools.

Theory, Task Construction, and Validation Process

Theory about Formative Assessment Practice

Typical Cycle

- **Gather**

  How much have my students learned of what I have taught?

- **Evaluate**

  How many have “got it”? Did enough of them get it so I can move on or do I need to slow down?

- **React**

  Do I re-teach to the entire class or assign a review to a few? How can I teach more effectively next time?

Rare But Effective Cycle

- **Collect**

  What and how are my students learning in relation to the learning goal?

- **Interpret**

  What are the strengths & problematic aspects of their thinking? What do they need next to deepen their learning?

- **Act**

  What learning experience, or feedback will address the needs I just identified?

FASK Task Construction

- Is guided by the formative assessment model and the facets of teachers' assessment knowledge and skills that we identified in our empirical data
- Focuses on four content topics in physical science.
- Incorporates the research findings on students' facets in the four topics as the responses for teachers to interpret and take actions.
- Is also informed by similar research work in mathematics education and inquiry-based instruction (e.g., Ball & Hill)

Matrix of FASK Tasks and Topics

Topic Cluster	Anticipate/Predict (P)	Interpret Need (IN)	Action Need (AN)	Action Eval. (ANE)
Force as Interaction (FAI)	Push Cart 1B (1,2)	Push Cart 1C (1,2,3)	Push Cart 1C (7,8)	Push Cart 1C (4,5,6)
Identification of Forces (IDF)	Car-1A (1,2,3)	Push Cart 1A (1,2,3,4)		
Forces to Explain Constant Velocity (FECV)	Car-1A (1,2,3)	Skydiver (1,2,3,4)	Skydiver (5,6)	Skydiver (7,8)
Forces to explain acceleration (FEA)	Car-1B (1)	Car-1B (2)	Car-1B (3,4)	Car-1B (5,6)

An Example of FASK Tasks

A 10th grade physical science class is beginning to study how forces can be used to explain motion. The class is discussing the forces involved in explaining the motion of a car accelerating along a straight, horizontal road. The students know that net force means the result of all the forces acting on the object. The teacher asks what happens to the net force acting on a car that is speeding up from a stop sign. Several students are saying that the net force would be getting bigger and bigger as the car speeds up.

Open Response Questions for the task:

1. At this stage in their study of forces, what percentage of the students would likely give this response?
2. What seems to be the cognitive/experiential need that these students have?
3. Describe an activity you might have these students do to address problematic aspects of their understanding.
4. How might you expect this activity to address their need?

Data Collected and Analyzed

- Teacher responses and think alouds to FASK tasks
- Videotapes and daily lesson logs of taught science lessons which included rich teacher and student dialogs
- Teacher interviews, surveys, classroom artifacts of a random sample of students, and stimulus-based reflective interviews
- External panel review of packets of the focus teachers' assessment practices

Preliminary Results of Validation – Ranked Responses to FASK Tasks

---------- Cluster of Problematic Facets of teacher actions * ----------

30 Establish what provides the net force. Do and experiment. Measure either the net force or the acceleration and assume the other is constant.

31 Experiment assuming the gravitational force is constant and measure the acceleration.

40 Choose a situation in which you assume (not measured) the net force will be constant and assume (not measured) that the acceleration will be constant. Assume the relation between force and acceleration will show up (be self evident)

50 Conduct a Force, mass, and acceleration experiment. Assume the relation between force and acceleration will show up.

70 The teacher should explain the relation between net force and motion (Newton's Laws.)

80 The teacher and students should differentiate between the meanings of net force, speed, and acceleration.

90 Teacher or students conduct a force related experience that does not relate to the central idea.

*Ranked from least problematic (30) to most problematic (90)

Teacher Responses Associated with Facets in the Facet Cluster

Strong Response: Facet 00 (a goal facet)

One student riding in a cart- second student pulling with a constant force (spring scale or bungy cord constant stretch. Allow cart and student to move down hallway- requiring the pulling student to keep the force constant. The class should discuss the motion (i.e. speeding up) during constant force and then during decreasing force.

Weak Response: Facet 90 (a low ranked facet)

I would discuss how it feels to go outside in the middle of winter after an ice storm and try to run on the icy pavement.

Preliminary Results of Validation – Video Data of Focus Teachers (I)

In daily videotaped science lessons,

- teachers with high FA more frequently implemented feedback or activities that responded to students' learning needs.
- teachers with high FA constantly attended to aspects of student learning in interpreting their work, identified the cognitive and experiential learning needs, and accordingly planned and employed activities to facilitate students' learning.
- teachers with low FA relied on affirming or restating students' responses to interpret students' responses and provide feedback. They often judged students' responses using a dichotomous scheme (correct or wrong).

Preliminary Results of Validation – Video Data of Focus Teachers (II)

When analyzing the video data,

- the indicators of accuracy, depth, relevance, and responsiveness of assessment interpretation and planned action are useful in differentiating teachers' assessment practice.
- it is worthwhile to examine the role of learning community in formative assessment practices. Teachers with high FA actively involve students in the assessment process, such as having them interpret and review their peer's work, inviting students to initiate assessment prompts and carrying on assessment conversations.

Preliminary Results on Measuring Teacher's Formative Assessment Practices

Different methods offer unique contributions.

- Interview questions are more efficient to reveal teachers' misconceptions of formative assessment
- Video analysis provides more accurate information on the process and quality of assessment practices, such as types and focuses of feedback offered to students
- Survey questions are useful in capturing the overall forms of teachers' assessment practice