

Hidden perspectives underlying success or failure teaching with clickers

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Abstract: Through research and personal experience, we have found that the most crucial factors determining who succeeds with clicker-based teaching, who gives up, and who merely muddles along have far more to do with instructors' deeper attitudes, models, and professional thought habits than with which "best practices" they try or what support they receive. This session explores some of these hidden perspectives and how they underlie clicker use.

Key Words: Classroom response systems, clickers, pedagogy, framing, difficulties.

This is the "proceedings paper" accompanying a workshop conducted at the Lilly Conference on College and University Teaching in Greensboro NC, Feb 4-6 2011. It attempts to capture the colloquial, conversational style of the presentation portions of the workshop itself. The paper was submitted to conference organizers on March 31 2011, but the proceedings volume was never completed due to a shortage of other submissions.

1. The Setup

The more I do this teaching stuff and this educational research stuff, the more I discover that what really matters to me **isn't** studying pedagogical practices, or identifying "best practices" for instruction, or developing effective curricula, or the details of how we learn and think. What increasingly interest me is the **boxes** we put ourselves in: the very deep, pervasive ways that we **frame our task** as teachers and our students' task as learners, **shaping how we think about** and make use of pedagogy, practices, curriculum, and so on. But before delving into that, some framing of this session is in order.

What does "teaching with clickers" really mean? It means many things to many people; a list of the various objectives teachers might have for using clickers in class could easily have dozens of items, many mutually incompatible. This inevitably raises the question "What **should** we use clickers for?" Clickers are a **tool**, not a **way** — an

obvious but oft-overlooked fact. They are not a pedagogy. A nail gun helps me drive nails much more effectively and efficiently, but doesn't help me drive them in the right places. I maintain that any discussion of teaching with clickers should begin with an explanation of what they're being used **for**: begin with pedagogy.

My colleagues and I use them to implement a pedagogy we call *Technology-Enhanced Formative Assessment* (TEFA; Beatty and Gerace, 2009). A talk on TEFA could easily fill several sessions of this length so an extraordinarily brief summary shall have to suffice. TEFA is a way to enact, with the help of clickers, four foundational principles in the classroom:

Principle 1: Motivate and focus student learning with **question-driven instruction**. This means using tough, rich, meaty, often messy questions to contextualize, motivate, catalyze, and precipitate learning. Students process and store information differently in response to a need. In TEFA, clicker questions, the discussion they engender, and the instructor interjections they motivate are the mechanism of instruction rather than something that punctuates more traditional instruction.

Principle 2: Develop students' understanding and scientific fluency through **dialogical discourse**. This means engaging students in highly participatory discussions—peer-to-peer and small-group as well as with the instructor and whole-class—in which multiple points of view, lines of thinking, ideas, assumptions, and possibilities are raised, explored, compared, connected, and milked for insight.

Principle 3: Inform and adjust teaching and learning decisions with **formative assessment**. This means continually probing students' progress, process, and difficulties, trying to build mental models of them as individuals and as a collective, adjusting teaching in real-time and providing students with feedback to adjust their learning process.

Principle 4: Help students develop metacognitive skills and cooperate in the learning process with **meta-level communication**. This means including “higher-level” communication about the instructional purposes of course elements and activities, the messages students are intended to take from them, communication within the classroom, and the nature of learning, knowledge, and the subject being taught. The purpose is to help students constructively frame their learning activities to more

efficiently and effectively learn what we're trying to teach, as opposed to merely inflicting learning upon them.

These four principles are enacted through an iterative **question cycle** in which a question is posed; students are given time to ponder it, alone or in small groups; responses are collected via clickers; a histogram of response counts is displayed; students offer reasons for their choices; a whole-class discussion develops in which their thinking, along with additional points and topics that arise, is explored; and the instructor provides some sort of closure or wrap-up, such as a summary, micro-lecture introducing new and now-motivated content, or meta-level commentary. Three or four question cycles might constitute the entirety of a 50-minute class meeting. What distinguishes TEFA from other clicker-using pedagogies is not the existence of these steps or this cycle, but the fact that in TEFA, the question cycle is the **core** of classroom instruction, the engine of learning, and that all elements are aimed towards implementing the four principles.

2. The Findings

Since 2005, my colleagues and I have been involved in a large NSF-funded research project in which we provided clicker sets to over forty middle- and high-school science and mathematics teachers; helped them learn to implement TEFA in their classes through copious professional development; and studied their learning process: the difficulties they encountered, the strategies and insights that helped them, and the ways in which they appropriated TEFA for their own needs and context. From that project as well as from the many experiences I and my colleagues have had using clickers ourselves and mentoring others in their use, we find that almost all of the difficulties teachers encounter when they attempt to implement TEFA can be reduced to only seven distinct, common ones. In approximately decreasing order of frequency, these **seven common and recurring difficulties** are “insufficient preparation time to create effective questions,” “insufficient class time to engage in lengthy TEFA question cycles,” “poor student participation,” “technical difficulties,” “incompatibility with the subject being taught,” “student behavior problems,” and “clash with the teacher’s style.”

This list should not be particularly surprising to anyone familiar with the challenges of teaching with clickers. More interesting is the observation that **not all teachers encounter them**. This motivates the question, “What factor(s) determine whether a

teacher does or doesn't wrestle with any particular difficulty?" Does it depend on the teacher's experience or skills, or on the subject or level being taught, or on the personalities of the students in the class, or on the clicker training they've received, or on whether they've discovered or been taught critical tactics or "best practices"?

Although the research to back up my claim is still underway, the picture that is emerging from our research and experiences to my eye, at least is that none of these is a critical factor. Instead, the key variable explaining who succeeds, who muddles along, and who gives up in the face of these almost universal difficulties is **the way the teacher frames their use of clickers in the classroom**: that is, the deeper perspectives, models, and assumptions about learning, teaching, and classroom activity he or she brings to the task.

"Framing" can be loosely defined as "answering the questions of what's going on here, and what I should be trying to do." When each of these seven difficulties is unpacked, we find that it arises from one or two basic perceptions of what should be going on in the classroom and what the teacher (and students) should be trying to do; and we find that teachers blissfully unconcerned by that difficulty have chosen an alternative perception.

For example, teachers who report "insufficient question preparation time" by far the most common difficulty arising in our study will, when asked, agree that this means "I'm busy" in conjunction with "Inventing good questions is hard!" Both statements are indubitably correct. However, underlying this latter statement is a hidden perspective: "Questions are my 'curriculum' for teaching with clickers, and I need well-engineered questions to be effective." My colleagues and I find evidence that teachers who do not seem to suffer from this difficulty take a different perspective: "Questions are the starting point for my class. Good questions help, but what matters most is the conversations that the students and I have about and around them." I term this alternative **"questions as program vs. questions as raw material."**

The second most common difficulty reported was "insufficient class time" for discussion-intensive TEFA question cycles. Unpacked, this means "I have a lot of material I have to cover" combined with "clicker questions and discussion take too long." Each proposition can be examined. The first generally reveals an underlying belief that "I must explicitly address in class everything students will be held accountable for"; teachers who don't struggle to find adequate time to cover material

seem to adopt a different perspective, which might be phrased as “I can use class time to focus on core ideas and big-picture understanding, and charge students with filling in the details outside of class.” I call this “**class for presenting content vs. class for digesting content.**” Figure 1 shows a question I use in introductory physics courses to help students digest the idea of “acceleration” and the implications of the technical definition of acceleration, and to relate that to their intuitions and to the everyday connotations of the term; what is significant is that I pose the question without having presented the definition of acceleration in class. The question and subsequent discussion is productive whether or not students have already encountered the definition.

Which of the following objects are **accelerating**?

- | | |
|---|--|
| 1. A race car driving around a circular track at 150 MPH | 4. A bowling ball colliding with a pin |
| 2. A sky diver falling at constant speed | 5. A vibrating guitar string |
| 3. A heavy box sliding across the floor, after being pushed and then released | 6. A baseball flying through the air |
| | 7. A child swinging on a swing |
| | 8. None are accelerating. |

Figure 1: A question designed to help students digest content not presented in lecture.

The second proposition, that question cycles take too long, typically stems from the belief that “Taking a long time on one clicker question means spending a lot of time on one topic. The contrasting view, evidenced by teachers who don’t struggle to find time for TEFA, is “one clicker question and associated discussion can address and weave together many ideas, skills, and relationships.” I call this “**questions as probes to check one thing vs. questions as contexts for exploring interrelated things.**” Figure 2 shows a question developed by a high school biology teacher in our project. The question cannot be answered without comparing the various organs, and the teacher

Which component(s) of the digestive system are most like the pictures below?
Enter all that apply.



1. Mouth
2. Pharynx
3. Esophagus
4. Stomach
5. Small Intestine
6. Large Intestine
7. Rectum
8. Liver
9. Gall bladder
10. Pancreas

Figure 2: A question designed to explore an interrelated set of ideas. (Credit: Cathy Wanat, Northampton HS, MA.)

reported that the question was spectacularly successful in getting students to interrelate and contrast many functional and structural aspects of the digestive system’s parts.

The third most commonly-reported difficulty was “poor student participation.” This stems from one of two likely causes: Students are uncomfortable speaking freely, or

students are uninterested. I argue that the former arises, or at least is exacerbated, when the teacher implicitly takes the point of view that “Clickers facilitate the sharing and critiquing of answers, to find out what students know or can do.” An alternative perspective, that seems far more effective in eliciting student participation, is “Clickers facilitate the sharing and exploration of thinking, so we can see new connections and perspectives.” I term this alternative “**clickers as assessment tool vs. clickers as exploration tool.**” Figure 3 shows a question I have used with great success to get students to explore the nature of and differences between the fundamental forces of gravity, electricity, and magnetism, and their associated “charges.” Students quickly recognized that no one answer could be “correct,” and framed their task as finding inventive, unexpected arguments in favor of one answer or another; in the process, many subtle characteristics and implications of the forces were articulated. (Note that the question is similar in style to that of Figure 2; effective questions can simultaneously address many of the difficulties and framing issues discussed in this session.)

If you were a **superhero**, which **power** would you rather have?

- 1) Change the **mass** of things
- 2) Change the **charge** of things
- 3) Change the **magnetization** of things

Figure 3: A question designed to explore, rather than assess, student thinking.

In a similar way, my experiences teaching with clickers and mentoring others, and preliminary results from our research study suggest that **hidden perspectives underlie most or all of the common difficulties teachers** report when learning to use clickers; that alternative perspectives exist which eliminate or mitigate these difficulties; and that how a teacher employs clickers—including the styles of questions they use, the way they facilitate discussion, and the conclusions or morals they draw for students can implicitly but clearly communicate one framing or another to students, strongly affecting the degree and kind of success the teacher encounters.

3. The Moral and Plea

For each pair of alternative perspectives identified, I do not mean to imply that one choice of perspective is inherently better or more correct than another. The moral I do want to stress, as strongly as possible, is that implicit perspectives underlie all of our teaching activities, strongly shaping everything we do and how our teaching plays out in class and affects students. I urge all teachers to regularly and searchingly ask “What am I assuming about the purpose of [insert tool, tactic, innovation, etc. here]? How else might I view it? What might be the implications of a different perspective?”

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Links

The “prezi” used during the talk – an interactive diagram that can be explored via panning and zooming – includes material and example questions not included in this paper; it is available online via a link at <http://ianbeatty.com/talks/lilly-2011>.

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