Powerful technology and powerful instruction

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Powerful technology

I first learned about simulating an epidemic several years ago from biology teachers on LabNet[1]. In one version (Averill, 1993), each student is given a small cup of clear liquid, and they are told that someone in the room has "AIDS": That student's cup is "contaminated" with sodium hydroxide (a base). The students then "exchange fluids" in pairs, combining the fluids in their cups and splitting the mixture. After several rounds, they each test their fluids with litmus paper. Some of the tests are positive for "AIDS" (the litmus paper turns blue, indicating a basic solution); others are negative, and the class tries to determine who was the original carrier.

Another version of the activity uses live bacteria (Powel, 1993): The students each get a small dish with a piece of candy sitting in liquid, which they use to wet their hands; the liquid in one dish is a culture of bacteria.[2] This time, the students shake hands with each other, to provide the contact, and they test for infection by trying to grow bacteria from their hands on agar plates, which they incubate overnight.

I don't remember the details of our conversations, but I do remember the teachers' enthusiasm about the activity.[3] Still, I am sure they would have been delighted to have Thinking Tags, instead of or in addition to their solutions and cultures. There are many advantages, as Colella described: The Tags allow for the onset and detection of "disease" during the simulation rather than afterward; the detection is straightforward and automatic; they are much less work for the teacher to prepare; the "rules of the game" are programmable, so the simulation is easy to customize (e.g. to make the probability of infection on contact 70% rather than 100%); and so on. Here is a compelling example of how well-designed technology can enhance classroom activity.

One of the first things that struck me about this chapter, though, was that Colella and her colleagues seem to have arrived at their simulation without knowledge of the older versions, which have been in circulation among biology teachers for at least 25 years.[4] It is a sign of a gap in communication that needs to be filled, and a sign of how filling that gap could benefit developers as well as teachers. What other ideas are there in the teaching community that could be so naturally and effectively enhanced with technology?

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It would be a mistake, moreover, to attribute the success of this activity to the technology. That this was a rich and productive learning experience for the students is clear, and it is clear the Tags helped that experience happen.

Still, students could become similarly immersed in the older versions of the

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[1]LabNet was an electronic community of science teachers, defunct as of February, 1998. See Ruopp, Gal, Drayton, & Pfister (1993).

[2]The particular bacteria chosen do not present a health risk to the students, as used in the activity.

[3]I also remember their warning each other that students tended to make off color references to their interactions – crude evidence, like Colella's, that they "appropriated the metaphor of the simulation" (Colella, p. #14#)!

[4]I don't know their origins; I found Averill (1993) and Powel (1993) in a search for something to cite for this commentary. Powel (1993) describes her version as an adaptation of an activity in a laboratory manual (Mangino, 1975).

activity. Given time and skilled guidance, they would be able to pose and explore questions such as "What is the probability of transmission in a single interaction, and what affects that probability?" "What is the delay, if any, between getting infected and being contagious?" "What are the probabilities of false positives or false negatives in the tests?" I am sure this happens in some classes, with teachers who feel at liberty to devote this depth of attention and have the expertise to facilitate it.

I am also sure the Tags would often be used as a demonstration: The class would run the simulation once, discuss what it shows about the spread of disease, and move on. Whether it is because they are pressed for time, in a constant rush to cover a standardized curriculum,[5] or because they are not prepared to think about learning and instruction in this way, most teachers would not use the Tags in the manner Colella describes.

That is to say, what happened in these classes depended substantially on the ways in which the teacher (or teachers) facilitated, encouraged, and guided the students' engagement and participation in a classroom version of scientific inquiry. This was not only powerful technology; it was also powerful instruction, and the two are not twinned.

As Colella writes, "one of a teacher's responsibilities . . . is to support children's inquiry and help ensure that learning opportunities are not squandered." (p. #6#). But there is no mention of a *teacher* in her account of the activity. On the contrary, in several places she implies that teaching was not important, for example in claiming that "the teacher also participated in the activities, though he did not teach any of the classes" (p. #9#), or in suggesting that the students essentially ran class themselves:

> The experiments are conceived entirely by the students, and the students retain complete control over the experimental execution. If any class member becomes marginalized . . . the group pulls them back in. (p. #18#)

Nevertheless, there are clues of a teacher's contributions throughout. First, there is little doubt that the regular teacher of the class, in "participating in the activities," was *teaching* by any meaningful definition of the term. His specific contributions are not evident – if he is one of the quoted participants, he is not identified – but I find it implausible to suppose he did not have a substantial influence, at least to "creat[ing] a social system in the classroom that supports certain kinds of discourse and activities" (Newman, 1990; quoted on p. #11#).

The more evident teaching in this account was by Colella, although she refers to herself only as "the researcher." "Conversations and explicit collaborative discussions" (p. #11#) are not only tools for research, they are part of effective instruction, and largely for the same reason: They provide "information about the evolution of students' understanding," (p. #11#). That information allows the teacher to assess the students' progress, diagnose their strengths and needs, and make judgments regarding whether or how to intervene (Hammer, 1997).

It is clear Colella was making these judgments and acting on them. In episode 1, she asks "Who in this room met the most people?" (p. #13#), prompting a "chorus" of response. In Episode 6A (p. #15#) she asks "Is there anyone who started with the virus other than [Doug]?" and then "Who started out with the virus?" to help focus students' attention on the task, and to support the idea that Doug was not Patient Zero. Episode 15 (p. #17#) begins with Colella's question, "Do you have a strategy to avoid [the

[5]Colella does not specify, but I am guessing it was not incidental that these were "low ability" students: It is in regular and upper track classes that teachers generally feel constrained to move quickly through an overfull curriculum. The constraint of time is reflected in Averill's (1993) and Powel's (1993) plans for the activities as one-shot, teacher-directed demonstrations.

virus]?" again, guiding the students toward a productive line of thinking. In Episode 21, (p. #18#), she affirms "That's what I thought," lending her authority to Allison's understanding of an experiment.

There is more we can infer that the teachers accomplished, such as helping the students accept the "information vacuum" (p. #12#) at the outset of the activity, a situation most of them found "fairly uncomfortable and unusual." But we would need more information to understand how the teachers did that. How did the students' discomfort manifest itself? What, precisely, did the teachers say and do?

To understand what happened in this activity, we would need to understand how the teachers interpreted and navigated moments of instruction such as these. More generally, to understand the contributions of technology to classroom instruction, we need to understand the interactions between the tools and the teaching. We need to consider, not just how technology can help students learn, but how it can help teachers help students learn. This is more reason for greater contact between developers and teachers.

How can technology help teachers teach?

That question sounds "teacher-centered" ("bad") rather than "student-centered" ("good"), but I contend that with respect to the development of educational technology this is a false dichotomy. Colella is working within a community that has, at this point, a long history of developing wonderful tools for learning. None of it, however, is effective in classroom contexts, or for most learners in any context, without facilitation, support, and guidance by talented teachers.

This is not at all to disparage technology but to frame its role with teachers in mind. Ultimately, teachers must carry out the student-centered instruction we hope to achieve. To help them do that, developers need to engage in some "teacher-centered" thought: How can technology support teachers in attending to and diagnosing their students' abilities and needs; how can technology help teachers respond to those needs?

This chapter is an example of powerful technology supporting and supported by powerful instruction. It highlights the need for greater attention to how that can happen, and for substantive collaboration with teachers in the development and assessment of educational technology.[6]

References

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[6] The BGuiLE Project (Reiser, *et al*, 1999) is an example of this sort of collaboration, drawing on teachers' expertise to inform the development of educational software and studying the affordances of the software for learning and instruction in classroom contexts.

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