A Huge Leap for the Classroom

true peer-to-peer learning, enhanced by technology

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The way to the classroom of the future is a staircase that all of us are building one step at a time. Sadly, some of the steps we build are unstable, and will soon need replacement. But many of those won't be replaced because of the cost—to the detriment of the kids. So it is important that we build the right ones first.

The most stable steps—those that will last the longest—are those steps that improve our pedagogy (i.e. how we teach), rather than just bring in new equipment for old ways of teaching.

Last time I praised one of these steps: Sal Khan's powerful idea that videos be used to "flip" the way our teachers teach, by having the explanations come before the class (via watching the videos at home) and the class time be entirely devoted to the teacher's helping individual students with their understanding. Recently I came across another step that extends the "flipped" approach farther.

Kahn's approach improves pedagogy by allowing one of the best "explainers" to be the one who does the explaining to all, by making those explanations infinitely repeatable, and by utilizing class time in the most productive way. This second new approach further improves pedagogy by making use of a readily available (and almost totally unused) asset—the power of students in every class to teach, and learn from, each other.

One-on-one tutoring has long been shown to be far more effective than classroom learning, by as much as two standard deviations. Yet our classrooms persist—less for educational reasons than for economic and social ones. Still, classrooms do have some potential advantages, and a big one is a large supply of peers to learn from. The pedagogical problem, though, is that it is not clear at every moment precisely who should be tutored by whom. But if we could figure this out, teachers could gain a huge amount from this powerful resource.

When we go from a pedagogy of one-to-many (i.e. lecturing) to a pedagogy of one-on-one (tutoring), part of the gain in learning comes from learners' increased engagement—a result of the tutors' being able to tailor all explanations and comments individually to each student's interest and needs. And another big part of the gain in effectiveness is that good tutors require

that their tutee answer *every* problem, and make *every* decision—and get individual feedback—unlike the typical classroom's "raise your hand if you want to volunteer" approach.

Perhaps one day computers will be as good as the best human tutors—many researchers are working on this. Already for certain things—like precisely repeating a single explanation over and over as many times as needed—the machines hold the edge. But for other things—like tailoring a different explanation for every piece of content for each learner based on precisely what that particular learner already knows and can do—humans are still unmatched, even with the great strides computers have recently made in adaptivity.

So how can we give our students the advantages of both machine *and* human tutoring, in the most efficient and helpful way? "Flipping" the classroom still leaves the pedagogical difficulty that a lone teacher can rarely, in a session of 45 minutes—or even in a programming block or college class of two hours—get to all the individual issues of 30-40 high school or 50-200 college students.

Enter Professor Eric Mazur of Harvard's Physics Department.

After years of giving traditional lectures and being frustrated by the results, Mazur started "flipping," assigning his recorded lectures for night-before watching. The results improved, but the issue remained of how to get *all* his students to make *all* the decisions, and ensure that each student received individualized feedback. Then Mazur (and some of his colleagues) had a very clever idea.

In place of lecturing, Mazur began in class to only pose questions on the previous night's individually-watched video—questions that each student had to answer, individually, on the student's own computer or smart phone. (The software, created by Mazur and his colleagues, works similarly to an audience response system—so-called "clickers"—but with no need to buy, or pass out and collect, or keep track of separate devices. It assumes, of course, that each student *has* his or her own device, a condition currntly more true of colleges than K-12. But more on that in a minute.)

Because students are utilizing "real" computers, the answers they are required to give can take more varied forms than is the case with the commercial clickers (draw a vector, for example) and new formats can be added easily.

The teacher sees all the student responses in real time, and therefore knows instantly how many students got the question right, and, assuming it is a good question, how many understand the concept. Since it is rare that all the students understand—in fact the questions are deliberately designed so that typically only a minority do—Mazur *then has each student find another student in the class with a different answer from his or her own, and has each student to try to convince that partner that their own answer is the correct one.*

Then everyone votes again. The percentage getting the correct answer typically improves considerably, as those people who were right manage to convince many of their peers. Only then does Mazur reveal the correct answer, taking questions from those not yet convinced.

Advantages? Far more understanding, and, perhaps unexpectedly, better teaching. This is, Mazur explains, because peers are the most likely to have thought patterns similar to other students, and are therefore the best people to be doing the explaining. No one is left out of any question or problem, either as a teacher or learner. And, having been shown where they were wrong in their thinking (or having had to convince someone), students typically forget less. Downside? (if you want to call it that): Far less silence, and traditional "order," in the classroom, as the students talk to each other—all focused on the problem at hand! This is good news.

But it gets even better. Mazur and his partners have now completed "Version 2.0" of their *Learning Catalytics* system. (They plan to sell it – Harvard will get a cut.) Now the teacher can pinpoint the individual students (i.e. seats) that gave each answer. So the teacher knows not only *how many* students didn't get the question right (the first and second time) but *where (and who) they are*. Because the seat positions are clear, the teacher can, in round two, instantly pair those students up with the ones who did know on the first try by sending both a message to "turn to the neighbor on your left or right". He can even split up "cliques" of friends who sit together (and often tend to have similar opinions), assigning seats for maximum learning.

And Mazur wants to know even more—what, for example, do students actually *say* when they try to convince each other? Are their explanations ones that the other students, and the teacher, can learn from? So for research for future system enhancements, Mazur and his colleagues installed microphones between each pair of seats and video cameras throughout the classroom and records the student-to-student conversations, and the students' body language. (The steeply declining price of tiny mics and video cams makes this possible.)

Using Mazur's system, his students all get—right in his classroom—a great many of the benefits of a private tutor. Because the tutors are their peers—who likely understand each other's thinking better than the teacher does—they get a tutor who is often *better* than the teacher. Tutors can be reassigned as often as necessary for maximum effectiveness. Teachers can match up peers on the fly, in the most productive ways for each student's learning.

The power in Mazur's system lies not in the technology, but rather in the pedagogy. It's the *concept* of divorcing the class time from the teacher-delivered explanation, and of using the students in the class as peer-to-peer tutors, that is the powerful learning enhancer. The technology supports this pedagogy, by enabling students to repeat, the night before class, any parts of the explanation that they don't understand, and in class by showing the teacher precisely who understands and who doesn't. But the underlying pedagogy can be used without any technology.

This is the crucial point: that changes toward the way today's kids learn best must drive the technology we acquire and use, rather than having our future classrooms be driven by *any* technology's feature set, bandwidth, availability or price. (The purchase at great expense of

interactive white boards for so many of our classrooms is a perfect example of doing this wrong.) Classroom technology should support and enhance the pedagogies that work in today's environment and context (such as students connecting with the world, and teaching themselves with coaching rather than being told.) Unfortunately, even our younger "Digital Native" teachers do not *automatically* know how to best use these pedagogies, which they didn't experience in their own educations; we must teach them.

Some see technology as the way to replace our classrooms. Yet classrooms are unlikely to go away until we find better ways to keep our kids safe while their parents work (the "dark side" of K-12 school), and until the ability of computers to tutor vastly improves. For now, we can increase our students' learning most if we think of technology as *a way to vastly improve the teacher-student interactions that go on inside our classrooms* (and, of course, to connect with the world outside those classrooms). Eric Mazur and his colleagues at learningcatalyics.com offer us a huge step toward making this happen. I recommend that you seriously consider bringing this true pedagogical innovation—either via the technology-enhanced commercial system or via its free "conceptual" version—to your own institution.

Marc Prensky is an internationally acclaimed thought leader, speaker, writer, consultant, and game designer in the critical areas of education and learning. He is the author of four books: The Five Skills Framework (Corwin Press, in press) Teaching Digital Natives: Partnering for Real Learning (Corwin Press, 2010), Don't Bother Me, Mom, I'm Learning (Paragon House, 2006) and Digital Game-Based Learning (McGraw Hill, 2001). Marc is the founder and CEO of Games2train, a game-based learning company, whose clients include IBM, Bank of America, Pfizer, the U.S. Department of Defense and the L.A. and Florida Virtual Schools, and is co-founder of a new "curricular games" company, Spree Learning Games. Marc holds an MBA from Harvard and a Masters in Teaching from Yale. More of his writings can be found at www.marcprensky.com/writing. Marc can be contacted at marc@games2train.com .