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BACK TO THE BOARD

At every conference I attend and in every article I read about student learning and college teaching, I hear the same message loud and clear—do not lecture! In math, however, this is easier said than done. Many students start their math classes anxious about the subject, and any attempt to help them learn on their own is interpreted as a sign of abandonment.

Personally, I like to try all kinds of ideas that move me away from lecturing and involve the students more in learning. Once in a while, an idea works better than expected, and this year I hit the jackpot. After a particularly and unusually bad test performance from the students in one of my early-morning math classes, I decided that I was at that point where I had to question whether the problem was my teaching or their study habits. Regardless of the answer, something had to change.

So I walked into class armed with 12 whiteboard markers and vowed to change the format of the class drastically. Our students are tired—they work full-time, have families, take care of sick relatives, attend the activities of their children, and, maybe, find the time to study. When I see my class at 8 a.m., I quite sure that many have been awake for only 10-20 minutes, despite my best attempts to convince them to spend some time waking up in order to learn more effectively.

So on this day I stood everyone up, told everyone to find a partner, gave each pair a marker, and sent everyone to the whiteboards. I could accommodate 12 pairs. I read a problem, and the students with markers dutifully wrote it down. The partner was to observe and help where necessary. After solving each problem, students swapped markers, taking turns being the "writer."

Even on the first day, the results were amazing. I could see right away who was struggling and on which steps.

- Students did not feel threatened by asking questions because they could ask another student (or two) first; and then when they had consensus that others had the same question, they could ask me.
- Students woke up. Standing up and getting the blood flowing did wonders for their thinking skills.
- Students seemed more willing to tackle a difficult problem (now that they could see everyone else was making the effort, too).
- Students taught each other math skills—not just the skills we were learning, but older, forgotten skills, as well. I heard mini-lectures (by students) about exponent rules, factoring, combining like terms, and graphing lines (all topics from previous math courses).

For the next two weeks, I incorporated "boardwork" into every class meeting. When I graded the next test, I found that more than half the class had earned A's. Clearly, this was exciting; but being a mathematician, I could not allow one result as conclusive evidence for the success of the technique.

During the remainder of the semester, I tried variations involving "boardwork" every day and in other math classes of various levels of difficulty. Students really like boardwork, they learn more during class, and most important, they begin to learn math on their own as well as how to teach it to others. Why does it work so well? I think it is the simple act of standing up and moving, and students come to the whiteboard armed with nothing but their brains. It is just too hard to hold a textbook, notes, and a calculator while writing on the board. Students might run back to their seats to look up something in their notes; but mostly, they think for themselves. I share here several variations on the technique that I have found to work very well.

- I almost always have students work with a buddy.
- Boardwork first, teach later: Begin class with 20 minutes of boardwork that emphasizes the previous day's material and maybe an older problem or two for a good challenge. Then teach something new during the remaining class time. I like this variation, especially on Monday mornings.
- Teach first, boardwork later: Show students the foundation for new procedures, walk them through a few examples, then send them to the board to try it out for themselves. Increase the level of difficulty

of the problems as you go. Surprisingly, except for a couple of good-natured groans, they are happy to meet the challenge.

- Self-pace: Give students a list of prepared problems and answers (problems on one side of the page, final answers on the other). Let them work at their own pace, checking answers as they go. Students who finish early can opt to work more problems (their choice) from the book. If you are teaching sections with application problems or sections in which students are moving at drastically different paces, this is a good variation—it gives you the time to really work with the students who are struggling.
- Rotate partners: After every two problems, students must find a new partner. This allows them to work with partners of various skill levels—sometimes they are the teacher, sometimes the learner.
- During all the variations I roam around the room, pointing to places in problems where students should take another look at their work, answering questions, and helping students think themselves to the next step when they are stuck. Sometimes I know exactly what problems I want in advance, and sometimes I write the problems as I go, adjusting to get at specific techniques that I have observed are weak.

Have sufficient numbers of whiteboards and maybe a digital camera handy for those moments when a student really wants a copy of work that has been recorded on the board. Ultimately, you will know this technique is working when you overhear the first student say, "I'm asking for my own whiteboard for Christmas!"

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