Special issue: Innovative Teaching Personal Essays

Using Group Whiteboards to Engage Students and Promote Active Learning

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We have often heard, "Two heads are better than one." In article publishing, we regularly employ this concept by utilizing peer reviews to improve articles. It is not easy to hear all the changes the reviewers want for an article, but it improves an article to incorporate reviewers' feedback. It makes me think of other ways to look at a topic or idea, to improve my argument or to make my argument more compelling. So I asked myself how I could incorporate the benefits of collaboration – of "two heads" – within my classroom?

In my physics class, I want students to develop as independent learners who take responsibility for their learning and develop critical thinking and reasoning skills. To promote higher level thinking and reasoning skills, I focus on developing a process of solving physics problems. I challenge my students with increasingly more complex physical scenarios in which they need to identify the relevant concept and determine how to represent a situation with various representations, including a sketch, graphs, and mathematical equations in order to solve a problem. I have noticed that a common strategy for novice physics students is to memorize how to solve a problem and then try to use the same equations to solve problems they think are similar, otherwise known as equation hunting. Students tend to focus on the surface features – if a problem involves a car moving, or a ball thrown – instead of the concept that is involved. Every problem can look completely new to students who are not able to identify the relevant

concept. So, they tend to use a memorized algorithm to solve any new problem without understanding the physical principles involved.

Another problem is that many of my introductory physics students come into class with a fear of physics. Sometimes this fear can create such intense anxiety that students are unable to participate in the learning process. As I considered what my students needed to effectively learn physics, it seemed they just needed a challenging environment that encouraged them to think critically, pushed them to ways of reasoning beyond what they had previously engaged in, and was in an atmosphere where they felt comfortable to discuss physics with peers and in a whole class setting. The question remained, "How can I make this happen?"

As a new physics instructor, I participated in an eighteen-month New Faculty Experience (NFE) sponsored by the National Science Foundation and the American Association of Physics Teachers. This program introduced new physics faculty to research-based instructional strategies in a three-day workshop in March and then mentored the new faculty in an online platform through another academic year as we implemented the innovations we had learned. I learned about whiteboarding from Dr. Dwain Desbien (2002), who developed Modeling Discourse Management and has been practicing and refining it ever since. After the March workshop, I came back to my classroom excited to try whiteboards in my own class in the last term of the academic year.

After I acquired whiteboards at the local hardware store (a 4' x 8' sheet of showerboard cut into 6 boards), I announced in class that we would be doing group work on whiteboards. My enthusiasm was not contagious. Students did not appreciate the abrupt change from the previous class method of Peer Instruction using concept questions and working on problems on paper with guidance and then solutions written on the board (Mazur, 1997). The end of course student

evaluations that term included comments like “Everything is fine but the whiteboard activities” and “Stop using whiteboard activities. They would be ok after you have lectured about the topics.”

I went into the summer term wondering what went wrong.

Through the mentoring in an online platform, I reflected on what appeared as a failed attempt at an innovation and discussed it with the other NFE new faculty and mentors. They helped me realize that it was not the innovation itself, but instead the abrupt change during a term in progress. Students felt that the class rules and operation had changed when they were already accustomed to learning with a different format. I began to realize that I needed to set an expectation at the beginning of an academic year and explain the reason for using whiteboards. It was not enough to be personally committed to an innovation: students had to buy in, as well.

The following Fall term, I set the expectations in the first week, having students work with whiteboards to introduce each other and review the syllabus – a generally less threatening activity than actually doing physics. The focus was on getting know their peers and working collaboratively. Students generally are more comfortable speaking to their peers in small groups, but they develop their confidence by having their understanding confirmed in their small groups prior to explaining to the whole class. Nonetheless with practice, they do become comfortable interacting in the Board Meetings, the part of the class where groups present their group boards to the class.

In my physics class, students now use small portable whiteboards to solve physics problems in groups of four. The whiteboards are a tool to make their collaborative thinking visible to their peers and themselves. In addition, I move throughout the room and scaffold student learning based on the thinking they have displayed on their whiteboards.

In a typical class session, I have introduced a concept and a basic example problem in pre-class videos. Then in class, students work on whiteboards in groups of four on more challenging physics problems. As groups are working on their problems, I circulate through the room to check their understanding visible on each group's whiteboard. For groups who need scaffolding, I ask clarifying questions to provide guidance. For groups who have solved the problem and are ready for a challenge, I seed new ideas on ways they can extend the problem and incorporate another physics concept not yet presented in class (Desbien, 2002).

Once the groups have mostly finished the problem, we conduct a Board Meeting by forming a circle in the classroom with each group holding their boards so all can see each other's work (Megowan-Romanowicz, 2016). Students compare their whiteboard work with other groups' whiteboards to find commonalities and differences. Physics problems can often be solved in a variety of ways, yet still come up with the same final answer. This becomes apparent by comparing whiteboards. One group presents their work, and the other students are tasked with asking questions of the presenting group. The class discussion is typically rich with thought provoking questions and incredible realizations that were not previously clear to students. For more details on how whiteboards are used in physics, see Wood and Kutcher (2017).

Working in small groups, students spend more class time engaged in the language of physics and verbalizing their understanding and thoughts. In order to explain or discuss physics, students must process the concepts at a higher level than would occur in a traditional lecture class in which the instructor explains the concepts and problems. In my class, students do the explaining. I provide guidance and join in their celebrations when they have their "ah ha" moments!

After a couple terms using whiteboards in class, the student evaluations now regularly list "Whiteboard activities" as the top thing about the course that helped students learn. I learned that even with an effective innovation there will be challenges to effective implementation. Reflection and learning from my students as to what works and what they need to learn is critical, as well as reflection and learning from my colleagues.

Using whiteboards in class and presenting during Board Meetings is not for all students. I make a significant effort to demonstrate this style of learning in the first class so students understand how the class will be conducted. I even suggest that if this type of learning – taking responsibility for your own learning in small groups – is not for them, then another section of physics may be a better fit.

Students learn better when they take responsibility for their learning. They push each other to develop their understanding of physics when they work in small groups. As they become comfortable working with peers, they develop friendships that make the class more enjoyable. Developing relationships in class helps them manage their fear of physics and focus on learning.

Implementing any new innovative teaching strategy takes time to reflect on the process and revise with each iteration. The most important feedback I receive is from the students – how they learn, how they think, and how they interact with the content and class. While two heads are better than one, an effectively run group meeting, a.k.a. Board Meeting, can provide students with a wider perspective and deeper learning. Learning is hard work, but in the right atmosphere, it is worth the effort!

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