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Modifying Active and Collaborative Learning To Make It Work for You: "Hands-on" in the Science Classroom

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The era of a scientist working to solve a problem in isolation is a thing of the past. All the same, the rapid advance of Internet course offerings, including laboratory courses, may misrepresent the skill sets necessary in scientific endeavors. In practice, the pursuit of science, sometimes due to the interdisciplinary nature of scientific endeavors, requires and relies heavily on collaborations (Gentile & Boehlert, 2010). Yet, active and collaborative skills are not always fostered in academia. I have been presenting some of these practices, which are commonplace in my chemistry classroom, to fellow faculty and students interested in tips for successfully incorporating Active and Collaborative Learning techniques. More than simply presenting these, my fellow faculty are informed by being participants and thus in many situations experience the student perspective of these practices. Students and participants alike are engaged by use of a variety of topics, models and tools (including cooking recipes, Lego blocks, 3x5 cards and molecular models).

Most of my workshop takes place in a collaborative group format, and best practices are emphasized for forming, molding and most importantly, nurturing collaborative groups. In my Chemistry classrooms students assemble into collaborative groups in almost every class session. Sometimes a group format will last only a few minutes and sometimes upwards of 20 minutes. Ways of structuring the curriculum are discussed so that students are acclimated to anticipate a classroom where their participation is expected and valued.

Use of "Clickers" to Stimulate Discussion

Participants in a session are intermittently "subjected" to short PowerPoint presentations. The remainder of a session (but also during the presentation) participants *actively* participate. For example, a simple low-tech clicker system is used (rather than an electronic clicker each participant gets four 3x5 cards printed with the letters A through D).

During a segment of the PowerPoint presentation multiple choice questions are asked and the participants raise their answer card of choice. It is important to exploit and capitalize on situations where there are split decisions and ask the participants to look around, find someone with a different answer and attempt to convince each other on the merits of their own answer choice (Osborne, 2010). Not utilizing the energy that is generated can be such a missed opportunity.

In teaching the value of this to faculty harder questions are orchestrated and faculty find themselves in a similar situation with their students: actively arguing the scientific merits of their answer. It takes some guidance to assure that rather than quenching the energy and having the class quiet down before moving on it makes sense to harness the energy for further deliberations.

Peer-to-Peer Instruction

Other more structured Collaborative Learning activities with peer-to-peer instruction are also implemented. Participants form "base groups" which soon are reorganized into "expert groups" (usually covering four topics) and regroup with their base group to teach and be taught (all four topics). Faculty need to make sure that while each "expert group" is discussing a topic they are using the right terminology and are ready to move on before they return to their base group to teach. Certifying that each "expert group" has acquired all the know-how to teach their topic empowers its members to present that topic as experts to their base group. Furthermore it eases the faculty's task of "deputizing" each person in a group as capable of teaching their topic.

If one has not taught using *base groups*, *expert groups*, *topic groups*, *informal groups* and so on, one could rightfully be somewhat confused, and worse would not know what structures should be put in place at what point to assure that peer-to-peer learning is effective. Along the way and perhaps more importantly, the techniques are not simply taught or presented. Though Johnson, Johnson, & Holubec (2008) and Barkley, Cross, & Major (2005) have assembled invaluable compendia to anyone interested in incorporating collaborative activities in the classroom, experience and implementation has taught me that modification, and sometimes even behavior modification is needed if one is to succeed. Not only is the standard classroom system set to discourage active learning in the classroom, some students also expect to be lectured in the classroom and "roll up their sleeves" in the laboratory. I have been identifying and mitigating some of the common pitfalls of implementing such activities so that both efficacy and efficiency of collaborative and active learning are addressed.

The Importance of Active Learning

Establishing collaborative groups early and consistently is a must for this undertaking to be successful. When I first started teaching Chemistry I assumed that students in my classes shared my curiosity for science; or at least by showing that connections to science with all other fields exist all around us I was sure I could unleash their own curiosity. Though I still believe that curiosity is a trait that we need to nurture in our classrooms, taking advantage of *Active Learning pedagogies* is far more productive than simply relying on *lecturing* about science. Science as a discipline requires of students to learn "hands-on." Active and collaborative learning can often be dismissed as practices not befitting science, due to the seeming rigor and precise language requirement in describing complex topics in depth. Often, even graduate research is conducted in relative isolation, launching a scientist's career with skepticism about collaborative work. Moreover the simple fact that the breadth of material that is covered each semester leaves little if any time available requires strict time management and assurances that implemented activities which otherwise subtract from time available to lecturing, have a clear and measurable additive value.

When I first started incorporating *Base groups*, I was worried that students would fail to use the precise language and rigor in team teaching their group. Worse, I was not sure they would even be willing to teach each other. Any faculty that has ever out of the blue asked students to form groups and work on a topic is well aware of the hesitations from the student side: students are not going to jump into a productive collaborative effort simply because they are instructed to do so. In order to achieve clear and measurable results in the science classroom, the expectation needs to be set early on that participation and collaboration are going to be expected of students. Of course successfully getting students to participate and making sure that their collaboration is truly beneficial requires rigorous planning and is more demanding not just of the students, but also of the faculty, than simply designing the flow of a lecture. It is the responsibility of the faculty to design activities that are not simply educational, but more importantly progressively built up from simple ice-breakers, base groups, and informal groups to larger project groups.

We have to battle the fallacy that students are the ones at fault when an activity does not work or that one classroom is just more cooperative than another. Proper design can yield the preferred results. Faculty expectations and predesigned activities can guide and nurture the active learning environment when administered suitably and consistently. While I draw on my own lessons and student end-of-semester feedbacks I assure you most my collaborative activities are met with much more enthusiasm than my best polished lectures. The feedback has given me new perspective upon which I have developed and fine-tuned my approach into building collaborative communities in my classrooms.

<u>Using One's Senses</u>

Establishing clear understanding of abstract scientific concepts can be better realized when students are fully engaged, when they debate their position, and they utilize all their senses and capacities to their advantage. Usually the first day of the semester after discussing just a few topics, I show students a functional MRI that shows how different regions of the brain are activated when a subject listens to a word, versus when that subject sees, or generates or speaks a word. I then go back and ask them to follow a topic by either covering their ears or eyes to – hopefully - demonstrate to them that in the same way they limit their potential for understanding when they cover their ears or eyes, they do so when they cover their mouth, and choose not to speak up. Much of science, including Chemistry, needs to be approached as a foreign language: taught and learned by similar means. Of course, all active and collaborative learning is done in conversation. However, after polling a classroom of students to find out how many of them have indeed ever attempted to vocalize "science" words such as *isotope, heterogeneous, orbital* to name a few, the results may not surprise you: students oftentimes read in silence, so they utter such words for the first time in the classroom, if they get a chance to do so. It is my charge not only to reach out to individuals in my classroom with different cultural sensitivities and convince them to (as the organizer of an HSI conference I attended in Albuquerque put it) *not self-sensor* during active learning, but to also guide faculty in my institution in doing so.

Conclusions

Students come to class with the expectation of being lectured to, often reluctant to participate in group activities and disinclined to lead their peers. Science faculty often perceive their role as a lecturer they deliver on students' expectations and do not effectively promote a team learning climate. This is even more so in the science classroom since faculty view the science laboratory as the sole place for collaborative efforts and informal peer learning to take place. The spirit of learning communities must begin in the classrooms. Students need to be led and molded into peer learning cohorts in class through active and collaborative activities. Participants in this mini-course are shown the merits of organizing different types of groups within their class. Best practices for forming and nurturing collaborative peer-led groups are discussed, such as the importance of appropriately sequencing activities, while identifying and mitigating some of the common pitfalls of implementing activities. Some of the presentation takes place in a collaborative group format wherein information is experienced in groups. Given time constraints some information on how to initiate student collaboration and peer teaching within the classroom is presented by the faculty.

From 2008 to 2010 I acted as the STEM Faculty Leader Discipline Expert for the science side of a CCRAA grant and while I managed the grant, during that time I also coordinated faculty development and training activities for both science and math faculty. In doing so it became abundantly clear that our faculty, though perhaps skeptical initially, were happy to learn about Collaborative Learning activities, but also that some of the methods of implementing such activities (e.g., frequency of activities, time management, linking activities over multiple sessions, battling low participation especially from one's best students) need also to be elaborated on, if one is to address efficacy and efficiency concerns. Successfully implementing collaborative activities is a tremendously rewarding experience, not just for students, but also for faculty. We have to get everyone on board, and as educators – perhaps even more so with the advent of online laboratory courses and MOOCs - the best thing we have to offer our students is the opportunity to actively learn together.

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