CWSEI – PHYS & ASTRO Newsletter

March 2012

Our department has always been committed to high standards in education. With support and leadership from the CWSEI, we have made increasing progress in successfully implementing research-based educational methods in our classrooms. This newsletter is meant to keep you up-to-date with the latest CWSEI efforts.

In this issue, we outline how active learning is currently implemented in UBC physics and astronomy courses.

Active learning in lecture courses

By PHAS-CWSEI team

In our last newsletter we introduced pre-reading assignments as a way to prepare students in advance for the next lectures. As one of the main benefits we listed that there is more class time available to go over challenging examples and correct for misconceptions. So what's a good way to "go over" challenging examples? More importantly, how do you make sure that students 'get it' after you spent some time on a difficult concept? Below you will find ideas that are already implemented in some courses in our department.

What is active learning and what is different in an active learning environment?

Simply put: Active learning refers to anytime you interrupt your lecture and make your students think about something and have them do something. Thus asking a question to the class, giving them some time, and then having a class discussion can be considered active learning. However, there is often the tendency to let the same few people answer, which can short-circuit the thinking of the other students. We want to discuss here techniques that allow the entire class to participate, such as working on worksheets or discussing difficult questions with their peers in small groups. But first let's discuss why it is important for students to be active in lectures.

Why active learning?

Research indicates that students learn more in an active learning environment. Why? It is important that the learner makes sense of the new knowledge and builds it into what he or she already knows (so-called constructive learning theory); this is something the professor cannot do for them. Hence students have to actively engage with the material in an effortful way. In an active learning environment, we provide students with tasks that support this effortful engagement.

Furthermore, active learning tasks break the routine and diversify the teaching approach. It can easily be observed that students' attention significantly drops after about 10 minutes of listening to the instructor. Interrupting the lecture with a question or a task, such as predicting the outcome of an experiment, allows students to refocus – or to catch up with the lecture in case they have already lost focus. An active learning task also exposes students to the material in a way that is different from the textbook or the instructor's introduction, giving the students another chance to connect with the material. For example, the task (clicker- or worksheet question, etc.) may have a narrow focus that emphasizes an important point. In successful implementations of active learning, we have found from surveys that students see clicker- or worksheet activities as directly relevant to exams and regard them as the most important part of the lecture. This in turn offers a chance to focus the students' attention on the main learning goals of the lecture. So if there is an important concept or example that students simply must know, we recommend doing it as an in-class activity.

Good in-class activities

Clickers A significant number of our faculty use clickers. Clickers, however, are only a tool – they do not lead to better learning by themselves. It is crucial to use them in connection with a well-choreographed peer instruction approach for best results. The main steps of this choreography are:

1. Show a relatively difficult conceptual question in multiple-choice format on a Powerpoint slide. Don't read it aloud: the students are already reading the question and your voice only distracts them. Also, it's possible you'll give away the answer or incorrect choices with inflections in your voice.
2. Ask the students to answer the question on their own. It's critical that each student forms an opinion and commits to an answer. The

students, in turn, become invested and interested in the question and are prepared for discussing the ideas with their peers (when necessary). Note: Do not open the iclicker poll immediately. That only encourages students to guess an answer without thinking about the question. Instead, give them sufficient time to choose an answer. Keep track of the time by reading the question and the answer choices word-by-word yourself and then deliberately deciding for yourself which choice is best. Then open the poll for a short time: if the students are ready, they'll vote within 15 seconds.

3. Look at the results on the receiver. If the vast majority of students got it right, it is still advisable to briefly explain the answer before moving on. If, however, the class is divided between two or more choices, which is desirable, tell your audience 'there are two popular answers' and then ask the students to discuss this question in small groups. Tell your students that they should try to reach consensus in their answer and in their reasoning; then have them vote again.

4. Discuss with the students the correct answer and why the other popular solutions are not correct. Have the students explain as much as possible.

A clicker question with peer discussion might take 3-5 minutes. But this is time well spent if the question addresses key concepts or common misconceptions. Our CWSEI team offers peer instruction with clickers workshops tailored to our PHAS faculty. Among other things, the design of good clicker questions is discussed and practiced.

Think-Pair-Share A similar approach without clickers is "Think-Pair-Share". The key element is again the peer discussion ("Pair") that follows the individual pondering of a question ("Think"). In the "Share" part, the instructor asks several student groups (usually 2 – 4 students) to share their solution or their strategy with the class. This approach requires that students are comfortable speaking up in front of their peers and will probably work best in smaller upper year classes.

Worksheets In-class worksheets are another good way to actively engage students during lecture. Usually a worksheet contains a few questions and/or tasks related to a concept (or synthesis of concepts). The questions (or parts) build on one another and provide a 'scaffold' for the students to explore the concept in depth. The instructor connects the parts of the worksheets by providing introductions, motivations, hints, explanations and summaries. It is important that students have done a related pre-reading assignment, so that the worksheets can focus on the difficult parts of a topic. A good worksheet question is difficult for any one student to compete individually, so it is good to stress that the worksheets be done in small groups. While the students work on their tasks the instructor walks between the groups and listens in on the discussions and looks at the worksheets. This will help to find out what the students are struggling with and how to continue in class. After about five to ten minutes (or when a majority of students have moved on to the next question), the instructor interrupts the activity and discusses the solution of a part of the worksheet with the class. If the instructor notices that several groups are stuck at the same point, the instructor could provide a hint to the class during the activity. Worksheets have two big advantages: students can work mostly at their own pace and many question formats are possible. Worksheets have been used to explore concepts, make sense of difficult mathematical equations, as well as with PhET computer simulations (with laptops in class). We are currently accumulating 'best practice' strategies and plan to have a workshop on worksheets in the future.

Demonstrations A popular way to interrupt the lecture is to show a lecture demonstration. This can be turned into a good active engagement activity by having the students predict the outcome of an experiment (e.g. by using clickers). The activity requires a careful explanation of the experiment and a good experimental set up that is large enough so that students can see all the essential components. A very simple apparatus is best for this type of activity. After performing the experiment, the outcome should be explained thoroughly in a class discussion.

Helping students learn now, not later

Students who passively sit in an instructor-centered lecture do their learning later at home. If they get stuck, their options are limited. In an active learning environment, students can be begin learning right away and get help from their peers and instructors as soon as they need it. If you'd like to try out any of these active learning approaches, we are happy to help with the design of the activities.