CWSEI – PHYS & ASTRO Newsletter

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Our department has always been committed to high standards in education. Recently, with support and leadership from the CWSEI, we have made increasing progress in successfully implementing research based educational methods in our classrooms. An increasing number of our faculty are showing keen interest in these developments. In response, we distribute this newsletter to keep you up-to-date with the latest CWSEI efforts

Professors Sarah Burke, Mike Hasinoff, Andrzej Kotlicki, Kristin Schleich, and Don Witt (PHYS153)

This year, the Physics 153 lectures and tutorials underwent a major transformation. (The labs were run separately by Bill McCutcheon in the traditional style with no changes.) This is a large first year service course for the Faculty of Applied Science with enrollment of over 800. It has 3 lecture sections and 16 tutorial sections. This transformation was a true team effort. Faculty on the team were Sarah Burke, Mike Hasinoff, Andrzej Kotlicki, Kristin Schleich, and Don Witt. We received support and advice from Louis Deslauriers and Cynthia Heiner, CWSEI STLFs.

The reason for the transformation was to improve learning. In particular, the goals were to more fully engage the students, improve retention and reduce the failure rate at the end of the year. To accomplish this, all lectures were based almost entirely on clicker questions and graded activities. This transformation of PHYS 153 was radical in that the number of students in the course, over 800, made it one of the largest courses anywhere to undergo such a transformation to a format in which no traditional lectures are provided.

Moreover, this course is a service course for the Faculty of Applied Science; thus it must teach the physics necessary for students to succeed as engineers. Concepts are important; however, the students must also be able to do computations for real world problems. Thus, a standard measure, exams at the same or higher level than in the past with same types of questions, was used to evaluate performance.

Staffing was one faculty member and two TA's per lecture section. Tutorials had two TA's running a mini-version of lectures with activities and clickers. This allowed the TA's to get teaching experience beyond a traditional tutorial. We had great support from a wonderful team of TA's. Two of the TA's who put in a big effort on this transformation were the Head TA, Anand Thirumalai and a veteran TA Matt Scholte.

This is a first report on this course transformation; more will follow.

The structure of the course:

Lectures: The lecture consisted of clicker questions and graded activities being presented to the class with almost no traditional lecturing. Physical demonstrations and simulations were shown and used as part of clickers and activities

- **Reading Quizzes**: There are several short readings per week with two online reading quizzes per week which were graded.
- **Clicker Questions**: These were both concept and computation based. Two types of clicker questions were used: Clickers that monitored the understanding of the material and quiz questions that followed up the activities *(as defined below)*. The quiz question clickers were graded.
- **Activities**: These were deeper problems that taught the main learning goals of the course. The students worked in groups of 3 on these. Activities ranged from a hands-on experiment to a theoretical calculation. There were about 3 activities per week in the course. The work on the activity was recorded and turned in on worksheets in term 1 and graded by the TAs. The work on the activity was kept in each student's engineering notebook in term 2 and the notebooks were collected periodically and graded by the TAs. Feedback on the activity was often presented immediately after the activity was finished. After each activity, graded quiz questions were asked of the students individually using clickers.
- **Midterms**: There were 2 midterms per term, 60 minutes each. All sections wrote the same common midterm, given in the evening. Each midterm consisted of 3 computational problems, each worth 10 points.
- **December and April Exams:** These exams were again common to all sections and computational based. The December exam consisted of 8 computational problems, each worth 10 points. The April Exam consisted of 6 computational problems, each worth 10 points, and 20 points of multiple choice questions. This format for both the December and April exams was the same as that used for the last few years.

In order to pass the course, students must receive at least 40% on each of the December and April Exams; furthermore, their average mark over both exams must be at least 50%. In addition, if they have passed this requirement on the final exams, they must also separately pass both the written and lab part of the course. This rule has been enforced in this

course for many years.

Tutorials: These were a mini version of the lectures. Each tutorial is 50 minutes. One purpose was to clean up any confusion on topics from lectures. The two TAs worked as a team. There was a discussion problem that was worked on in groups of 3 followed by clicker questions. The TAs used the remaining time to answer general questions.

- **Homework:** Homework sets consisting of 5 or 6 written problems were assigned each week. The homework sets were divided into A and B sets to avoid students copying each other's work. This also gave students access to 10 to 12 different problems to review for the final. Additionally, there were periodic Mastering Physics assignments.
- **Tutorial Clickers and Discussion problems**: Using the new methods, in the fall we were able to cover more advanced topics when considering thermodynamics such as a more complete introduction to entropy and temperature-entropy plots.

The first data we have for comparison is from the April and December exams. We compared the percentage of students failing on the raw grade this year vs. past years. Specifically we compared the percentage of students with <40% and <50% grade, respectively, on the exam in 2010-2011 to that in past years for both the December and April exams. In these graphs, the notation 2k11=2011, etc., indicate the year the course was completed. Although exams are not necessarily a complete measure of learning, the results show improvement.