CWSEI – PHYS & ASTRO Newsletter

February 2011

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 monthly newsletter to keep you up-to-date with the latest CWSEI efforts.

Dr. Louis Deslauriers (CWSEI STLF)

At one point or another most physics instructors will ask themselves if their students have adequate math preparation and how significant a role it plays in their learning. Answering these questions is a formidable task, requiring careful study of student thinking as they apply mathematics in various physics contexts. As a pragmatic first step in answering these questions we spent the last two years developing math diagnostics at various levels. The principle aim of these math diagnostics is to provide instructors and physics students with a simple assessment tool that can be used to measure general mathematical knowledge at the start of a physics course. Although these diagnostics say very little about general problem solving ability (or lack thereof), the feedback they provide instructors and students will hopefully result in increased learning of physics.

First year mathematic diagnostic

The first year mathematic diagnostic has been developed with the help of many instructors here at UBC and at other institutions. It consists of 20 multiple choice questions testing basic mathematical knowledge relevant to any first year physics course. On average, students take about 30 minutes to complete the test.

This diagnostic was administered in several 1st year physics courses here at UBC and at other institutions. The histogram in figure 1 shows the average score at various institutions. An attempt was made at grouping the 1st year scores in three clusters: (1) the right-most group are two algebra-based 1st year courses taken by pre-med students. (2) The four courses in the middle are all calculus-based and are most similar to our Phys153 taken by UBC engineering majors. (3) The large group to the left is comprised of more advanced calculus-based courses such as Phys107 (honours) here at UBC. Notably, the course E. Private** is populated mostly by 2nd year physics majors, and the E. Public* course is a 1st year classical mechanics course taken by honours physics students.

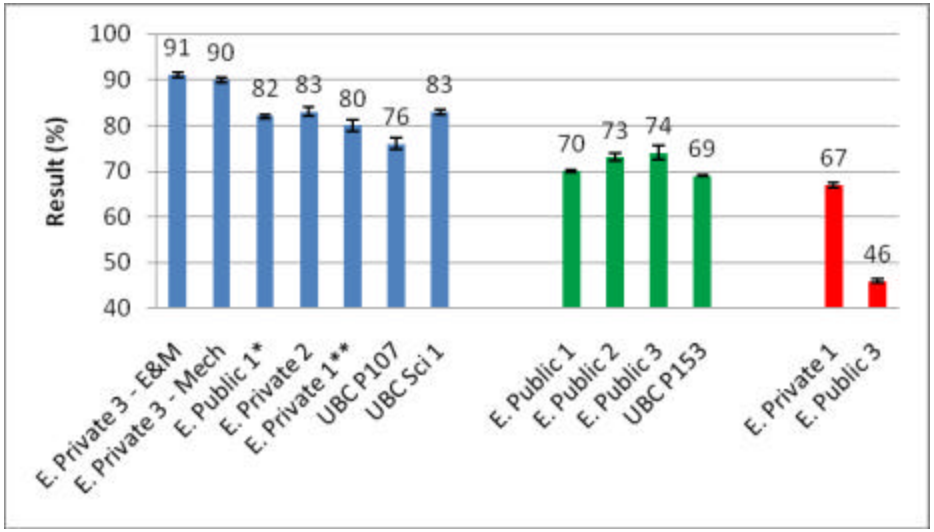

Fig 1: Histogram showing the average scores on the 1st year math diagnostics in different courses at various institutions. "E. Private" and "E. Public" stand for Elite Private University and Elite Public University, respectively.

Upper level mathematic diagnostic

The upper level mathematic diagnostic has also been developed with the help of many instructors here at UBC and at other institutions. It comprises 25 questions testing more advanced mathematical knowledge that 3rd year physics students are expected to know, such as multivariate and vector calculus, ordinary differential equations, linear algebra, and simple probability and statistics. Students typically take about 45 minutes to complete the test.

This diagnostic was administered in several upper level physics courses here at UBC and at other institutions. The next histogram in figure 2 shows the average upper level diagnostic score at various institutions

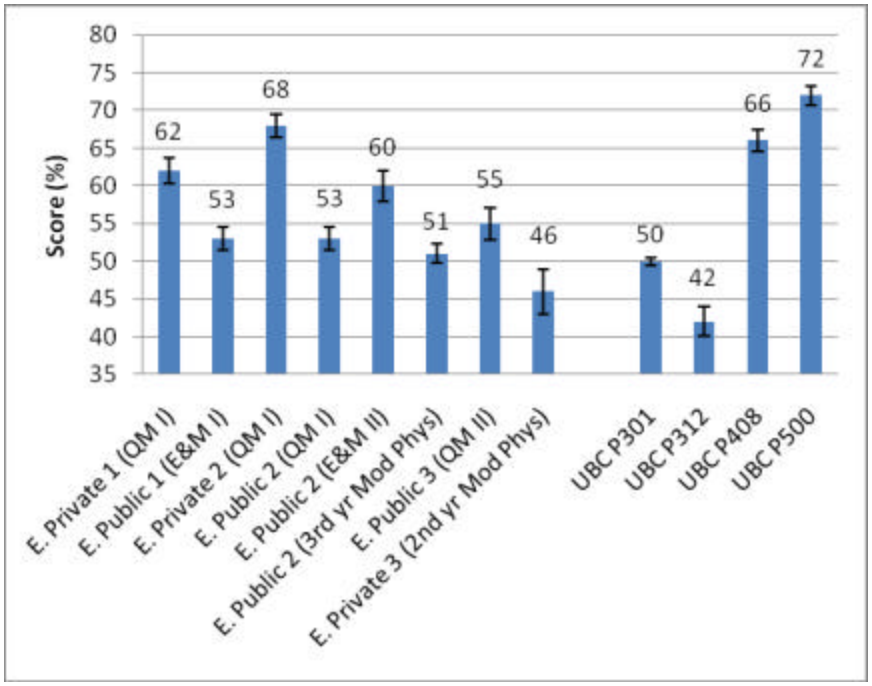

Fig 2: Histogram showing the average scores on the upper level diagnostics in different courses at various institutions. Again, "E. Private" and "E. Public" stand for Elite Private University and Elite Public University, respectively.

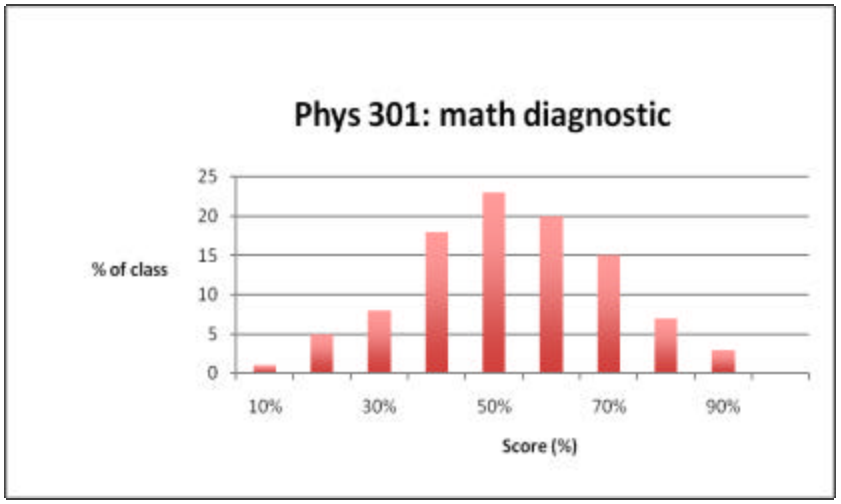

Fig 3: Histogram showing the distribution of scores on the upper level math diagnostic in our large 120 students 3rd year Electricity and Magnetism course (Phys301). The course is populated with physics majors, physics honours, and engineering physics students.

Scores on these diagnostics are often highly correlated with the students' exam performance. Most students appear to enjoy testing themselves taking these diagnostics and are often quite surprised at the weaknesses in their math background the tests reveal.

Of course, the diagnostics can be used not only to compare students from different universities, but also to learn more about each group. For example, while many physics instructors may feel that there is a bi-modal distribution of math abilities amongst our students, the Phys301 histogram reveals that this is not the case, at least for that large group of 120 third year students.

Collecting and analysing such information is one way to understand what our students learn and retain as they progress through their degrees. Also, this will enable us to track some of the effects of the various changes that are now being implemented in various courses, in order to make sure that they result in overall improvements.