FIRST YEAR FLUIDS – ENCOURAGING STUDENT ENGAGEMENT WHEN THE CLASS SIZE IS LARGE

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Abstract: Over the last six years, the authors have been responsible for a first year fluids course given to aerospace, civil and mechanical engineering students. The University had decided that these students should be taught as a single group for core first year courses and the class size has been around 230 each year. This paper aims to show how the teaching methodology was applied to the challenge of a large class and how student engagement was promoted.

There were normally two hours of lectures and one hour of tutorial each week for 12 weeks. The lecture style involved formal teaching interspersed with active learning elements, for example a short question/puzzle for the students to consider. The class was divided into small groups of about 25 – 30 students for tutorials; these ran simultaneously. A 10-minute test was held at the end of each tutorial during weeks 3 – 11. Each test contained five questions based on the previous week's lecture material and the marks contributed towards 20% of the course mark. It was a condition for passing the course that a student must pass at least six of the nine tutorial tests. Thus, the assessment was designed to encourage and maintain student involvement with the course. Each student also had to participate in three laboratory classes – these practical aspects supplemented the lecture material.

It is believed that the teaching was successful and the assessment strategy had the desired effect. Lecture attendance was good and student feedback confirmed the weekly tests were useful.

Keywords: first year, large class, assessment, fluids.

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1. INTRODUCTION

About seven years ago, the University decided that first year aerospace, civil and mechanical engineering students should be taught as a single group for core subjects (maths, fluids, solids and structures) in order to make more efficient use of staff time. Prior to that, the three groups of students were generally taught separately.

The authors were given responsibility for the fluids course and have continued to oversee it throughout the last six years. The class size has been around 230 each year. This paper aims to show how the challenges associated with teaching a large class were overcome and how student engagement was encouraged.

2. COURSE STRUCTURE

There were normally two hours of lectures and one hour of tutorial each week for 12 weeks. A formal teaching style was generally employed in lectures with effort made to present the material clearly and in a logical manner. While the course content (fluid properties; fluid statics – pressure, forces and moments, buoyancy; fluid flow – categories, continuity, Bernoulli and momentum equations) is relevant to all three groups of students, it was important to use a variety of examples and applications to maintain interest across the class.

Attempts were made to intersperse the teaching with active learning elements to promote thinking and learning during the lecture. The students would be given a few minutes to do a short calculation or consider a question or puzzle, for example, finding how deep a diver can be before the pressure on the body has doubled, considering whether walls of different thickness need different levels of formwork support just after the concrete has been poured. Students are often reticent to ask questions or give answers in front of a large class so the questions were often put in multiple choice format and a show of hands requested for each possible answer. Alternatively, the lecturer walked around the room and took a sample of answers from individual students. It is important that lecturers are approachable and it is believed that interactive efforts made in lectures will encourage future engagement.

The class was divided into eight or nine small groups of about 25 – 30 students for tutorials, which occurred simultaneously. Each tutorial class was led by a postgraduate student although the two lecturers aimed to visit all the classes each week, spending about 15 minutes in each. Students were expected to work through questions based on that week's lecture material. Solutions to tutorial questions were made available on Queen's Online (the University's intranet) the day after the class to enable students to complete questions and revise for subsequent tests. Greater student engagement is expected, and did happen, in the tutorials. The group sizes were relatively small and the setting was more informal than the lecture. The postgraduate leader was encouraged to speak to students individually regarding their work and get to know the students by name.

Each student had to participate in three laboratory classes, each of duration 1.5 hours, which supplemented the lecture material on fluid statics, laminar and turbulent flows, and flow rate measurement. The lab classes involved a combination of demonstration and student practice followed by analysis of the data recorded. Timetabling challenges arose due to the large class size. There were typically 44 student groups (5 – 6 students per group on average) and it was aimed to schedule each group's lab classes at a stage during the semester to correspond roughly with the associated lecture material. Recording of student attendance and results (pass/fail) was made more efficient by using Sharepoint. The postgraduate students responsible for the lab

classes were expected to enter the data on Sharepoint soon after the classes while keeping a paper copy for backup.

3. ASSESSMENT

A 2-hour exam at the end of the course contributed towards 80% of the overall mark. The first part (40%) of the exam consisted of 20 multiple choice questions – it was necessary to introduce this format to reduce the time involved in marking. For the rest of the exam, students were able to choose three out of five longer, structured questions worth 20% each.

No marks were available for the laboratory element. All work associated with each lab class was expected to be completed within the 1.5-hour session and no submission of work was required. It was desired to keep this aspect of the assessment simple. However, it was a condition for passing the course that a student must attend and participate in all three lab classes. Therefore, only the result (pass/fail/absent) was recorded at the end of each lab class.

The main impetus in promoting student engagement occurred through the system of continuous assessment. A 10-minute test was held at the end of each tutorial in weeks 3 – 11. Each test contained five questions based on the previous week's lecture material and the marks from all nine tests counted towards 20% of the overall mark for the course. It was a condition for passing the course that a student must pass at least six of the nine tutorial tests. Thus, the assessment was designed to encourage and maintain student involvement with the course.

The tutorial tests were also designed for efficient marking. Some questions were of multiple choice format (testing knowledge of definitions, for example) and others involved calculations. Each answer was simply marked right (1 mark) or wrong (zero marks) and no marks were given for method. The pass mark for each test was 2 (out of 5).

It was aimed to give students quick feedback on their tests. The marks were published on Queen's Online within a few days of the test. Students could therefore view the accumulation of marks as the semester progressed and count the number of tests passed. Students had the opportunity of receiving more detailed feedback by speaking to their tutorial class leader (who marked the tests for his/her class) and seeing their marked test.

The condition of passing at least six tests in order to pass the course opens the possibility of a student failing the course by week 6. This could have a negative effect on their engagement. This was countered with the incentive that if the student performed well enough to gain at least 40% overall (through tutorial tests and exam), then they did not have to resit the exam but only sufficient tutorial tests to bring them up to six passes. If a student failed the continuous assessment element at an early stage, and subsequently lost interest in the course, achieving below 40% overall, they were asked to resit the exam, a less appealing scenario.

4. LECTURERS' OBSERVATIONS

The assessment strategy certainly had the desired effect of encouraging student engagement with the course. The condition of passing at least six tests meant that frequent absence from tutorials was not a realistic option. Figure 1 shows the tutorial attendance rate in the weeks when tests were held. The data represent mean values for the classes in 2007, 2008 and 2009.

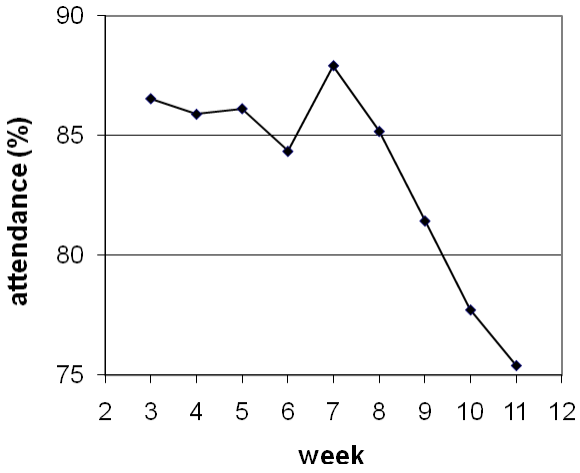

Figure 1: Attendance rate at tutorials during weeks 3 – 11 of the semester.

Attendance didn't reach 100% – some students couldn't attend every week due to extenuating circumstances while a few others (about 6% of the total) were registered but didn't appear for either tests or the final exam. Attendance dropped towards the end of the semester – some probably felt they needn't attend after attaining the required six passes even though the marks from all nine tests counted towards the overall mark for the course.

It is believed that studying and learning, and not just attendance, were promoted. The test questions were such that passing a test would be difficult without having read over the lecture notes and attempted some tutorial questions. Figure 2 shows that only 44% of the class had achieved the necessary six passes at the earliest possible stage. Again, these figures are mean values for the classes in 2007, 2008 and 2009.

Around 17% of the class didn't pass the continuous assessment element. It is noted that this includes some who were registered at the beginning of the course but who probably withdrew during the semester. About 32% of the class passed all nine tests.

The third test was particularly challenging with approximately only 63% of the class passing it. This was not planned but the lecturers subsequently felt that this result, coming at an early stage in the process, would motivate students to work.

The competitive nature of the assessment probably was beneficial and motivational also. Students would compare their results with each other and there was always the personal target of achieving 5/5 or improving on previous weeks' results.

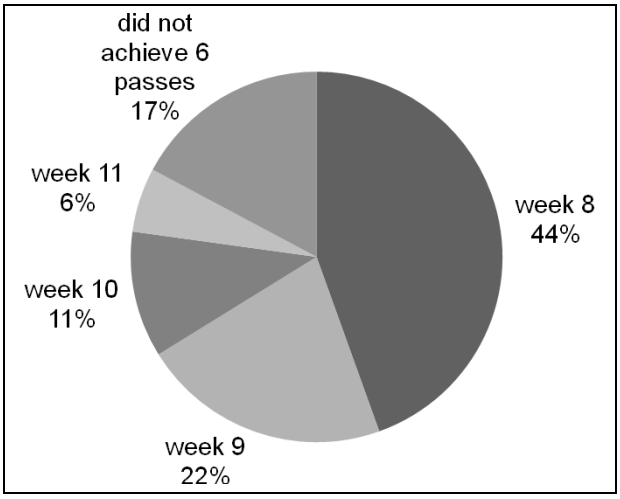

Figure 2: Chart showing proportions of the class and the stage during the semester at which they achieved six passes.

Attendance at lectures was relatively good. There is little data available but records for 2006 indicate an average attendance of about 70% over the semester. (This data includes students registered at the beginning of the course but who probably withdrew before the end.) It is unclear whether the interactive elements of the lectures or the pressure to pass enough tutorial tests had significant effects on lecture attendance.

5. STUDENT COMMENTS

A selection of comments made by students on the end of course questionnaires is presented below. This shows that while continuous assessment was not universally popular, students recognised its relevance to their learning and progress.

"Class tests were useful in making you work and learn throughout the year and helped understanding."
"Constant tests were somewhat tiring."
"The idea of tests each week was very beneficial."
"The most useful tutorial structure of any module so far. I feel more prepared for exam through use of the tutorial material than for any other module."
"Weekly tests keep you on top of things."
"Frequent tests good to encourage revision."
"Continuous testing/assessment helped with learning."
"As annoying as the weekly tests are, I feel that I now understand this course better than any other."
"Class tests – good for promoting continuous learning."
"Well set out notes and good interaction."
"Class tests – provided motivation to revise consistently."
"Thought weekly tests were effective and allowed me to see my progress."

The sample of questionnaire scores (Table 1) also shows some success in encouraging student involvement with the course.

Question	Score (Fluids)	Average score (all first year courses)
Encouraged student participation when appropriate	4.4	3.6
Made me feel that my contribution to class was valued	4.0	3.4
Showed interest in my progress at tutorials etc.	4.3	3.5
Set achievable objectives for coursework/assignments/projects	4.5	4.1
The module was well organised	4.8	4.1

Table 1: Questionnaire scores for mechanical engineering students in 2004. (5 represents "strongly agree", 3 represents "neutral", 1 represents "strongly disagree")

6. CONCLUSIONS

The authors have been responsible for a first year fluids course given to aerospace, civil and mechanical engineering students and have implemented a teaching methodology to cater for class sizes of about 230 students.

While a formal teaching style dominates the lectures, some interactive elements have been included to encourage student participation. For tutorials, the class was divided into smaller groups of about 25 – 30 students. Continuous assessment was performed by a 10-minute test held at the end of each tutorial in weeks 3 – 11. A condition for passing the course was that a student must pass at least six of the nine tutorial tests. This assessment strategy had the desired effect of maintaining student involvement with the course over the semester. The laboratory element was kept simple. All work associated with each lab was expected to be completed within the session and the result was simply recorded as pass/fail/absent.

A very large effort was required in setting up this course. At the start of subsequent years, there was much work in generating spreadsheets to record test and lab marks. Excellent organisation and a well structured plan for the course (tutorial questions and tests following a step behind the lecture material, tutorial solutions going online each week) have been very important. A large team of willing postgraduate helpers for tutorial and lab classes has been vital. Encouraging interaction within lectures has required effort.

Student feedback showed they appreciated the weekly tests, recognising that their learning was being enhanced. It is believed that, despite the large class size, there was some success in promoting student engagement with, and enjoyment of, the course.