

Contemporary service course students: Who are they?

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Introduction

It's unusual for a physics course to have large enrolment increases in recent years. However, in The Physical Basis of Biological Systems - a service course for students with interests in the biomedical and life sciences - total annual enrolment has more than doubled over the period 2000 – 2005. At the same time there has been a surge of academic interest in biology and biological physics (note the recent cover story of *Physics Today* by Goldstein, Nelson and Powers (2005)). This could have contributed to increasing student numbers, and could mean a different type of student is enrolling in physics. Changing academic advice to students, and changing requirements to enter some in-demand degrees, may also be affecting enrolments. In this environment, with the increasing diversity of students at university a common theme, the aim to provide appropriate learning experiences prompts the question: 'Who are these students?' This is important because as Sharma, Mills, Mendez and Pollard ((ed) 2005) note,

In order to teach more effectively, we need to have a clear understanding of who our students are, what motivates them to study physics, ... their backgrounds and ... their plans.

This study investigates the composition of the audience for this course and how the students are coping, in order to inform future course development.

The course is offered at first-year level. It consists of lectures (delivered to hundreds of students), small-group tutorials and laboratory activities, with support from a course website. It is offered twice per year, with some variation in course material according to the different student audiences expected historically. Major client groups have been students aiming to enter Medicine and Dentistry (in Semester I), and those enrolled in Human Movement Studies (Semester II).

Findings reported below draw on several sources of information - enrolment data, student surveys, and assessment results over recent years. Student types have been investigated according to their ambitions for university coursework and future careers, background - outside exposure to physics, cultural influences, including gender, and their hopes and expectations for the course.

Findings

Study plans and performance

The variety of degrees in which students of this course over the most recent four semesters have been enrolled is shown in Figure 1. There are large numbers for Human Movement Studies, as expected, and also in the Bachelor of Science; some of these have declared an interest in a biological study plan. However a significant number of students are not involved in these core degrees. Small numbers are doing other Applied Science degrees, Bachelor of Arts, Bachelor of Biotechnology and Bachelor of Engineering. There is a smattering of other science-related degrees, such as Bachelor of Marine Studies and Bachelor of Pharmacy, and also other apparently unrelated degrees such as Bachelor of Business Management. The Special enrolment category includes overseas exchange students.

Figure 1 displays the final grades awarded for the course, according to the degrees in which students were enrolled. (Range of grades is 1-7, 7 being best). The distributions consistently show that levels



of achievement differ between student groups defined by study plan. Most noticeable is that the grades of Human Movement students tend to be distinctly less than Science degree students. Arts and non-science students have limited achievement. Biotechnology, Engineering and science double-degree students, who could be expected to have exposure to aspects of the physical sciences outside this course, all tend to perform at least moderately well.

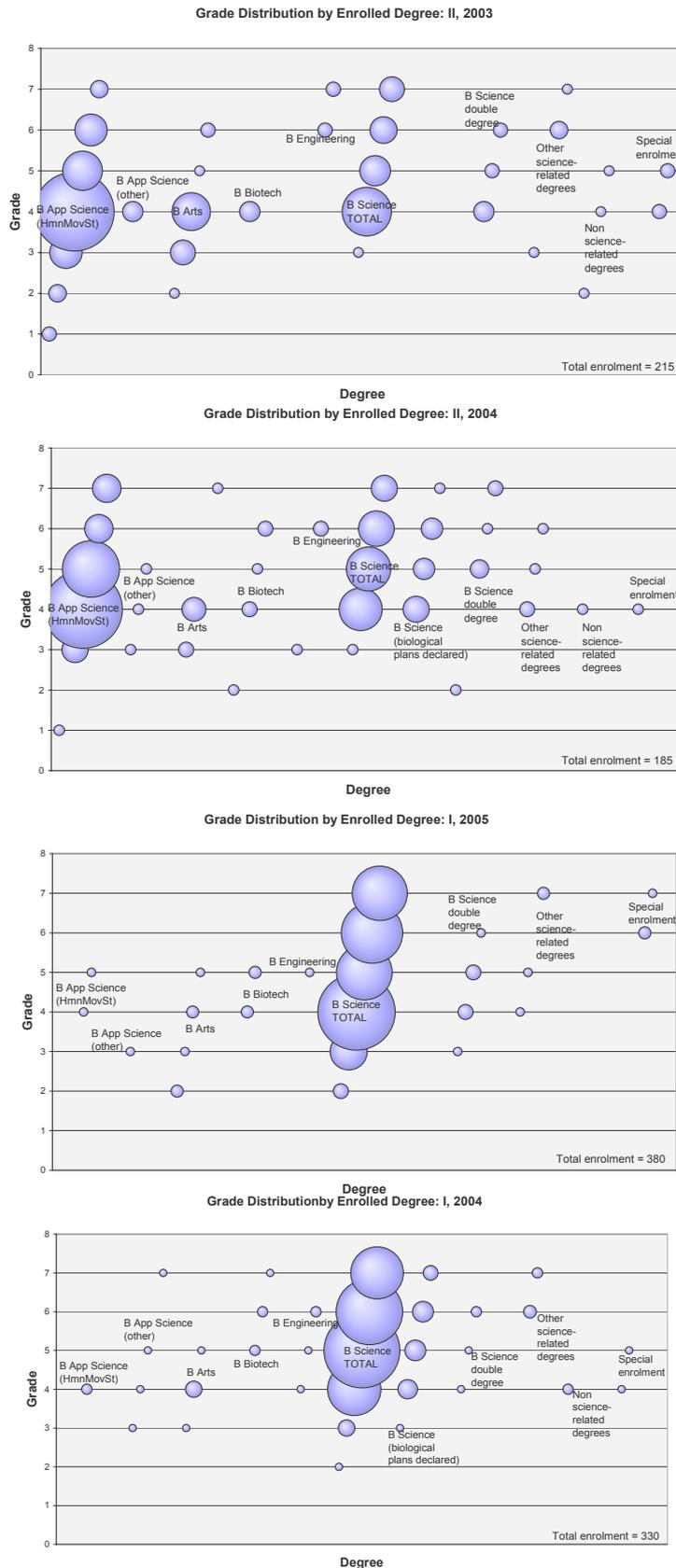


Figure 1. Distributions of students' study plans and grades awarded for The Physical Basis of Biological Systems. In each plot, bubble size is proportional to number of students.

Hopes and expectations

After identifying their study plans, survey respondents were asked to answer an open-ended question ‘What do you hope to get out of this course?’ Responses ranged from the idealistic to the pragmatic. Overwhelming themes were: knowledge/skills, entry to another degree, and marks.

Numbers of students explicitly wanted knowledge of physics applied to their area of interest; equally they emphasised they were looking for a basic understanding of physics. Some individuals were treating this course as revision, and as a way to develop skills such as problem-solving, analytical thinking, mathematical and laboratory proficiency. Nominated courses for upgrade were Medicine and Dentistry (both postgraduate), Pharmacy, Veterinary Science and Science (from Arts). Comments about marks fell into two groups, characterised by ‘a 7’ and ‘a passing grade ... and that’s about it’. The course is being used as a ‘GPA (*Grade Point Average*) boost’ by some students. Entry to Medicine and Dentistry is very competitive, and attracts high achievers; students aspiring to these courses are generally enrolled in the BSc (with a biological plan). From the data above, we can see that when a biological interest is declared, these students perform at least as well as the average science student. Interestingly, students aiming at entry to a medical degree showed an appreciation that the knowledge and skills they gained from this course would help them in their future studies. In contrast, the survey shows that Human Movement students commonly just want to pass this course, which is compulsory for their degree. As well as being less motivated, they appear to be less confident. A minor theme was that students were hoping for enjoyment!

Previous experience and cultural influences:

Gender

For this course, numbers of male and female students have been roughly equal for at least the four most recent semesters. This compares well with the figure of 40% quoted by Sharma, Mills, Mendez and Pollard (2005) for the Australia-wide fraction of university science students who are female. The spread of final grades by gender is shown in Figure 2. Since gender information was via name, unfamiliarity prevented a determination for some cases. It appears that females are more likely to get a 5 than males but may be under-represented in the grade of 7. In each of the most recent four semesters, the distribution of grades for females was clumped, and more skewed than for males. The male distribution was sometimes bimodal, dipping between pass marks and high achievement.

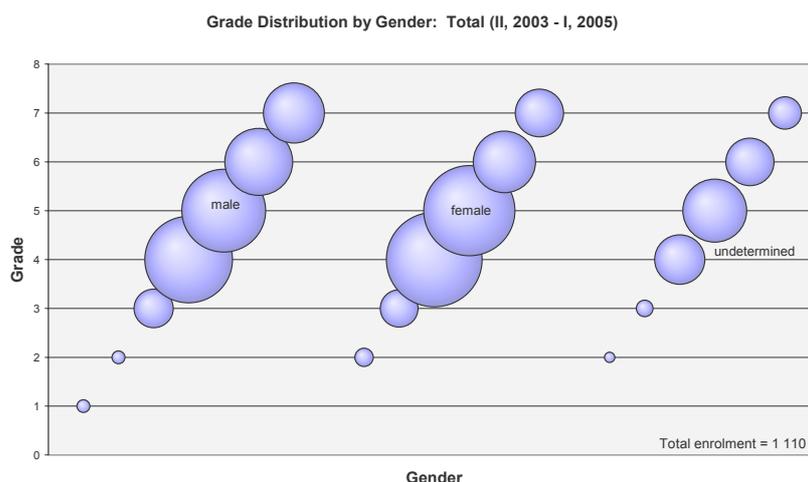


Figure 2. Comparison of grades awarded with students’ gender.

Background knowledge

The survey queried students’ backgrounds, with limited answer options. To check the amount of prior experience that might support students in this course, representative student groups in the diverse population of Semester II, 2004 were investigated. Figure 3 shows increasing depth of preparation



along the vertical axis. Levels of previous exposure to physics and maths are consistent with the achievement levels noted above.

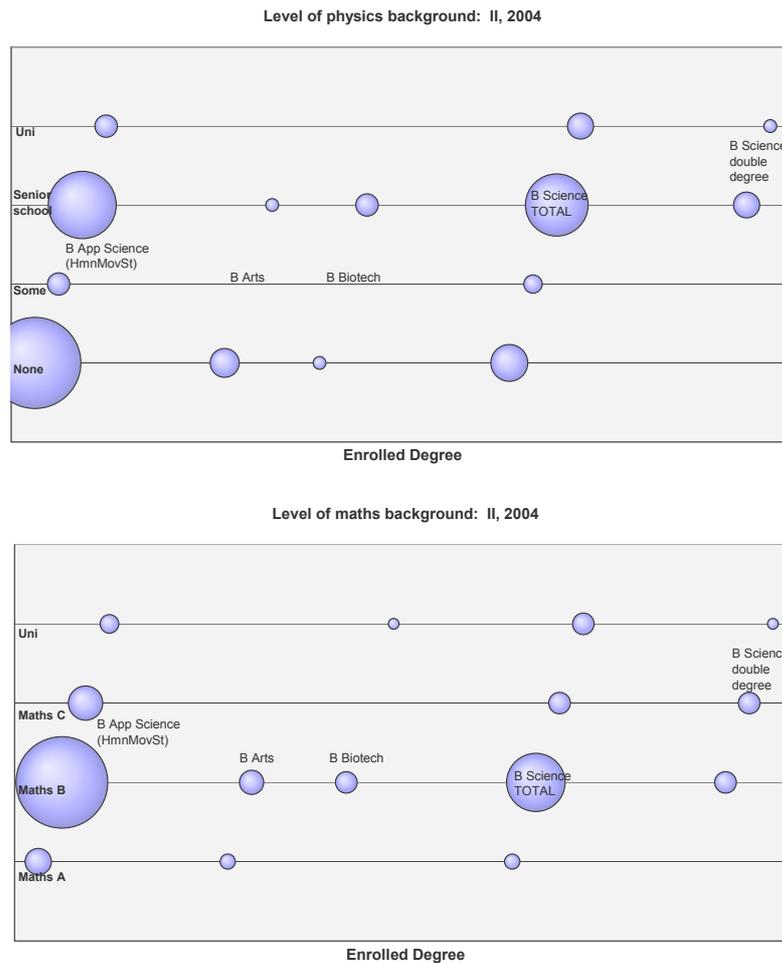


Figure 3. Comparison of students' background knowledge with enrolled degree.

Geography

Almost half of the students went to secondary school in the city of Brisbane in which the university campus is located. About another third attended within the state of Queensland. Other regions of Australia supplied a minimal number of students. Students who were schooled in another country made up about 10% of the course population. This data implies a greater-than-expected homogeneity in the education system experienced by students of this course before university.

Conceptual understanding

On final surveys, students show reasonable satisfaction with the course, giving ratings of 3.2 – 3.8 (maximum score = 5) over the period 2000-2005.

The understanding of these students of the fundamental concept of forces acting on a falling body, a well-known difficulty, has been probed by examining their responses to a multiple-choice quiz:

Drying of seedpods in some plants causes the seeds to be 'fired' into the air. When each seed is at the top of its trajectory, which of the following statements about the nett force acting on it is true? (Ignore air resistance.)

- A. Nett force acts vertically downwards.
- B. Nett force is directed upwards.
- C. Nett force changes direction at this instant.
- D. Nett force is zero.

Answer option	Student choice (entire class)	Student choice (upper quartile)	Student choice (lower quartile)
A	41 (23%)	25 (14%)	4 (2%)
B	2 (1%)	1 (0.01%)	0 (0%)
C	14 (8%)	2 (0.01%)	4 (2%)
D	119 (68%)	16 (9%)	36 (20%)

Statistical analysis: UQ Information Technology Services.

This question adapts a topic from the seminal Mechanics Diagnostic Test (Halloun and Hestenes 1985), to a biological context. To answer correctly (A), students need to identify the gravitational force as the only force acting on a seed, and recognise that its weight is unchanging throughout the motion. The right answer was the most common choice of the top students in the class. The only other option significantly considered by the highest-achieving students, D, was the most popular choice of the lowest achievers, and of the class overall. A donkey vote would improve the apparent performance of the class. The fact that students had to read past the right answer to pick either option C or D implies that they did think about the physical situation of the seed - momentarily stationary - but wrongly. An 'impetus theory of motion', the idea that motion implies a force in the same direction, is held by 75% of students beginning calculus-based physics according to Knight (2002 p95). Clement (1982) claims that at best, 30% of students have correct understanding of force acting on a projectile (after a calculus-based physics course). Therefore students in this course have misconceptions similar to other students worldwide in the research literature.

Discussion

Combining information from several sources has yielded insight into the contemporary student in a first-year university physics service course. A range of student types have been identified and quantified. A student in this course is just as likely to be female as male, probably had a similar secondary schooling experience to his/her classmates, and has conceptual difficulties in common with physics students around the world. Student performance is correlated with student type defined by degree, prior knowledge and gender. The course constituency varies widely, but is dominated by two groups (upgraders and Human Movement Studies) with disparate career plans that affect their drive to learn. Upgraders are strongly motivated by marks and some of them are aware of the importance of the course content for their futures. With regard to students less likely to achieve at high levels, the question arises as to how much is due to being handicapped by less physics/math background, and how much to being less likely to aim at high-level performance? For these students, a better course experience will relate to hoped-for outcomes other than high marks. Physics knowledge relevant to their areas of interest, and skill development, were suggested by the students' input. The first of these strategies is widely acknowledged as increasing student engagement. The implication is that gains can be made in the course by increased emphasis on using and developing basic physics skills, particularly in applied physics scenarios.

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