Do students' experiences of a service subject correspond to their expectations?

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Abstract*: What impact does a single semester of physics have on students destined to major in disciplines other than physics? As part of a national study, supported by funding from the Australian Learning and Teaching Council (ALTC), we have trialled an instrument designed to uncover expectations and experiences of non-physics majors enrolled in a first year physics subject. The trial surveyed bio/medical science majors at a large metropolitan university. We were particularly interested in student views of the value of physics to their major area of study and whether those views were transformed over the course of the semester. Analysis of data obtained indicates that student perceptions of the value of physics are positive and change little over the semester in which they do the subject. However some experiences, such as the laboratory work they undertake, elicited some robust responses from students. The paper discusses the findings of the trial survey, which are related to a broader study on indicators of good practice on the teaching of physics to non-physics majors. The broadening of this study to include physics subjects in which non-physics majors are enrolled at 22 Australian universities is briefly described.*

Introduction

The work reported here is part of a larger project funded by the ALTC as part of the Discipline Based Initiatives program. The project entitled *Forging New Directions in Physics Education at Australian Universities* is national in scope and encompasses physics academics from 26 Australian universities. One strand of the project aims to clarify, identify and promote good practice in physics service teaching (Kirkup, Scott and Sharma 2007) and is the focus of this paper.

Ehrlich (2002) offers a familiar stereotype of students forced to enrol in a physics subject to satisfy course requirements:

> Starting with [the] initial student perspective [that students are taking physics only to fulfil a requirement] only an extremely skilled instructor might be able to get the majority of his/her students to see the intrinsic beauty [of physics], and not merely a hurdle to get over.

The position is adopted that only an extraordinary instructor will be able to turn such students on to physics. The sense is that students are taking physics 'under sufferance' – but how valid is this stereotype of the uninterested and poorly engaged student and in what ways (if any) are student perceptions of the relevance and worth of physics changed by their experiences of the first (and in many cases only) physics subject they undertake at University?

Dissatisfaction with subjects delivered to students taking service subjects can be traced back many decades in papers and 'opinion pieces' (Caswell 1934; Lapp 1940) and owing to the fact that such subjects are delivered largely to first year students, are implicated in student attrition (Pitkethly and Prosser 2001).

As academics, we devote significant human and physical resources to non-physics majors, upon who depends (in many cases) the financial viability of our departments (Pollard et al. 2006). It is sensible to investigate the expectations of non-physics majors as they enter our subjects and the extent to which their experiences align with the expectations. A potential outcome of such a study, when carried out locally or nationally, is to offer direction to curriculum reform of service subjects. Another driver of this work is the identification of good practice in the teaching of physics to non-physics majors, allowing for the promotion, dissemination and adoption of such practice nationally.

Methodology

Table 1. Survey A (expectations) and Survey B (experiences) questions. Where questions have been modified as a result of review, the revised questions (for survey administration during 2008) are shown highlighted in parentheses.

	Survey A	Survey B
Q1	It is apparent to me that this subject is a valuable part of my degree.	It is apparent to me that this subject is a valuable part of my degree.
Q2	Only unusually able people are capable of understanding physical principles in science. (Only people with an extraordinary ability are capable of understanding physics).	Only unusually able people are capable of understanding physical principles in science. (Only people with an extraordinary ability are capable of understanding physics).
Q3	I am keen to see how this subject links to my major area of study.	I am able to appreciate the links between this subject and my major area of study.
Q4	I am anxious about studying this subject this semester (I believe an understanding of physics will benefit my studies in other areas of my degree).	I am anxious about my upcoming exam in this subject. (I believe an understanding of physics will benefit my studies in other areas of my degree).
Q5	I am confident that my mathematics background is sufficient for me to be successful in this subject.	I believe my mathematics background was sufficient for me to be successful in this subject.
Q6	If offered, I would take advantage of extra maths support that was directly related to the maths in this subject. (I expect to do well in class tests in this subject).	My achievements in class tests in this subject exceeded my expectations.
Q7	I am looking forward to doing labs in this subject.	I enjoyed the labs in this subject. (The labs in this subject were a positive learning experience).
Q8	If it were possible, I would have avoided taking this subject.	I would advise others to avoid taking this subject if at all possible.
Q9	I expect the links between this subject and my major area of study to be made obvious throughout the semester.	The lecturers succeeded in linking this subject to my major area of study.
Q10	I expect to have to work harder in this subject than in my other subjects this semester.	I worked harder in this subject than for my other subjects this semester.
Q11	What final grade are you aiming for in this subject?	What final grade are you aiming for in this subject?
Q12	Did you study physics to year 12 at school?	Did you study physics to year 12 at school?
Q13	*Open-ended question:* Please describe briefly any particular expectations you have as you begin your study in this subject.	*Open-ended question:* Please describe briefly your experience of this subject, and in particular what you think might be done to improve the subject.

Surveys

Two short student surveys were designed for the project: survey A to be administered in week 1 or 2 of semester and survey B at the end of the semester, but before the examination period. The surveys were deliberately brief as students are faced with a plethora of surveys every semester and ‘survey fatigue’ is a common complaint of students.

Survey A examines a range of expectations held by students about physics and the subject they are about to commence. Survey B consists of identical, or complementary, questions. Surveys A and B are given in Table 1. Several questions are designed to draw out whether students expect the relevance of physics to their major area of study to be manifest and whether having reached the end of the subject, that expectation was realised (see questions 1, 3, 4 and 9).

Questions 1 to 10 use the standard 5-point Likert scale, where the multiple choice responses range from *strongly disagree* to *strongly agree*, with *neutral* in the centre. Question 11 is also multiple choice, with the following response categories: *don't know*, *pass*, *credit*, *distinction* and *high distinction*.

Subject surveyed

Data were gathered in the second semester of 2007 at a large metropolitan Australian university, for the purpose of trialling questions before administering the survey nationally in 2008. The physics subject chosen was populated by non-physics majors drawn from the biological/medical sciences, half of whom had not completed Year 12 physics. The subject consisted of 3.5 hours of lectures/tutorial and 2.5 hours of laboratory time per week. The laboratory and lecture material were in-step and all the students did the same experiment at the same time. About 150 anonymous responses (from a class of 170 students) were obtained for each of surveys A and B, with subsequent analysis of the data resulting in a number of questions being either reworded, significantly modified or replaced with others (see Table 1).

Results and discussion

Multiple choice questions

After assigning a number to each of the response categories on the Likert scale (*strongly disagree* = 1, *disagree* = 2, *neutral* = 3, *agree* = 4 and *strongly agree* = 5), the mean expectations scores (survey A) and experiences scores (survey B) were calculated for each of the first ten multiple choice survey questions. The majority of questions were worded in such a way that higher scores correlated with positive expectations or experiences of the subject. The mean expectations score was subtracted from the mean experiences score on matching questions in surveys A and B. A positive difference indicates that the students' experiences exceeded their expectation and a negative difference indicating the converse; a value close to zero suggests that experiences closely matched expectations. Figure 1 shows the questions ranked in order of positive to negative change.

Questions 2 and 8 were exceptions to the rule, as a 'good experience' of the subject would be anticipated to elicit negative responses. In order to be able to rank these two questions on the same scale the experiences score was subtracted from the expectations score for both. Questions 4 and 6 were omitted from this analysis as the links between corresponding questions in surveys A and B were absent or tenuous. They appear in revised form in the 2008 surveys.

In order to establish whether any of the differences were statistically significant a t-test was performed on matching expectations and experiences questions. We used a two-tailed, two sample equal variance distribution in performing the t-test and the results are presented in Table 2. The t-test revealed that the large differences associated with questions 3, 5, 7 and 10 are statistically significant ($p < 0.05$).

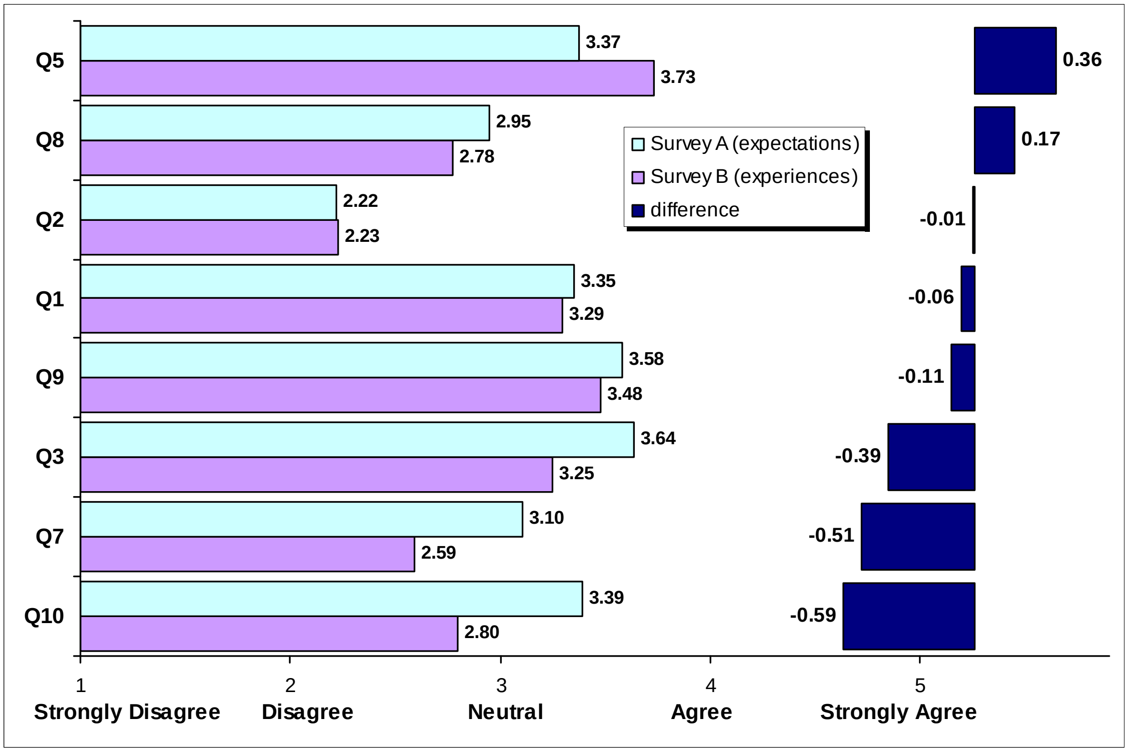

Figure 1. Mean expectation (survey A) and experience (survey B) scores for the 2007 trial survey responses ranked by the differences. Note that calculation of the Q2 and Q8 differences are reversed (explanation in text).

Table 2. Statistical analysis of differences between expectations and experiences means (for individual survey questions).

	Q1	Q2	Q3	Q5	Q7	Q8	Q9	Q10
p	0.58	0.88	<0.05	<0.05	<0.05	0.23	0.37	<0.05

We note that questions 1, 2, 8 and 9 showed no statistically significant difference between surveys A and B, denoting that experiences were a good match to expectations. We do not focus on questions that produced non-significant change in this paper, but we make the point that, in general, non-significant differences are worthy of consideration. For example, a low score on corresponding questions in surveys A and B would be a matter requiring exploration, i.e. absolute values for responses may be as important as, or more important than, changes that occur over a semester.

Question 5, *I am confident that my mathematics background is sufficient for me to be successful in this subject*, was the only one for which experiences significantly exceeded expectations. The responses at the beginning of semester suggested students were unsure of this statement (indicated by a mean score of 3.37 which is close to the neutral value of 3) but by the end of semester they were much closer (mean = 3.73) to agreeing with the statement. We conjecture that students were concerned that a physics subject would require an amount of fluency with mathematics that they did not possess, but that experience of the subject showed them that their mathematical abilities were adequate for the purposes of satisfying the requirements of the subject.

The three questions in which experiences were significantly less than expectations were 3 (seeing clear links), 7 (enjoying the laboratory) and 10 (work harder than in other subjects). Although question 10 might be useful for gauging student perceptions of the effort expended in this subject, relative to other subjects s/he is taking, there is no clear-cut preference (from our point of view) for either a positive or negative change. Do we want them to have to work harder? The other two questions can shed some light on areas requiring further examination. In particular, the responses concerning the laboratory suggest that reform of the laboratory program or its implementation be considered. Students went from feeling neutral about the laboratory component at the start of semester (mean = 3.10) to rather negative about it by the end (mean = 2.59).

Question 11 revealed that the students had ambitious aims with respect to their final grade in the subject, with almost 60% declaring that they were aiming for the grade of distinction or high distinction, as shown in figure 2. (Note that *Fail* was not an option in the multiple choice response set). As the examinations approached the declared aims became better aligned with the grades historically obtained by students in this subject.

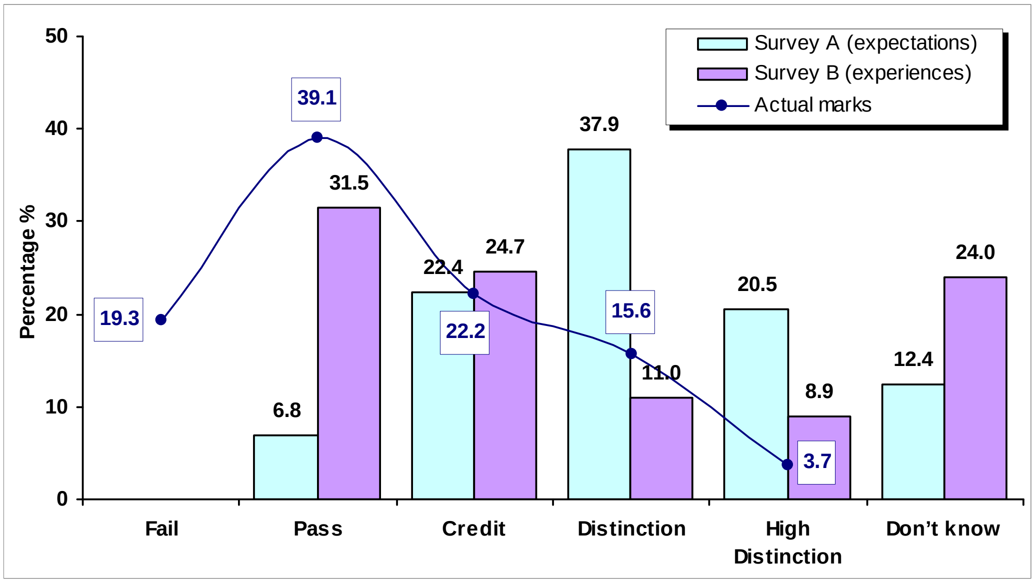

Figure 2. Grades aimed for (as stated by students) at the start and end of semester contrasted against actual grades

Open-ended question

The last question on surveys A and B was open-ended and sought to qualitatively measure the expectations and experiences (respectively) of students taking the subject. About half the survey participants responded to this question. The most common expectations and experiences that emerged are given in Table 3.

Table 3. Dominant student expectations and experiences. Number in brackets denotes number of responses citing each.

Expectations	**Experiences**
1. The subject should be made interesting. (**6**)	1. Concerns relating to the provision of laboratory experiences. (**22**)
2. The subject will be challenging and difficult. (**6**)	2. The lectures/lecturers were interesting. (**15**)
3. Shouldn't have to stay until end of lab session as already have a full timetable. (**6**)	3. Should provide more worked examples as well as working solutions to the resource book. (**8**)
4. Should be able to see links with major area of study. (**5**)	4. There were a number of class tests issues. (**7**)
5. The subject will require a lot of maths and calculations. (**5**)	5. The subject was challenging and difficult. (**4**)
6. I will learn new things. (**5**)	6. There should be more links made between labs to lectures and/or theory. (**3**)

The open-ended responses support a number of the observations that emerged in the mean score differences shown in Figure 1. The experiences section strongly affirms student frustration with the laboratory component of the subject. Moreover it provides quite specific information, detailing student concerns with the design and implementation of the laboratory program. More encouragingly however, the second most popular response category (in the experiences section) details a positive attitude towards both the lectures and the lecturers.

Conclusion

To what extent do students' experiences of a service subject correspond to their expectations? In this paper we have reported the development, trialling and modification of a survey designed to shed light on this issue. The surveys were designed specifically with matters relating to students not majoring in physics in mind. We believe that the questions posed on surveys A and B could be used with minor modification by other disciplines for whom service teaching is major responsibility (e.g. mathematics and chemistry). The survey was valuable in teasing out areas of particular concern. In the first trial of the surveys it was apparent that students were neutral or positively disposed toward laboratories on entering the subject, but that their experiences fell short of their expectations. The open-ended responses gave substance to the issues of most concern and should form the basis of more detailed considerations.

As a discipline we are keen to explore service teaching issues that have national traction and this instrument has the potential for uncovering national 'themes'. A question we might ask, prompted by the current study, is 'to what extent are laboratory physics experiences for non-physics majors a national issue?' At the time of writing (first semester 2008) we are rolling out the revised survey to a total of over 4000 students enrolled in 35 subjects in 22 universities around Australia who are delivering first year physics subjects to non-physics majors. As well as isolating areas of concern, we hope to assess the value of the surveys for identifying subjects that have been particularly successful at exceeding students' expectations of a physics service subject.

Acknowledgements

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