Impact of Running First Year and Final Year Electronics Laboratory Classes in Parallel

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Abstract*: First electronics courses are considered difficult by students because of the circuit theory content, and retention of students in electronics is a problem worldwide. Retention is especially problematic at universities that offer a common first-year program since the students can change streams, for example from Electrical to Mechanical. At our university we ran the laboratory classes for a challenging first-year electronics course in the same room at the same time as a popular final-year mechatronics class that involved visible use of Lego Mindstorms, a model elevator, digital model trains and slot cars, etc. We report the outcomes of a quantitative and qualitative study of the impact of this organisation. One lab stream did not see the parallel classes and thus acted as a control group.*

Introduction

Initial accounting courses are widely anticipated by students to be boring and arithmetic in nature. Lecturers are at pains to maintain student enthusiasm, and to ensure that the students realise as soon as possible that, once the book keeping is done, the subject of accounting requires insightful interpretation to assess the financial state of a business (McGuigan & Weil, 2010, Lucas, 2000). McGuigan & Weil (2010) assert that students really only progress once this threshold barrier is crossed. The reverse situation appears to be the case in teaching electronics: Students commence their studies anticipating that they will momentarily be constructing music players and learning how a cellphone works, but hit a wall of disappointment when they encounter circuit theory and must struggle with mathematics governing how invisible electrons circulate around a handful of barely-visible components before they can design anything interesting. The upshot of this is that they become discouraged and are less likely to continue with studies in electronics. This retention problem is a well-recognised one, and both the reasons for it and strategies to mitigate it have been presented (Tsividis, 2009 & Tsividis, 2000).

The Courses

In 2009 one of us was called upon to teach both an introductory electronics course given to first-year students, designated ENEL111, and a final-year course in mechatronics, designated ENEL417.

The electronics course is regarded as the most difficult of first-year courses. It is compulsory for a number of degree streams including electronic, software and mechanical engineering, and has a typical enrolment in the order of 140 students. It is composed of lectures, tutorials and laboratory sessions. The laboratory classes are run with no more than 24 students per class working as 12 pairs of students, and are of 3 hours' duration. The total enrolment means that there are 6 separate laboratory streams that run each week for a total of 18 hours of staff lab time per week. Assessment is based on an examination, tests held during the semester, and upon marks awarded in real time during the laboratory sessions and awarded based upon laboratory work books that are written in the laboratory classes and submitted for marking. Each laboratory class is attended by two postgraduate students and one or two academic staff. In response to student enquiries or requests, "mini-lectures" of a few minutes' duration are delivered on a whiteboard to assist students when there are common difficulties with the laboratory exercises. In summary, the course is hard but richly supported.

The mechatronics course, in contrast to electronics, is widely regarded as fun, and although it is both a demanding course and an optional one it attracts the majority of the eligible students. It is composed of lectures and four half days of laboratory work per week, though many students devote an unrepresentative fraction of their time to the course. Assessment is purely based on laboratory projects, usually four per semester. Each student presents and explains his work at an appointed time, demonstrating it in action in front of the class. The lectures run purely to provide the students with information and theory that they will need to attack the laboratory projects. Every year the projects change in detail, but adhere to one of a few themes. Representative example projects include a Lego Mindstorms-based robot to carry a payload up a taught string, a circuit board carrying a microcontroller that decodes DCC signals and drives a small railway locomotive, or an ultrasonic fluid depth sensor built around an 8-pin ultramicrocontroller. Anything from 5 to 9 Mechatronics students typically worked in the space in front of classes of 24 Electronics students.

A few moments work with a pocket calculator shows that there are not sufficient hours in a week for these two courses not to overlap. It was therefore decided that they should run in the same room at the same time, in order for given staff to be available to all classes in both courses. Figures 1 and 2 show photographs of the situation. During 2009 it was observed that the first-year students took particular note of the mechatronic project demonstrations. Was this spark of interest having any impact on student retention or student grades? We decided to find out.

The Study

In 2010 the first-year electronics class was studied as part of a separate project looking at Threshold Concepts in Electronics, a subject of considerable interest in this discipline (Meyer & Land, 2006). There were 140 students enrolled in ENEL111, 99 of whom explicitly participated in various parts of the research study. The research, conducted with ethical approval from the university, adopted an interpretive approach, gathering data using a multimethod approach. Data were reported from informal observation and interviews with students during laboratory and tutorial classes carried out by an independent researcher not involved in teaching the course, from three student focus groups held in weeks 10 and 11, with 13 volunteering students, from two online surveys (administered early and late in the semester, 64 students responding to the first survey and 52 responding to the second survey), and from a course appraisal survey filled out at the end of the course without teacher supervision by 87 students. The data were analysed using an inductive sense-making approach and emergent and recurrent themes were identified (Patton, 2002, p 41).

One quirk of the timetable was of particular interest. The room used for the parallel classes also shared space with an electronic engineering class involving lasers. This occurred on one particular afternoon, and precluded the use of the laboratory by other students for reasons of safety. It thus came to pass that one of the six different first-year streams using this laboratory did not ever see the mechatronics class running. In effect this group (around 18% of the class) provided a "control group" upon whom the parallel classes could have no impact.

Figure 1: Mechatronics (ENEL417) students in the foreground seated facing away from the camera and Electronics (ENEL111) students seated facing the camera and in rows and bays farther in the background.

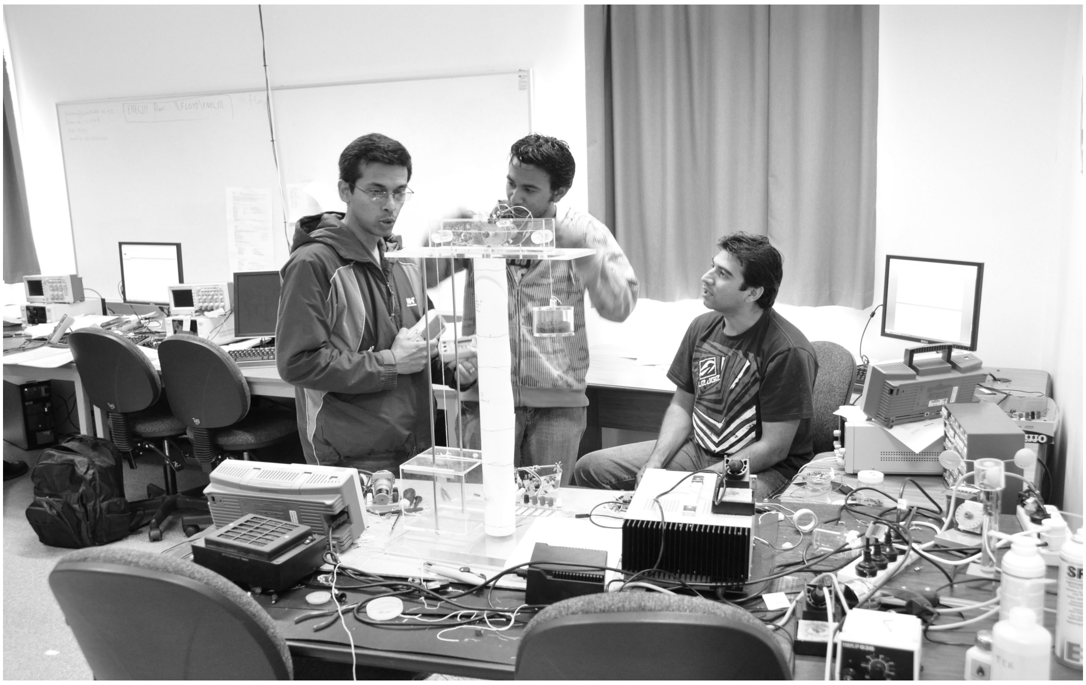


Figure 2: Mechatronics (ENEL417) students discussing a project in full view of Electronics (ENEL111) students.

Qualitative Results

We were interested to know what, if any, difference does it make in terms of commitment and engagement if Year 1 students can see the potential of electronics as exemplified in a Year 4 laboratory. Student comments made during interviews were recorded and categorised according to their degree of reaction to the Year 4 work being done . Comments ranged across a spectrum from indifference to enthusiasm; responses appeared to be influenced by the students' preconceptions about where they were going, but also by a strong single-mindedness that lead them to ignore events around them that did not promise some value.

The comments quoted below were made in the first third of the semester, before the Year 4 projects became highly visible, so they reflect attitude and interest rather than a strong response to spectacle. Spanning the range of enthusiasm, typical comments ranged from:

I don't think about it really.

to

I don't take any note of what they are doing. It's sort of but not really what I want to end up doing.

to

From what I have seen it looks like they are doing mostly control electronics. I suppose I'll have to see later on if that's the area that I want to get into, so and it's pretty up in the air to say right now

to

I think they were making elevators but they were not distracting me. It does give you an idea about what you might end up doing.

to

They are all doing mechanics aren't they? Are they doing electronic engineering? They are doing mechatronics engineering. Currently I am doing electronics, but seeing that I might move to do mechatronics as well.

and

This thing has been there for a while we're used to see it going up and down and yeah, I'm a bit curious to see what they are doing.

Focus groups were held around two-thirds of the way through the semester. Comments became more intense, but in the cohort studied (2010) comments were considerably less encouraging than they had been in the previous year. The students were concerned with how busy they were, or with the negative aspects of the concurrent classes:

It looks like they are doing cool stuff – I saw a train there, we could have a talk with them and find out, but we've just been busy with labs.

It's interesting to watch what they are doing sometimes, you get a bit distracted.

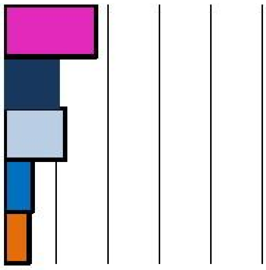
If we didn't have demonstrators, maybe it would be good to interact with those students, but they learned it 3 or 4 years ago…

I guess they do affect us, but it might be a bit off putting when you see their whiteboard and they've got this massive diagram of a circuit and you think Oh, no, I'd better change course!

Interviews with students suggested that those undecided about their progression into second-year electronics courses had yet to make that decision even towards the end of classes. When asked what would help them make the decision the only recurrent response was "grades": If they received good grades they would be retained. This is consistent with a trend observed in other disciplines, namely that making first-year classes less demanding is the most effective way to improve retention.

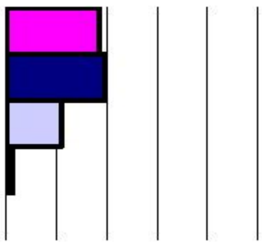
Quantitative Results

The students were asked in one survey toward the end of the semester if they felt that the parallel mechatronics class was a positive experience. Their responses were analysed and the results are shown in Figure 3. Something like 18% of the class should have little or no exposure because they fell in the class scheduled when mechatronics did not run coincidentally. Figure 4 shows the results when the same analysis is carried out on a question to which we have a reasonable idea of the answer: Whether the students were able to access resources. We expect all students to have access to resources but not always in a timely manner because resources will occasionally be overloaded. The results are very gratifying, since about 20% responded to the effect that they seldom or never had a positive exposure to mechatronics while 2% said the same for resource access, exactly as one might expect. The remaining students Always, Usually or Sometimes had a good experience.



Always 1	30	35.3%	35.3%
Usually 2	18	21.2%	56.5%
Sometimes 3	20	23.5%	80.0%
Seldom 4	9	10.6%	90.6%
Never 5	8	9.4%	100.0%
	85	100.0%	100.0%

Figure 3: Student response when asked if it has been a positive experience having the 4 th year mechatronics class running occasionally in the same laboratory space.



Always 1	32	36.8%	36.8%
Usually 2	34	39.1%	75.9%
Sometimes 3	19	21.8%	97.7%
Seldom 4	2	2.3%	100.0%
Never 5	0	0.0%	
	87	100.0%	100.0%

Figure 4: Student response when asked a routine question about their ability to access resources when they needed them.

The results from this survey appear encouraging, but are at odds with the qualitative impressions recorded by an independent researcher (i.e., a person not involved with the teaching of the course, and at pains to assure the students of their independence and impartiality). If we accept the impressions gleaned through the impartial researcher, the above survey results must be considered to represent the "answers that the students thought we wanted" and do not reflect the true impact of the events. This is consistent with the more sceptical studies of student evaluations (Rundle, 1996).

Unfortunately, numerical analysis of student marks supports the earlier qualitative impression that the parallel labs were not influential. The average mark of students in the first-year class that was unable to work in the presence of fourth-year students was 68% (n=24) and the average for the remainder of the class was 66% (n=108), showing no significant difference, and in any case a marginally lower result. The distribution of marks for these "exposed" and "unexposed" groups are shown in figure 5.

Conclusion

The study does more to support the suggestion (Rundle, 1996) that numerical evaluation data is untrustworthy than it does to establish any productive outcome from the parallel classes. No positive impact was observed on marks, and no trend was found in student attitude as a result of the parallel classes. Nevertheless, it goes against every instinct of the instructor to suggest that the exposure has no impact at all. Students complain that they are not introduced to enough real-world professional activities in their junior years, while the worst that can be said of the exposure here is that they felt too busy to pay attention or at best were not distracted. In some cases it generated real enthusiasm.

Perhaps the events will come to bear in each student's memory when it comes time to choose courses in the future, once the pressure to accumulate marks is lower.

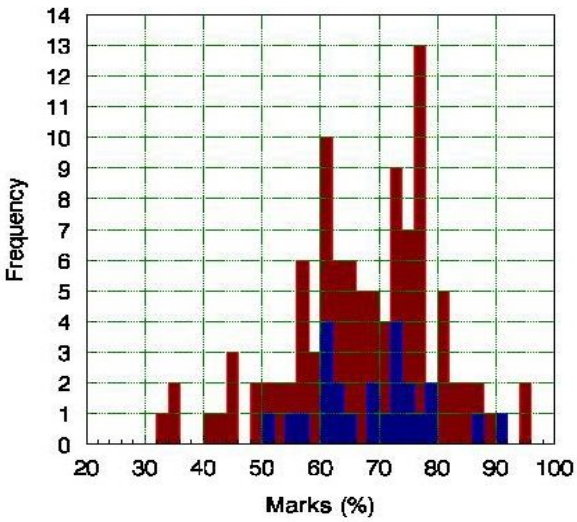


Figure 5: Student mark distributions for the groups with (background or red) and without (foreground or blue) parallel lab classes.

The anticipated (lack of) impact on retention may be confirmed when figures become available in the future, and we will expand this report in that event. However, it is unlikely to be possible to unequivocally attribute changes in retention to the parallel classes because many other factors will also bear in any given year.

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