Virtual Classroom on a DVD – Revisiting Live Lectures

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Abstract—**Results of a large four-year longitudinal study of issues affecting student learning has motivated the development of a new mode of teaching, which takes the context of student learning into account and enhances student understanding of subject material. This new mode of lecture delivery is based on digital capture and student-controlled, user-configurable playback of synchronized lecturer dynamic annotation and video. This approach was tested in a large undergraduate course during which lectures were delivered entirely via pre-recorded lecture material on DVD, and in which the face-to-face teaching time was used instead for focused discussion classes. We present the results of a study of this novel delivery mode, using an electronic whiteboard and DVD capture. Our evaluations show convincingly that students are better able to review and understand lecture material.**

Index Terms—**self-directed learning, educational technology, evaluation, teaching modes**

I. Introduction

Students of today balance university study, part-time work and many other commitments. It is important that new and creative teaching methods are used in order to support students in balancing study and work and to help them learn effectively [9]. We have been seeking to understand the complete picture of the student experience in engineering studies, and searching for new ways to address problems in student learning. Having identified student learning issues, we have looked hard for a range of solutions, initiated many programs to address these, and in the process of addressing them, have come up with some radically innovative new approaches to teaching. These new methodologies of teaching that we have developed have proven to be highly effective, and help students to develop critical thinking skills that helps them to take control of their own learning process.

Maintaining student attention span is a perennial challenge in the teaching and learning environment, especially in a large class [1]. This is exacerbated by other difficulties students face, such as fatigue or non-attendance due to balancing part-time work or other commitments, or difficulties with comprehension for students whose first language is not English. As a result, only a small percentage of students are usually able to grasp the key concepts at the time of the live lecture delivery, while the remaining students are left to develop this critical understanding in their own time, with whatever assistance they can find and comprehend [2]. Previous studies [5] have shown that students prefer to study in their own time, when they are less fatigued, rather than attending regular structured classes. We believe that it is particularly critical for science and engineering students, where long and/or complex mathematical concepts are often conveyed, and in which the live lecture environment provides little support for any student who loses the train of a particular derivation or explanation, for any reason. For example, even with printed lecture notes and student note-taking, it is still easy for a student to miss a crucial step in the explanation of a difficult but conceptually important problem. In order to address the above problems and in pursuit of optimal student learning, students' individual learning styles need to be taken into account.

Previous attempts to address the problems have included videotaping of lectures [3], but this proved to be somewhat unsuccessful, as large scale equipment set up was required. Multiple cameras were needed and students were not compelled to watch these videotaped lectures on their televisions at home. Another method included a voiceover to accompany PowerPoint slides, which also proved to be ineffective, because students preferred to see a visual image of the lecturer explaining the concepts, rather than listening to a disembodied voice and trying to work out which equation or diagram the lecturer is referring to at a given point in time.

The objectives of revisiting live lectures were to:

- Gain a deeper understanding of the context in which student learning occurs
- Propose new teaching methods to allow students to exercise greater control over their learning experience, and which address specific problems discovered from student feedback
- Implement new technologies designed to convey the richness of the classroom experience to students engaged in self-directed study
- Experiment with the novel technologies in a variety of different teaching modes during the regular teaching semester
- Evaluate both the new educational technology and the delivery mode it facilitated, over a series of courses

Manuscript received June 25, 2007

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II. Issues Affecting Student Learning

In order to understand directly from students the underlying problems and parameters of their learning approaches and behaviors, a survey of engineering students was conducted over four years, between 2003 and 2006 [2]. In each year, approximately 100 students participated, with a total of 400 respondents over the past four years. Participants were mainly (82%) in their third year of study, with the remainder (16%) mainly in the fourth year of a four-year degree program. The aim of the survey was to determine what duration and proportion of students' time was spent on learning activities (lecture, tutorial, laboratory attendance, class preparation, assignment work and study), perceived reasons for poor performance, what types of materials they used for their study, what financial support they received during their studies, and what other commitments competed with study for their discretionary time. A further objective was to map survey findings over a period of time, to remove the dependence on a particular student cohort, and to identify likely trends.

The survey was conducted as a written questionnaire, comprising a total of thirty questions. Multiple choice style questions were used throughout, and covered student attendance of various types of classes and the reasons behind this, study patterns and approaches outside of class hours, the form and quantity of financial assistance received by students, the effectiveness of lectures versus self-directed study, and the effect of large class sizes.

Of considerable interest were students' ratings of their attendance at lectures and tutorials. As seen in Fig. 1, 100% lecture attendance has been dropping in trend terms, while students are increasingly dependent on both tutorials and self-study.

The use of text books as the main study aid was low (approximately 10% of students), while the most commonly used study aids were past exam papers, lecture notes and worked examples (Fig. 2).

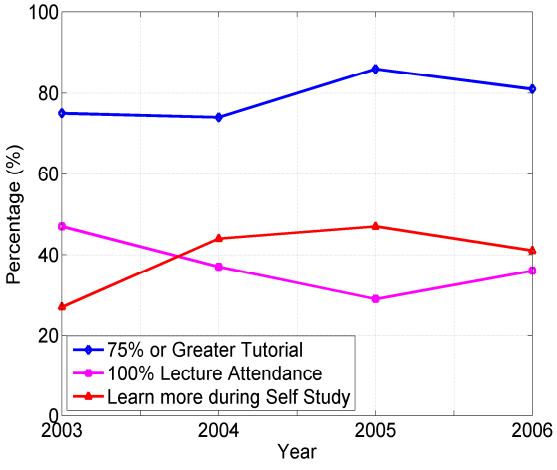

Fig. 1: Tutorial, lecture attendance and use of self-directed study.

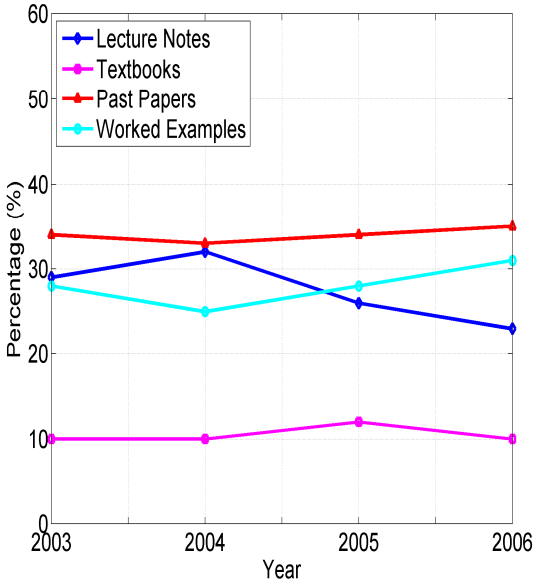

Fig 2: Main study aids

From our survey it was clear that a significant increase in the proportion of students with part-time work was evident in trend terms even during the period of this survey. Clearly, there is an inverse relationship between part-time work and class attendance, with only 30% percent of the students attending 90% of the lectures with about 60% of the students doing part time work. Many students indicated in their responses that one of the reasons they were absent from university was tiredness and work.

The time students spent on study out of class hours (not including assignment work or laboratory preparation or write-up) was particularly revealing, with fewer than 10% (Fig. 3) of students spending more than 20 hours per week on study out of class.

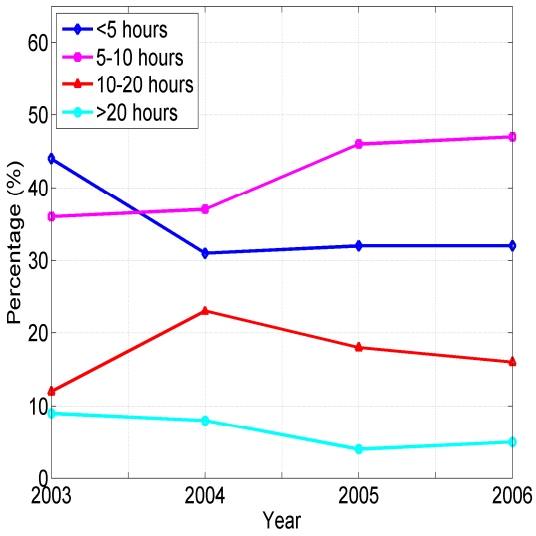

Fig. 3: Time spent on study after class

The University of New South Wales typically recommends that students study at least 20 hours per week outside of class hours, indicating that the majority of students are not pursuing self-directed study to the required extent. Many students indicated in their responses that one of the reasons they were absent from university was tiredness and work.

These surveys indicated that the ability to independently review live lecture content at their own pace outside of class hours would be of major benefit to students. Fig. 1 shows that there is a drop in lecture attendance, due mainly to part-time work, and therefore students who miss lectures need to have a way of accessing the live lecture at a later time.

In a large class lecture environment, students experience various problems that range from language difficulties, struggles in picking up difficult concepts and an inability to do ongoing revision throughout the course. Having access to live lectures, with full visual and audio impact, outside of class hours helps to alleviate these problems, encourages independent learning and time spent on study after class, which is low as highlighted in Fig. 3. In response to the survey findings, we developed a new mode of lecture delivery based on DVD capture and student-controlled playback of synchronized lecturer dynamic annotation and video. This gives students the ability to independently review live lecture content at their own pace outside of class hours.

III. DVD-BASED LECTURES FOR SELF-DIRECTED LEARNING

With the use of the electronic whiteboard and tablet PC [10], we pre-recorded the lectures and provided them to students on a DVD using our VCPlayer software [3], [7], [8]. The DVD included the lecturer's annotated slides in digital format (See Fig. 4), along with a video and audio of the lecturer's presentation, which resembles the live classroom situation. Having the lectures on DVD allowed students to watch them as often as required in order for them to acquire the level of understanding needed. In addition, students could watch them in their own time and at their own pace, so their concentration and interest levels were high. Previous studies [4] have shown that in practice most annotations that are used are attention marks (e.g. highlighting in a different color), which provide critical linkage between spoken context and the slide content. We believe that the recording of rich non-persistent information such as video and dynamic annotation can be used to improve self-directed student learning or as preparatory material for more focused lecture/tutorial sessions which offer new possibilities for course delivery. Furthermore, unlike existing reports of some similar tools [6], we have applied the VCPlayer extensively in signal processing teaching, and describe an undergraduate evaluation herein.

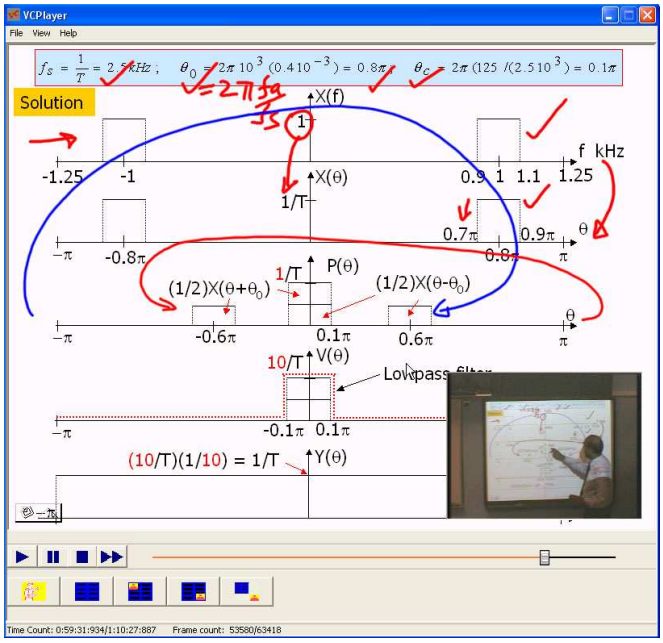

Fig. 4: An example of captured lecture content

From our experiences with this mode of teaching, the first lecture of any course should be delivered live, in order to motivate the students while familiarizing them with the delivery mode. In subsequent weeks, students then receive DVDs that capture lecture material in either of two modes:

(i) Lectures are given live, in the traditional format, except that the lecturer's video and annotation of electronic slides are captured using the VCPlayer, and later made available to students; OR

(ii) Lectures are pre-recorded using either electronic whiteboard or tablet PC, and then made available to students one week in advance of their class.

In the case of delivery mode (ii), we suggest that tutorial classes be made compulsory, and that an optional focused discussion class be run in place of the usual lecture time. The purposes of the discussion class are to give the students the face-to-face time needed to ask questions and resolve course-related issues. Obviously there is no reason why a delivery modes (i) and (ii) should not be combined as desired when designing a course. Students should be encouraged to watch the DVDs as many times as they need, in order to acquire the level of understanding they want. Ideally, a large proportion of students would actually watch at least selected portions of the lectures more than once. Assessment methods for this mode of delivery need not change from those employed concurrently with traditional lecture delivery.

IV. RESULTS OF DVD-BASED TEACHING APPROACH

The self-directed learning mode (ii) outlined in the previous section was evaluated for the third-year undergraduate course "Signal Processing I", which ran over 14 weeks at UNSW in 2006, and was attended by 113 students. In this study, after a

live introductory lecture was given in the first week, all lecture material was delivered via DVDs pre-recorded in the VCPlayer format (for playback on student PCs). Optional discussion classes were also scheduled during the allocated lecture slots. Compulsory tutorials and laboratories were scheduled and their format was traditional. Assessment of student understanding of the DVD-based lectures was conducted by a series of three surveys, each completed by students at the end of their class exams. The surveys consisted of eight questions, of which seven used a Likert scale (from strongly agree to strongly disagree) and one comprised a free-format comments field. The questions in all surveys were identical. The numbers of participants in the three surveys were 113, 104 and 88 respectively.

As illustrated in Fig. 5, responses to the first seven questions of the surveys showed that the acceptance of the DVD-based lecture delivery mode was supported by about 80% of students. Around 10% of the students were undecided whether DVD-based or traditional lectures were preferable, and around 10% did not support the DVD-based lecture format. While these are positive results, clearly caution must be exercised in balancing the use of the pre-recorded lecture format with other methods of lecture delivery. The remaining (eighth) survey question revealed that 80% of students used the DVD for every lecture, while 34% used it more than once. Over the duration of the course, only 30-40% of students attended the optional discussion classes, perhaps indicating their preference for the DVD-based lectures.

Furthermore, an analysis of student pass rates over the duration of this study was carried out. Table 1 shows that results from the midterm exams and overall marks for the same course (given by the same lecturer) across four consecutive years. As indicated in this table, week 9 results are traditionally poor (with standard lecture delivery), since students just begin to realize the deficiencies in their understanding of signal processing concepts. Although the assessment scheme (in terms of optional versus compulsory class exams) differed slightly and the group of students was different from one year to another, these results suggest that a selective use of the DVD-based delivery mode combined with traditional course delivery may enable students to achieve higher levels of understanding.

V. Comments from Students

Many of the free-format comments from students in the survey supported the findings in Fig. 5, for example:

> "The DVD is a great way to save time and make learning more efficient and personal . . . it is really beneficial that you can skip the bits you already know and concentrate on the more difficult ideas";
>
> "DVDs are better as this eliminates distractions due to people talking in class";
>
> "I can revisit more difficult concepts more than once and develop a better understanding. This could benefit the lecturer as they may not have to re-explain concepts at a consultation";
>
> "If I can't understand a concept early in the lecture, I can go back before trying to understand the later material which could depend on the previous concept, and avoid becoming 'lost' as I might in a live lecture";
>
> "I think it is a good idea and should be used in other courses within the school".

VI. Conclusion

This paper presents results from a survey of issues affecting student study behavior and learning. Key implications were that students increasingly had more part-time work commitments competing for both their class attendance and their discretionary study time, and that they preferred lecturer-generated materials such as worked solutions, past exam papers and lectures notes to text books as study aids. It was also found through the survey that students are not spending the recommended time studying after class.

This motivated the introduction of a new mode of teaching, using DVD-based electronic whiteboard and video capture. The proposed mode of delivery enables self-paced, individualized learning for students with a range of different preferences or difficulties, and offers a genuine alternative to the large classroom environment while allowing students to achieve their desired level of understanding. The novel method of course delivery has been highly commended by students, and results presented herein show potential for increasing student understanding of course material beyond the level that would be possible using traditional methods. This teaching methodology is currently being trialed in many other courses within the School. Future work will include progressive evaluations of this novel method of teaching delivery.

Acknowledgment

This project was funded by the Australian Government Department of Science and Training (DEST) Capital Development Pool Program 2004-2005 (Education Delivery) and UNSW School of Electrical Engineering Educational Technology Development funding (2006).

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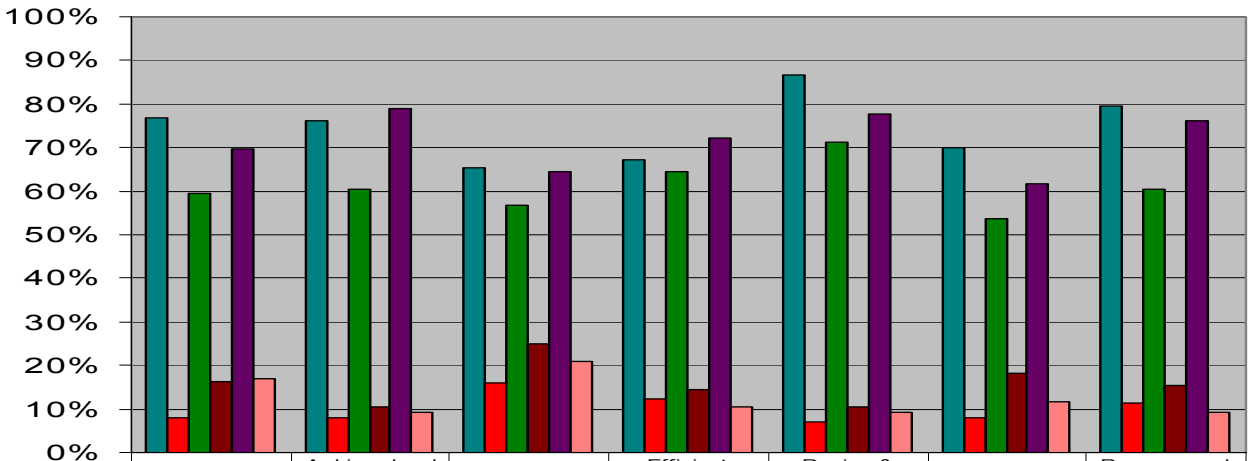

	Acceptable alternative	Achieve level of understanding	Preferred choice	Efficient learning method	Review & understand better	Learnt more	Recommend to other courses
Agreed April	77%	76%	65%	67%	87%	70%	80%
Disagreed April	8%	8%	16%	12%	7%	8%	12%
Agreed May	60%	61%	57%	64%	71%	54%	61%
Disagreed May	16%	11%	25%	14%	11%	18%	15%
Agreed June	70%	79%	64%	72%	78%	62%	76%
Disagreed June	17%	9%	21%	11%	9%	12%	9%

Fig. 5: Results of seven questions from a survey of DVD-based self-directed learning mode show that students consistently support this mode of delivery.

TABLE 1. COMPARISON OF MID-TERM AND FINAL EXAM PASS RATES FOR DIFFERENT LECTURE DELIVERY MODES.

	Students	Week 4 (April)	**Week 9 (May)**	Week 14 (June)	Final Pass Rate
2003 Traditional	121	not held	**48.7%**	not held	81.0%
2004 Traditional plus some AVI tutorials and electronic whiteboard discussions	118	not held	**43.8%**	70.1% (compulsory)	86.4%
2005 Mixed traditional (80%) and DVD-based (20%)	129	not held	**37.4%**	72.0% (compulsory)	89.9%
2006 DVD-based (100%)	113	74.2%	**66.1%**	60.0% (optional)	85.1%