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Video introductions to undergraduate laboratories

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Abstract

As well as lectures and tutorials, courses in the experimental sciences include a laboratory component, which gives the student the opportunity to gain direct "hands-on" experience of the phenomena of interest. The better prepared a student is, the better the use that can be made of time in the laboratory. It is vital that the best use of the expensive resources (experimental apparatus and personal academic help) be made in the limited time that they are available (2-3 hours). Students have always been encouraged to read the experimental notes before attending the laboratory, and to encourage them to do so a "pretest" must be submitted before they enter the laboratory. Even after successfully completing the pre-test, however, students are often at a loss to know exactly what to do when confronted with unfamiliar equipment, and much demonstrator time can be spent on repeatedly explaining the same simple starting procedures.

Roger Lewis describes the development, trialling and evaluation of video materials which are intended to help students with pre-laboratory instruction.

Video Introductions to Undergraduate Laboratories

Roger A. Lewis

The educational challenge

As well as lectures and tutorials, courses in the experimental sciences include a laboratory component, which gives the student the opportunity to gain direct "hands-on" experience of the phenomena of interest. The better prepared a student is, the better the use that can be made of time in the laboratory. It is vital that the best use of the expensive resources (experimental apparatus and personal academic help) be made in the limited time that they are available (2-3 hours). Students have always been encouraged to read the experimental notes before attending the laboratory, and to encourage them to do so a "pre-test" must be submitted before they enter the laboratory. Even after successfully completing the pre-test, however, students are often at a loss to know exactly what to do when confronted with unfamiliar equipment, and much demonstrator time can be spent on repeatedly explaining the same simple starting procedures.

The video solution

A role was perceived here for short (approximately 10 minute) introductory videos. The videos introduce the experiment, briefly state the aim, show the apparatus and how it is used, and discuss what sorts of results and errors might be expected. The videos do not attempt to cover material that the laboratory manual presents well (such as the derivation of theory), but rather present material that the laboratory manual handles poorly (such as the appearance of the apparatus and its operation). Likewise, the videos cannot provide detailed individual instruction (a strength of the demonstrators), but do allow routine information to be presented repeatedly. Compared to "live" demonstrators, who are often graduate students and who vary from class to class, the videos may also have advantages in being presented by a more experienced teacher and in supplying a uniform starting point for all students doing a particular experiment.

While video is not new its use is of current interest for two reasons. First, video technology is accessible, certainly to our students, as illustrated in Figure 1. Over two-thirds of our students claim access to video players, while less than half had access to an (IBM-compatible) PC and a little more than half claim access to Macintosh computers. (All students can, in fact, use Macintosh and IBM-PCs in campus computer laboratories, and video players in the library.)

Second, video serves as a source material for higher technologies. Video may be manipulated in a huge variety of ways using digital and/or analog processors and may be distributed in many forms: as broadcast or cable

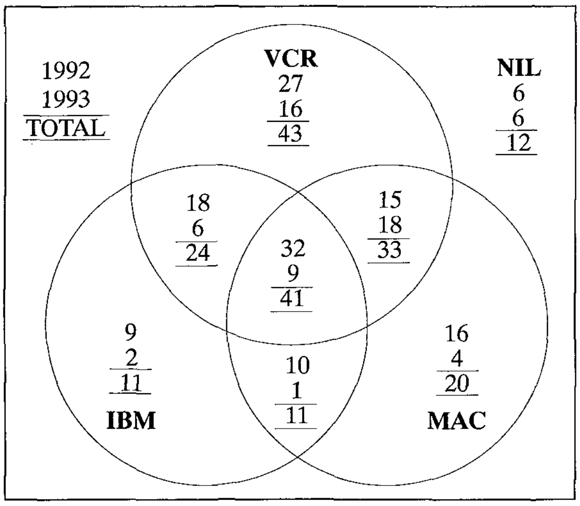

Figure 1. Access to various technologies claimed by students. VCR - video cassettes; IBM - IBM or compatible PCs; MAC - Macintosh computer; NIL - none of thwe above.

TV; as tapes in a number of formats; as discs, including compact discs; and as computer files. Adding to video a control/navigation/interaction aid, generally by computer, is the most common route to multimedia.

What was done

In 1992, two videos were filmed by technical staff of the Department of Physics using a VHS camera and editing the master tape "on the fly" - a shot was re-taken until satisfactory, then the camera moved to the next shot. This crude procedure was followed to ensure distribution copies were only second generation, and not third generation, VHS. Two further videos were filmed and edited that year by the Educational Media Unit, using higher quality U-matic equipment. In 1993, under a CAUT grant, videos of the remaining 26 experiments in the laboratory were produced using the even higher quality Betacam technology.

The videos were trialled with students from the course PHYS 142 in 1992. PHYS 142 is the standard, calculus based course for physics majors. The majority of students in the course are electrical or computer engineering students. Students attend a two-hour laboratory class each week. In this time, the experiment is conducted, the data collected and a report written. This format places the students under some time pressure. Students normally work in pairs and complete 12 experiments during the course. In 1993 the videos were trialled with students in another course, PHYS132, "Physics for the environmental and life sciences". This is a non-calculus course. Classes run for three hours and a different set of experiments is performed but otherwise the format is similar to PHYS 142.

In each course, students were divided into two groups. One group watched videos during the first half of the course and not during the second half of the course. The other group did the opposite. The videos were viewed by individuals or pairs at integrated player/ monitors set up in the laboratory. For control purposes in the trial, viewing of the assigned videos was made compulsory, and permitted only within the normal laboratory class.

At the end of the session the reports for each half of session were marked. Each student received a mark on one or two experiments for which s/he saw the video and one or two for which s/he did not. This arrangement minimized the effects of between-student variability in the analysis of how the videos affected student marks. It also ensured that, whatever the effect of the videos, no student would be disadvantaged regarding final grades. A survey was also administered in each class.

The educational outcomes

Student survey

The anonymous survey was made compulsory to guarantee an accurate poll of opinion across the whole student body. The substantive questions asked and student responses to them, given on a Likert scale, are shown in Table 1. An analysis was carried out to determine if the answers given by certain groups of students differed from those of other groups. For example, the students first watching videos were randomly chosen and so it was not expected their responses would differ statistically from the group watching videos second, which was found to be the case. Likewise, the particular class attended (Wednesday evening versus Friday morning, say) did not influence the answers given in the survey. Perhaps of more interest is the finding that the students in the calculus-based class (PHYS 142) and the non-calculus class (PHYS 132) did not differ markedly in their answers to the survey questions.

	1992	1993
PRODUCTION VALUES		
How do you rate the video clips you have seen?		
length [1: far too short to 5: far too long]	3.1	3.1
technical quality [1: very poor to 5: very good]	3.5	3.6
connection to experiment [1: very irrelevant to 5: very relevant]	4.2	4.2
helpfulness [1: very unhelpful to 5: very helpful]	3.8	4.2
LEARNING PROCESSES		
How do you think the videos affected your understanding of the experiment? [1: very negatively to 5: very positively]	3.9	4.0
performance of the experiment? [1: very negatively to 5: very positively]	3.8	3.8
OVERALL EVALUATION		
Overall, what do you think of using video clips next year? [1: very bad idea to 5: very good idea]	4.0	4.4

Table 1. Responses to student survey. The numerical values given are averages measured on a Likert scale.

The videos were regarded as being *relevant* to *very relevant.* This question was the one answered most positively by the respondents and reflects that the content of the videos is closely linked to the experiment. The videos were viewed as being *helpful.* Concerning the perceived effect that the videos had on the students' learning, students judged that both their *understanding* and their *performance* of the experiment were positively affected.

Other questions sought to determine to what extent videos should be produced and distributed. There was a strong indication that videos be *optional* rather than *compulsory* but opinion was fairly evenly divided as to whether videos should be prepared for *all* experiments or just the *hard* ones. The answers to these two questions taken together suggest that students have a desire for flexibility and control in their learning. The methods of distribution and delivery that would have greatest impact, among those suggested in the survey form, are shown in Figure 2. While laboratory-based delivery is most popular, each method had its adherents. Presently, all these modes of distribution are being used.

Questions about the videos themselves – their length, technical quality, connection to the experiment and helpfulness – all received positive to very positive comments. Concerning the *length,* the videos were "about right". The *technical quality* was rated as "average" to "good". Given the high speed and low budget with which these videos were made, and in contrast to the technical quality of other video material with which the students are familiar (commercial broadcast TV, for example), these results are unexpectedly good. Of practical interest is the observation that there is no significant difference between the perceived technical quality of the original videos made within the Department (with rudimentary scripts, VHS camera and some very rough cuts) and those made with the assistance of the Educational Media Unit (with explicit story boarding, full scripts, better equipment and editing) and finally those made with the assistance of the Graduate Consortium (of higher technical quality still).

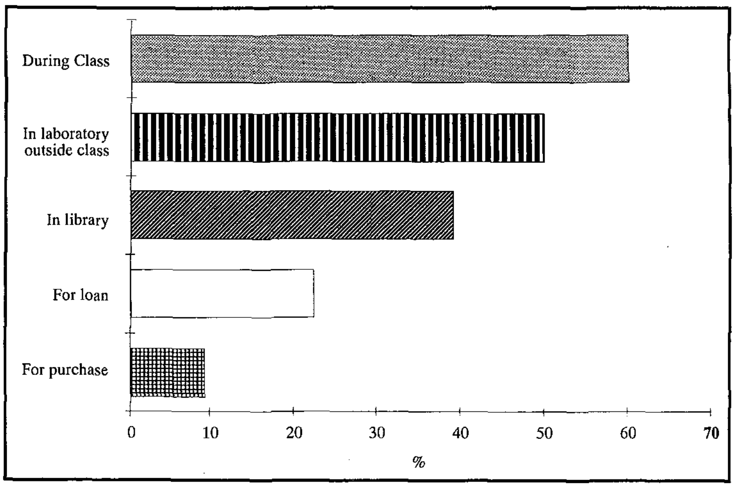

Figure 2. Preferred modes of delivery of introductory laboratory videos.

The final multi-choice question served to sum up the whole impact of the video program. The question asked, "Overall, what do you think of using video clips next year?" The question therefore enquired about the practical value of the videos. Using the videos in future was rated as a "good idea". Evidently, the students think the videos worthwhile and worth retaining.

One line of space was provided to answer the question "What would improve the video component of the laboratory?" In 1992, the most commonly given reply related to a specific technical shortcoming in delivery: poor sound through the headphones. New headphones solve this problem. In 1993, the most common reply was "nothing – the videos are fine as they are".

Effect on student performance: book mark

The main way of assessing students in the laboratory is by marking reports selected from those submitted week by week. The students were not told which reports would be marked and the markers were not aware of which students had or had not seen the video relevant to the report being marked. The performance of each student in the experiment(s) for which s/he had seen the video was compared with the performance in the experiment(s) for which s/he had not. The effect of video on the book mark is not great, as may be seen from Table 2; indeed, there is statistically no difference between the marks gained with or without watching the video.

	Group 1	Group 2	t	P
1992				
Book mark	-0.0055	+0.0048	0.045	0.96
Class mark	+0.35	-0.32	-1.95	0.05
TOTAL MARK	**+0.09**	**-0.08**	**-0.81**	**0.42**
1993				
Book mark	-0.10	+0.09	0.94	0.35
Class mark	-0.10	+0.09	1.90	0.06
TOTAL MARK	**-0.10**	**+0.09**	1.17	0.25

Table 2. *Effect of video on student performance as measured by book mark, class mark and total mark; in each case the mark is out of ten. The performance of the student in an experiment in which s/he saw a video, relative to one in which s/he did not, is shown. The t statistic and the probability P for the hypothesis that the performance is the same for the two groups are also shown.*

The obvious conclusion is that the videos have no effect on the book mark. It may be argued that the videos were poorly conceived, presented and delivered; the positive responses given in the student survey as to the quality, relevance and helpfulness of the videos suggest that this is unlikely. An alternative explanation is, not that the treatment has no effect, but that this measurement of student performance is insensitive to it. The videos may be affecting student learning but to an extent or in a way that is not detected in the book mark.

Effect on student performance: class mark

Class marks are kept week-by-week by the demonstrators. They are intended to reflect the understanding and performance of the student as exhibited in the class. Demonstrators are particularly urged to distinguish the class work from the book work and award class marks accordingly. Unlike the book markers, the demonstrators were aware of which students had seen the videos and this may have influenced their allocation of class marks. Nevertheless, Table 2 shows no significant ($P < 0.05$) difference in the class mark as a result of viewing videos.

Lessons for others

Students like the videos

The students respond very positively to the videos. On all questions concerning the videos: length, quality, helpfulness, relevance, effect on understanding and performance, students responded positively, a result made more telling by the fact that in the trial they were forced to use the videos. This result is common among reports on educational innovations: the students like it.

Marks are not affected

In a carefully controlled trial it is found, at the 0.05 level of significance, that the videos have *no* effect on marks. The videos have no observable effect on student performance as it is currently measured. This finding contrasts with the students' claim that the videos improve their understanding and performance. It may be that the videos have a positive effect on performance, but the effect is too small to be measured in the trial described. It may be that the impact is in a dimension not measured by the current book and class marks. This finding has stimulated a reevaluation of how assessment is performed in the laboratory.

Technical quality is not an issue

The "professional" finish afforded by more sophisticated production facilities and techniques does not affect the student perception of the videos. The students seem to value primarily the content and relevance of the videos. Time is best invested in getting these right, rather than in preparing complex graphics or special effects.

Flexibility and control are important

Students appreciate flexibility and control in the use of learning tools; the answer to "when" and "where" they would like videos was "whenever and wherever possible". Currently, the videos are available for viewing in the laboratory; for viewing in and borrowing from the library; and for sale. The whole use is optional.

A resource is of little use if the students have limited means to access it. It is of practical consequence that, outside class time, our students are better able to use videotapes than software for either IBM-PC or Macintosh computers, let alone CD-ROMS, videodiscs and more esoteric technologies.

Conclusion

Students like the videos and this seems to be related to the strong relevance of the videos to the tasks they are to perform in the laboratory. Students judge that their understanding and performance are enhanced by watching the videos, a perception not reflected in their marks. The students want the videos to be optional and to be available through a variety of channels, and this is how the videos are presently being used. The continued use of the videos in the laboratory has strong student endorsement.

Acknowledgements

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Use the following settings to connect to the University network.

Settings: If using a 2400 baud modem - set line to no parity, 8 bit, 1 stop bit
dial up number **21 3207**
If using a 9600 baud modem - set line to no parity, 8 bit, 1 stop bit
dial up number **21 3211**

Select **Connect to Library** to search the Library catalogue or select **Connect to Wumpus** to telnet to remote databases.

Ready Reference of telnet addresses and logins:

Uncover

Telnet: uncover.carl.org
select 5 (vt 100)
select No 1
Uncover/Uncover2
Logoff: //exit

ISI Current Contents

Telnet: abn.nla.gov.au
select vtsofi
Login: nla
SOFI
Current contents
(user id and passwords available from your Faculty Librarian or Information Desk)
Logoff: /q or <shift> 666 (Macintosh)

ABN/OZLINE

Telnet:	abn.nla.gov.au
	select vtsofi
Login:	nla
	SOFI
Choose	No1 Search ABN Supersearch/Ozline
Userid	1staffwi492+your initials
Password 1	camp
Userid 2	wollonuni664+your initials
Password 2	book
Logoff	/q

FirstSearch

Telnet:	Fscat.oclc.org
Authorization	100102165
Password	AXAX%XGRE
Logoff	bye

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Pam Epe is the Research Services Librarian at the University of Wollongong Library