Empowering physics demonstrators to enhance first year laboratory experiences by use of real time visualisation – a working DVD

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Abstract: *The first year Physics laboratory programs at UTS have been designed to be open-ended and enquiry based, encouraging students to learn the techniques of scientific analysis by investigating physical situations with minimal reference to prescribed directions. The role of the demonstrator in this process is pivotal as they guide the students in their chosen exploration method. Demonstrators are responsible for a class of 40 students and there will be many different approaches on which they are required to give expert guidance.*

We have developed a DVD of the experiments in the program, with easy navigation so that demonstrators can access key parts of the experiment efficiently. The DVD uses demonstrators as presenters this bringing an authentic perspective to experiments. A feature of the DVD is the ease with which it can be updated.

In this paper we describe the background to the development of the DVDs, their relationship to the philosophy of the laboratory program and the outcomes of trials of the DVDs. In addition we examine responses to the DVD obtained through focus group sessions which indicate that care will need to be taken so that this resource, created to assist demonstrators to foster enquiry in the laboratory, is not transformed into a prescriptive tool restraining student creativity and ingenuity.

Introduction

In 2006 University of Technology, Sydney (UTS) completed a new science building complex including first year laboratories. This presents opportunities with access to better equipped laboratory spaces, good information technology facilities, less crowding in the laboratories and rationalisation of equipment. This was balanced by an equal number of challenges.

Challenges

Due to the heavy use of the first year laboratories, there is reduced access to the laboratories for academics, particularly demonstrators. Full time academic staff are no longer located close to the laboratories and therefore rely more than previously on external demonstrating staff, particularly in evening classes. Time and location constraints mean that external staff have less access to lecturers to whom they can refer during a laboratory session. Very importantly, technical staff are no longer solely dedicated to the physics laboratory area.

In response to the above challenges, support was sought for a project entitled *Enhancing the student experiences in first year physics laboratories: A living laboratory DVD*. Funding for this project was granted by the *Faculty of Science Learning and Teaching Performance Fund*. The primary objective was to provide support for the challenges faced by the demonstrators who are at the 'coalface' of the experiment.

Philosophy of Physics laboratories at UTS

Research on laboratory teaching in higher education has emphasised the fact that laboratory teaching should aid students' understanding of the processes of scientific enquiry and to permit them to undertake appropriate enquiries (Boud, Dunn and Hegarty-Hazel 1986). The physics laboratories are designed in a way to foster enquiry-oriented learning by students. The experiments during the first few weeks of the semester are more guided and fall under the category of *Structured Investigations*,

(Hazel and Baillie 1998) where the aim is given, material and method are partially given and the answer is open. As the course progresses students take up *Unstructured Investigations* where only the aim is given and material, method and answer are open. It is increasingly important that the teachers' skills are enhanced to promote students' participation in meaningful scientific enquiries.

UTS Online (a *Blackboard*™ online system) is used strongly with the laboratory program, with the demonstrators obtaining class lists, entering marks, communicating with students, timetabling … An important part of each laboratory experiment is the online prelaboratory which students are required to undertake before the experiment – with the demonstrators overseeing the students performance and guiding/assessing this as required.

Previously demonstrators relied on a printed manual for giving them schematic diagrams of equipment and sets of data obtained by lecturers who had carried out the experiment. Such a printed demonstrator manual is always convenient to look up the theory and analysis part. However, it does not give the same impact to the demonstrators (especially new or casual demonstrators) as seeing the equipments or doing the experiment physically. The DVD was envisaged to complement the printed manual and empower the demonstrators with a real-time visualisation of one or more implementations of the experimental method.

Methodology

The DVD is basically a catalogue of equipment, techniques, data examples, hints on safety aspects pertaining to EHS policies of UTS [online] (2007/8) and reassurances. Short movie clips in the DVDs hosted by the experienced academic staff or demonstrators, provide a virtual laboratory experience. This also enables the new/part-time demonstrators to have an understanding of the relationship between the experiments conducted in the laboratory and the theory topics done in lectures.

Making of the DVD

The structure of the DVD was planned before shooting the video clips. It features layered menus. We chose Phase Alternating Line **(**PAL) for the DVDs as Australia uses the PAL system.

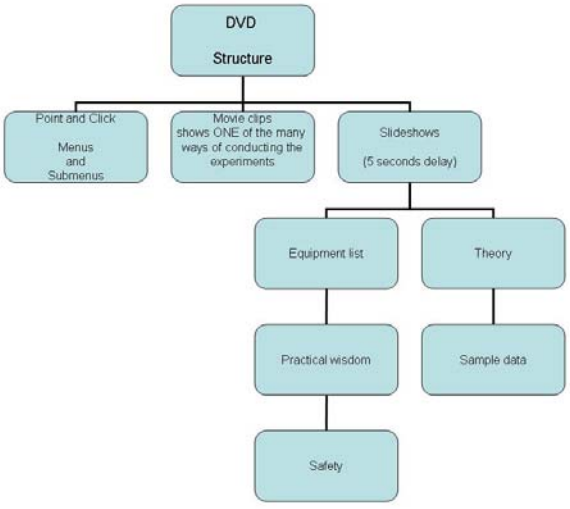

Figure 1. Structure of the DVD

Key features of the DVD

The DVD consists of a *Main Menu* leading to different topics/experiments packaged to the particular subject(course). Each topic/experiment is further broken into a pattern under sub-menu or sub-sub

menu with links to *Overview, Theory, Practical Wisdom (PW), Safety, Measurements* and *Sample data*.

The *Overview* under each submenu gives an insight into the actual "outcome" and philosophy behind the specified experiments.

The *Theory* gives a brief summary of needed formulae together with a guide to the handling of uncertainties in that experiment.

The *Practical Wisdom* section gives valuable experiences and insights about running the particular experiment in the laboratory. Demonstrators' comments are added to this from the online feedback sessions or 'Collaboration' (*Blackboard*) set up for each laboratory.

The *Safety* menu gives a quick checklist of what aspects of the experiment may need to be treated with caution/guidance given etc.

The *Measurements* button leads either directly to movie clips of the experiment and *Sample Data* - or to a sub-sub menu with those clips broken into specific items.

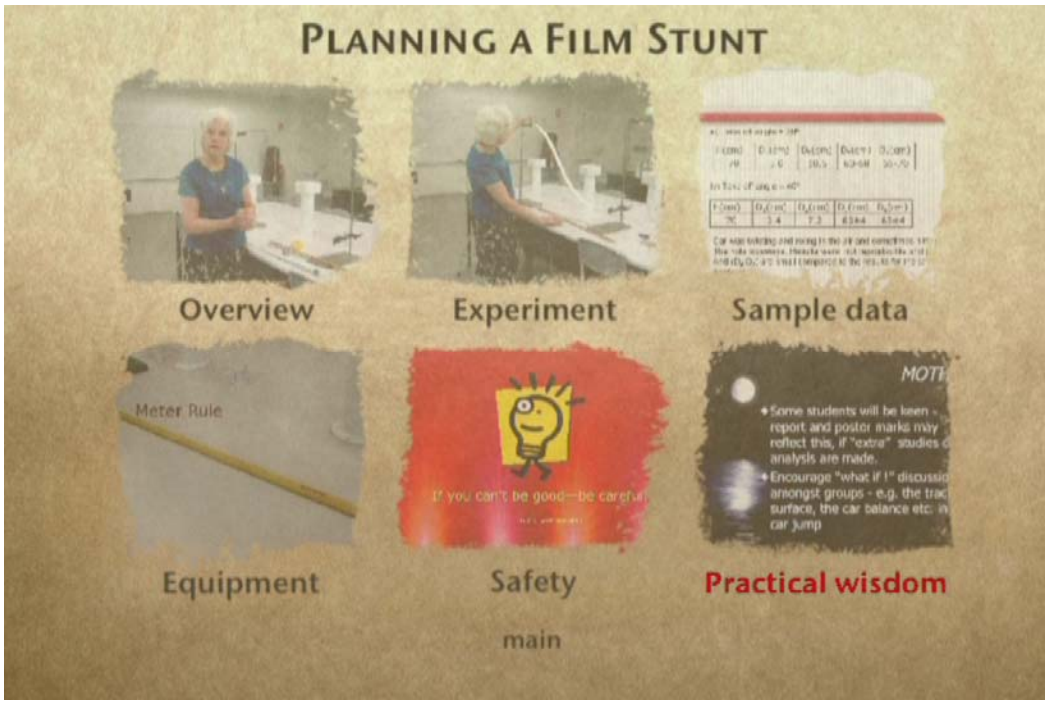

Figure 2. Screenshot of a submenu of Structured Investigation from the DVD

Different DVDs were created for different subjects viz. Physical Modeling (PM), Physical Aspects of Nature (PAN) and Foundations of Physics (FoP). There is considerable overlap of the three different first year physics subjects enabling the usage of some items in more than one DVD. Also, due to larger data volume in PM, we initially brok the contents into two DVDs, while one DVD each was sufficient for PAN and FoP respectively.

Software

Final Cut Pro was used to import movies from tape, edit the movie clips and insert text, titles and subtitles. The finalised movie clips were then exported as .avi files.

DVD Studio Pro was used to create a template for the interface. The various movie clips and slideshows were then structured to produce DVD masters. Miscellaneous software like *gimp, inkscape* etc. were used for graphics. *MS PowerPoint*™ proved useful in producing updatable materials such as PW from demonstrators and the 'voice over' feature of *Final Cut Pro* was used with some slide shows.

Concept testing

The α-version of the DVD was distributed to first year physics lecturers, UTS demonstrators, technical staff and select members of the AIP education community during November, 2007. We did face some technical challenges by a few viewers who could not open the DVDs on some computers or DVD players owing to the particular DVD format. To identify such issues and to get an insight about the usefulness of the DVDs to the demonstrators we organised a focus group session.

Focus Group Session

An independent focus group session was facilitated by Les Kirkup, Physics and Advanced Materials, UTS as an open discussion with seven demonstrators. The session was primarily focused to bring out the usefulness of the DVD to demonstrators. Also, discussions about the interface of the DVD and updatability of the contents were raised.

Initial responses to the DVDs were positive. Here is a quote from one of the experienced demonstrators: 'I would look at the DVD, even being experienced, just to get a few hints. So I would not throw it away and say "I know everything". I don't, I've forgotten a number of things. I'll keep it and have a look at it, even if it's only briefly, I would look at it on the train just to prompt me for the session.'

Communication was identified as a major challenge for the demonstrators, casual suggestions or hints about running the laboratory sessions being hard to pass on. The PW section where the feedback/experiences by the demonstrators are shared is one of the most appreciated parts of the DVD. This module of the DVD can be easily modified and appended. This has also encouraged the demonstrators to communicate with the lecturing staff via e-mails (sending in some suggestions to include in the PW section of the DVD).

One other welcome suggestion that came across in the focus group was to have the content online. This is a good suggestion which may be implemented, though most of the demonstrators prefer having DVDs.

The *safety* section in the DVDs has been appreciated by most of the users as it answers some of the inherent issues regarding the use of some equipment and familiarises them with EHS requirements of UTS (2007/8).

Suggestions were made towards improving the quality of the pictures, e.g. having all the topics pertaining to one subject on the same DVD. These formed the basis of editing in the production of the β-version of the DVDs which were distributed to our demonstrators early this year (before the start of autumn semester, 2008).

Benefit to the students

One of the interesting suggestions from the focus group session was to make the contents available for the students. An unintended outcome of this would likely be that students would copy the steps taken by the presenter, in effect replacing a written prescription that might appear in a cook book

type of experiment with a video based but equally prescriptive approach. This is against the philosophy of physics labs at UTS. Thus, we had to caution our demonstrators against the use of DVDs in the laboratories and emphasise that the DVD is solely for the demonstrators.

The participation of the demonstrators revealed their enthusiasm and also brought forward some of the difficulties that were easily resolved. One of them was having an understanding between the principal demonstrators and assistant demonstrators on a particular class. The DVD was reinforcing the way the experiment could be run during the laboratory sessions. This revealed a positive outcome of creating the DVDs which had not been anticipated. In some instances the DVDs provided assistant demonstrators with significant assurance to run the practical sessions independently in the absence of principal demonstrators.

Conclusion

In the process of developing visual teaching aids to part-time demonstrators, we have been able to foster a sense of self-confidence and encouragement amongst them. The added visual impact of the DVDs along with the printed demonstrator manuals have paved the way for better coordination between the laboratory sessions and teaching in lecture classes. Positive comments from the demonstrators have given us motivation to update and improve the newer versions of the DVDs. The third version of the DVDs has been designed to accommodate the content more compactly. Using Dual Layer DVDs it has been possible to gather all of the Physical Modelling material into one disk and to include extra material in the PAN DVD which had previously been trimmed down to accommodate the limited size.

The utility of having a virtual laboratory resource is not limited to DVDs. It can be extended to podcasts, *Blackboard* etc. Such a visualisation is also customisable for different university laboratory structures. We foresee the use of auto links between printed demonstrator manuals and virtual laboratory resources.

Acknowledgement

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