Practical preparation videos on a zero Rand budget

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Abstract. Due to limited equipment and laboratory space for practicals, students only have a relatively short time to complete their weekly practical. In this time they need to familiarise themselves with the apparatus that they are going to be using, carry out the experimental procedure, and obtain and interpret all the expected results. Their practical manual is comprehensive enough for them to prepare adequately for a practical session. But with the addition of a preparation video to supplement the practical guidebook, the hope was that students would arrive at a practical already familiar with the apparatus and with a clearer idea of what they are going to have to do. A video would also help cater for students with different types of learning methods, in line with universal design for learning. The project was undertaken to produce videos for half of our first semester second year practicals at The University of the Free State. No money was spent buying equipment or software, nor to pay professionals for their services. The assigned demonstrators for each practical were given the task to write the script for and present the video for their own practical. Evaluation of the effect of the videos were done by comparing the students' experience and marks with two other groups. These are the practicals from the previous year, where all the practicals were presented in the same way, but none of them had introductory videos, and also to half of the current year's practicals which did not have videos. The demonstrators also gave feedback on their experience, each of them were responsible for two practicals this year, one of them we made an introductory video for and the other we did not.

1. Introduction

The physics programme at the University of the Free State requires students to complete a practical module during each semester of their three year undergraduate study. This project was part of the second year, first semester practical module. The aim of this module is to introduce students to a higher level of laboratory work, allowing students to develop essential scientific skills, such as reviewing physical problems or hypotheses, constructing experiments to observe physical phenomenon, collecting and analysing experimental data, and drawing scientific conclusions. The module consists of eight practical sessions in which a student must complete one experiment each session. Each student has a study guide containing the background information and written instructions regarding each experiment.

The students work in groups of two with one demonstrator assigned to four groups to provide guidance during the experiment. The students are expected to keep a detailed log book of their procedure and results which is evaluated at the end of each practical session. In addition to this, the students are also required to write pre- and post-practical tests to evaluate their understanding of the concepts in the experiment. Due to limited resources such as laboratory space and personnel time, the students have a set time limit of three hours in which they must complete an experiment. Although the study guide provides comprehensive information about the apparatus and the experiment, many of the student have little experience with practical equipment. This results in students having to spend much of their practical time coming to grips with apparatus rather than focussing on the experiment and the concepts which are meant to be learned. With technology becoming readily available, additional resources such

as videos can be employed to provide better learning tools to students to encourage development and academic success.

In this study the effectiveness of such demonstrative videos is investigated in the context of the practical module. The introductory videos that were made provided only supplementary information to the study guide. Thus the study guide remained the students' main source of information regarding the experiment, with the videos serving to illustrate the equipment, the procedures used, and an example of the desired outcomes. The videos were planned to aid the students in familiarising themselves with the equipment and so that a student could spend more time on the physical concepts of the experiment. While many studies across multiple fields [1] have shown the advantages of employing videos, our aim included a low cost and time approach [2] such that these demonstrative videos could easily be implemented across all practical courses with little extra resources.

2. Method

All equipment used to produce the videos was sourced from within the physics department and the university at no cost. The videos were recorded using two entry level DSLR (digital single-lens reflex) cameras which were mounted on tripods to keep the video steady. One of the cameras was equipped with a 200 zoom lens which was used to capture close-up shots of the equipment, as illustrated on camera A in figure 1. For audio an external microphone was connected to the main camera and a second microphone connected to a cell phone. Several trial video recordings were made to ensure that quality of audio and video quality was clear and that the framing was appropriate. The trial recordings showed that the built-in microphones in the cameras did not have satisfactory audio quality, thus the audio was recorded with the microphone connected to the cell phone. The trial recordings also revealed that the demonstrators had difficulties presenting their experiment flawlessly in one take, thus several shorter scenes were recorded which made it easier and quicker to retake any scenes.

The introductory videos were broken into three main sections. The first was to give a brief introduction about the experiment, the second was to show all the apparatus that will be used and how they operate and thirdly a brief experimental procedure to show the students what they will need to do and a short example of the desired outcome. Because the videos then contained several scenes, attention was placed on keeping both the framing and position of the camera constant throughout the video. Using free video editing software (iMovie and Lightworks) the final videos were produced by combining the recorded short scenes and audio tracks with a short title screen. The videos were rendered at a resolution of 720p or 480p to keep the video size to less than 100 MB, which would make it easier for off-campus students with limited internet bandwidth to view the videos. The videos were distributed to the student using the university's e-learning platform, Blackboard. The aim and emphasis of the videos was not to show the students what they should obtain in their experiment but rather to familiarise the students to the equipment they would use during their experiment.

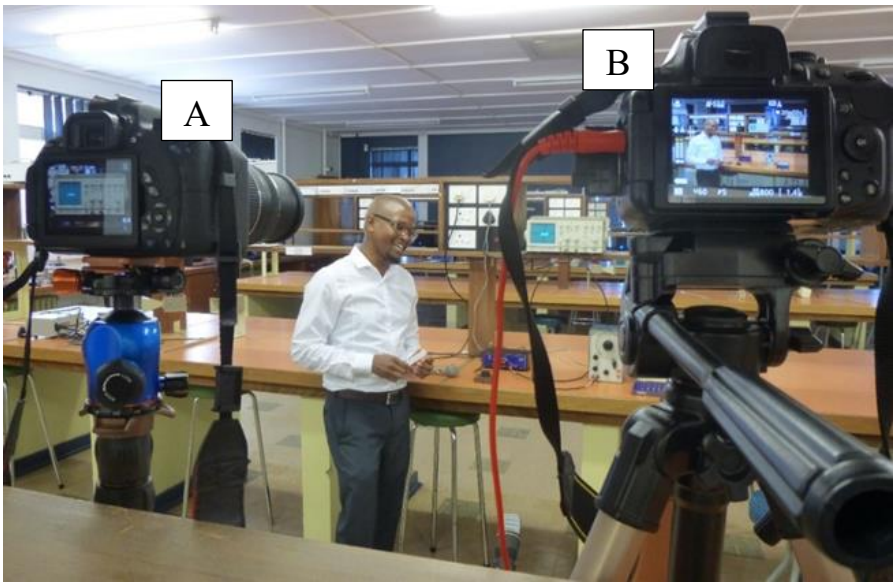

Figure 1: Example of how the videos were shot, camera A with a zoom lens focused on a part of the apparatus, while camera B recorded the whole scene.

3. Student feedback

It was decided to only make introductory videos for four of the eight practicals so that a comparison between the practicals with and without the introductory videos could be made in terms of student marks and experience. To gauge how effective the videos were and how they benefitted the students, a short questionnaire was set up. This was completed by the students at the end of each of the practical sessions that had an introductory video. The aim of the questionnaire was to see if the project was worth continuing with and/or expanding, and to guide the making of the next set of introductory videos.

The first questions that needed answering was whether or not the students actually watched the videos, where they watched them and on what type of device. These questions are crucial for the right choices to be made in future about the size and format of the videos. Positively, 85 % of students did watch the videos: 50 % of them did so on campus (where they can use the university's internet without cost) and under 20 % of the students watched the videos on a mobile device. This data is summarised in figure 2.

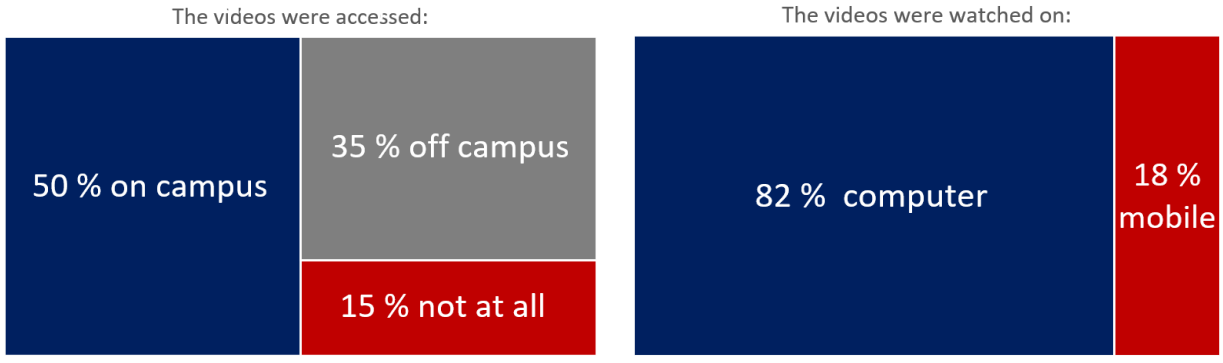

Figure 2: Where and on what type of device students watched the videos.

The next part of the questionnaire was to see how the students' understanding of the practical improved. The majority of students gave positive feedback that the videos helped them to better understand the aim of the practical, how the apparatus works and how to do the experiment (figure 3).

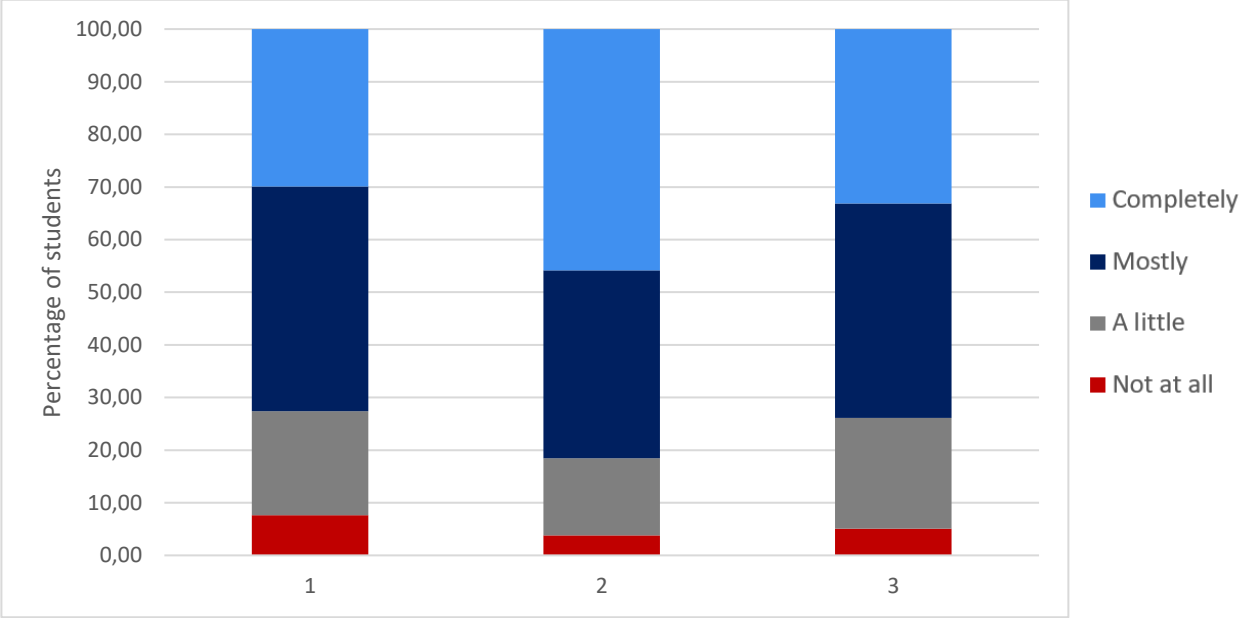

Figure 3: How the students felt the videos helped them better understand (1) the aim of the practical, (2) how the apparatus works and (3) how to do the experiment.

The students were also asked for feedback on what they liked about the videos (figure 4). Students liked the explanation and demonstration of the apparatus, and how to use it and go about the practical. They also remarked that the videos help them see what will be expected of them during the practical, and a number of students said that they like that the videos were concise and short. Positive remarks were also given about the overall quality of the videos and the way the demonstrators presented the videos.

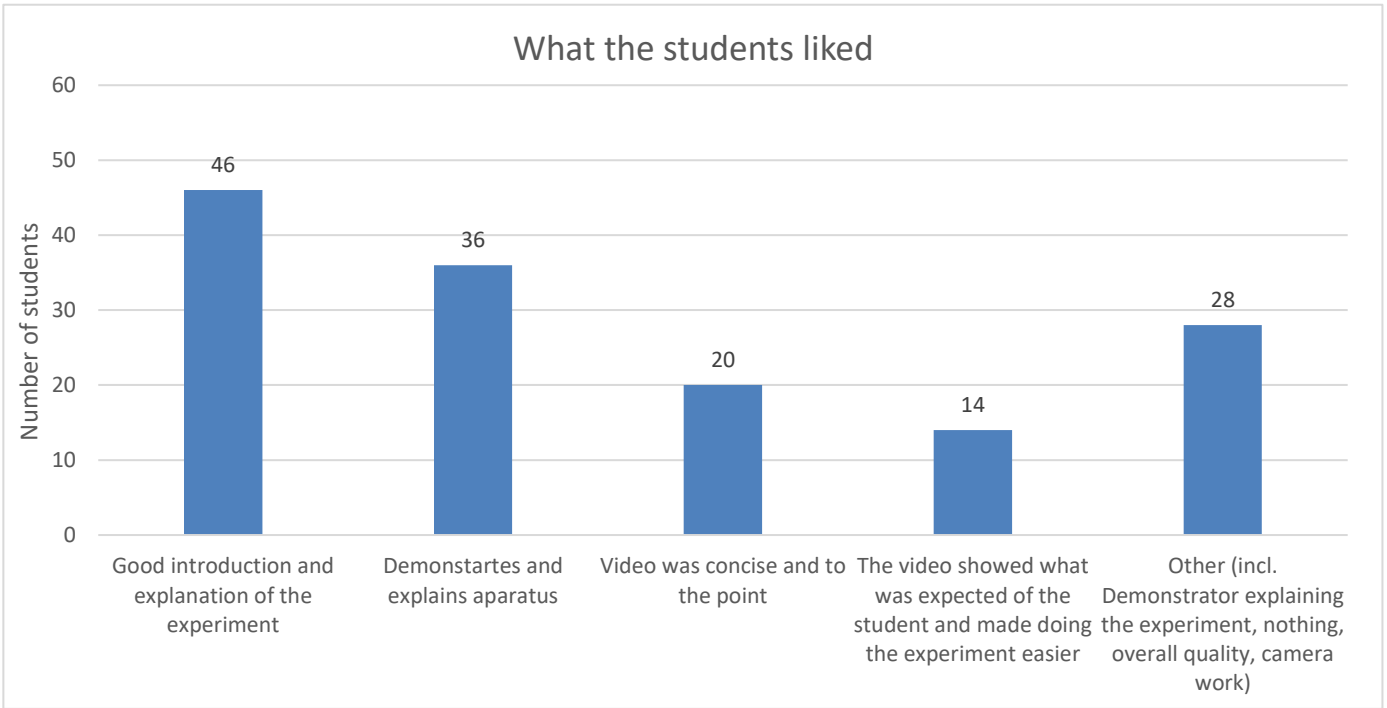

Figure 4: What students liked about the videos.

Figure 5 shows students' feedback on what about the videos could be improved on, more than half simply said that the videos are good enough as they are. Some students wanted more in depth

explanation of the apparatus and on how to do the experiment, this however is not the aim of the videos, the videos are meant to only be a short introduction and demonstration to supplement the practical manual, and not to replace it. A few students felt the video and especially the audio quality should be improved, this was expected considering the quality of the microphones used.

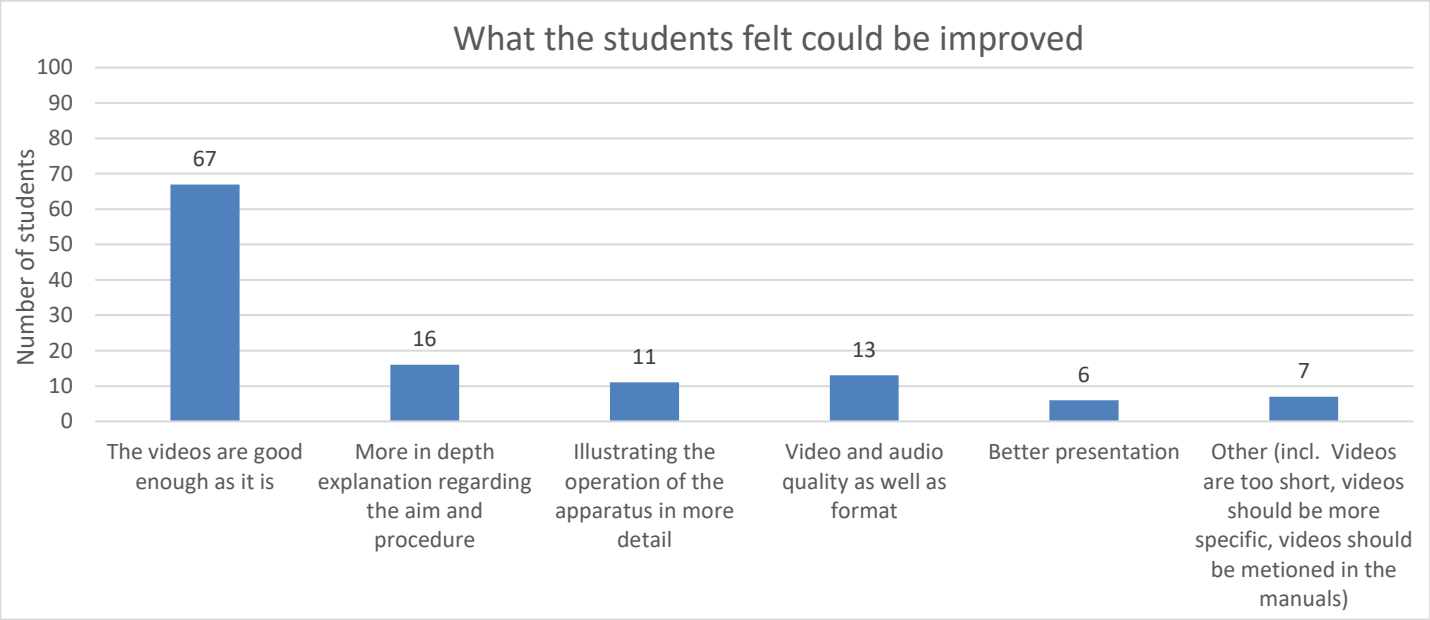

Figure 5: Suggestions made by students to improve the videos.

To consider the effect of the introductory videos on the students' performance, average marks for the practicals were compared for 2017 (59 students) and 2018 (55 students), with the results shown by the bars in figure 6. The results are neutral since the marks for two of the practicals showed an improvement but the other two did not. A direct comparison of marks is difficult because the demonstrators for the practical were not the same as in the previous year and this could have introduced a bias based on their individual styles. Since only half of the practicals had introductory videos in 2018, the effect of the change in demonstrator or class could be compensated for by considering the difference in average marks for the practicals having no introductory video. Such compensated mark levels are shown by the black dotted lines for the 2018 data in figure 6 and indicate that the conclusion that the results are neutral remains unchanged.

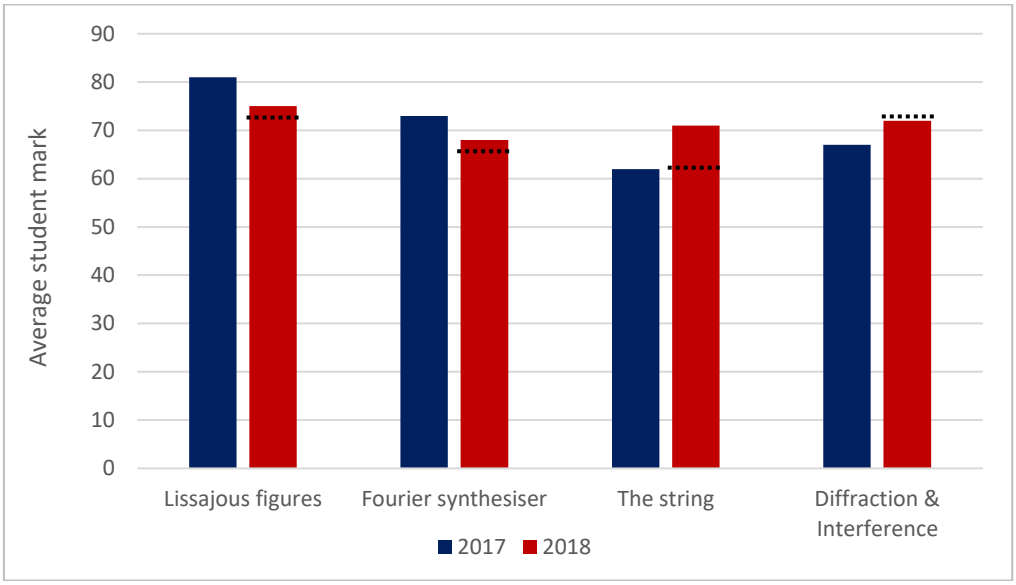

Figure 6: A comparison of the average student marks for 2017 (no video) and 2018 (with video). The black dotted lines for the 2018 results consider a possible adjustment to the 2018 marks for better comparison, by compensating with the difference of average marks demonstrated by the same persons for practicals having no introductory video in both years.

Although there was no clear improvement in marks due to the videos, they were still considered of value. To get a better sense of this, the students were asked to complete a second questionnaire after completing all the practicals, but before the practical exam which consisted of a written part and a practical part where the students repeat a small part of each experiment done during the semester. This time they were asked about their overall impression about the role the videos played in how they experienced the practicals. Again, as can be seen in figure 7, most of the answers were positive. In particular, the students felt overwhelmingly that the videos make it easier and quicker to prepare and helped them better understand what they were doing during the practical. Also, exactly half of the students indicated that they had used the videos to help them prepare for the practical exam.

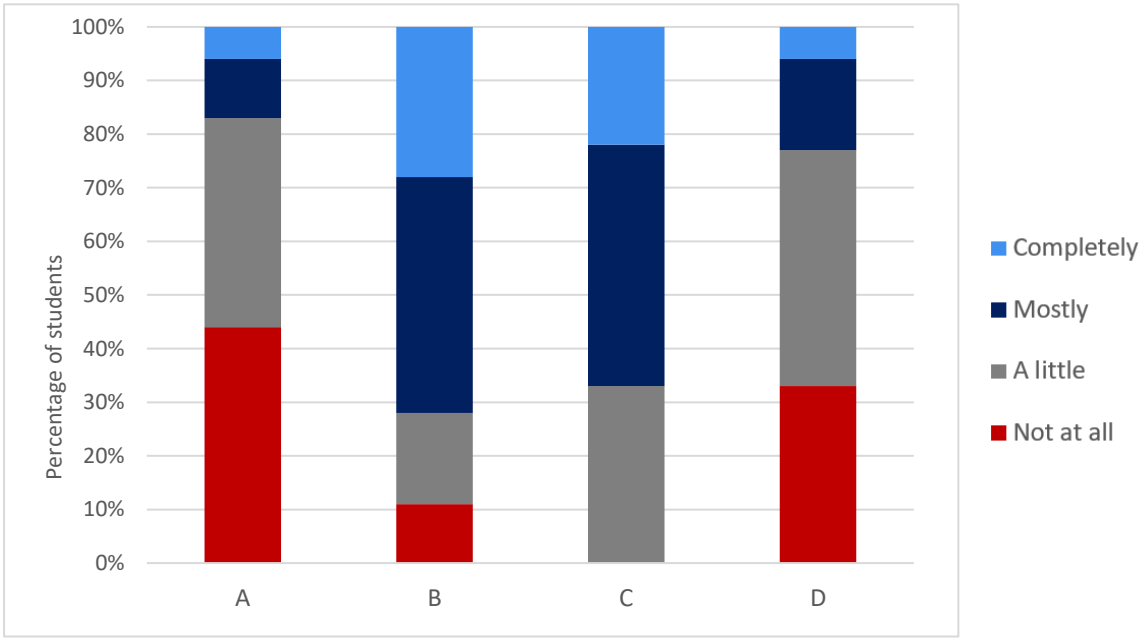

Figure 7: Students' response to the questions: Did watching the videos (A) make you feel less nervous about the practical? (B) make it easier and quicker to prepare for the practical? (C) help you better understand what you were doing during the practical? (D) help you finish the practical in time?

At the end of the semester the four demonstrators were also asked to give feedback on their experience of the project. For all of them it was the first time that they did something like this, and they all enjoyed and learned from the process of making the videos. Writing the script for the videos helped them prepare well for the practicals, and they all felt that the videos helped them and the students to successfully complete the semester. A few of their comments are shown in figure 8.

Figure 8: Feedback from the demonstrators.

4. Conclusion

As a result of to student participation, it was found that the videos helped most students in some way, be it to help them prepare more effectively, enter the practical session more at ease and knowing what is expected from them, or understanding the apparatus better and finishing on time. The demonstrators learned quite a bit from the making of the videos and it also helped them prepare for the semester. The feedback from the students also provided valuable information regarding the format, content and quality of the videos. For the next year, the project will be expanded and all eight of the practicals will have introductory videos. The demonstrators for the practicals will again be responsible for writing the script for and presenting the videos for their practicals. They will also in the future be involved in the editing of the videos. The type of content and format of the videos was found to be satisfactory and will remain the same. It was effective to keep the videos concise and to only use the videos to supplement the physical practical manual. The same cameras and free software will be used, while the only cost to expand the project will be to purchase a better quality microphone.

References

[1] Croker K, Andersson H, Lush D, Prince R and Gomez S 2010 Enhancing the student experience of laboratory practical through digital video guides *Biosci. Ed.* **16(1)** 1-13

[2] Hansch A, Hillers L, McConachie K, Newman C, Schildhauer T, Schmidt J P 2015 Video and Online Learning: Critical Reflections and Findings from the Field *SSRN e-Journal* http://dx.doi.org/10.2139/ssrn.2577882