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USE OF ON-LINE VIDEO FOR MATHEMATICS PEER INSTRUCTION: A PILOT EXPERIENCE

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Abstract

The learning of mathematics is often associated with established prejudices, such as a belief that it is a difficult and boring subject. The association of mathematics with a passive learning process, involving a teacher/lecturer writing on a board and the students simply following or copying what is written, accentuates that perception. This paper presents a pilot project for mathematics peer instruction using on-line videos created by the students. The context of the project is an engineering mathematics foundation module in an Irish college of engineering, covering basic engineering mathematics prerequisites. The course is open to a wide range of students with varying educational backgrounds, making student engagement and the maintenance of a positive attitude towards the topics particularly important.

Results from the pilot demonstrate the potential for increased student engagement with the subject matter, as well as an improved attitude towards the discipline. The students recognized the need to focus and develop a clear understanding of the problem and the path to the solution as the main benefit of the video making process. The students involved in the pilot project valued the use of on-line instruction materials created by the lecturer or available from other sources. However, they showed a stronger preference for peer and own videos over more institutional material.

Keywords: peer instruction, online instruction, video instruction

1 INTRODUCTION

1.1 Introduction

Traditionally education placed the students in the role of content receiver. Students had been generating content but with a limited audience (the teacher/lecturer). The availability of technology and the level of confidence and expertise of the students using them (digital natives) provide a context for digital student generated content that can be shared among their peers for revision and discussion.

The integration of online videos in the learning process has the potential to bring the learning experience closer to the students' world and can improve their attitude towards the discipline.

Two different approaches can be identified when integrating online videos into learning: it can involve the student reviewing videos online that will provide solutions and explanations to relevant problems (Khan Academy and YouTube contributions being familiar examples worldwide) or the student actively creating the solution and the video associated with it. Both processes create an appropriate thinking framework for problem solving in general and mathematical problem solving in particular.

Furthermore, reviewing other students' work will provide the student with the experience of following different approaches to the final solution.

The context of this project is an engineering mathematics foundation module in DIT's college of engineering covering basic engineering mathematics prerequisites. The course is open to a wide range of students with varying educational backgrounds, making student engagement and the maintenance of positivity towards the topics particularly important. In some cases, the diversity of students can contribute to a general lack of engagement and can be a particular challenge for the lecturer.

This paper will describe the two approaches to the generation of educational videos: created by the instructor or by the student as a formative activity. The research was conducted with a class of fourteen students attending a preliminary mathematics module. All students were given access to lecturer and student generated videos.

The question being addressed is:

Is the use of video in peer instruction a tool for increased student engagement in a mathematics course and does it improve their attitudes towards the discipline?

1.2 Literature review

The use of videos in educational contexts has become increasingly popular, mainly in schools but also in third level institutions [1]. It has also become an area of interest for researchers in the area of education and technology in education. This interest has focussed in different aspects of the usage of videos, such as the authentic nature of learning, motivation, achievement of deeper thinking, creativity, self learning and engagement. However the application of on- line videos and other Web 2.0 tools are still often centred on expert-vetted content [2].

Research carried out at an engineering college [3] demonstrated that the use of videos created by the lecturers has a positive effect on students' learning motivation, reduction of student absenteeism, their ability for self learning, reduction of face to face tutoring and facilitation of comprehension of complex engineering problems. Furthermore, it is a low cost resource that does not involve intensive or extra training for the lecturers. This research also provides recommendations on limiting the amount of information per video and their duration, and defining the content of the videos very precisely.

One of the main advantages found by students using on-line videos in education was the individual control of pace which allows diverse groups of students to learn the same content adapting the learning pace to their needs [4]. In the context of a college classroom with mature students, international students, students with disabilities and the wide diversity range of students encountered, the self pacing of material can provide the flexibility the lecturer lacks of due to time and space limitations. With the use of on-line videos part of the learning process becomes asynchronous and independent of the location providing extra flexibility.

An evaluation of the use of videos for teaching and learning purposes states that pupils respond better to materials produced by their peers and educators as they feel more comfortable in a familiar environment whereas professional material can be seen as more streamlined education and the innovation factor can be hidden under the corporative look [5].

The need of a well structured problem and questions that challenge the students has been evaluated in different studies [6], [7]. Further studies point at the potential for technology to obstruct the learning process as students may focus on the medium itself and forget about the fundamental concepts [8] and [9].

One of the first benefits of peer instruction is the inclusiveness of the method. In the traditional face to face lecturer-student situation a question from the lecturer will usually engage only a few highly motivated students whereas a peer instruction scenario will engage every student in the class [10].This effect can be prolonged to the on-line version of peer instruction with the appropriate set of rules [9].

The use of peer instruction provides the students with a set of transferable skills which include converting their thoughts to language, explain, simplify and clarify problems, rehearse, summarize and revise their work among others. In a face to face situation the use of peer instruction can loosen blockages to learning. In this context the cognitive demands upon the helper are greater than upon the learner as they have to monitor the learner's progress and detect and correct errors [11]. In an on-line version of peer instruction mechanisms have to be created to facilitate the discussion and continuity of the interaction from the on-line starting point to the classroom.

In the context of Kolb's learning circle and learning [12], the use of student generated videos can be considered to cover two main categories: the active experience and the reflective observation. The active experience presents a new challenge to the student that will experiment with different techniques and methods to find the appropriate solution to the problem. The reflective observation will happen in the second part of the process were all students will interact with their own and their peers' on-line resources and reflect on the material and the different approaches found in the solutions.

The use of on-line student generated resources involves a change in the traditional roles for educators and students. The educator becomes a facilitator, ensuring that the shared knowledge is valid and reliable [2]. The student becomes the creator of material which provides him/her with a sense of ownership and in the process the students gain more self confidence [13].

In summary, the resources and literature in the area of online video and student generated video in particular, show this to be an expanding and beneficial tool for learning that needs further exploration [14].

2 METHODOLOGY

The research was conducted with 14 students in an engineering mathematics foundation module in DIT's college of engineering over the spring semester of 2012. The module covers basic engineering mathematics concepts.

Each of the 14 students was assigned a particular problem as part of their year course work. The video task was included as a question in one of two assignments and it contributed towards the final mark as a sixth of that assignment's mark (15%). All questions in the assignment were marked equally including the video task.

The students were given a week to study their individual problem and find a suitable solution. This solution and the reasoning for choosing a particular method and checks performed on the solution had to be recorded and submitted for online distribution among the members of the class.

The recordings were facilitated by readily available technologies such as smart phones, laptop cameras and USB web cams. These were made available to the students in the classroom; however some of the students preferred to create their videos at home using their own resources.

A group interview was conducted among the students to analyse the effects of the exercise on the students' engagement with, attitude to and knowledge of the particular topic.

The following questions were asked in the group interview to spark conversation and debate:

- How did you find making the video?
- Do you feel you benefited from making the videos?
- How did this reflect on your ability to solve that particular kind of problem?
- Did you look at your peers' videos?
- Did the videos help in your revision?
- Do you feel you benefited from watching the videos?
- Was the format of the videos appropriate?
- Did you find difficulties when making your video (technical or other)?
- General comments about the process

3 RESULTS

3.1 Findings from group interview

The students found the process stressful but beneficial. The need for a clear and correct solution and an understandable reasoning forced them to think about the question and the techniques and methods involved beforehand. The students spent longer in the pre solving phase than they would usually.

They needed to study the problem before starting with any calculations, which increased their awareness of the topic and the different techniques involved. The pressure of being recorded while solving their exercise helped them to focus on the techniques and methods involved.

There was a general agreement that the process of making the videos was most beneficial to them. A few students primarily viewed their own video on line and stated that this was the most useful part of the project. They felt they organized their ideas for the video recording. Therefore, by watching their own video they get their own vision of the problem/solution and in the most suited way for their understanding.

The marks allocated to the video were an encouragement to engage in the project and the students felt the extra marks were worth the effort.

Most students used or are planning to use the videos for revision. The ability to "stop and try it themselves" was found to be a very helpful feature that was used during revision times. Self-pacing and the independence, asynchronous access to the material were found to be one of the main advantages of the on-line videos.

The students commented on the difficulties encountered: quality and size of the videos, visibility of the writing and the synchronization between the oral explanation and the hand written solution.

Some students suggested a template to make all the solutions look similar in format but most of the students thought it would curtail their own set up of the problem if they had to fit their answer into a particular format.

It was the first time they were recording an educational video and they found it interesting and challenging. The fact that the videos were placed on a commercial site under the control of the lecturer was not an issue for the students. They felt they did not want more control over the release or editing of the videos as they preferred to focus on the mathematical problems and no extra technical burdens. It was agreed that the videos would be privately released to the class members exclusively.

3.2 Lessons learned

Videos are a useful tool that can help students reflect on problems and bring structure to their thoughts and to their solutions to particular problems.

The active learner approach to online videos, where the students solve a problem and disseminate that solution to their peers via online videos, showed that it can increase student engagement in deeper thought, increase motivation and provide confidence for weaker students. The pilot experience showed an increase engagement with the subject matter that materialized in higher rates of class attendance and higher rates of assignment submissions.

These online videos contributed to increased integration of students with different foundation levels as weaker students are given the chance to review the videos at their own pace. They can also see how their solution is useful to other students, which encourages further engagement and confidence.

Formative assessment including the use of technology not only increases engagement but it also enhances the students' transferable skills.

Aligned with other research one of the findings of this project was the preference for peer and own videos over more institutionalized material.

4 CHALLENGES AND LIMITATIONS

A number of challenges arose during this pilot experience. The first one of these challenges being an initial reluctance from the students to show their work to their peers. The incorporation of the videos to the formal assessment of the module encouraged them to participate fully. This motivation was not affected by the fact that the actual figure allocated to the videos was around 2% of their final mark.

The second challenge for the pilot was the acknowledgement of social factors as access to technology and digital exclusion. The pilot provided an environment were no student felt excluded. Most students created their videos in the classroom using the same technology provided by the lecturer. Given the limited size of the cohort it was possible to facilitate and integrate the assessment in the classroom; however it might prove more challenging with a bigger cohort of students.

During the process of recording minor issues arose, such as students suffering from public speaking anxiety or lack of rehearsal of the oral explanation which implied several versions needed to be recorded. All of these issues were due to the inexperience of the students in the

process and they were solved with practice. A few students created their first video with no oral explanation but they realized the video was easier to follow with the explanation and all of them added oral explanations for their second video.

The videos were posted online under the control of the lecturer and all the exercises were revised before posting. The possibility of giving the control of the editing and posting to the students was discussed and the students in this pilot preferred the lecturer to be in charge of that part. The amount of time involved in editing and posting is considerable and can be a limitation for other modules with more students.

5 SUGGESTIONS FOR PRACTICE / FUTURE WORK

The findings from this research have proven the benefits of using student generated online videos, however the scope of the study was limited by the class size and the fact that it was dealing with one particular topic.

Further work could include the analysis of these techniques when applied with larger groups and on a variety of areas of knowledge. As discussed in the challenges and limitations section the management of larger groups may require extra resources such as extra recording facilities or a teaching assistant to facilitate them. A possible solution to this problem would be to create working groups in the class which would be responsible for the recording, editing and posting of the group member's videos. This would also provide extra ownership of the material and independence in the execution that can be valuable to the students in the future.

Further study of the impact of these techniques in engagement and attitude could be performed with different groups of students at different levels. A quantitative study of the attendance and performance of students taking part in on-line peer instruction could provide extra information about the benefits of this method.

Analysing the students' perceptions with a wider and more varied set of students such as mature students could provide valuable information on the learning process and the added value of the online videos.

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