LEARNING MATHEMATICS THROUGH THE MAKING OF VIDEO EXPLANATIONS FOR A MULTI-LANGUAGE DATABASE

[1]Anita Campbell and [2]Manuella D'Oliviera Pio

[1]Academic Support Programme for Engineering, [1]Centre for Research in Engineering Education, [2]Department of Electrical Engineering, University of Cape Town

The move from high school mathematics to university level mathematics is a big leap for first year students. The use of videos for learning mathematics is advantageous in two ways. Firstly, making short videos in groups uses constructivist characteristics such as the learning being active, collaborative and motivational. Secondly, videos that have been made can be a resource for other students. Home language explanations are a type of academic support that might help new students adjust to a predominantly English learning environment, especially early in their first year. This paper reports on an on-going action research study on building a multi-language database of video explanations, where students collaboratively made video explanations for including in the databank using Blackberry Torch devices.

THE FOCUS OF THE PROJECT

This research proposal describes the development of a platform to share multi-language video explanations made by first year mathematics students. As part of an on-going action research study, we are interested in these research questions: How can we best support students in making videos and how can the videos be set up on a database so as to promote ease of use and learning? We also examine possible ways in which the effectiveness of the database can be measured.

MOTIVATION FOR THE PROJECT

Statistics on students in the Academic Support Programme for Engineering in Cape Town (ASPECT) show that 50% of first year students are likely to graduate with an engineering degree, and their progress from first to second year is generally with low marks (Pearce et al. 2012). From 2000 to 2008, the mathematics and physics class averages of ASPECT students were only slightly below mainstream students, but the class averages of both groups were generally below 60%. There is a clear need to help more students pass and to pass with better understanding so that they are more likely to graduate. These are also the students that we have had access to for video production by students since one author is a lecturer in the ASPECT programme.

Many factors affect students' success at university. First generation students, as many ASPECT students are, have potentially more adjustments to make in their first year and beyond, particularly if they are also low-income students (Engle & Tinto 2008). Learning in a predominantly English environment with little home language support is an additional challenge faced by some students.

Campbell, A. & D'Oliviera Pio, M. (2013). Learning mathematics through the making of video explanations for a multi-language database. In Z. Davis & S. Jaffer (Eds.), *Proceedings of the 19th Annual Congress of the Association for Mathematics Education of South Africa*, Vol. 1. (pp. 230 – 234). Cape Town: AMESA.

The use of short videos as a learning tool has increased due to the widespread availability of devices capable of taking good quality videos. Students can learn from online videos on sites like the Khan Academy (www.khanacademy.org) or from vodcasts of lectures for courses that they are currently taking. Video production by students is emerging as an educational technology, as seen by sites such as http://studentmathmovies.wikispaces.com/ and http://www.mathtrain.com/ where primary school students showcase their videos.

The potential value of creating a multilingual searchable databank will be that:

(1) students who make the videos themselves tend to learn the mathematics more meaningfully than if they had to explain the mathematical concepts verbally;

(2) students learning completely in English for the first time and finding it hard to grasp mathematics concepts, can have access to some home-language translations;

(3) this could be developed into a platform where first year students can get to know one another or link to senior students who made the videos a year or two before and who can play a small mentor role.

THEORETICAL FRAMEWORK

This project takes the form of action research (Kemmis & McTaggart 2005), and is part of the second major cycle of planning, acting, observing and reflecting. The first cycle was reported in Campbell (2013). Video production by students is a form of active learning, involving collaboration between students, both having roots in constructivism. Making a video or making comments on a video that will be seen by other students might help students to become part of a 'community of practice' (Lave and Wenger, 1991). The use of technology in teaching is seen as motivational to students from a generation who already use it in their everyday lives.

Simply watching videos can be a very passive experience. A goal of the database is to engage students more. This could be achieved through a 'liking' feature or establishing a place for comments. The lectures on the site http://ed.ted.com have three tabs displayed for each video: Watch, Think and Dig Deeper. The Think tab allows you to take a comprehension test based on the explanation either as a multiple choice quiz that is immediately marked, or a longer open-ended question with no answer given while the Dig Deeper tab provides links to further resources or something more on the topic. They encourage using customized versions of these videos and quizzes to 'flip the classroom' (Fulton 2012) by assigning as homework the viewing of the videos and answering the quizzes and spending class time on collaborative work and more advanced questions. This second major action research cycle in this project will look at ways to incorporate interactive features such as these in the database of videos.

LITERATURE REVIEW

There is a growing body of research pointing to ways in which videos have been used successfully in teaching and learning (e.g., Snelson 2008). We are interested both in learning that happens as a result of producing videos as well as learning through watching and engaging with existing videos through posting comments, answering quizzes or rating the videos. We will explore literature on both types of learning.

An example of literature involving video production in mathematics learning is work by Karppinen (2005) who considered six characteristics of meaningful learning in relation to digital and online video material and pointed out the importance of integrating video production or viewing into other learning tasks or resources. The characteristics were drawn from constructivist-based literature and describe meaningful learning as (1) active, (2) constructive and individual, (3) collaborative and conversational, (4) contextual, (5) guided, and (6) emotionally involving and motivating.

The premise that alternative language translations would be beneficial to new university students is based on personal discussions with students who have noted that adjusting to the almost all-English environment was the biggest challenge in their first year of study. The expanded study will explore literature that can show how widespread this challenge is.

Applied or "word" problems are known to be perceived as difficult to many first year university students (Craig 2002; Klymchuk et al. 2010). This provides motivation for focusing the development of the database on such questions rather than more symbol-heavy, low-word questions.

We will also consider literature on how to make videos, for example Quillen (2013) reports that the optimum length for an educational video seems to be 2-3 minutes. The discovery of this claim by the founder of the mobile video business, Vuclip, made us reconsider guidelines for students making the videos.

METHODOLOGY

Reflections from the previous action research cycle have informed some of the changes in this cycle. These are discussed under two headings: *Development of the database* and *Video production*.

Development of the database

A University of Cape Town (UCT) branded Word Press site was set up with the URL: mathsinyourlanguage.uct.ac.za. A YouTube channel was established which would store the videos that would be accessible through the WordPress site. We investigated ways of linking to other platforms where students can watch more video explanations on a topic, such as Math TV and Khan Academy. We also tried to make the database more interactive by setting up a place for students to rate and comment on the videos.

However, consultation with a lecturer in Information Systems (IS) at UCT led to a different direction for the database development. The design and creation of the database was proposed and accepted as a topic for a group project by four final year Information Systems students, supervised by a senior lecturer from IS. This entailed the students developing all aspects of the database from scratch rather than making use of any existing platforms such as YouTube, Facebook or the university's online management system. The database is due to be completed in September 2013.

In order to improve the quality of the videos put in the database, various video editing packages were investigated. The limitations and advantages of the packages considered will be discussed.

Video production

A major concern is that the videos the students make have to be of sufficient quality to be used. In the first action research cycle, students were given a 45-minute presentation by a senior film and media student on how to make good mathematics videos using the Blackberry Torch devices that the students used. Although the quality of the presentation was high, it didn't seem to match the varied experiences and needs of the class. In reconsidering the means of providing technical support and knowledge to students in this cycle, we looked to compile a brief hand-out that could be given to students as a reference, warning of common mistakes and encouraging best practice while making videos. The online learning management system used by the course would contain further video production tips for interested students to access. A summary of good practice for video production was compiled based on a review of videos in the first cycle and observations of instructional videos on a variety of websites (see Figure 1).

1. Make sure the question being answered is read clearly and audibly right at the beginning of the video, as well as a mention of what topic the question falls under.
2. If the question has several parts, first read out and show all the parts beforehand, and then read out each part as it is tackled.
3. Zoom in and out correctly to highlight the parts being answered.
4. Preferably no actual person should be present in the video; but a clear voice and a clear shot of the question and steps to the solution is vital.
5. Use of different colours to highlight different parts being answered.

Figure 1: Good practice for video production

Reviewing the videos from the previous action research cycle led us to feel that certain topics would be better suited to video production. Generally, questions involving applications were more likely to have contextual settings that would be usefully described in other languages, such as optimization questions, compared to more mathematical questions using jargon terms, such as "Evaluate the given limit."

The assessment of student learning as a result of video production will be investigated in this action research cycle. Using the principle of triangulation, observations on the video production will be made in three ways: (1) students' views will be gained through an anonymous, online evaluation, (2) the researchers will make observations during the tutorials when videos are made, (3) the lecturer for the course where video production will be used will be informally interviewed to gain her views on the experience of having students make videos and how it may have impacted their learning as observed in tests and questions asked.

In the next semester's action research cycle we would like to get feedback from students who found the site useful and if this has in some way helped their progression to second year.

REFERENCES

Campbell, A. (2013). Building a multi-language database of video explanations for first year mathematics. In N. Tisani & M. Madiba (Eds.), *Proceedings of the Higher Education Learning and Teaching Association of Southern Africa (HELTASA) 2012 Conference*, 28 – 30 November 2012, Stellenbosch University, (pp. 5-11). Available from http://yourls.sun.ac.za/heltasaconfproc2013, accessed 9 May 2013.

Craig, T. (2002). Factors affecting students' perceptions of difficulty in calculus word problems. In I. Vakalis, D. H. Hallet, C. Kourouonoitis, D. Quinney, & C. Tzanakis (Eds.), *Proceedings of the Second International Conference on the Teaching of Mathematics at the Undergraduate Level – ICTM-2*. Crete, Greece: Wiley, CD format, #411.

Engle, J. & Tinto, V. (2008). *Moving beyond access: college success for low-income, first-generation students*. Washington DC: The Pell Institute for the Study of Opportunity in Higher Education.

Fulton, K. P. (2012). 10 reasons to flip. *Phi Delta Kappan*, 94(2), 20-24.

Karppinen, P. (2005). Meaningful learning with digital and online videos: Theoretical perspectives. *AACE Journal*, 13(3), 233-250. Available from www.editlib.org/p/6021, accessed 17 March 2013.

Kemmis, S. & McTaggart, R. (2005). *Participatory action research: Communicative action and the public sphere*. New York: Sage Publications.

Klymchuk, S., Zverkova, T., Gruenwald, N. & Sauerbier, G. (2010). University students' difficulties in solving application problems in calculus: Student perspectives. *Mathematics Education Research Journal,* 22(2), 81-91.

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. UK: Cambridge University Press.

Pearce, H., Campbell, A., Craig, T., Le Roux, P., Nathoo, K. & Vicatos, E. (2012). The articulation between the extended (5-year) and mainstream (4-year) programmes in Engineering at the University of Cape Town: Reflections and possibilities. Paper presented at the HELTASA Foundations Programmes Colloquial in Pretoria, June 2012.

Quillen, I. (2013). What Will It Take to Bring Mobile Ed to the Developing World? *MindShift*. <http://blogs.kqed.org/mindshift/2013/02/what-will-it-take-to-bring-mobile-ed-work-to-the-developing-world/?utm_source=feedburner&utm_medium=email&utm_campaign=Feed%3A+kqed%2FnHAK+%28MindShift%29>, accessed 8 March 2013.

Snelson, C. (2008). YouTube and beyond: Integrating web-based video into online education. In K. McFerrin et al. (Eds.), *Proceedings of Society for Information Technology & Teacher Education International Conference 2008* (pp. 732-737). Chesapeake, VA: AACE. Available at http://www.editlib.org/p/27254, accessed on 10 May 2013.