Improving Students Learning and Achievement in Mathematics by Using Smart board

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Abstract

Mathematics skill deficiencies for entrants into degrees are well-documented. Quizzes at the first month of semester and mid-term test confirmed that incoming students to the Shahid Rajaee Teacher Training University lacked basic mathematical skills. In 2011 visual learning resources were created using smart board, an interactive whiteboard, to help students fill the gap between high school and university mathematics. They were also used to support student learning in subjects. The visual resources demonstrated and discussed how to start and complete mathematics problems. They enabled students to develop their conceptual understanding of mathematics at their own pace, in their own time and with feedback. The visual resources enabled weaker students to catch up and additional resources were subsequently developed to sustain improvements in new topics. This paper discusses the production process of the visual resources and provides an overview of their impact.

Key words: mathematics, smart board, high school, university

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Introduction

The decline in students wanting to study mathematics at school has led to students entering university who are ill-equipped to handle the mathematics required in their courses. Such trends have been identified worldwide, in Canada (Kajander and Lovricz [6]), in France (Artigue [1]), in Japan (Hoyles et al. [5]), in the United Kingdom (Walkden and James [14]) and in the United States of America (Wilson [15]). Consequently there has been a high failure rate amongst students taking first year mathematics subjects. The representation of mathematical symbols online is seen as a way to deliver resources that can help solve this problem. However, representing mathematical symbols online is not simple especially if the pedagogical requirements demand line-by-line or character-by-character development of a mathematical argument.

Mathematical visual resources were developed using a smartboard. The visual images were of handwriting a mathematical answer to a pre-written question with the voice of an unseen person explaining the developing solution.

Resources were created for topics in a subject and combined definitions, rules, and questions for the students to answer. For each subject a printed worked solution was provided as well as a video solution. The video solutions combined audio and visual components.

The literature revealed that video resources have better learning outcomes than visual-only or audio-only presentations (Kozma [7]). Video resources or resources combining audio and visual components have been used to improve a range of student learning outcomes including:

Motivation to learn and attitudes (Wood and Petocz [16]);

Enjoyment and interest in finding solutions (Overbaugh [12]);

Remembering and understanding of content (Juneau [10]);

Learning and transfer of learning (Choi & Johnson [4]);

constructing rich mental representations that improve the transfer of knowledge (Chambel et al. [3]);

Problem-based learning (Overbaugh [12]);

Recall, comprehension and retention (Kozma [7]) and

Reinforcement of learning (LeeSing and Miles [8], Mayer [9], Moreno and Mayer [11], and Veronikas and Maushak [13]).

The literature provided examples of the many ways in which video resources have been used successfully to improve learning. However, it did not adequately address the many choices that must be made when producing video worked mathematical solutions as learning resources. Therefore, these decisions were left to the researchers, acting as teachers, in determining how much or little to present, both in terms of spoken text and visuals.

Production

Perhaps the most obvious video production style for this use would be to record a person solving a problem on a whiteboard or blackboard. This approach has been used at some universities. However, it was believed that the image of the teacher could be a distraction. Also there was a concern that the solution would not be rendered large enough to be easily legible without complex video editing and multi-camera recording. As the video files were to be delivered via the internet or a DVD, the size of the file had to be limited so that students could access them from limited bandwidth connections.

Any interactive whiteboard can transmit/convert all notes and diagrams written on the whiteboard to a Windows as a digital file as they are written. They can then be viewed, edited, shared, saved and printed.

The video resources were captured using a readily available smartboard at the School of Mathematics, Faculty of Science, Shahid Rajaee Teacher Training University (SRTTU). The solution was written on the smartboard by the same person who operated the video capture equipment. The solver wrote each solution on the smartboard. The video output was captured and edited using a computer application.

The resulting files needed to be edited for timing. If the solution was played at the speed it was recorded at, then the answer appeared at a rate that seemed very slow to a viewer. This slowness was partly due to the solver sometimes had to stop to think about what to write next. To produce a video in which the solution develops at a ‘natural’ speed the video file was edited. The video solution was then compressed to decrease the file size and hence download time. However, whether this was desirable depended on the size and quality of the handwriting. When the video was compressed to decrease download time, it became increasingly difficult to read the solution.

Initially, the video showed the question being written, followed by the developing solution. In later video resources it was recognized that there is no need for the student to see the question being written. Subsequently, the writing of the question was removed from the video during the editing process. Therefore, the video started with the question already written.

The visual component was reinforced by an audio component in which the solver explained the thinking behind the solution. They explained the step-by-step sequence of what had happened and was going to happen. In this way the audio commentary was aided students in the development of their own problem-solving skills.

Prior to recording the audio commentary, the video was edited to remove lengthy visual pauses. The audio was then recorded as the researchers watched the video solution. The resulting audio was then combined with the video using the computer video editing application. The combined file was edited to ensure that the audio track proceeded at the same pace as the video track.

One of the questions faced when recording the audio component was to how much detail should be included. Should the solver merely give a general strategy at the beginning of the problem, or should they provide a step-by-step audio commentary? Audio solutions could be: brief, only the main part of the solution was recorded, simple, the solution was recorded but the solver does not explain the working and detailed, in which the assumed knowledge of a question was described in addition to explaining the main part of the solution. Of course it would possible to record brief, simple and detailed audio tracks for each solution and thus provide students with the choice of audio track. However, in this investigation the time required to record multiple audio tracks was not available and detailed audio solutions were used.

An attempt to develop video resources by recording the audio and video tracks by smartboard simultaneously was undertaken. Due to pauses this did not remove the need to edit the audio track, although it could speed up the process of producing the final deliverable video solution. Simultaneously recording both components created more opportunities for recording errors and made correcting them more difficult. If, for instance, the visual component was correct but there was an error on the audio it was difficult to edit and to re-record just the erroneous section. Another disadvantage of simultaneously recording both components occurred when the visual component required editing to remove pauses. The only solution was to speed up the video. This had the effect of also speeding up the audio track, creating distortion. Also, when the video was sped up over no audio, unwanted noise was created.

Delivery of the Resources

The video solutions were made available through learning management systems at the Shahid Rajaee Teacher Training University. As in some part of Iran students do not access to high speed internet, the video resources were available to them in DVD as well. In both instances there were instructions on the subject homepage to guide students' use of the website. The instructions given to students were as follows:

There are a number of definitions, rules and questions on each topic.

Attempt to learn definitions and rules.

Solve each question.

When you have your solution, click on the Answer button under the question to see if your solution is correct.

If it is incorrect, click on the Video Solution button.

The video learning resources was structured so that even without reading the instructions students could choose from a variety of solutions, definitions or additional questions. By making these video resources available in this way, an environment was created in which students decided upon their-own navigational directions and this encouraged them to make connections between correctly/incorrectly answered questions; their prior knowledge and the provided resources.

Links to definitions were included for students to refer to when they needed to recall prior knowledge, such as definitions and rules for the topic. This assisted students to bring to mind the knowledge needed to work through a particular mathematical problem.

Students could play the video as many times as they wanted and move forwards and backwards within the solution. They could choose to play the solution to a particular point, pause and attempt to complete the solution themselves. They could then restart the solution and compare their working with that of the remainder of the worked solution. This helped students to build up their mathematics knowledge and skills from the simple to the complex. Gagné (1965) believed that ‘skills need to be learned one at a time and … lower level skills must be mastered before higher level skills can be considered.’ (cited in Beevers and Paterson [2], p.134).

Conclusion

It is clear from the work undertaken that the video resources were useful in assisting students to develop both their mathematical skills and knowledge. It has been possible to improve learning outcomes through the use of online video resources. Further development of the resources may increase the effectiveness of the resources. Such development may be a simple extension of the existing resources or may involve developing more exciting ways to engage students, such as gaming, or providing relevance with mathematical applications specific to various disciplines. There is much scope to further improve the video resources by introducing visualizations and alternative strategies for completing and asking questions. The interest shown by the academic community suggests that the work undertaken in this research project has the potential to be used by other faculties. The video solutions are an efficient way to deliver resources that appear character-by-character and line-by-line. Thus allowing students to see and hear the process of solving a mathematical problem. The production methods described are simple and achievable by most departments and schools and hence allow teaching staff to conceptualize how their students’ mathematical needs can be met with variety of developing video resources.

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