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THE USE OF SCREENCASTS IN MATHEMATICAL AND SCIENTIFIC EDUCATION

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ABSTRACT

One issue that tends to be forgotten when dealing with the creation of multimedia learning objects such as screencasts is the time taken to create them. Available resources, especially time, are often very limited. An analysis of the relationship between the resources invested to create these objects and their

effect on teaching can be very useful. We look at three different cases of producing learning resources, based on interviews, and extract basic preliminary conclusions as to the importance of time for determining whether screencasts should be produced and how.

KEYWORDS:

multimedia learning, screencasts, e-learning, mathematics communication, learning objects.



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Teaching mathematics and other scientific disciplines in virtual learning environments poses a number of challenges resulting from the combination of subject and medium. In our case, one extremely important barrier is communicating content. For centuries we have taught mathematics through a combination of verbal, gestural and written communication, with instructors building a discourse by writing on the blackboard, explaining verbally what they are doing, how and why, and pointing out the different elements on the board used at any time.

One of the traditional learning and teaching mechanisms frequently used in the field is that of worked-out examples, solved examples of typical problems that students will often encounter in their learning process (for a discussion, see Renkl, 2008). Screencasts are useful for communicating these worked-out examples in virtual learning environments. A screencast is a recording of everything that happens on a computer screen, usually accompanied by a voiceover describing what is being done, how and why. Atkinson et al. (2000), review instructional principles applicable to screencast production. Mullamphy et al. (2010) analyse the convenience of using screencasts in different educational situations, and Loch (2012) provides a detailed example of the use of screencasts in a particular case.

A wide variety of tools and methodologies can be used to produce a screencast. The type of content to be shown in a screencast or the tools used to create and edit it, among other factors, will vary depending on our educational objectives and, conversely, those objectives influence the decisions we make concerning tools.

As in the creation of any learning resource, time is a key factor in deciding how to produce a screencast (or whether to produce it or not) and is one of teachers' most limited

resources. We present three cases of the use of screencasts based on interviews with their producers. These cases will allow us to draw some preliminary conclusions as to the importance of time for creating screencasts in teaching situations.

CASE 1

Environment. All the activity is carried out in the virtual learning environment at the Universitat Oberta de Catalunya (UOC). Initially, in an Introduction to Mathematics video, the content is the result of capturing interaction with a tablet PC and then editing. The course content covered pre-maths, from arithmetic to polynomials or matrices, functions, then derivation and integration. Later the experience was extended to a Mathematical Analysis course for first-year engineering students, and a decision was taken to make more intense use of video resources.

Why video resources. Initially, video was more of a complementary resource. In the Mathematical Analysis course, however, a need for improved materials was detected following substantiated complaints by students: the existing learning materials have good content, but they fail to clearly articulate a link between course theory and practice. The new video material was designed to link both elements, and the goal was not to produce a reduced number of small, specific resources but rather a series of videos for each learning unit to explain what will be done in the learning unit, then recapitulate what has been done and, finally, explain what kind of problems can be solved with the theory and how the concepts and techniques can be used to do so. Videos play the role of a masterclass and last between twenty minutes and one hour. There are between 20 and 30 hours of videos in the course.

Tools. The main tool used to create the resources is Livescribe, a pen with a small microcamera located at the tip and voice-recording capabilities, recording what is written, and when, and combining it with an audio recording of what is being said. The result of the recording is called a 'pencast' (similar to the term 'screencast'). The recording is shown to students as an image of a sheet of paper where the writing appears progressively, allowing for an intuitive navigation interface: clicking on any part of the page takes the playback to the point when the writing was on that part of the page.

One advantage of such a tool lies in its low cost, especially when compared to tablet PC devices. In addition, it offers more intuitive use, since by physically writing on paper, there is direct hand-eye coordination. The resulting pencast is a small computer application. For students, there is no need to install additional software. For those who will have to produce these learning objects, no prior training is required, which is a key factor in promoting adoption of the tool. The tool's main limitation is the fact that it is virtually impossible to make small edits to the finished product. For the purposes of the learning resource within the course, this does not represent a serious problem.

Team and process. Although each video is produced by an individual partner, during the course several partners produce a number of them, although each set of three videos (introduction, conclusion, linking theory with practice) corresponds to a single person. Before creating a resource, the teaching assistant has a script they can make as detailed and specific as they like in keeping with their own teaching style. A resource used by the team is a 'first pass' without any recording to fine-tune the rhythm of discourse.

Time factor. As we have seen, in terms of the time spent producing each resource, the

time spent producing a learning resource is approximately twice the length of the resource. It is therefore a quick and easy way of producing resources and allows large volumes of material to be created by a diverse team with no previous training.

CASE 2

Environment. A first-year physics course in an Industrial Engineering programme taught in a traditional face-to-face environment, centred especially on practical sessions. The covered contents are mainly mechanics and electromagnetism.

Why video resources. The inconvenient and limited number of hours when the teacher was available to students leads students to email the teacher. As a result, explanations that would be trivial in face-to-face situations become unwieldy. An alternative has to be found, and the chosen solution is the use of video recordings.

Tools. The chosen software solution is Camtasia Studio, selected after testing the available tools. The factors that influenced the decision include ease of use and editing capabilities.

Team and process. The teacher in charge of problem-solving sessions is also solely responsible for developing video resources.

Two types of videos are created. The first type corresponds to very detailed worked-out exercises, designed with LaTeX and saved as a PDF file. A video is created setting out the problem, using the document as a basis, with the addition, if and when needed, of figures created by scientific simulation software. The PDF document is a standard text document format: it is not in slide form.

The second type of video has its origin in



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capturing interaction with tablet PC class devices, later combined with an annotation tool with a notebook interface for free-format note taking. These are extremely short video clips, never over two minutes long. This requires careful planning of what has to be said and, if needed, a later editing process.

The typical time spent creating one of these two-minute videos is usually about five minutes. For videos of worked-out examples, the time is only slightly longer than the length of the final product.

These videos represent the virtual equivalent of informal interaction between student and teacher in Q&A sessions. The goal is not to create videos to be stored in a repository of reusable learning objects: these clips are expected to be played a very limited number of times before being discarded. Even in the case of worked-out examples, the video with explanatory commentary is intended to be used as a resource the first time that students address the problem: the permanent resource that will be used for future reference and study by students is the paper document.

Informal evaluation by the teacher suggests that, above and beyond the improvement in students' understanding of explanations, one benefit of using this procedure is a significant improvement in student satisfaction with teaching and a significant increase in students' engagement with the subject.

Time factor. As we can see, these resources of variable length all share the need to be produced in large quantities by a single person. This leads to the need for the shortest possible production time, no more than a few minutes per produced resource. The goal is to replace conventional teaching-learning activities that play a major role in the learning process but where content is far more important than form: students do not expect

high production values. If teachers have the communication skills that are to be expected of them in traditional teaching environments, some of these traditional resources can be substituted by the use of video resources in an effective, efficient way, with sustainable time investment.

CASE 3

Environment. This case revolves around an introductory course in statistics for undergraduate Computer Science students in the virtual learning environment at the UOC.

Why video resources. Students have problems understanding and solving problems with common calculations linked to normal distribution problems and the use of statistical tables. The faculty decides that "paper explanations" using sequentially presented text and images can be very complicated to follow, whereas dealing with these kinds of issues in a traditional classroom environment poses a much easier problem. The decision was therefore taken to experiment with the use of video and produce two short resources.

Team, tools and process. The process starts with a PDF document in which a teaching assistant has set up explanatory material to supplement the existing educational materials on the subject, consisting of a brief review of the theory, the standardisation process and typical examples of problem solving. The same teaching assistant, with no video editing experience, produced an initial resource with the PDF document as a starting point, using the Apple Keynote presentation tool, to export the slide presentation with a synchronised audio recording of the explanations. The tool's limitations, combined with a lack of experience, led to a product that met the requirements but whose presentation had room for improvement. This material was then redone with the help of

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an expert in audiovisual production. Firstly, the original presentation was edited and re-exported to video, then a new voiceover was recorded and finally video and audio were combined using professional video editing software. We speak, therefore, of coupling an author with considerable expertise on the subject and teaching experience with a video production professional, using quality software and hardware for production.

Time factor. When compared to the two previous cases, far more time is invested here. Two professionals worked for two days, taking into account that the work started from existing, working material which was then enhanced with the greatest attention paid to production values. We speak of a single video resource, and the aim is to reuse it indefinitely, since the subject dealt with should not change in the medium term.

CONCLUSIONS

We have seen three cases of different uses of video resources for teaching mathematics and physics. We have seen that all three used

very different methodologies and technologies, and with a larger catalogue of experiences we expect to find an even greater diversity of ways of doing things.

But we can also see there is a common element in the previous evaluation to determine whether or not to develop a resource: a cost-benefit analysis of the time factor. In essence:

- Only if we expect the resource to be reused a large enough number of times to have a comparable impact on teaching will the time investment make sense.
- If a large number of resources needs to be produced and most of them are expected to be reused frequently, it is essential that production time does not pose an obstacle.
- If resource producers have no previous experience, the learning curve for the production tools must be considered: investing time in learning a tool will only make sense if it is expected to be used often enough to capitalise on the investment, or if the production value provided by the tool, combined with the number of times that the resource will be used, justifies this investment.

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