[O15] Podcasts in undergraduate science education (or 'can you teach physics in .mp3 format?')

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Abstract

As more and more students acquire mobile devices capable of playing audio and video (phones, music players such as iPods, laptops) many science educators have dabbled with podcasts and videocasts to deliver educational content. The enabling technologies are new, but the underlying educational principles are not. The default action appears to be 'podcast one's lecture'. But is this enhancing student learning or is it potentially a retrograde step?

This contribution surveys how podcasts are currently being deployed in the teaching of undergraduate science curricula, citing examples from current practice. In addition, we present results from a final year student Honours project at the University of Edinburgh that has quantitatively investigated the efficacy of using audio podcasts to address student misconceptions about rotational motion with a cohort of over 200 students. Suitably prepared audiocasts, even without images or video, are shown to have a small, yet consistent positive effect on student understanding (evidenced by in-class questions a few days later, with data collected using a personal response system). The potential uses of podcasts in teaching contexts are discussed.

Introduction

Podcasting, a compound of the words iPod™ and broadcasting, is a relatively recent addition to the collection of tools that collectively make up the next generation of digital services, often termed 'Web 2.0' tools. The growth in the number of podcast feed pages, where users can subscribe to a series of podcasts and automatically have new episodes 'delivered' to them, is staggering. There are now more feeds than the total number of radio stations in the world.

It is therefore no surprise that this expansion, fuelled by the widespread availability and low cost of personal hardware, has given fresh impetus to educators to exploit the opportunities this offers. Apple have sold over 8.5 million iPods™ in the last quarter of 2006 alone and students are some of the biggest buyers of consumer electronics like laptops and personal audio players. It is a point of ongoing debate as to whether or not this is genuinely a novel educational development, or merely a re-invention of an old wheel in a new technological guise. However the response from the educational community has been swift: as of October 2006 the iTunes™ Music Store lists over six thousand podcasts in the education category.

A major challenge is to successfully establish mechanisms that integrate these new technologies into the curriculum, in pursuit of enhanced and / or more flexible, 'learnercentred' learning. However, the default method for utilising podcasts seem to be to record lectures (there are many examples of simply audio recordings of lectures in the relevant area on the iTunes™ music store). Notwithstanding the value to some students who may be able to review the lecture, whilst in possession of appropriate other notes or visuals, or to ameliorate disability or accessibility issues, this does seem a somewhat unimaginative use of the technology.

A detailed review of the educational possibilities of audio and or video as distribution media is beyond the scope of this contribution. Here we briefly mention some recent reports of deploying podcasts in educational contexts. The range of potential uses for a podcast is broad; a good summary is presented in annotated case study form (Nie, 2007). Within the UK, the IMPALA project (Impala, 2006) has collected a valuable repository of online materials (papers, screencasts etc) covering the broader pedagogical possibilities offered by podcasts (Nie, 2006), case studies of use to provide supplementary materials (Edirisingha, 2006), and orientation to future in-class activities (Woodward, 2007) going far beyond the simple act of a digital recording of a lecture. Chan and Lee have described a pilot study that uses podcasts to address student preconceptions and anxieties on an information technology course at an Australian University (Lee, 2005; Chan, 2005). A subsequent study investigates student-generated podcasts (with minimal staff input), prepared to support new students (McLoughlin, 2006). A study in Engineering in Leicester (Edirisingha, 2006) describes the use of 'profcasts', material distinct from on-campus teaching or self-learning activities. The same authors also propose a model for integrating these within blended learning environments.

This paper addresses the use of podcasts as pre-lecture resources, to provide advance exposure to conceptually-difficult topics to be covered during class teaching in the following week. Our aim is to explicitly test how, if at all, podcasts can be used to enhance student understanding of these concepts, in a subject context that traditionally relies on visual representation to communicate concepts. We describe some of the experiments we performed in order to obtain some quantitative data on the usefulness of prior exposure to material. We then evaluate the results, conclude with some implications this might have for the use of podcasts in teaching.

Methods

The context for this investigation is the introductory first-year Physics course at the University of Edinburgh, the pedagogical design details of which have been reported elsewhere (Bates, 2005) together with details of students' behaviour in using the online support materials to aid learning (Hardy, 2005). The course has an extensive online component to complement face-to-face teaching, and approximately 250 students enrol each year. Recently, we have successfully integrated an Electronic Voting System (EVS) into whole-class lectures (Bates, 2007), which is the mechanism used to collect student responses to various questions during the lectures for later analysis. The handsets are issued to students at the start of the course, and retained for its entire duration. Loaned to students like a library item, we retain a record of which student 'owned' which handset.

The main challenge for this investigation was how to provide clear, systematic, and reliable data to support ideas that are, at worst, wholly abstract. We chose to create two podcast episodes, on targeted topics that we know (from previous experience teaching the course) students find difficult. These would be delivered a few days ahead of the material being covered in class, with a few weeks between the two episodes. The podcasts were designed to engage the students with the material and to prompt them to think about what would be covered in the following lectures, and question their own understanding about the topics based on any previous exposure to them. They contained relevant examples to contextualise the material, and were both approximately 8 minutes long. Scripts are available online (Stevens, 2007).

The class was divided into two groups according to the days of attendance at course workshops. (Students sign up to whichever workshop day they choose, or their timetable permits.) Those electing to do workshops on Monday and Tuesday were allocated as being in Group 1, those on Thursday and Friday in Group 2. In the first experiment, the podcast was delivered to Group 1 students at the start of their respective workshops. Three days later, the whole class was posed various concept questions at the start of a lecture. These were answered in the usual way using the EVS handsets and data saved for analysis. A few weeks later, the experiment was repeated with Group 2 receiving the podcast in their workshops and the whole class being questioned three days later. In effect, by repeating the experiment in this way, each half of the class acts as a control group for the other half. Issues of equity are addressed, as each student received one (and missed one) podcast.

By broadcasting the podcast, we were making use of a captive audience. In fact, it is suggested by other pilot studies that the majority of students play podcasts as downloads through a PC (Woodward, 2007). In some respects, it may seem that we had somewhat artificially distorted the concept of a podcast, by not offering it for download. If it were offered for optional subscription or download to a selected portion of the class, we could not be sure of uptake. The issue of mobility is not crucial here; we are not looking to open up new learning avenues by exploiting the fact that the material could be used anywhere. Instead, we are aiming to tap into student self-study time, be that on the move or at a PC.

A more important issue was to ensure that, on average, the two groups of students could be considered equivalent in ability. This was evaluated on the basis of student performance in an online diagnostic test undertaken at the start of the course, based on the standard physics concept test, the Force Concept Inventory (Hestenes, 1992). The two groups (N=85 and 88 students respectively) had mean scores of 18.6 and 18.0 (both out of 33), with standard deviations of 6.1 and 7.1 respectively. The two distributions returned a Student T-test value of 0.35, suggesting there is indeed no significant difference in ability between the groups.

Here, we report only selected results from the second podcast episode (due primarily to space limitations). This podcast was designed around misconceptions concerning angular momentum and content and questions were developed together. An initial question was used as a starting point, one that had seen much use previously and had typically produced very poor performance by students indicating severe misconceptions. Three others were also designed, each to address a particular misconception about angular momentum. The content of the podcast would then be designed specifically aimed at resolving these misconceptions. It was decided to use two separate voices to give a conversational tone to the podcast and we related the material directly to that used in a formal teaching environment (the lectures), by using two ‘personalities’ who crop up frequently in the course. ‘Alison and Billy’ (A and B) are used during lectures to concretize abstract algebraic examples.

We made use of a simple, every-day example (observing a car being driven) that included all these different aspects and to state some of the actual misconceptions in the podcast script. The questions are illustrated in **Figure 1**. The first is designed to lead the students in gently, with a very easy and often-stated example. Question 2 is the original question from previous

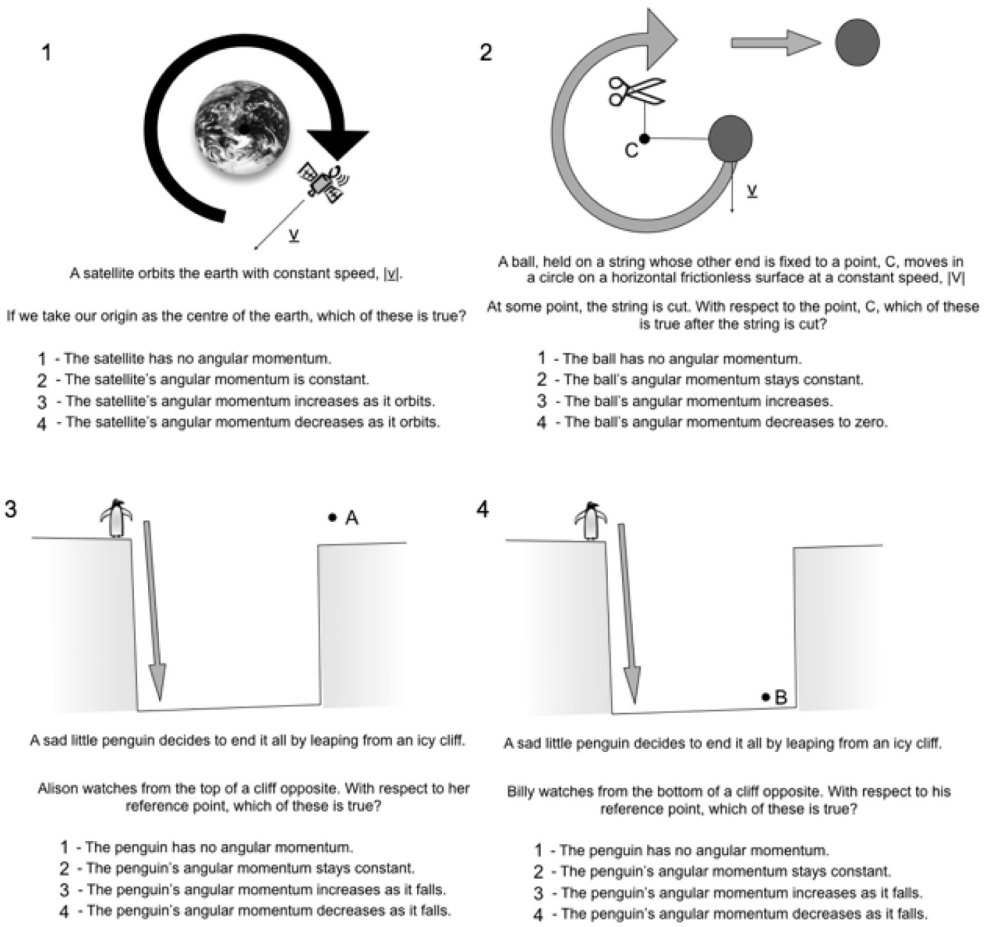

Figure 1: Questions used to evaluate the impact of the podcast

course content, similar to that shown in **Figure 1**, in the sense that a similarly small (often negligible) number of students choose the correct answer (2). The classic misconception in this case is illustrated by choosing answer 1. Questions 3 and 4 are designed to test the students understanding of how different choices of origin and changing velocity influence the angular momentum of the object. The correct answer in both cases is 3. These two questions are similar in scope, and go beyond the concepts tested in the previous question.

The podcast was then delivered to Group 2 (on Thursday 9th and Friday 10th November 2006) and the above questions posed in the lecture on the following Monday. The total number of respondents for these questions varied between 99 and 105.

Results

A record of handset ownership enabled us to correlate answers with group membership. In analyzing results, we made a number of pragmatic assumptions:

- Students attended workshop classes on the days they were allocated to attend them.
- Students brought and used their own handset in lectures.
- Students answering outside the possible choices (e.g. number 5 or above for the questions shown in **Figure 1**) were discounted.

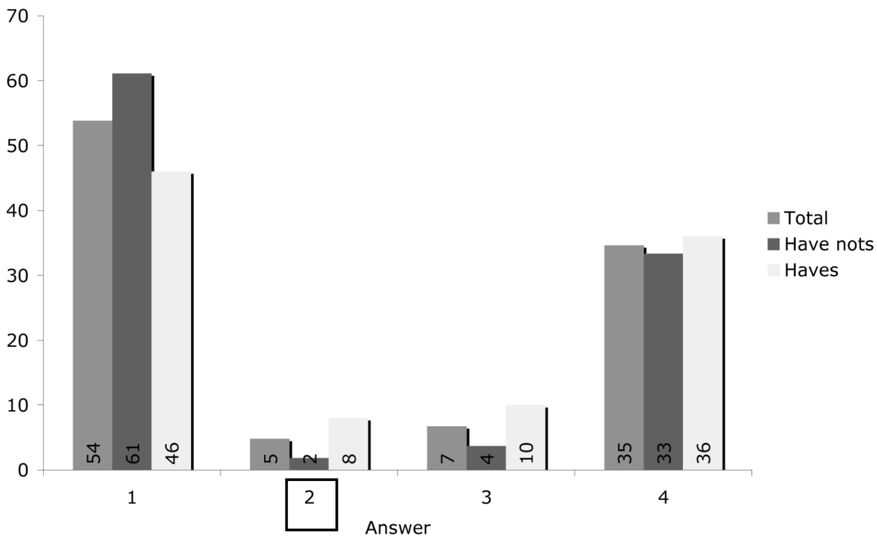

Figure 2: Response distribution for question 2

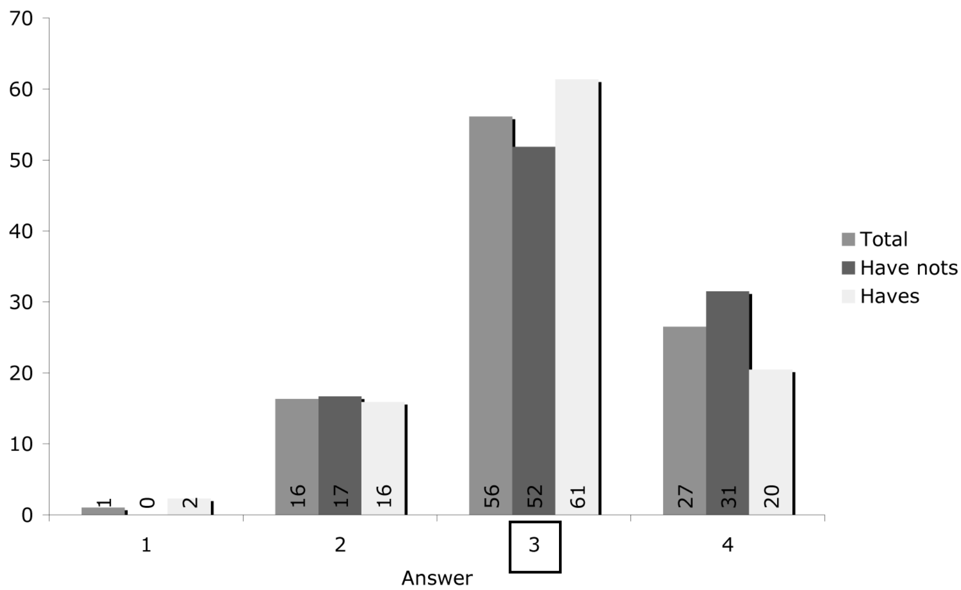

Figure 3: Response distribution for question 4

Selected answer distributions to the questions in **Figure 1** are shown in **Figures 2** and **3**, broken down into groups who 'had' and 'had not' heard the podcast. The results for Question 1 (not shown) confirmed that nearly all students found this question to be straightforward, requiring a pre-University level of conceptual understanding of circular motion. In the case of those students who had earlier heard the podcast, practically this entire group (98%) chose the correct answer, compared with 88% from the group who had not heard the podcast.

Question 2 addressed a commonly-held misconception about angular momentum. What is particularly interesting in **Figure 2**, is that not only do a slightly larger proportion of those students who had the podcast choose the correct answer (item 2), appreciably fewer chose the 'classic' incorrect answer (item 1), which is indicative of a fundamental misunderstanding, which can be paraphrased as 'only things moving in a circle have angular momentum'.

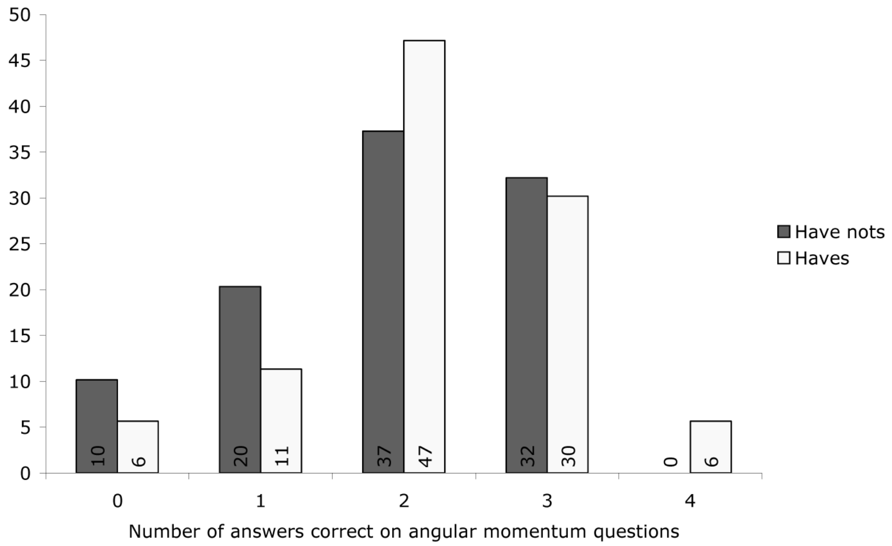

Figure 4: Number of correct responses for angular momentum questions

The observed trend of slightly more 'haves' than 'have-nots' choosing the correct response is again seen in the responses to questions 3 and 4. The results for question 4 are illustrated in **Figure 3**. The fourth question attracted a larger proportion of incorrect answers than the third, despite the fact it is essentially the same question.

In assessing the response distributions of all four questions collectively, there is a consistent, if small, trend. In each case, approximately 10% more of the 'haves' get the correct answer than the 'have-nots'. To further investigate this, we have calculated the number of correct answers for each student from the set of four angular momentum questions used after the podcast. The resulting histogram is shown in **Figure 4**. The distributions are similar, with a slight shift of that for the 'haves' to a higher number of correct questions. This is reflected in the mean number of correct answers. For the group of students having not had the podcast it was 1.9, for those who had it was 2.2. The results should not be over-interpreted though; both distributions have large standard deviations and a Student T-test does not indicate any statistically significant difference between them.

Discussion

The subtitle for this paper was 'Can you teach Physics in .mp3 format?' The simple answer is a cautious 'probably' but of greater importance is to address why you might want to do that and what the additional benefit to the learner is intended to be. We do not claim to have quantitatively demonstrated the unequivocal effectiveness of podcasts in improving conceptual understanding. In some ways, we had set ourselves high targets that mitigated against this. We were using only audio in a subject where exposition via diagrams, sketches and mathematics are believed to be essential to its successful teaching. We were aiming to target and address widely-held misconceptions which have confounded large proportions (sometimes, all) of previous cohorts. Finally, we had no previous experience of writing, producing or delivering such material for maximum effectiveness, and learned a great deal on-the-fly.

Evaluating the impact of these podcasts, it seems fair to say that the effectiveness of the podcasts seemed to increase when the content was more directed and as our own experience of authoring and integrating them within the course developed. We had, and in some respects continue to have, reservations about whether podcasting is the best way to approach conveying concepts in physics, an inherently visual subject.

One area under active development is the use of a multiplicity of media in more skill-focussed activities. We are currently devising a new course aimed at fostering and enhancing problem-solving skills, which is deliberately biased towards skills over content. This course will be entirely activity-based with no formal lectures. Informed by what we have learned here, we plan to make use of multiple media outputs (podcasts included) to convey techniques or examples to students.

The future use of emergent technologies in educational contexts seems set to develop apace. But this should not be because it is the latest fashionable thing to do. The aim, to quote Millar (2001, p289) should be to engage the learner;

> *'Science should be taught in whatever way is most likely to engage the active involvement of learners and make them feel willing to take on the serious intellectual work of reconstructing meaning'.*

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