DUMP: A Database of Useful MCQs for Physics

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Abstract
This communication describes the output of a Development Project awarded in 2005 to fund a collaborative project between the Universities of Edinburgh and St. Andrews. The project aimed to take an in-house collection of over 400 multiple choice / multiple response questions on topics in introductory Physics (gathered and developed over many years of teaching) and publish them in an interactive, online, browsable collection, freely available to educators to use as a resource for their teaching. The system that we have created has functionality similar to online shopping or auction sites such as Amazon and eBay (without the cost!).

In this communication we will outline some of the rationale that led us to attempt this project, describe the issues and challenges for the project, illustrate ways the system can be used to support teaching and learning and conclude with thoughts for the future progress and sustainability of such systems, including plans for the continuing development of the output from this project.

Our aims in this project were straightforward; to produce a browsable, online library of these materials that was freely available to all interested academics.

Background
The role of technology in assessment - in delivering it, grading it and providing feedback on it, is becoming a very visible part of academic life for today's students. The current landscape and areas of rapid forward development have been reviewed recently[1,2]. This communication reports the output of a Development Project (2005-2006) that aimed to publish a collection of assessment materials (multiple choice / response questions) that we had developed over a period of years to support the teaching of an introductory course in classical Physics at Edinburgh. These materials had grown in a somewhat *ad hoc* manner over a period of time and had been mainly deployed to provide opportunities for students to obtain formative feedback on their conceptual understanding (…or otherwise) of the subject material. Effective formative feedback has the potential to transform the student learning experience[3].

In our case, the subject matter of the course aided us favourably in the art of writing questions. Drawing on an extensive literature related to the exposure of fundamental misconceptions in this subject material, we were able to author material that went beyond rote recall or manipulation, instead probing understanding of fundamental (or 'threshold') concepts which build the foundations for mastery of the subject[4,5]. Anecdotal (student questionnaires) and now more quantitative data[6] indicate these resources are both highly-valued and widely-used by students for on-demand formative assessment ('how am I doing?') during the course and additionally as a revision aid prior to end-of-course summative assessment. More recently, we have begun to repurpose some of these questions for use in interactive engagement episodes within lectures, using electronic voting systems[7].

At the same time as this Development Project, the HEA Physical Sciences Centre started a QuestionBank project, to design and populate a repository for a much wider range of question types beyond the simple MCQ/MRQ format used here.

Challenges
Our aims in this project were straightforward; to produce a browsable, online library of these materials that was freely available to all interested academics. But collections such as ours are certainly not unique; many others will have something like this and certainly all textbooks now come with supplementary material on disk or online (including some extremely sophisticated (subscription) services[8]. However, the demand within the learning object economy is for user-selected, shareable and interoperable resources. Many existing electronic resources fail to deliver these requirements. Staff need not necessarily re-invent wheels, but do need granularity and customisability ('I'd like this

one but not that one'), together with an import / export facility ('We need it in this format not that one') to ease integration into local systems and / or methods of use.

The challenges, therefore, were to deliver this resource within a framework that facilitated easy browsing, discovery, reusability and interoperability of these materials.
The academic side of the project work was reasonably straightforward; to quality control the existing batch of questions, fill in gaps in coverage, and provide useful answer-specific feedback where it was lacking (essential if these materials were to be meaningfully used by students for formative feedback). However, it was in the technical development of the system that the majority of the effort was deployed. Here, we looked to the world of e-commerce for inspiration. The success of shopping and auction sites such as Amazon or eBay relies on an easy-to-use interface, allowing users to *discover* relevant things easily, from a huge range. The approach we adopted was to categorise resources into topics or categories to coarse filter resources, then add-in keyword filtering or text searching to discover appropriate resources. Figure 1 illustrates this, for a collection of resources on space and time.

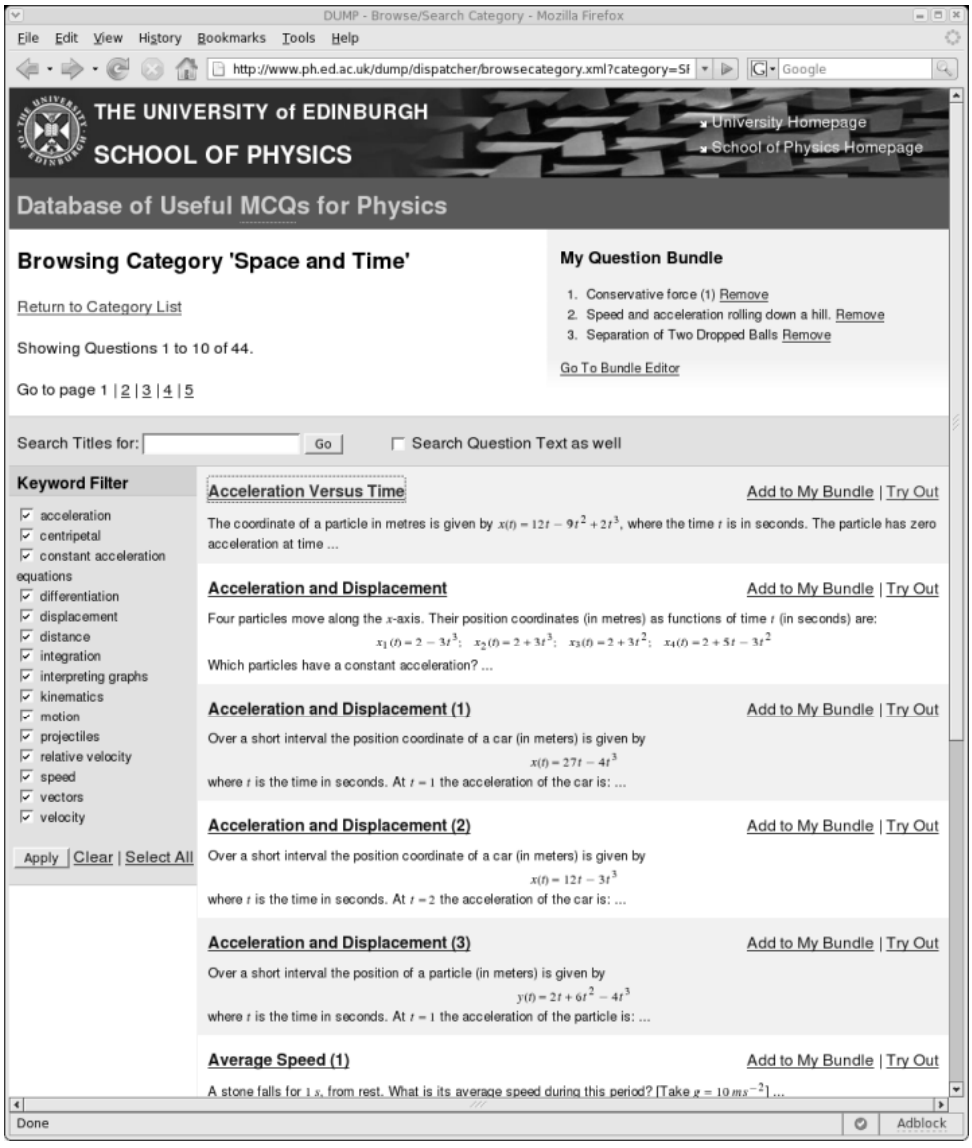

Figure 1: Discovery of resources within DUMP

The anatomy and functionality of DUMP
A detailed technical description of the inner workings of the system is not appropriate for this communication. It is, however, worth highlighting that the system reuses many of the components from our development of an in-house content management system for course resources[9], adhering to established and emerging web standards, such as utilisation of MathML for the display of mathematics online[10]. One of the design features is that a single ('golden') copy of the source is capable of being rendered in different outputs, (with appropriate question metadata used to categorise and classify each resource). This single-source, multiple-output approach is realised by storing resources internally within DUMP in XML format, and standard tools are used to transform this into various user-specified outputs formats. This directly addresses the issue of interoperability permitting export into widely utilised formats such as html (for online use), pdf (for paper deployment, perhaps as an in-class test) and emerging standard formats such as QTI[11] (for import into other delivery systems – such as virtual learning environments - or repositories).

It is always troublesome to animate a working system – to bring it to life and show its features and functionality - within the confines of a body of text and images. By far the best way to explore the system is in its native environment – online at http://www.ph.ed.ac.uk/dump. A simple registration process will allow you full access to all resources.

Figure 1 illustrates how groups of resources may be discovered via a combination of categorisation and keyword filtering or text searching. The matching results are shown, with the system displaying the question title, image as a thumbnail if there is one and the first 50 words or so of the question stub. The individual questions can then be viewed, either by clicking on the question title or the 'Try out' action link associated with each question. Figure 2 illustrates the per-question view after doing just that.

Having located and browsed individual resources, it is possible to export these from the library in various different formats. However, more commonly, people will want to build up a body of questions, perhaps relating to a particular topic. This is facilitated in DUMP using an analogy of the shopping cart in commercial sites, which we call the bundle. Questions may be added to bundles from either the per-question view (Figure 2) or the list of questions (Figure 1). The contents of the bundle are displayed on the top right of all pages and the bundle editor screen within the system (illustrated in Figure 3) allows for personalisation and export of bundled questions.

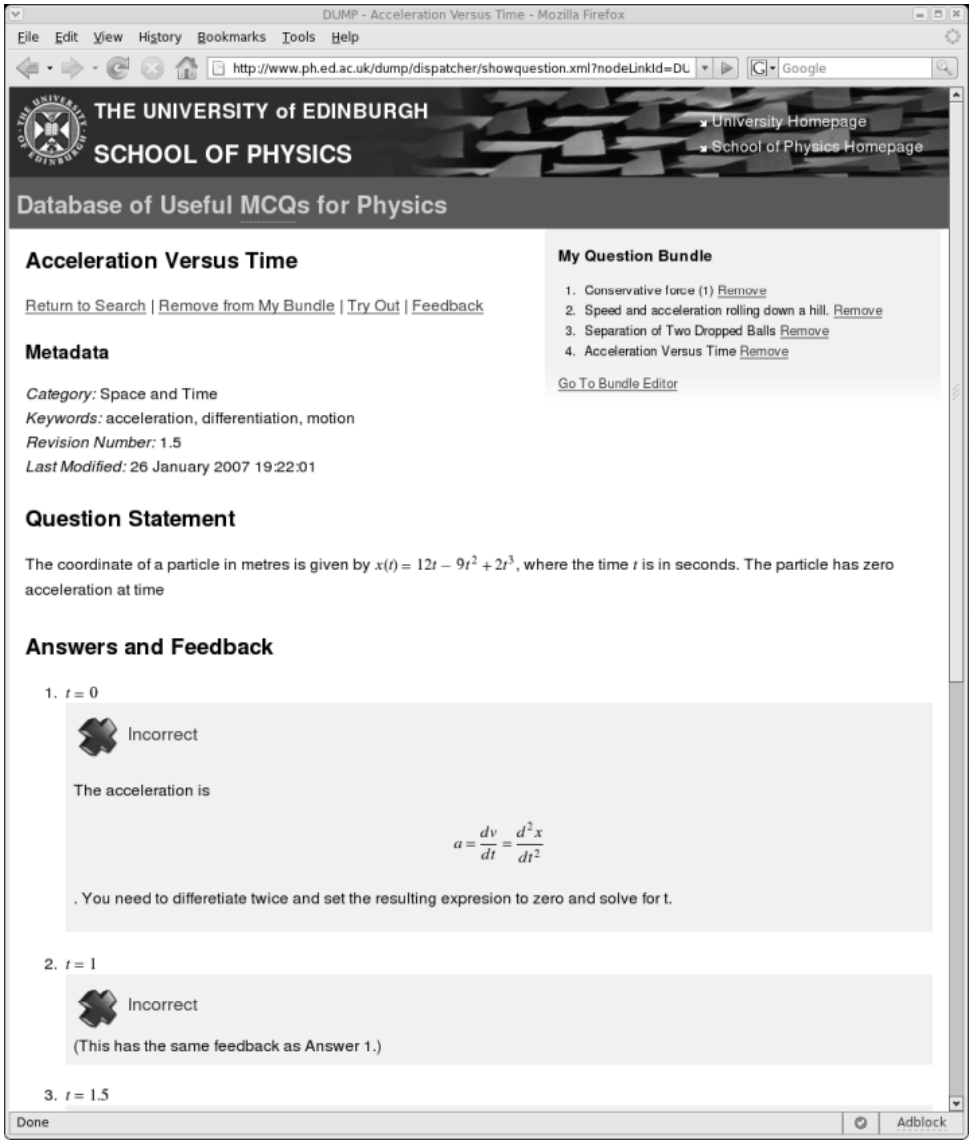

Figure 2: Per-question view of resources within DUMP

The sort of personalisation or customisation that a user might want to do before exporting a bundle includes aspects such as setting a title for the bundle, a bespoke numbering scheme, introductory text to preface the questions etc. There is then the choice of export formats. Currently supported formats are

- Complete interactive web bundle, that can be used as-is, mounted on a personal site, given to students on a pen drive etc.
- Various versions of a pdf format: a 'student view' with only questions; a 'staff view' with questions and correct answers highlighted; and a 'full view' of questions with feedback for each response.
- A QTI-compliant output channel.

To date, DUMP has 38 registered users and contains over 450 questions, spanning predominantly introductory classical Physics, with brief excursions into optics and quantum mechanics. Having successfully designed and built the system, and populated it with a reasonable volume of useful content, we are developing the project further, not as 'more of the same', but as an opportunity to take something from cottage industry to more widespread adoption.

Previous experience has taught us that such developments require a critical mass of users and involvement to succeed; otherwise they are destined to become stale and stagnate. The current state of DUMP is that it does not yet have this critical mass, but we believe it is capable of achieving it. In the particular case of question banks or online repositories, probably the key issue is the bottleneck of content creation / provision. There are good examples of worthy systems or tools that lie sparsely populated, serving as a real disincentive to wider uptake amongst the academic community.

We have been fortunate to secure on-going Development Project funding through the Physical Sciences Centre to take forward this continued development. In particular, this follow-on project, DUMP2.0[12], will:

- Deliver a content creation interface for designated users;
- Provide for an export format for question bundles to Respondus[13] (or equivalent) for ease of importing directly into commonly-used VLE platforms;
- Evaluate the experiences of the existing group of early adopter users;
- Establish a successful and thriving community of practice around the DUMP system, exploiting the opportunities offered by the new wave of Web2.0 tools, facilitating online collaboration and communication.

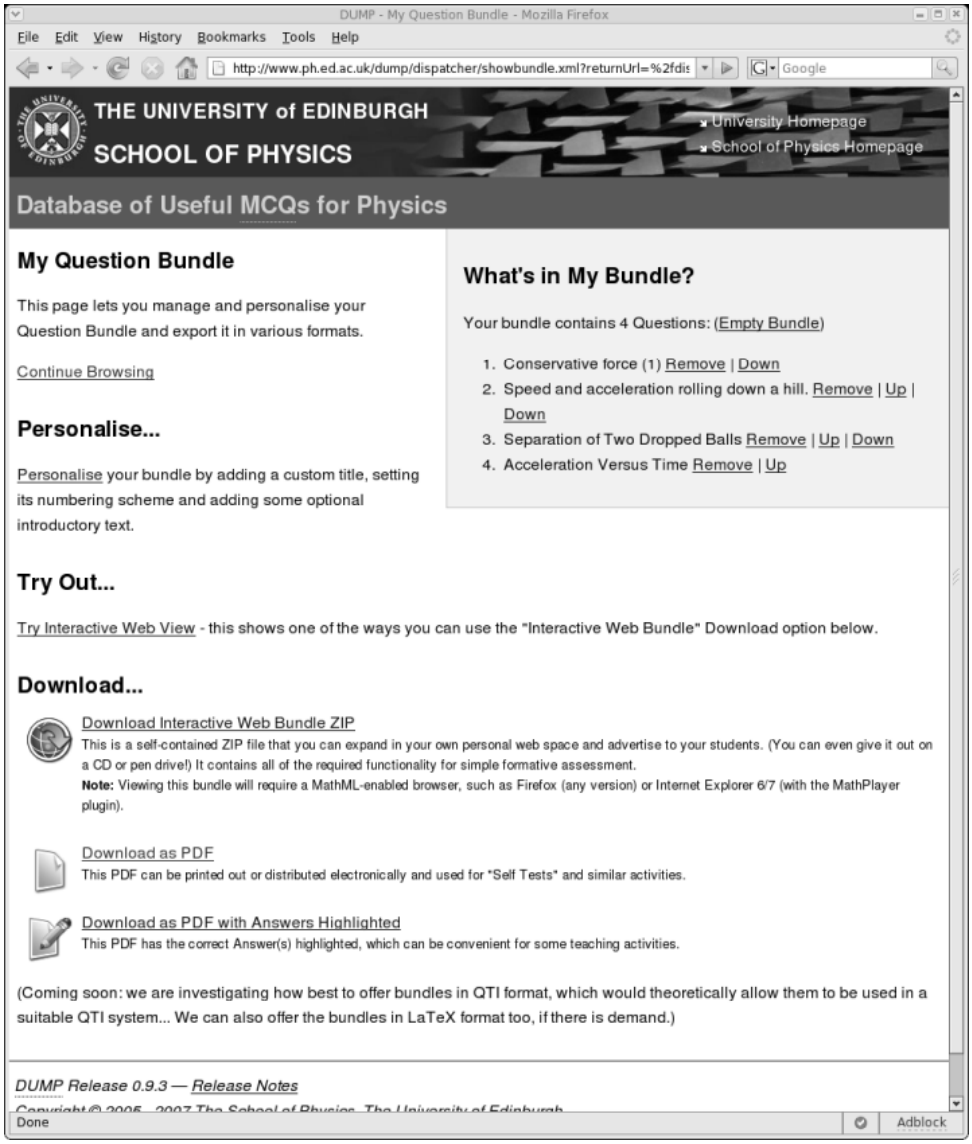

Figure 3: The bundle editor view of DUMP, with associated exports.

References

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3. See for example Enhancing student learning through effective formative feedback by Nicol D. et al., www.heacademy.ac.uk/embedded_object.asp?id=20876&filename=ASS096 (accessed 10th May 2007).
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6. See for example the outputs from the projects we have undertaken to try and understand how students make use of online learning materials, available online at http://www.epcc.ed.ac.uk/projects/steer (accessed 12th May 2007).
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8. http://www.masteringphysics.com/, (accessed 3rd June 2007).
9. http://www.ph.ed.ac.uk/elearning/projects/aardvark (accessed 3rd June 2007).
10. http://www.w3.org/Math/ (accessed 3rd June 2007).
11. http://www.imsglobal.org/question/qti_v2p0/imsqti_mdudv2p0.html (accessed 3rd June 2007).
12. The '2.0' in the project title points towards the intended use of more 'Web2.0' type tools in the building of a community of users.
13. http://www.respondus.com (accessed 3rd June 2000).