Technological and Pedagogical Issues Surrounding Mass Production of Multimedia Learning Content

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This paper discusses technological and pedagogical issues surrounding the mass production of multimedia learning content. The technical approach taken in overcoming the complexities of delivering learning content seamlessly to a diverse group of learners (with basic Information Technology literacy) are outlined. In particular, challenges facing learning technologists in delivering fit for purpose learning solutions which conform to learning technology standards are discussed.

Over the last year, fifty (50) hours of lecture based material have been recorded with emphasis on capturing classroom interactions. The multimedia learning content is packaged in accessible formats; readily available through the web-based learning environment; with cross browser / platform support for multiple access points. This face-to-face lecture material is divided into pedagogically sound (i.e. ensuring that learning outcomes are adhered to) and technically feasible multimedia learning objects. An hour of classroom teaching is divided into three learning object 'chunks'. Hence, over 150 learning objects that adhere to software engineering principles have been accumulated. In particular, highly reusable and easily maintainable learning objects were created. Furthermore, key facts contextualising the learning outcomes are summarised into a five minute delivery accessible via audio/visual handheld devices.

1 INTRODUCTION

This paper discusses technological and pedagogical issues surrounding the mass production of multimedia learning solutions. When delivering fit for purpose learning solutions, learning technologists are confronted with numerous cultural, pedagogical and technical challenges. Ideally, the multimedia learning solutions should adhere to sound educational principles; be culturally viable and technically feasible while conforming to learning technology standards. The case study discussed here, designed learning objects which overcome the complexities of delivering learning content seamlessly to a diverse group of learners while maintaining relatively low production costs. The increase in reusability of learning objects facilitates return on investment, which in turn reduces the costs associated with production. The production experiences are shared with a view to making the notion of affordable, accessible, durable and reusable learning objects a reality.

2 OVERVIEW OF LEARNING TECHNOLOGY

2.1 Standards Initiatives

The Advanced Distributed Learning (ADL) initiative (ADL 2007), IEEE Learning Technology Standards Committee (LTSC) (LTSC 2002) and the IMS Global Learning Consortium (IMS 2002) have been actively pursuing Learning Technology standards at various levels. The Sharable Content Object Reference Model (SCORM), established in 1998 by the ADL initiative, aimed to provide a technical architecture for learning objects to be easily shared across multiple learning delivery environments. SCORM has multiple, interrelated specifications derived from previous or ongoing work of other specification and standards bodies including the Aviation Industry CBT Committee (AICC) (AICC 2007), IMS Global Learning Consortium and IEEE LTSC.

The LTSC and IMS Global Learning Consortium worked towards unifying the terminology used to describe educational materials. Several definitions and interpretations exist to describe Learning Objects, leading to confusion and potentially hampering effective collaboration amongst stakeholders within the learning technology community as illustrated in Figure 1. “Different definitions abound, different uses are envisaged, and different sectors have particular reasons for pursuing their development. In this environment of uncertainty and disagreement, the various stakeholders are going off in all directions” (Rehak et al. 2003). The LTSC defined both digital and non-digital educational resources as learning objects. Wiley (2002) narrowed the scope of learning objects to digital resources only and proposed that Learning Objects are “any digital resource that can be reused to support learning” (Wiley 2002). Hence, digital resources would include any size object that can be delivered across the network on demand. The relevance of emerging developments, standards and definitions within learning technology standards are recognized as important, as the success of mass producing multimedia-rich learning objects should be compliant to standards.

Figure 1 - Learning Objects – Confusion in Terminology (Barikzai 2006)

Designing learning objects with reusability in mind, potentially increases stakeholder participation and reduces production costs. Smaller learning objects like pre-recorded video;

animations; smaller web-delivered applications, like a Java calculator are relatively easy to exploit therefore more reusable. However, larger learning objects aiming to deliver complete learning experiences or a complete instructional event are much harder to exploit and reuse. The experiences of developing learning objects over the past 15 years have helped to evaluate this approach. The developments have included large scale subject-specific learning objects; addressing learning technology standards; managing learning object repositories and embedding learning objects within collaborative learning environments.

2.2 Learning Object Design Challenges

The cultural and pedagogical openness of learning solutions with emphasis on making learning objects available 'en masse' to be shared amongst scholars, based on agreed scholarly protocols, is desirable. Wiley noted "Learning Objects became the technology of choice for the next generation of instructional design, development, and delivery, due to its potential for reusability, generativity, adaptability, and scalability" (Wiley 2002). These development approaches were based on the principles of object orientation. While, the learning technology community adopted standards in making interoperability and reusability, it was not possible to truly 'pick and mix' learning objects, thus the need for further research (Polsani 2003). A discussion of the challenges is outlined below.

Affordability: Learning Objects can only become fully exploitable if the learning effectiveness is increased significantly and the time and cost is reduced. The multimedia learning objects have been produced that can effectively replicate classroom based material in a cost-effective digital form. The learning experiences of the learners and affordability both in terms of hardware and bandwidth have been considered.

Accessibility: Standard compliant systems and content can enable the use of learning objects from every location simply using internet protocol (HTTP, FTP etc) via a web browser thus potentially increasing accessibility. Additionally, the learning objects are accessible using multiple devices e.g. PDAs, mobile phones and other mobile devices. Furthermore, allowing access via a managed library, the stakeholders can exploit learning objects all the time.

Durability: Achieving learning object durability is not straightforward. To be able to use legacy systems and content, when the base technology is constantly changing is a big challenge not only to the learning technology community but also within the software development community. When mass producing learning objects, forward compatibility of production tools increases durability of the development life cycle while allowing customization of content (for subject disciplines that change) enables durability of the learning content.

Re-usability: Learning object reusability refers to all levels of reuse, in terms of both learning content and the underpinning software building blocks. Academics, interested in exploiting learning content, should ideally be able to audition learning objects relevant to their needs through the use of educational metadata. Re-using software building blocks and development techniques is easier to achieve via in-house developments within institutions and by using the same vendor's software tools across institutions.

Interoperability: Ideally, learning objects should be accessible using different Learning Management Systems (LMSs), on different platforms and independent of tools. It should be possible to 'pick' and 'mix' learning objects independent of software constraints. However, the multimedia learning objects produced are highly interactive software thus requiring some additional software plug-ins. Most of the required plug-ins are readily available for various operating systems and platforms. The multimedia learning objects are packaged in a variety of different configurations such that learning objects of varying granularity are available to be reused with the learning management system.

2.3 Embedding Learning Objects within Learning Management Systems

The multimedia learning objects produced conform to metadata standards. As well as individually adding metadata for each learning object, a library catalogue approach is adopted whereby the catalogue manages the metadata. Furthermore, the learning objects reside in the centralized object repository and are readily accessible via the MOODLE Learning Management System. MOODLE (MOODLE 2008) is a free and open source (under the GNU Public License) course management system (CMS) designed using sound pedagogical principles, to help educators create effective online learning communities.

3 LEARNING STYLES

3.1 Addressing Learning Styles

The process-oriented (conversational) nature of teaching and learning (as illustrated in Figure 2) can be supported by a variety of computer-based media. Capturing the interactions and conversations during the classroom session is very valuable. These recordings are useful to support student learning as well as enabling teacher's to reflect upon the delivery in relation to student performance.

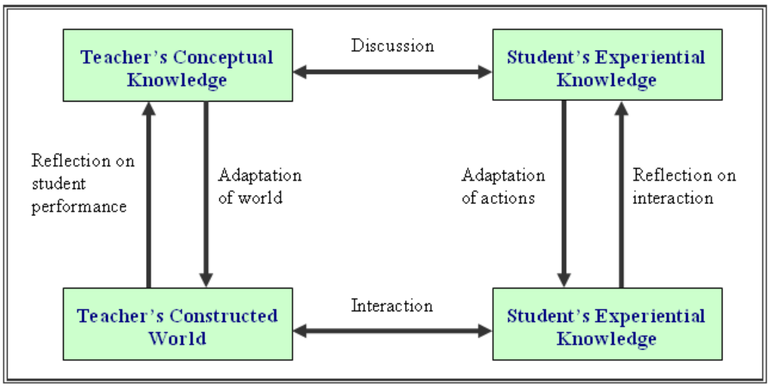

Figure 2 – Conversational Framework, adapted from (Laurillard 1993)

The two way dialogue between the learner and teacher identifies learner's preconceptions of learning and the learning environment. It is important to identify the stakeholders involved in constructing the learning environment; the learning objects supporting the learning environment and the learning scenarios required to engage the learners with the learning objects.

3.2 Stakeholders

The stakeholders, academics, learning technologists and management, have overlapping responsibilities and interchanging roles within the learning object life cycle (Figure 3). The stakeholder activities include exploiting learning object development and management tools; creating new learning objects; re-engineering existing learning objects; modifying existing learning objects; auditioning/reusing existing learning objects and managing repositories and libraries of learning objects.

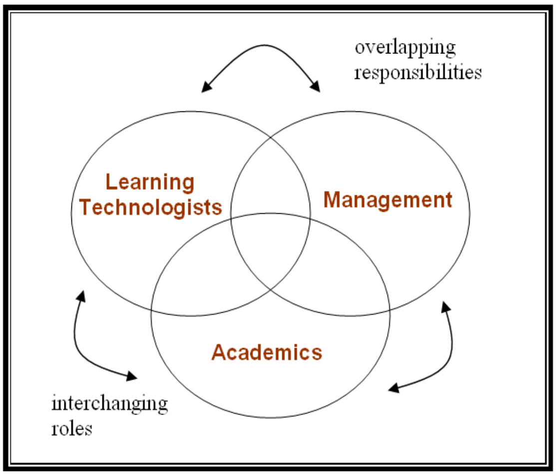

Figure 3 - Stakeholders within the Learning Technology Community (Barikzai 2006)

However, not all stakeholders are primarily interested in all of the activities. For example, creating new learning objects primarily involves teams of academics and learning technologists. As this activity, especially when conducted in large scale, will tie down resources; management would no doubt become involved.

3.3 Determining Levels of Granularity

When producing learning objects from classroom based material it is advantageous to determine the level of granularity of material. The classroom interactions typically are over an hour long and hence need to be broken down into learning chunks which are self contained objects. Each self contained object has associated learning outcomes and learning material that delivers the learning outcome.

The process of determining the level of granularity of a classroom based lecture into segments is processed by assessing natural breaks in the material delivered that allow each object to be usable within its own right. This breaking down of the object ensures that there are designated learning outcomes and the material to achieve this. An example of how a learning object is broken down is illustrated in Figure 4.

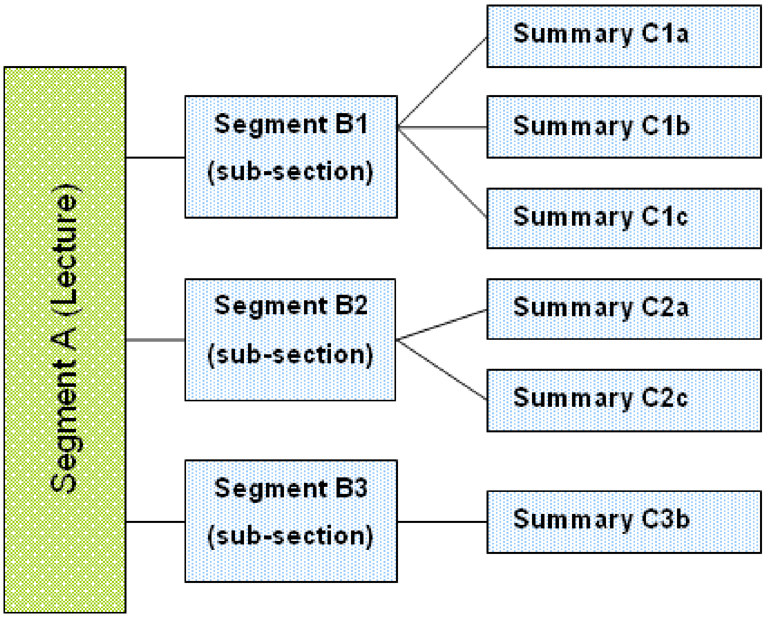

Figure 4 – Granularity of Classroom Based Lecture Material

Chunking the material into smaller sections allows each segment of material to be used for its initial purpose as well as being mixed for new purposes. This allows for two benefits, that of reusability and lower redevelopment time.

The learning objects are more reusable as each segment contains individual meaning outlined in the material that can be incorporated with learning objects from other lectures to create new material. The chunking into smaller objects also means that if the outcomes for any section of a lecture changes then only a small section of the distance learning material needs to be re-developed as the change will only be applicable to a small section of the lecture. This re-use and rapid re-development helps to reduce the ongoing cost of producing distance learning material.

4 RESEARCH APPROACH

The research approach incorporated aspects of action research and rapid prototyping (from software engineering) while developing exemplar case studies. The research was influenced by developments within the educational technology domain as well as technical developments in software engineering.

A case study approach to research typically looks in depth at particular issues with a single or small number of subjects thus enabling the researcher to conduct investigations and carry out development activities at close range (Brumfit 1989). This approach was appropriate for conducting a number of small investigations and technical explorations related to mass producing the multimedia learning objects. Action research techniques were used for the development of case studies. Hence, formal and informal discourse with the identified stakeholders was established using synchronous and asynchronous collaborative tools; face-to-face dialogue; observations and interview techniques.

Rapid prototyping was used for developing the case studies as this approach is useful verifying the user requirements and verifying the feasibility of designs. Prototypes refer to working models of a system and are relatively inexpensive and quick to build, ideal for keeping production costs down. Further development within the rapid development model can then ensure that any improvements to the development are incorporated into the subsequent production. This rolling change of development model ensures that the material produced meets the pedagogical criteria of both learners and academics.

5 CASE STUDY

5.1 Project background

The case study described here was developed in association with an educational charity through the Knowledge Transfer Partnership. ION is an independent, not for profit educational charity which aims to advance education of the public and health professionals in all matters relating to nutrition and to preserve and protect the health of the general public by giving advice, assistance and where necessary treatment through nutritional therapy.

5.2 Educational Design

The multimedia learning objects produced achieved the same pedagogical standards that the classroom based material attained. The production comprised of four components or building blocks, as depicted in Figure 5.

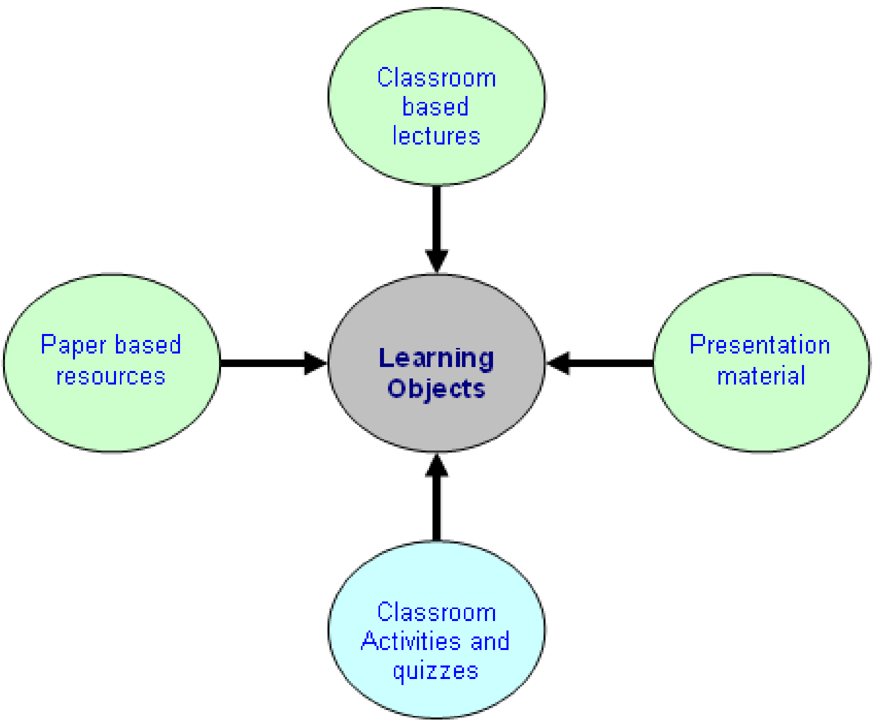

Figure 5 – Multimedia Learning Object Building Blocks

Once each core element of the classroom based material had been identified, scalable solutions were identified to allow mass production of a significant amount of material. The solution identified had met a range of criteria to ensure that it was feasible for the project to run successfully. The solutions needed to be SCORM compliant to ensure interoperability, be produced on a limited budget, retain the meaning of the original material to ensure learning outcomes, and overcome technological issues such as bandwidth and cross platform / browser operability.

5.3 Development Tools

5.3.1 Capturing Classroom Interactions

The tools used to capture the material needed to be consumer-level equipment to meet the budget and operating skills of team members producing the material. All written materials, diagrams and presentation material associated with a lecture could be digitally captured through integration with software packaging tools or deliverance in formats such as PDF's that are widely accepted as a viewable object, irrespective of platform.

Two cameras were used to capture the classroom interactions. An advantage of this is that one camera can be setup to record a wide area whilst a second camera can focus on a narrow shot. This dual recording means a narrow shot captures an increased intensity of facial expression that may be used to deliver meaning in a lecture and a wide angle shot negates risk of the focus point (presenting lecturer) moving out of shot or additional material not being captured.

The radio microphones used to capture spoken word from the lecturer in relation to the teaching subject also ensures that the strength of tonal expression that may be delivered from the lecturer is not lost amidst external noise such as student chatter.

5.3.2 Packaging the Classroom Interactions

To package the material into learning objects development work had to be carried out on the captured material to transform it into web deliverable learning objects. That material came as two sets of video with associated audio, electronic presentation slides, PDF documents and occasionally selected tasks and questions. This is then processed through a selection of software tools to produce each multimedia learning object, as outlined in Figure 6.

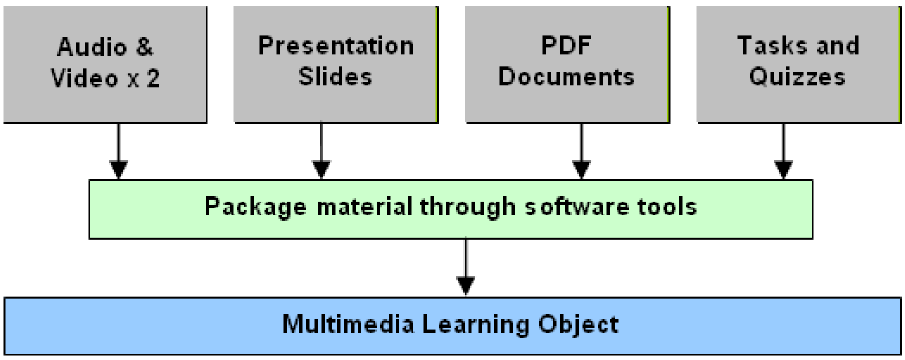

Figure 6 - Processing of captured information to create multimedia learning objects

The software tools used to create the material were a mix of open source and proprietary software that allowed all development time to be concentrated on producing tools within a rapid development environment rather than developing actual development tools. The choice of these tools is integral to reducing the development time of each learning object.

The multimedia packaging tools were assessed on their ability to create media that could integrate easily with existing software tools such as presentation slide software, commonly used in the creation of educational material. This ensures that existing work does not need to be reproduced, reducing overall development time and ensuring meaning is not lost through re-creation. Other key criteria were that the material produced is cross platform / browser compliant so that the material produces has an extended reach to all computer users and is not restricted by hardware or software compliance issues (Figure 7).

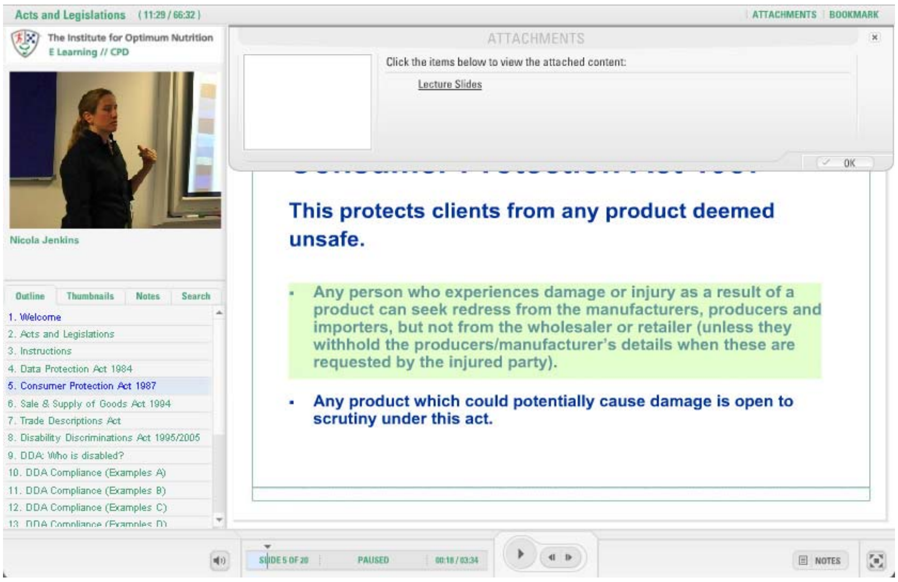

Figure 7 - Multimedia Learning Object Example

The additional benefit of utilizing existing software solutions is that they can be fully branded and incorporate a user friendly interface to increase usability amongst a variety of user types. In addition to classroom based lectures that can be produced using the software tools, tasks and quizzes can be integrated into the learning objects, to simulate the classroom interaction between students and lecturers in a virtual learning environment. This simulated interaction allows the lecturer to reflect on classroom based experiences and discuss future improvements with learning technologists.

The rapid production of both lectures, tasks and quizzes into single reusable learning objects increases the usability of each object as the experience is encapsulated within one section rather than a fragmented, or disjointed experience, where each object was not a of a similar look and feel which may have otherwise decreased usability. The advantage of using one software tool to create many objects is that the standardization of user interfaces increases usability. The tools also offer the capability to separate each learning object into chunks that may be used for its intended subject matter. Each object may be split into many objects and re-used for separate uses for differing purposes to increase re-usability and decrease the expense of creating learning objects.

5.4 Mass Production: Challenges and Risks

Forward Compatibility Challenge

Creating multimedia learning objects on a mass production basis, once established becomes an extremely effective approach for producing high quality material on a low, sustained budget. However due to the ongoing nature of mass production it is critical that each tool's output is compatible with subsequent tools input and that such outputs from the initial tool can be quickly manipulated within the subsequent tool. This was achieved by ensuring that all captured audio/visual material was easily edited in media editing software, that the outputs of the editing software were suitable for web delivery and that the learning objects produced were SCORM compliant to effectively integrate with our LMS, as depicted in Figure 8.

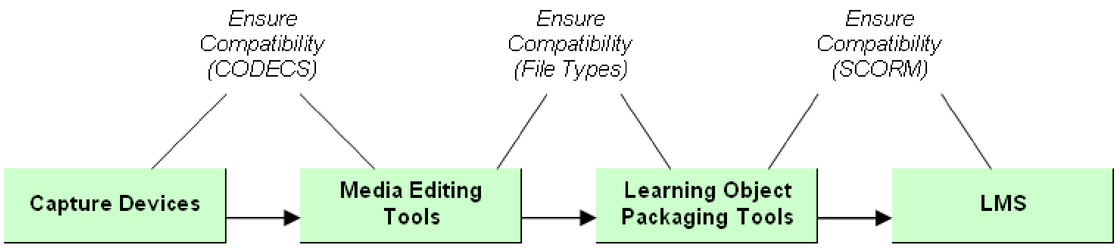

Figure 8 - Design Challenge: Ensuring Forward Compatibility

Learning Object Delivery Challenge

The classroom based lectures, in this case study, are one hour long and for web delivery are broken down into three natural segments that contain all of the learning outcomes the original material did. This inclusion of all the original material ensures that the intended learning outcomes are preserved.

The web based material can be further contextualised into five minute bite size sections that cover the fundamental learning outcomes of each section. These smaller chunks are more suited to mobile delivery due to current technical limitations of mobile delivery. This mobile learning is useful for summarizing and recapping learning outcomes already undertaken in either a classroom or through the web delivery.

Production Risk Management

The process of capturing audio/video material, editing the material into learning objects and ensuring that the material is both technically and pedagogically sound was modeled using a workflow diagram. The documenting the workflow process is useful to assess risks and ensure value in each section of work undertaken. For example, a key stakeholder leaving the project is difficult to negate, especially within a project with limited budgets. This risk is overcome by having all tasks fully documented and all stakeholders cross trained to undertake various roles to ensure future success of the project.

Pedagogical Risk Management
Pedagogical risks include material produced not being fit for purpose. These are absolved by ensuring that each prototype produced is substantially evaluated to ensure that it meets the learning outcomes expected in the original classroom based lecture. The key stakeholders that assess this information are the original students and the presenting lecturer. To engage students in this review the material is provided as an additional resource for the course providing a basis for students to be sufficiently interested in using the material and providing feedback. Initial evaluations of the learning objects were positive but this needs to be extended to formalise the learning objects by engaging with stakeholders to assess the true value of the learning content.

6 CONCLUSION
Within this paper we have focused on the mass production of learning objects. The experience of producing learning objects with the use of existing software tools has demonstrated, as in the case study, to be a sustainable method for producing cost-effective reusable learning objects.

Future work will look at formalising the learning objects by engaging with stakeholders to assess the true value of the learning content. The next stage will also focus on widening participation by enabling community based learning, specifically targeting learners from less affluent neighbourhoods. In addition, the development efforts will focus on affordability and adaptability of learning objects. Affordable learning objects will help in widening participation by enabling community based learning, specifically targeting learners from less affluent neighbourhoods. The use of learning standards makes it easier for learning object providers to offer adaptable learning by enabling learning objects to be adaptable and open to change. Metadata, when used appropriately, can aid personalised learning by allowing learners to customise their learning according to the metadata descriptions provided. However, it is envisaged that in the future learners will be able to engage with the learning object to personalize and customize the learning experience.

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