A Case in the Design of Generative Learning Objects (GLOs): Applied Statistical Methods GLOs

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Abstract: This paper introduces the concept of a Generative Learning Objects (GLOs), based on separating the learning design from the surface instantiation of a learning object. This produces a number of advantages: i) focuses attention on the quality of the learning design that is at the heart of the GLO; ii) provides a basis for a marked improvement in productivity. We then present a GLO architecture that describes the building and production of GLOs. Finally, the paper concentrates on our present work in the development of a particular GLO design: Applied Statistical Methods GLOs.

Background

This paper reports on the joint efforts of two major centres to develop the next generation of learning object design. This section briefly introduces the partners and then concentrates on the need to develop generative learning objects (GLOs). The paper then introduces our approach to the construction of GLOs and offers an example of our on-going work in the development of Applied Statistical Methods GLOs.

Universities' Collaboration in eLearning (UCeL)[1] is a partnership between a number of UK higher education faculties and is pioneering methods of collaborative and interactive eLearning content creation (Leeder et al., 2004). Founded in March 2002 by the Universities of Cambridge, Manchester, Nottingham, East Anglia, Wolverhampton and Peninsula Medical School, UCeL is actively exploring ways in which high quality content can be unlocked in the form of reusable learning objects (RLOs) across the many disciplines comprising the wide field of health professional education. A number of subject areas have been identified as broadly generalisable, and therefore potentially the most promising, for generating reusable content across all health professional disciplines. These are: statistics, epidemiology, research methods, anatomy and physiology. For the first two years since its inception, UCeL collaborators have created, developed and evaluated a range of RLOs[2] and these resources have proved valuable in the understanding of many fundamental concepts that health professionals need to learn (Wharrad & Leeder, 2003). UCeL runs national hands-on workshops[3] to engage educators in the practical skills of RLO content creation. In the course of these workshops, a brainstorming session seeks to identify the factors that will maximise reusability of materials. A consistently desirable quality is that of adaptability and it is this quality that informs the design of generative learning objects.

The Learning Objects Group at London Metropolitan University have developed highly interactive learning objects based on constructivist pedagogy. The group has contributed to the design of learning objects through a synthesis of concepts derived from software engineering, to ensure reusability, and rich pedagogy (Boyle 2003). These learning objects have been used with over 1000 students at two higher education establishments over a two-

[1] http://www.ucel.ac.uk/
[2] http://www.ucel.ac.uk/rlos/
[3] http://www.ucel.ac.uk/workshops/

year period, and dramatic improvements in the pass rates have been obtained (Bradley and Boyle 2004). The experience of these studies, however, has shown that that considerable productivity improvements can be gained through more flexible design of the learning objects. This has led the group to the concept of generative learning objects, and to work in partnership with UCeL to explore more generic methods of RLO creation.

Interactive multimedia is notoriously expensive and time-consuming to produce yet there is evidence that if made and deployed effectively it can enhance the learning experience (e.g. Chalk et al., 2003). Student evaluations show that, provided the materials are high quality, they are well received and valued (Chapple et al., 1993; Wharrad et al., 2001); consequently if material can be made collectively and shared across courses and institutions then the deliverables will be significantly more cost-effective (Tope, 1996). This first generation of RLOs whilst engaging, interactive and educationally effective, is limited. The basic unit of reuse is the object as a whole and this leads to marked limitation in productivity. There is a clear need to develop a more flexible format for developing learning objects which will support both increased productivity in development and flexible repurposing by local tutors. It is these considerations that led to the development of the concept of generative learning objects (GLOs).

Generative Learning Objects (GLOs)

For GLOs to be truly adaptable, the underlying general structure of the material needs to be separated from the specific content. How this is achieved depends to a large extent on the nature of the material itself: the concept that needs to be understood; the process, procedure or code that must be stepped through; or, as in this example, the dataset that requires application of a statistical method. The act of making a GLO is thus one of deconstruction where the higher levels of content are separated from the deep structures at the core, the 'essence'. It is these deep structures that form the basis for reuse with lecturers providing their own instance of material for their particular teaching and learning purposes. The challenge then, is to make the GLO powerful enough for general reuse whilst keeping it simple to modify in as many different ways as possible.

There is growing interest in the concept of learning design (IMS-D 2003, Britain 2004). However there is an unfortunate tendency to treat learning objects as "things" slotted into learning designs, rather than being built on learning designs themselves. Britain points out that, in order to achieve the learning objective, a learning object has to have a learning design built in (however basic). The key concept of generative learning objects is to separate the deep structure from the surface structure of the learning object. In that sense it uses a model of reuse, which is closer to that in object-oriented software engineering. This raises the question of what exactly is the nature of the deep structure. As argued in Boyle et al. (2004), this includes the learning design that underpins the object. The concept of "generative learning objects" separates the learning design from its surface instantiation. The surface learning object is then viewed as a particular realisation of the underlying learning design. This has a number of advantages. Importantly it focuses attention on the quality of the learning design underpinning the object. As the surface object is generated in a series of steps from this design, it permits intervention at these stages. This means that many variants can be produced from the same design. Because the learning objects are divided into their basic components, and structures, it becomes easier to identify and modify individual components. Our ultimate vision has been to produce a "generative learning object architecture" supported by series of tools that make intervention at key stages in the generation of the object as easy as possible. In this way, the productivity of those making learning objects can be greatly increased. By creating user-friendly tools to support this process, it also facilitates easy repurposing of the learning objects by local tutors.

The GLO Architecture

In Boyle et al. (2004), two possible approaches to the development of generative learning objects are presented. Both approaches illustrate the key separation of learning design from surface realization. The first approach "deconstructs" a multi-media learning object. The second approach illustrates how the GLO conception can facilitate thinking in more productive ways about learning object designs. It illustrates how learning objects can be created as learning designs, with surface content added later. This process produces specialized learning objects highly relevant to the target learner groups. It is this second approach that we explore in this paper.

The creation of a GLO is divided broadly into two parts, the building of the Learning Object Template and the addition of the subject specific content. The Learning Object Template will contain the deep structure or the learning design. Once a Learning Object Template has been created, tutors can add different subject specific content, the surface structure, to produce many Learning Objects, fit for purpose in their particular fields. See Figure 1 for an illustration of this process.

The building of the Learning Object Template will be similar to the approach currently used by UCeL in the production of RLOs. A workshop of experts, students, an artist and a facilitator will work together to establish the learning design. The role of the facilitator will be particularly important because of the new need of ensuring that the material produced is suitable for building a GLO. This simply means separating the core-learning objective from subject specific examples, data and terminology. This material will be shaped into a Learning Object Template using existing software and tools developed especially to enable re-usability. A peer review process similar to that currently employed by UCeL will assure quality.

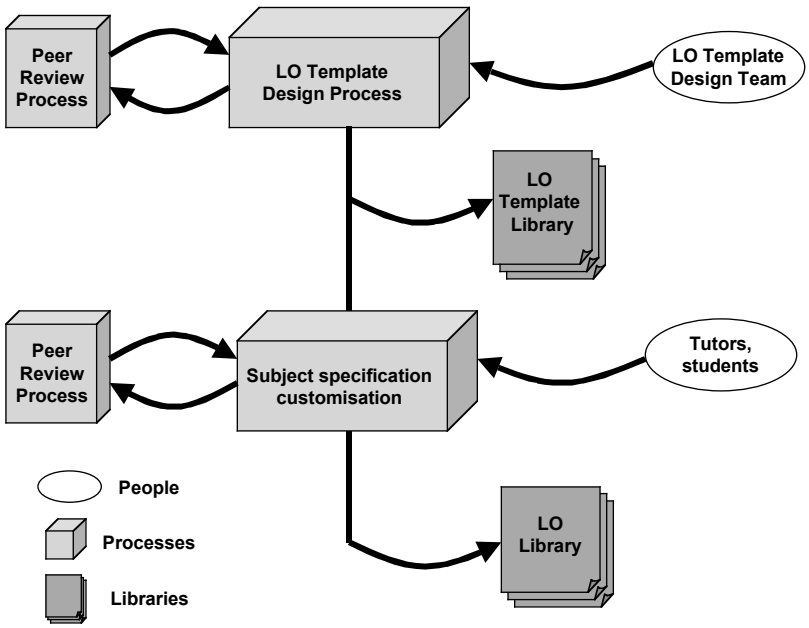

Figure 1: Building of GLOs. This figure shows the people involved in different processes and the libraries created at different stages.

The second stage is the creation of Learning Objects for application in specific subject areas. Based on the Learning Object Template, software tools will automatically generate web-based forms that tutors and students will use to supply the subject specific content. This content will be automatically combined with the Learning Object Template to produce a finished Learning Object. After a further process of peer review, the Learning Object will be published. An important point is that at any time in the future, if improvements are made to the Learning Object Template, the subject specific content can be re-combined with no further intervention other than a review process.

The diagram in Figure 2 outlines the production of GLOs. It shows the people, the software tools they will use, and the output database or library that is created. The separation of the deep structure from the surface structure or, the Learning Design from the subject specific content is shown: the deep structure being in the Learning Object Template Library and the surface structure being in the subject specific content database. The way in which these are connected is also shown. The Learning Object Library, though it holds the finished product, is not of primary importance because its content, the Learning Objects, can be re-created at any time. This ability to re-create the learning objects naturally leads to the idea that multiple versions could be created, for example, for publication via differing media or with different branding for publication by different organisations. The problems of localisation to

other languages would also be partly addressed with this model[4]. In what follows, we will describe the different components in the diagram:

The Learning Object Template Design Team - this team will comprise academic experts, students and facilitators. The academic experts will impart their understanding of the pedagogy needed to achieve the Learning Objectives, whilst the facilitators will bring their understanding of what is required to create a Learning Design that can be expressed in a Learning Object Template. The students will ensure that the material produced will meet their needs. This team is clearly of key importance because the material that they produce will determine the efficacy of the rest of the process.

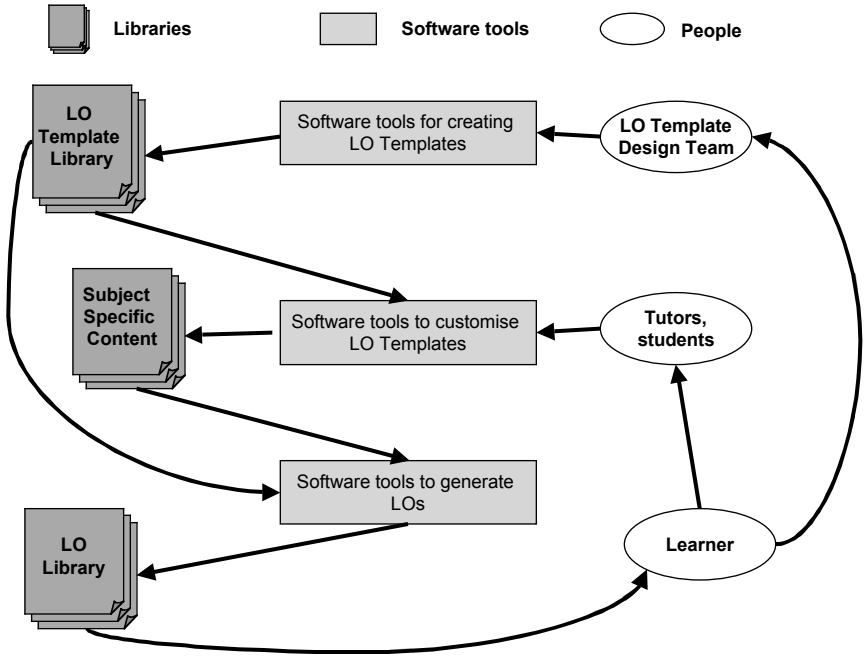

Figure 2: Production of GLOs. This figure shows the people involved, the software tools used and the libraries created at different stages.

Software tools to customise the Learning Object Templates – Using existing multimedia applications and tools developed especially, software developers will shape the material produced by the Design Team into Learning Object Templates. It is envisaged that eventually tools will be developed that the facilitators could use, during the design workshops, to initiate this process and simultaneously allow the Design Team to see their ideas taking shape.

Learning Object Template Library – this will be a database of all the Learning Object Templates that have been created. The Learning Object Templates will be XML documents that describe the components needed to create a Learning Object. They will contain the deep structure, i.e. the pedagogy comprising the learning design. This information will be separated from the surface instantiation: the specific content supplied and the means of presentation.

Tutors – Tutors/teachers will provide the subject specific content, the surface structure of the Learning Object that will make it fit for purpose in their particular field.

Software tools to customise the Learning Object Templates – This software will create HTML forms based on the information contained in a Learning Object Template. These forms will guide tutors through the process of

[4] Many questions arise, for example, issues of IPR, version control and process management.

supplying all the subject specific content that is needed to create a complete Learning Object. The completed Learning Object will be presented to the tutors for evaluation but the data they supply will be stored separately form the Learning Object Template.

Subject specific content database – this is where the subject specific content supplied by the tutors will be stored. Note that this data is not within an instance of a finished Learning Object. It is in a database and available to be re-combined with the Learning Object Template at any time. This will considerably reduce the workload in the likely event that the Learning Object Template needs modification.

Software tools to generate Learning Objects – This software will re-combine subject specific content with the appropriate Learning Object Template to produce a finished Learning Object. It will be possible to configure this software to produce Learning Objects for presentation via different media, for example, web, printed and handheld, and for publication by different organisations, i.e. branded.

Learning Object Library – This is where the finished Learning Objects are stored. This library would probably be kept on a number of different servers. At any time, its contents could be re-created from the Learning Object Templates and the subject specific content. In addition, all the HTML needed to present the library on-line, with all the appropriate metadata could be generated automatically.

Learner – Because GLOs will be made to address specific learning need, it is of vital importance to have the learner involved at all stages of their creation, thus ensuring that the finished product, the Learning Objects are fit for purpose and of that highest pedagogic standards. Feedback from learners will be an important part of quality control; the model described will allow changes, brought about in response to this feedback, to be easily disseminated into all the Learning Objects.

We are currently exploring a range of GLOs. The first stage has been to identify the generic concept that is based on actual educational need, has a common core that can be readily adapted and will be of use to a broad educational base and across a number of disciplines. Secondly, these themes require prototyping and testing. In the following section, we give an example of the design of an Applied Statistical Methods GLO.

Applied Statistical Methods GLOs

Statistical issues arise as important natural parts of the process of reaching conclusions. From astronomical to psychology studies, statistical methods are required for data analysis across disciplines. The same terminology, graphical representation and statistical tests can apply to different data sets. Depending on the type of questions we want to investigate, the learner would need to apply different tests.

In 1992, the four UK HE Funding bodies set up the Teaching and Learning Technology Programme (TLTP). The projects funded under this scheme were aiming to use modern authoring tools to develop computer-based teaching materials. As part of the TLTP phase 1, the STEPS[5] project (STatistical Education through Problem Solving: The STEPS Project 1999) brought together nine departments in seven universities throughout the UK to develop problem-based teaching and learning materials for statistics. In all, thirty or so academic statisticians and programmers helped to develop the STEPS materials. The materials produced are based around specific problems arising in Biology, Business, Geography and Psychology.

Taking the STEPS materials as the starting point, we are using the different statistical tests as the core for Applied Statistical Methods GLOs. Tutors can adapt these GLOs to their own subject specific needs by using different data sets relevant to their courses. Interdisciplinary workshops explore analogous data sets across subjects and create the core materials that will subsequently be developed and tested. Using this approach, lecturers can rapidly apply an appropriate data set to a particular method to customise the GLO for their own particular discipline to make the material more relevant and engaging for learners.

[5] http://www.stats.gla.ac.uk/steps/

We aim to create a collection of GLOs, each with a key statistical method at its core. Subject areas are: Psychology, Criminology, Politics, Health Sciences, Nursing and Public Health. Workshops will first identify the statistical methods that generalise across the disciplines. UCeL and London Metropolitan programmers will then develop the core statistical materials. A further series of content development workshops will bring together teachers and students to explore how the generic core materials can be adapted by applying their own data to the core method. The final GLOs will be piloted and evaluated with students in each of the subject areas. We expect to report on at the ED-MEDIA 2005 conference the following deliverables: workshops run during January 05 to March 05 and the work on content development with academic staff during May 05 to June 05. We will continue with the Applied Statistical Methods GLO project for almost another year, during which development of resources, dissemination and feedback will be taking place.

Summary and Conclusions

Increasing RLO productivity and support flexible repurposing by local tutors are the major goals behind the concept of Generative Learning Objects (GLOs). Our basic approach in the development and design of GLOs has made use of a more flexible design based in a process of deconstruction: separating higher level contents from the deep structure at the core. It is these deep structures that form the basis for reuse with lecturers providing their own instance of material for their particular teaching and learning purposes.

In this paper we offered an example of the design of a particular GLO: Applied Statistical Methods. This on-going work aims to create a collection of GLOs, each with a key statistical method at its core. We expect to report on at the ED-MEDIA 2005 conference how workshops and content development work with academic staff have shaped the GLOs content, the development of resources and the dissemination and feedback stages.

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