# To boldly GLO – towards the next generation of Learning Objects

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**Abstract**: This session commences with a demonstration of Reusable Learning Objects (RLOs) currently in use followed by a brief panel discussion of the factors considered crucial for reusability: community of practice, quality assurance, flexibility etc.. A major challenge for the next generation of RLOs is to develop Generative Learning Objects (GLOs) that support adaptable modification to meet a range of learning demands. How this might be achieved, and the educational benefits of such flexible learning objects are then discussed and this general discussion will form the largest part of the panel session. The panel offers extensive experience of successful uptake and embedding of RLOs in teaching and learning practice as well as deep understanding of the theoretical and technical issues that underpin this practice.

## Introduction

This symposium reports on the joint efforts of two major centres to develop the next generation of learning object design. This section briefly introduces the partners; the paper then concentrates on the need to develop a new generation of "generative learning objects".

Universities' Collaboration in eLearning (UCeL) is a partnership between a number of UK higher education faculties and is pioneering methods of collaborative and interactive eLearning content creation. 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 and made reusable 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 and these resources have proved valuable in the understanding of many fundamental concepts that health professionals need to learn. UCeL runs national hands-on workshops 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 the next generation of 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 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 (Wharrad et al., 2001); consequently if material can be collectively made 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. However, 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.

**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; 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. We argue that this is 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. This will be illustrated in the symposium. Because the learning objects are divided into their basic components, and structures, it becomes easier to identify and modify individual components. The ultimate vision is 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 learning objects can be greatly increased. By creating user-friendly tools to support this process, it will also facilitate easy repurposing of the learning objects by local tutors.

**Explorations in the development of generative learning objects**

The symposium will explore and illustrate two approaches to the development of generative learning objects. Both approaches illustrate the key separation of learning design from surface realization. The first approach "deconstructs" a multimedia learning object that has been successfully used for two years in several universities. It first asks the question: why convert this to a generative learning object? The talk will show how limitations in the productivity, and flexibility of the learning object can be overcome by converting it to generative learning object format. 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.

**Reconstructing a learning object as a GLO: a simple illustration**

Figure 1 gives an illustrative screen for a learning object dealing with the 'while ...loop" in the Java programming language. This learning object uses a lot of interactive animation. It is implemented in Flash. Examination of this object immediately illustrates the advantages of converting it to more flexible format. For example, the code which is shown is for Java programming. However loops are a common construct in most programming languages. There is considerable productivity to be gained by allowing flexible access to and modification of the code component. Multiple instances of the object can be created, with immediate benefits in productivity. Equally the commentary is in English. It is more productive to let tutors both choose the language they wish to use, and adapt and modify the commentary to meet the needs of their local situation.

Creating a generative structure that allows local tutors to easily edit these components supports the local specialization that makes learning objects more acceptable and effective in the context of delivery.

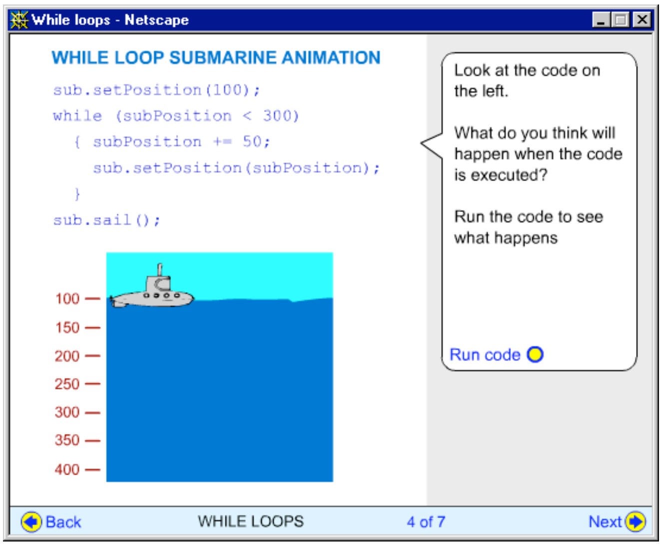



Figure 1: Screen from learning object for the while loop

There are deeper challenges in creating an effective GLO structure. For eample, we have developed a mobile multimedia version of this learning object for use over PDAs and the new generation of mobile phones. In this case, the text disappears and is replaced by speech. The pedagogical function, i.e. providing explanatory dialogue, remains. But the surface realisation is markedly different. The challenge for this GLO is to develop an architecture that represents the essential pedagogical pattern underpinning the object, and supports rendering this pattern to a variety of powerful surface instantiations.

**New design based learning objects**

The panel are currently exploring a range of GLOs. The first stage has been to identify the generic concept that a) is based on actual educational need; b) has a common core that can be readily adapted; c) will be of use to a broad educational base and across a number of disciplines. Secondly, these themes require prototyping and testing. Topics under development are: Complex Decision Making; Applied Statistical Methods; Principles of Conservation.

**Complex Decision Making**

This learning object takes the learner through a series of vignettes that form the decision making process. The case is presented as a series of characters or 'players'. The central player is the decision maker themself and this is the person who is faced with having to make a difficult choice, for example whether or not to terminate a pregnancy. The learner takes an interactive journey through the decision-making process. By interrogating the various players - the decision-maker and the decision influencers - the learner builds up a complete picture of the complex decision-making process. As each player offers their view, the learner records their own thoughts and votes on what they think the final decision will be. The learner's reflections are recorded at each stage and the learner receives a printable output at the end of the process documenting all the views, their reflections and the final outcome.

The teacher builds the learning object using a web-based template or proforma. By responding to a number of questions on the form they are prompted to provide all the information required that will lead the decision-maker to produce their decision. The decision-influencers are grouped into three categories: family & friends; health professionals; other stakeholders. Each player can have up to four views on the matter. The views are ranked according to how closely they concur with or deviate from the default position. So in the case where the decision is whether to have an abortion, the view that she should would score 3. A view that she should not would score 0. There are also two intermediate views scoring 2 if slightly in favour of the intervention and 1 if slightly against. The decision-maker also has a response to each of the possible views they are presented with and up to four final decisions, selected depending on the scores of the views presented.

The main deliverable of the learning experience (for both learner and teacher) is a complete printable transcript of the process containing all the opinions and responses together with the learner's reflections at each stage and the final decision and learner's concluding comments. The learning object itself is generated automatically from the teacher's input. This would be in text format initially, but with further development could contain audio and/or video vignettes. As the collection of GLOs expands, the best ones can be selected for audio-visual development and showcasing.

**Applied Statistical Methods**

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 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, the panel are using the different statistical tests as the core for Adaptive 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.

**Principles of Conservation (The General Balance Equation)**

There are many instances of systems where a fundamental property inherent within that system is conserved. Examples include many "scientific" systems in which the properties of, for example, the mass or the number of certain atoms entering, leaving or remaining within the system are conserved. However, the same basic principle also describes many situations that would not conventionally be considered to demonstrate analogous tendencies.

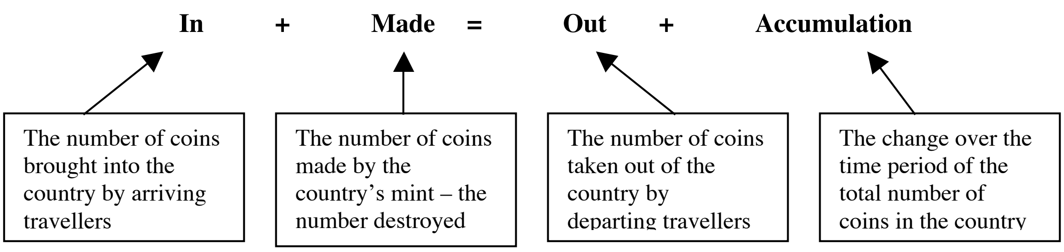
The universal equation that describes conservation under such circumstances can conveniently be written as:

**In + Made (Net) = Out + Accumulation**

The four terms that constitute this equation allow all the intrinsic features that characterize the behaviour of the system to be accounted for. This GLO therefore, exploits the universal applicability of the fundamental equation, but allows each of the four terms to be tailored to the desired and particular learning outcome. Intriguingly, the applicability of this equation touches a multitude of applications in diverse areas of study; this may be a prime example of a GLO that can be re-utilised to aid teaching and learning in a range of hitherto unconnected disciplines.

Examples, including situations that lie beyond the more obvious applications in the natural sciences or engineering, include the following:

- **Coins in a currency in a country over a time period**



- **Water in a tank fitted with supply and exit pipes**

| **In** + | **Made** = | **Out** + | **Accumulation** |
| --- | --- | --- | --- |
| The water flowing into the tank | Zero – you can't make water | The water flowing out of the tank | The change in the amount of the water within the tank |

- **The number of patients in a hospital**

| **In** + | **Made** = | **Out** + | **Accumulation** |
| --- | --- | --- | --- |
| Admissions | The net difference between births and deaths | Discharges | The change in the number of patients in the hospital |

- **Micro-organisms within a closed fermenter**

| **In** + | **Made** = | **Out** + | **Accumulation** |
| --- | --- | --- | --- |
| Zero (closed system) | The rate at which the micro-organisms divide | Zero (closed system) | The change in the number of organisms in the system |

## Conclusions

Generative learning objects are in their early stages of conceptualisation and production. They already have a number of aspects and a set of features depending on the subject areas they serve. The concept of a GLO is based on separating the "learning design" from the surface instantiation of a learning object. This produces a number of advantages. It focuses attention on the quality of the learning design that is at the heart of the GLO. It also provides a basis for a marked improvement in productivity. For example, the same learning object format can be used for all computer languages using "while" loops rather than just one. Crucially, it also supports the adaptation of content by local tutors to suit their needs and preferences. The role of this symposium has been to highlight the importance of GLOs, and to elucidate the crucial concepts on which they are based.

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