An Agile method for developing learning objects

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There is considerable international interest in learning objects. The emphasis on technical issues such as standardisation of metadata schemes and software packaging has diverted attention from the central issues of how to develop pedagogically effective learning objects. This paper presents the development methodology of the UK Centre for Excellence in Teaching and Learning (CETL) for Reusable Learning Objects. This is an 'Agile' approach that balances the requirement for flexibility to fit a pressurised work environment with the need to facilitate the development of high quality resources. The approach is grounded in front line practice, including the development of EASA award winning learning objects. The paper outlines this method from problem identification, through design, to learning object production. It complements the earlier work on design principles and heuristics to provide a comprehensive and flexible framework for learning object development.

Keywords: reusable learning objects, methodology, agile methods

Introduction

There have been two major strands of work on learning objects. The first strand has focused on developing international standards and specifications for learning object metadata and packaging (IEEE, 2002; IMS, 2005; SCORM, 2004). This provides standard ways of packaging and describing learning objects – that have already been created. It says little, however, about how to create standalone, pedagogically effective learning objects in the first place. The second major strand has focused on filling this gap by providing pedagogical and structural design principles for creating learning objects (Boyle, 2003; Bradley & Boyle, 2004). These principles provide orienting heuristics to guide the design process. An important complement of this approach is to provide a full life-cycle framework that guides designers in moving from problem identification through to learning object production. This paper aims to elucidate the methodology developed to meet this challenge by the Centre for Excellence in Teaching and Learning (CETL) in Reusable Learning Objects.

The CETL commenced in April 2005 with funding of £3.3 million (since extended to £3.44m) from the Higher Education Funding Council for England (HEFCE). The CETL is a partnership of three universities: London Metropolitan University, University of Cambridge and the University of Nottingham, to develop and evaluate learning objects across a range of subject areas. These learning objects are used and evaluated with a minimum of 2000 students across the three institutions each year. The CETL also has a major staff development programme, and works to support communities outside the CETL partnership in developing and evaluating learning objects (RLO-CETL, 2006).

There were two major influences on the development of the CETL methodology. The first is the extensive experience of the partners in developing learning objects. This includes work at London Metropolitan University in developing learning objects for programming that led to a European Academic Software Award in 2004 (EASA, 2004). It also includes the work of the Universities of Cambridge and Nottingham in developing learning objects for a range of subjects including Nursing and Health Science (SONET, 2006; Leeder, McLachlan, Rodrigues, Stephens, Wharrad. & McElduff, 2004). The

methodology described is grounded in this extensive experience, and that gained during the first year of CETL operations.

The second major influence is that of 'Agile' development methods, especially DSDM (Stapleton, 1997; Yeomans, 2000). Agile methods grew out of the rejection of heavyweight, bureaucratic approaches to software development such as the Waterfall method. The Agile approach aims to "Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done" (Agile Manifesto, 2001). The Agile approach provides an ethos and process that links the grounded categories derived from the empirical base into a wider conceptual perspective. These two major influences on the development of the CETL methodology are summarised in Figure 1.

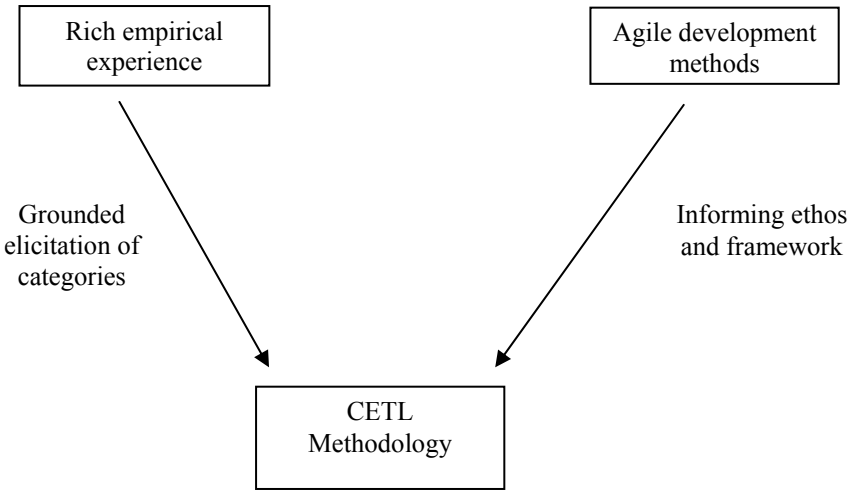

Figure 1: Influences on the development of the CETL methodology

Overview of the method

The aim is to provide a robust and flexible framework that will support the development of high quality learning objects**.** The need is to produce a light 'agile' development method that is structured but adaptable to local circumstances. The methodology should allow the development team to achieve the best route to creating effective learning objects in the context of local opportunities and constraints. To achieve this flexibility it is useful to focus initially on the key development functions that need to be covered. The key high level functions that need to be covered are:

- analysis of learner needs
- design
- development
- delivery
- evaluation.

The methodology aims to provide a flexible framework that provides structures and processes to realise these functions. The central focus is on producing high quality learning objects. The methodology should assist the development teams to find the best route to achieve this in the context of the particular project. To do this there has to be an appropriate balance of structure and flexibility. Each project follows a path through the CETL development framework, which covers the main development functions. However, no two paths have to be exactly the same. The optimal path is a mapping from the main development methodology that best suits local circumstances.

Most development projects involve more than one learning object. A batch of learning objects is usually developed to meet the learners' needs. Each project has thus embedded within it a series of strands – one for each learning object developed – which can operate at least partially in parallel. Development is carried out by collaborative groups of academic tutors and multimedia developers, in which:

- the academic tutors are responsible for the conceptual (pedagogical) design of the learning object, while the multimedia developers provide expertise in presentation (multimedia) design and development
- there is close involvement of academic staff in the whole life cycle of development, delivery and evaluation of the learning objects
- there is a strong emphasis on quality assurance and student evaluation.

The framework emphasises the need to understand the problem before designing the solution. Projects should start, therefore, with an analysis of the learner's needs. The output of this analysis informs the design and development process. Design and development is an iterative process involving a collaborative group, including centrally the academic tutor(s) and a multimedia developer. An important feature of the method is that the learning objects are then used with significant groups of students. There is "use before reuse". The use with students provides a basis for evaluating the extent to which the learning objects have met the original objectives. Finally, and only at this stage, are the learning objects packaged, with full metadata description, and stored in a repository for wider reuse.

Figure 2 presents a diagrammatic outline of the main stages. The following sections discuss, in turn, the main phases in the development of learning objects: analysis of learner needs and initial RLO specification; design and development; delivery and evaluation, and packaging for reuse.

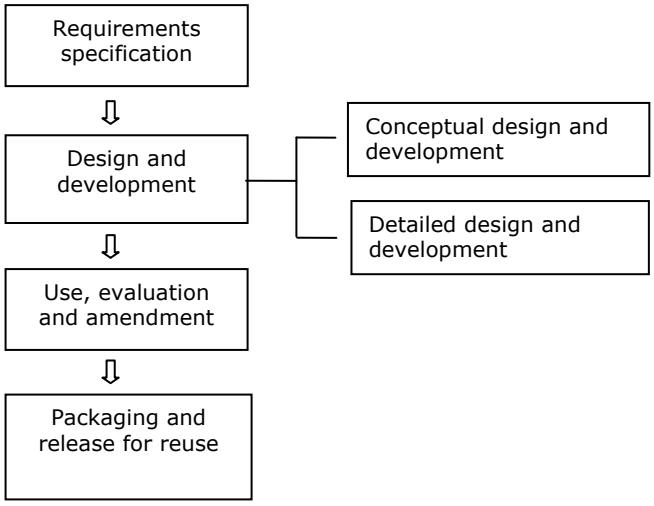

Figure 2: High level overview of development methodology

Learning needs and project specification

The seeds of a new project reside in a number of questions. What are the problems the students face? How might the availability of new learning objects help the students to deal with these problems? Can learning objects offer a new learning opportunity that will extend the quality of the learning experience of students? A further important issue – is there widespread scope for the reuse of the learning objects developed?

A weakness of many educational artefacts is that they are not based on a proper analysis of learner needs. The RLO-CETL places a strong emphasis on understanding problems before attempting to produce the solutions. The main expertise for this comes from subject tutor(s) who teach the students and have an intimate understanding of the problems students experience.

The initial phase typically takes the form of an informal discussion between the tutor(s) and the local academic co-ordinator (LAC). Each LAC manages and co-ordinates learning object developments in their home institution. This may be initiated by the CETL team identifying a topic and approaching tutors, or by a tutor approaching the CETL with an outline proposal. The discussion focuses on the student problems and how these can be addressed by developing learning objects to produce an enhanced

learning experience for the students. The culmination of successful discussions is the initiation of a project by signing the Project Agreement form.

Another technique the CETL uses at this early stage is to run workshops where staff generate ideas for the possible learning objects. These workshops involve both identifying 'common' problems and brainstorming outline design specifications. We involve students in these workshops to provide the 'student view', as well as the tutor views. The one-day workshops provide a telescoped analysis and initial design of possible learning objects. Promising ideas are followed up through a full project development cycle. There is also an extended residential event for CETL staff, held annually in June, which provides a deeper and more sustained exploration of problems and possible design solutions. A strong cohort of students is present during this event. Our experience is that this acts as an important input to balance and correct, where appropriate, staff views of the issues (Cook, Leeder, Wharrad, Morales & Boyle, 2004).

Projects operate within constraints of time and local context. The basic requirement of the first phase is to have a baseline understanding of the problem and a specification for developing learning object(s) to tackle it. This specification sets clear challenges that we expect the design phase to tackle. It should also provide a baseline for the evaluation of the learning objects – to what extent do they deal effectively with the challenges/problems identified in the analysis phase?

The Project Agreement sets out the aims and objectives of the project (e.g. develop fifteen learning objects to enhance study skills in first year university students). The tutor agrees to both develop and evaluate the learning objects with a substantial cohort of students. The CETL provides funding to release the tutors time to work on the development process (typically around £7/8k). A multimedia developer and an evaluator are assigned to the project. At this stage the tutor also agrees to the licence that will govern the distribution and reuse of the learning objects.

Table 1: Summary of phase 1 activities and outcome

Main personnel	Activities	Supporting documents	Outcome
Tutor(s)	Propose outline ideas for learning objects Refine in light of LAC feedback		
Local academic co-ordinator (LAC)	• Discuss ideas with tutor. • Help tutor refine ideas to be suitable for RLO development • Support tutor to write project specification	The standard project specification template form	Signed project specification form, with agreed funding and allocation of resources to project

Note. This table is a summary of a dynamic process. The tutor may consult with other tutors and preferably students in refining the ideas. The LAC will usually consult with other CETL personnel experienced in RLO development.

When the team and resources are allocated the project proper commences. The learning objects are developed in a series of 'mini-project' strands that may be conducted in parallel or in sequence, as determined by the development team. The core of the development team consists of the tutor(s) and the multimedia developer, supported by an evaluator. The management oversight of the project is provided by the local academic co-ordinator. The management ethos is to provide quality enhancement support that facilitates the successful execution of the project.

Design and development

The CETL aims to provide a framework that provides a flexible approach that adapts to individual circumstances, while ensuring quality control of the processes. The development methodology has to

achieve a balance between project discipline on the one hand, and the dynamic flexibility required for real progress with staff working part time under difficult and often 'noisy' conditions.

There are two main approaches that feed into the CETL design and development approach. London Metropolitan University, where the tutors and multimedia developer work in close proximity, has developed an intense iterative approach were specification and development are intertwined in the development process. This approach was used to successfully develop the learning objects that won the EASA award. The Cambridge and Nottingham partners have developed a structured framework to support distributed development where the tutor and multimedia developer often reside in different institutions. This uses an approach with more clearly demarcated sub-phases of development.

The CETL treats these two as poles that specify a range within which an agile path may be chosen. The project development methodology supports both modes of development and supports variation between these two poles to suit local circumstances. The 'distributed mode', with its explicit separation of specification and development, is described first. This is followed by their description of the 'intensive iterative' mode where tutor and multimedia developer work intensely together, usually in close proximity.

Distributed development mode

This mode is based on a distributed development model where the tutor and multimedia developer often reside at different institutions. The production workflow with its accompanying templates was developed with the dual aims of a) supporting a community of practice that is geographically distributed and b) providing a framework to help new practitioners organise their expertise and materials in a format suitable for learning object production. The process is divided into stages, with clear quality checks and hand-over points.

The two main stages are 'design/content specification' and 'multimedia development'. In the content creation stage a specification for a learning object is created by a subject expert using a special template that helps them to organise their materials into a format suitable for RLO development. The specification is then dispatched for the first stage of peer-review. The peer-reviewer, who is the subject expert's counterpart, in another institution, is encouraged to be constructively critical and to offer suggestions for improvement. The author may be required to make some modifications before the RLO moves on to the next stage.

The specification and content supplied by the tutor are electronically dispatched to the developer. The developer then builds a multimedia learning object based on the specification. The resulting RLO is checked for functionality to ensure it works correctly. The RLO then goes out for the second phase peer-review (usually back to its first stage reviewer). This ensures that it meets the specification and that nothing has been lost in the development process. If necessary, it may be returned for further modifications and development. Finally, the RLO is delivered for use and student evaluation.

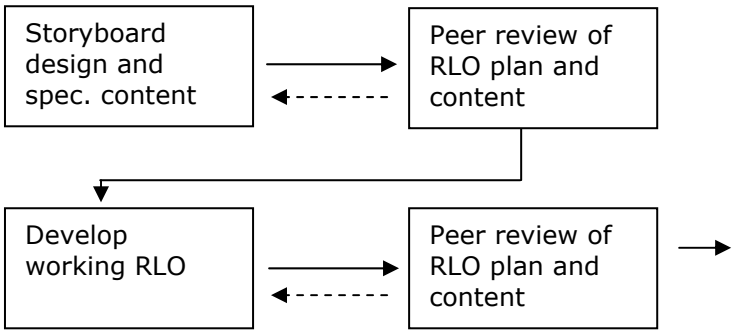

Figure 3: Summary of distributed development path

Intense iterative development

In the intense iterative mode of development the tutor and multimedia developer operate in close proximity. The development of the multimedia learning objects involves close, dynamic interaction between the module tutors and the multimedia developer. This supports a rapid prototyping style of development. The tutor will typically express their initial ideas on paper for the multimedia developer. This may lead to the development and initial prototype, which enables joint visualisation of the idea. Inspection of the prototype leads to ideas for further refinement and development. The prototype then 'evolves' through several of these intense cycles. The cycles of: *design ideas – prototype implementation – and critical evaluation* drive the development of the learning object. This approach is resonant of approaches to software development known as 'agile' or rapid application development (RAD) methods. These approaches emphasise:

- rapid, iterative prototyping
- the use of small agile teams
- user in the design team
- emphasis on products (prototypes) rather than following set processes
- tight timescales, sometimes controlled though explicit time-boxing (Yeomans, 2000).

A major advantage of this approach for the tutor is that they can see the evolving visualisation of the idea. This can be a considerable help in translating their ideas into an animated visual format. Because iterative prototypes are produced, students can be asked to express their views of the evolving learning object. This approach thus permits critical, constructive evaluation to be incorporated early in the design phase. This permits problems to be detected early, and hopefully, corrected or removed. A possible disadvantage from the multimedia developer's point of view is that the tutor may not express their ideas explicitly enough, for example, through storyboards. There can be a tension between the multimedia developer's preference for fuller storyboards and what the tutor may supply.

Learning objects are small and relatively self-contained. This means that parallel development on several learning objects can take place at the same time, with partially overlapping personnel. The multimedia developer, for example, may be shared across different teams. Prototypes may be posted on an Intranet site dedicated to the projects. Members of the wider group can provide constructive comments on the prototypes as they are developed. This 'spiral' model of development is illustrated in Figure 4. This Figure makes explicit that refinement of the specification is a natural part of this dynamic, iterative process.

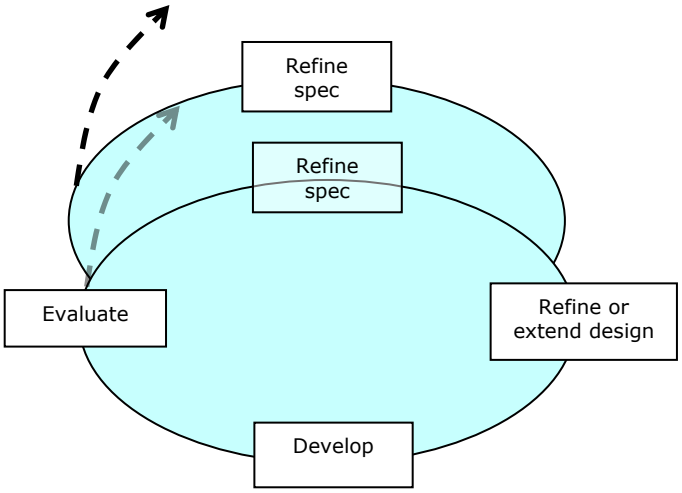

Figure 4: Intense iterative development

A proposed advantage of the 'agile' approach is a more rapid development of usable resources and systems. However, a possible danger is not maintaining time discipline. In order to do this, techniques such as 'time boxing' may be used (Stapleton, 1997). This technique specifies setting out the targets outputs for a given time period. Crucially, however, these targets are clearly prioritised. In developing a

set of learning objects the team thus have to prioritise which are the more important. As the learning objects are self-contained the failure to produce a full set is much less damaging than the failure to complete a whole system. Those learning objects that have been developed can be used, and those that remain can be deferred to a later cycle. However, even with this flexibility it is important to make sure that a sufficient group of learning objects are produced to meet the learning needs of the tutor in the target implementation.

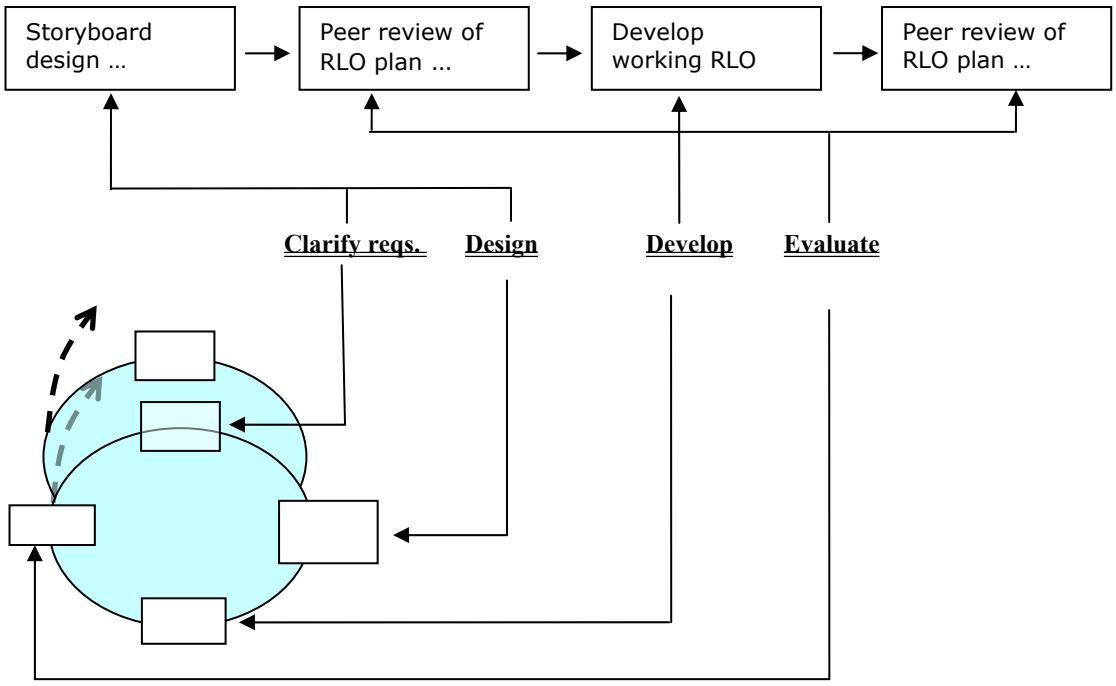

Figure 5: How development functions relate to structures

The CETL supports both modes of development. The choice of mode will depend on the circumstances of the tutor, and in particular, the geographical relationship with the multimedia developer. The relationship of the development paths to the central development functions is illustrated in Figure 5.

Delivery and evaluation: "Use before reuse"

Each new batch of learning objects is normally subjected to prolonged use and evaluation with students. The learning objects are incorporated as part of the students' normal course, and field evaluation data is collected on the students' use and views of the learning objects. The students will normally use the learning objects over a period of weeks. This period may range from one week to a full term/semester.

The learning objects are evaluated against the requirements elicited in the analysis phase. The basic evaluative framework thus needs to be thought out at this early stage. The means of evaluation used should be appropriate to these aims, rigorous and yet feasible to implement. The information should be formally recorded and be available to be included in the learning object metadata.

The evaluation is concerned with the extent and pattern of the students' use of the learning objects, their assessment of the learning objects, and evidence for the pedagogical effectiveness of the learning objects. The evaluation regime may use one or more of the following techniques:

- online tracking of the students use of the learning objects
- direct observation of the use of the objects, for example, in laboratory sessions
- questionnaires to elicit the views of the full student cohort
- detailed qualitative student feedback through interviews and/or focus groups
- measures of improved student performance in, for example, class tests.

Questionnaires can provide a broad survey of student views. The CETL has developed common questionnaires so that student reactions across different institutions can be compared. The information supplied by questionnaires, however, may not provide in-depth information on student problems. Observation provides rich, direct qualitative information. This can arise naturally from interaction with the students in laboratory sessions where the learning objects are used. Interviews and focus groups provide rich, qualitative information where particular issues can be explored in depth. They can be subject to a social facilitation effect, but handled carefully, they can provide important insights into the students' views of the main issues and problems. The RLO CETL has developed a full toolset to support evaluation.

The evaluation data for each batch of learning objects is incorporated in a report to the Local Academic Co-ordinators, and through them to the CETL Management Committee. The CETL encourages the authors of these reports to consider them for external publication. By the end of this phase the learning objects are ready for packaging and storage in the main CETL learning object repository; this is open for external searching, downloading and reuse of the learning objects.

Technical standardisation for storage and retrieval

The CETL learning objects are packaged and have metadata added, following the international specifications and standards established by the IMS and IEEE. The RELOAD tool is normally used for the packaging of the files into an IMS conformant zip file (RELOAD, 2006). The objects are then deposited in the CETL Learning Object Management System, which is built on the commercial Intralibrary system (Intrallect, 2005). The learning objects will then be available for downloading to individual sites, nationally or internationally, from the central repository. As the CETL grows, this will become increasingly important as the central source which holds, and enables the distribution of, the learning objects developed by the CETL.

Summary

The idea of learning objects has had a widespread impact. However, the technical answers supplied by the standardisation community do not address many of the central concerns of tutors. There is a need to develop methods that support the development of high quality learning objects. The paper addresses this issue by presenting the development methodology of the CETL for Reusable Learning Objects. This methodology follows the philosophy of the Agile movement in supporting small dynamic, creative teams. It provides a flexible, structured framework for these collaborative teams to develop high quality learning objects. The methodology has evolved from and is grounded in successful practice. It emphasises starting with understanding the problem and then designing, using and evaluating learning objects to tackle this problem. This method complements the design heuristics articulated in previous work, where learning objects are viewed not as inert content but rather as virtual micro-contexts for learning. The design of these contexts should embody rich pedagogy with structural properties such as cohesion and decoupling to support reuse (e.g. Boyle, 2003). The CETL methodology, used with this design guidance, supplies a powerful, user-centred framework for learning object development.

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