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CELEBRATE Evaluation Report

Version 2

Author(s): *Robert McCormick, Peter Scrimshaw, Nai Li and Carmel Clifford, The Open University*

Contact: *61, rue de Trèves, B- 1040 Brussels*

Abstract:

The deliverable is the Evaluation Report that builds on the Evaluation Framework (D1.2) and gives the results of the evaluation of the production, distribution and use of LOs in six pilot countries. The following seven data reports are associated with the main Evaluation report, and are drawn upon in the report:

1) Classroom Studies

Ilomäki, L. & Lakkala, M., (eds.) (2004) *Learning objects in classroom settings: A report of 13 case studies conducted in Finland, France, Hungary, Ireland and United Kingdom*. CELEBRATE Work Package 7.

2) Experimental Studies

Jaakkola, T. & Nurmi, S., (2004) *Learning Objects – A lot of smoke but is there a fire? Academic Impact of Using Learning Objects in Different Pedagogical Settings*. CELEBRATE Work Package 7.

3) Interview Studies

McCormick, R. & Clifford, C., (eds.) (2004) *Teachers Views on Learning Objects: An Interview Report with Teachers in Schools in Finland, France, Hungary, Israel, Norway and the United Kingdom*. CELEBRATE Work Package 7.

4) Teacher Registration Questionnaire

Li, N. (2004) *Teacher Registration Questionnaire Report*. CELEBRATE Work Package 7.

5) Teacher as User of LOs Questionnaire

Li, N. (2004) *Teacher as User of LOs Questionnaire Report*. CELEBRATE Work Package 7.

6) [Teacher as User of Demonstration Portal Questionnaire] Jaakkola, T. & Nurmi, S., (2004) *Teacher as User of Demonstration Portal Questionnaire Report*. CELEBRATE Work Package 7.

7) Pop-ups Evaluation Questionnaire

Li, N. (2004) *Pop-ups Evaluation Questionnaire Report*. CELEBRATE Work Package 7.

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RE = restricted to a group specified by the consortium (including the Commission Services), CO = confidential, only for members of the consortium ((including the Commission Services)

****Nature: P= Prototype, R = Report, D = Demonstrator, O =**

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Executive Summary

Introduction

This document represents Deliverable D7.2 of the CELEBRATE project. It represents the report of the evaluation conducted as part of Work Package 7.

Context *e*Learning with Broadband Technologies (CELEBRATE) was a large-scale 30-month demonstration project (June 2002 – November 2004) co-ordinated by European Schoolnet and supported by the European Commission's Information Society Technologies Programme (IST). It was designed to address all parts of the educational content value chain and involved 23 participants from the public and private sectors including Ministries of Education, universities, leading educational publishers, content developers, VLE vendors and technology suppliers from 11 countries.

The project proposal was developed in 2001 when both Ministries and publishers were starting to invest heavily in new forms of digital content called Learning Objects (LOs). The key questions that the project attempted to answer were:

- Do teachers actually like these new types of learning resources and do LOs support innovative forms of teaching and learning with ICT?
- Is it possible to outline pedagogy for collaborative learning involving the creation and use of a critical mass of interoperable Learning Objects (LOs) in a new generation of integrated managed learning environments?
- Do emerging standards (for interoperability) make it easier for schools to exchange and reuse LOs within the sorts of learning platforms (LMS, LCMS, VLEs etc.) that schools are increasingly using? And can teachers and students make their own standards' compliant, interoperable LOs?
- Can CELEBRATE demonstrate a technical solution – a Learning Object Brokerage System – that will allow Ministries, publishers and individual schools to more easily exchange and/or sell Learning Objects across national borders?
- At the end of the project, is there a demand for a federated, European Learning Object Exchange (ELOE)¹ (which permits central and local metadata repositories to co-exist) and can CELEBRATE offer self-sustainable services to schools and content developers based around this concept?
- Finally, can a project such as CELEBRATE act as a catalyst for the European *e*Learning content industry and develop viable business models for LO content development and distribution?

This report provides an evaluation of the extent to which new, more flexible forms of content development and distribution (based on reusable LOs) had an impact upon the learning process and supported new pedagogy for *e*Learning in schools. While CELEBRATE provides an analysis of how a fairly large number of schools exploited

¹ This refers to the system that will replace the CELEBRATE system that provides LOs to teachers from a federated set of repositories (i.e. what currently is provided by the Demonstration Portal and Brokerage System).

new forms of content, this report will not attempt to outline how specific national content strategies can facilitate the widespread use of LOs. However, it is hoped that the recommendations made in this report will help policy makers to decide how to best support Learning Object use by a much larger number of schools.

Evaluation approach

The evaluation did not evaluate all work packages,² but focused on the outcomes of Work Package 3 (Brokerage system), Work Package 4 (Creation of Learning Objects), Work Package 5 (Demonstrator Portal) and Work Package 6 (Broadband Pilots). Because we evaluated how teachers used LOs in terms of pedagogy, we also indirectly considered some outputs from Work Package 2 (Pedagogical Models).

We did not include evaluation of the project *per se* (e.g. whether it was directed efficiently), as the way the project was set up was not itself meant to reflect the way the ideas explored in the project would be implemented subsequently. However, the deliverables for each work package contain the information upon which others can judge the success of the project.

The evaluation used both quantitative and qualitative methods and had a number of instruments for collecting data:

- *Questionnaires*
 - Registration questionnaire
 - Teacher as user questionnaire
 - Portal questionnaire
 - Pop-ups associated with individual LOs that enabled each LOs to be evaluated by teachers
- *Routine data taken from the Demonstration Portal*
- *Interview studies*
 - Teacher interviews
 - Content developer interviews
- *Classroom studies*
 - Classroom observation case studies
 - Experimental study of the use of LOs in classrooms.

For each of the major data instruments relating to teachers, a separate ‘data report’ has been produced. In general all the data referred to in this Evaluation Report are taken from these data reports³. More details about these instruments, response rates and reports are presented in the Evaluation Methodology Appendix (Appendix 2).

² More information about each Work Package can be found in CELEBRATE Bid: Annex 1.

³ We also make reference to other CELEBRATE deliverables, and these are listed appropriately in the references for each section. They can be found in the CELEBRATE web site.

Hypothesis

The Evaluation Framework (D1.2) was built up at the beginning of the project and it was intended to help CELEBRATE team members understand how the evaluation contributed to the project, and what form the evaluation was expected to take. It outlined the general principles and structure of the evaluation design, upon which the details were then built. It also laid down the purposes of the evaluation and what would be evaluated. The basic questions that would be the subject of the evaluation were identified along with the instruments to be used for answering these questions.

The Evaluation Framework established an hypothesis that guided the evaluation, and a statement of the extent to which it has been supported provides a general conclusion about the outcomes of the evaluation. In summary the

Overall judgement on the hypothesis

Given suitable pre-conditions and working methods:

- learning objects can be created and translated and, although there are examples of modifying them, we have little evidence on the impact of this;
- there are various models of a ‘market’ that can be created to protect the rights of creators and provide necessary income where appropriate,
- and that through the Demonstration Portal learning objects can be distributed and presented, but we do not know the impact of a federated set of repositories from the pilot trials;⁴
- learning objects can be selected and employed usefully and efficiently by teachers though there is a need for a threshold level of ICT skill,
- learning objects can be selected and employed usefully by teachers of varying backgrounds and interests, but there are some reservations about how efficiently;
- learning objects can be selected and employed usefully and efficiently by teachers working with students of selected ages, ethnicities, social backgrounds, levels of previous achievement, and diverse first languages and cultures.
- learning objects can be selected and employed usefully and efficiently by teachers in a range of subject areas and classroom contexts reflecting diverse education systems, though there are issues of a match to the curriculum;
- learning objects can be selected and employed usefully and efficiently by teachers using a variety of pedagogical models once the conditions of access to ICT resources, ICT skill and teacher preparation time are overcome;

⁴ See, however, the usability evaluation of the federated search using the Brokerage System (Appendix 4).

Detailed account of the findings on the hypothesis

Here we consider each element of the overall statement above to give an account of the findings of the evaluation. (The relevant sections of the main report, where each part is discussed, are given in parenthesis.)

Given suitable pre-conditions and working methods, learning objects can be successfully created, translated and modified by content developers and teachers. (Section 2)

LOs were indeed created, and in significant numbers. They were also produced for a range of subjects, across the full age range planned and in different styles. Around at least a third of the LOs were thought good enough by teachers to try out in their classrooms.

Translation into English was achieved and a number of authoring templates were provided to allow teachers to create LOs. This involved a level of systematic face-to-face training that (if essential) suggests it will not be possible to enable all teachers to take on this role. However, the vision of teachers each modifying LOs for their own use did not generally appear. Nor was our own initial assumption that LOs would be produced only by central agencies or individual teachers correct. Instead a number of different mixtures of approach were tried.

What preconditions and working methods were most favourable to LO production? In fact a very wide range of strategies were tried out. In general it appeared that the approaches that were most successful in generating large numbers of LOs of an acceptable quality involved teams. These needed to have members with expertise in programming, classroom teaching with ICT, and subject knowledge.

Given suitable pre-conditions and working methods, learning objects can be successfully created, translated and modified within a 'market' that can be created to protect the rights of creators and provide necessary income where appropriate. (Section 2)

The development of models for future funding and copyright could only be partly explored within the project, as it ended before long-term arrangements were in place for the future. However, several models were being actively discussed and it was possible to identify some of the underlying options and questions that could focus decision making in this area.

Given suitable pre-conditions and working methods, learning objects can be distributed and presented. (Section 3)

Overall, teachers were positive about the Demonstration Portal and felt it was very useful for teaching and learning. They used it to gain access to a variety of learning resources and to motivate their students to learn. They appreciated that the Demonstration Portal provided a safer online learning environment for their students. The data suggest that LOs were successfully being distributed and presented through this Portal once the initial problems were overcome. Indeed many teachers went further than just using it as a way of finding LOs, but saw it as a basic 'virtual classroom' that could store LOs and give students access to them.

Given suitable pre-conditions and working methods, learning objects can be selected and employed usefully and efficiently by teachers (Section 4)

Overall, the selection pattern of LOs by teachers reflected the project's LO subject profile, which focused on mathematics, science, art, and language. The evidence suggests that, in general, teachers were positive about the CELEBRATE LOs and felt they were useful for their teaching and student learning. Teachers had some reservations about the flexibility and usability of LOs and some reported that they encountered technical difficulties when using the LOs, but these mainly related to the local ICT infrastructure rather than LOs themselves. But there are also pedagogic issues in relation to usability with some teachers not being able to fit them into their teaching, affecting the 'efficiency' with which teachers could use them. Therefore, this part of the hypothesis is confirmed but with some reservations about how 'efficiently' this can be done.

The conditions for this confirmation do not seem to rely on the need for general guidance on pedagogy. For those teachers who need help, this is more related to their ICT skills, and how to use LOs, rather than their general lack of teaching experience.

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers of varying backgrounds and interests. (Section 5)

The judgements of the teachers suggest that, while there are some important differences between teachers, most groups in most respects view the use of LOs in broadly similar ways. Given that teachers overall view LOs favourably, this suggests that there are no large subgroups of CELEBRATE teachers, who take a strongly negative view. However, it is important to note that the CELEBRATE teachers were generally either experienced users of core ICT systems, or of these and of a wider range of systems as well. This represents an important pre-condition. The project does not therefore tell us about the views on LOs of inexperienced teachers, in terms of ICT skills and usage.

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers working with students of selected ages, ethnicities, social backgrounds, levels of previous achievement, and diverse first languages and cultures. (Section 5)

Where students are concerned, again the indications are that the CELEBRATE LOs already include a sufficient range to be used successfully across the full age and achievement ranges, although lower achieving students may be one group that needs better provision. Taken together these responses suggest that differences in student backgrounds and characteristics were not, in general, a problem in using LOs successfully, although some groups were not seen as being sufficiently well served at present.

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently in a range of subject areas and classroom contexts reflecting diverse education systems. (Section 6)

It is evident that there do not appear to be subject-related factors preventing the useful and effective use of LOs, except in as much as the LOs fail to match the curriculum topic of the teacher, which is more an issue across, rather than within, countries. (This may not be the case in subject areas other than those upon which CELEBRATE focused.) It may well be that, with a larger number of LOs in any one subject, the lack of match to specific topics can be overcome. But even the relatively modest numbers

of CELEBRATE, did deliver satisfaction in the subjects covered using hundreds rather than thousands of LOs.

Teachers are convinced of the effect on motivation, though there is less general evidence on whether it improves achievement. Where we were able to carry out a specific study of the impact on achievement, we have robust evidence that they can be more effective than traditional means of teaching. The evidence for improvements in types of learning is modest, for example with ‘problem solving’ and ‘conceptual learning’, though again the experimental study does show that some elements of conceptual understanding can be effectively dealt with.

Whatever the limitations in our evidence of improvements in achievement, the effect on student autonomy and active learning are evident and useful.

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers using a variety of pedagogical models. (Section 7)

It is evident that, given current conditions of ICT access, including local conditions of line speeds and network capabilities, ICT skills, and teacher time for preparation limit the employability of LOs. It is likely that access will be a temporary problem as computers become more common in all classrooms and as wireless and portable devices spread. In some schools, for example in the primary sector, technical support will still be an issue, and this will limit the improvement in some conditions. Preparation time is of course soluble, but given pressures on teachers it is less tractable. But finding that time creates resource issues as large as those associated with ensuring ICT access.

When these conditions are improved, however, the employability of LOs is evident, and they can support advanced pedagogy. Any single LO is unlikely to do more than contribute to a teacher’s repertoire, rather than radically change it (though it can equally constrain it). Currently that means a blended approach with LOs contributing to the pedagogic setting created by the teacher. There is an interplay between the affordances of an LO’s pedagogy and the pedagogical practices the teacher is able to construct, given her pedagogic competence with using LOs, and her underlying conceptions of learning. LOs can, in this context, enhance active learning by students, collaboration, authentic material and activity, and provide multiple perspectives on knowledge. It is clear that the locus of ‘control’ or design of pedagogy is in the hands of the teacher. Nevertheless, there are issues of pedagogic design that relate to the creation of affordances and also features such as game playing, a focus on ideas, and developing tool-like features in LOs, that will exist.

Recommendations

Here we present our main recommendations concerning the future development of the European Learning Object Exchange (ELOE). These proposals are filled out in more detail in Appendix 1 (*Detailed Recommendations*). The recommendations cover seven interrelated topics:

- identifying and implementing the changes required to move to a full scale programme;
- planning and developing the ELOE as a learning organisation;
- improving and tightening the technical and educational specification for LOs;

- identifying long-term targets for the range and types of LOs to be provided;
- identifying and implementing ways of supporting advanced pedagogy;
- building the capability to use LOs into professional development and training;
- identifying key questions for future research and evaluation.

Recommendation A: Identifying and implementing the changes required to move to a full-scale programme.

As CELEBRATE evolves from a pilot project into a full-scale Europe-wide service, a number of the approaches used in the project will need modification or replacement. These approaches include:

- adopting clarity about the purposes of the ELOE in terms of the approach to the ‘learning object enterprise’, as assimilation, change or transformation, and the extent to which it can adopt any combination of these approaches;
- on the basis of the above clarification, to make strategic choices of which teachers to target, what LOs to develop and how supply will meet demand.

Recommendation B: Planning and developing the ELOE as a learning organisation

The ELOE should be developed in ways that make it a learning organisation, designed so that both the system and the partners can easily generate and analyse much of the data needed to improve it. This will involve:

- teachers taking part in LO development and piloting and in identifying an appropriate role for the ELOE VLE;
- selectively extending the range of data and information drawn from the Portal and Brokerage System for analysis, along with appropriate staffing;
- ministries interested in free provision of LOs being brought together to plan joint development, with a role to encourage knowledge exchange and partnerships between content providers.

Recommendation C: Improving and tightening the technical and educational specification for LOs.

The design of the LOs will also need some revision and closer specification to ensure that:

- all LOs should be interoperable on all systems meeting the entry standard recommended in A above;
- small modular LOs should be preferred to larger integrated ones, accompanied with basic teacher instructions on operational use;

Recommendation D: Identifying long-term targets for the range and types of LOs to be provided

During the pilot the aim was to provide sufficient LOs to make clear what the potential of this approach would be. In the longer term there will be a need:

- to specify (presumably at national level) whether the aim is to cover the whole curriculum or to focus on specific pedagogically difficult topics;
- a selective and teacher-led expansion in the numbers of LOs translated.

Recommendation E: Identify and implement ways of supporting advanced pedagogy

One theme in the project was to explore ways of combining LO use with advanced pedagogy. If this is to continue as a key element in the ELOE it will require that LOs should be:

- available that support advanced pedagogy;
- accompanied by advice to teachers on how to use the LOs in these ways.

Teachers should be directly involved in generating the advice.

Recommendation F: Building the capability to use LOs into professional development and training

There are three major foci of this development:

- time for professional development and a larger involvement in sharing of best practice and LO evaluation and development;
- where the introduction of LOs is to be a major feature of national policy, LO use should be integrated into initial teacher training;
- cross-European information on how teachers are being trained to develop or modify LOs should be collected and made available to all developers.

Recommendation G: Identifying key questions for future research and evaluation

The evaluation has identified a number of gaps in our knowledge that require further exploration. Many of these have already been covered, but there are a number of strategic areas where further systematic research, literature reviews and evaluations are required. Topics for this programme are listed in Appendix 1. They include:

- why teachers choose the LOs they do, how they can be helped to make choices and how successful these choices are in terms of student learning;
- what the long-term effects of LO use are upon teachers and students;
- what new problems would emerge if the use of LOs was extended into more culturally challenging areas such as history and religious education.

The Evaluation Report

Authors:

Robert McCormick, Peter Scrimshaw, Nai Li, and Carmel Clifford
Faculty of Education and Language Studies
the Open University, UK

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Section 1 Project Overview

1.1 Introduction

Context *e*Learning with Broadband Technologies (CELEBRATE) was a large-scale 30-month demonstration project (June 2002-November 2004) co-ordinated by European Schoolnet and supported by the European Commission's Information Society Technologies Programme (IST). It was designed to address all parts of the educational content value chain and involved 23 participants from the public and private sectors including Ministries of Education, universities, leading educational publishers, content developers, VLE vendors and technology suppliers from 11 countries.

The project proposal was developed in 2001 when both Ministries and publishers were starting to invest heavily in new forms of digital content called Learning Objects (LOs). The key questions that the project attempted to answer were:

- Do teachers actually like these new types of learning resources and do LOs support innovative forms of teaching and learning with ICT?
- Is it possible to outline pedagogy for collaborative learning involving the creation and use of a critical mass of interoperable Learning Objects (LOs) in a new generation of integrated managed learning environments?
- Do emerging standards (for interoperability) make it easier for schools to exchange and reuse LOs within the sorts of learning platforms (LMS, LCMS, VLEs etc.) that schools are increasingly using? And can teachers and students make their own standards' compliant, interoperable LOs?
- Can CELEBRATE demonstrate a technical solution – a Learning Object Brokerage System – that will allow Ministries, publishers and individual schools to more easily exchange and/or sell Learning Objects across national borders?
- At the end of the project, is there a demand for a federated, European Learning Object Brokerage System (which permits central and local metadata repositories to co-exist) and can CELEBRATE offer self-sustainable services to schools and content developers based around this concept?
- Finally, can a project such as CELEBRATE act as a catalyst for the European *e*Learning content industry and develop viable business models for LO content development and distribution?

1.2 Project Approach

Learning objects and simple LO authoring tools were developed by project partners and made available via a password protected web site (Demonstration Portal) to selected primary and secondary schools, drawing on existing broadband pilots and implementations in six countries. It was a conscious decision to target schools that already had high levels of ICT provision and teachers with better than average ICT skills, as the project wanted to explore how content could be exploited by Europe's schools once some of the initial issues had been addressed related to infrastructure and basic ICT training.

In trying to outline this vision of how LOs could be used by teachers, the project did *not* attempt to provide a migration strategy for how the majority of schools in different countries could be enabled to reach the levels attained by schools in the CELEBRATE pilots. This is an important point to keep in mind when reading this report.

This report provides an evaluation of the extent to which new, more flexible forms of content development and distribution (based on reusable LOs) had an impact upon the learning process and supported new pedagogy for eLearning in schools. While CELEBRATE provides an analysis of how a fairly large number of schools exploited new forms of content, this report will not attempt to outline how specific national content strategies can facilitate the widespread use of LOs. However, it is hoped that the recommendations made in this report will help policy makers to decide how to best support LO use by a much larger number of schools.

In reading the report, it is also worth bearing in mind some of the following aspects of the project and a few of the initial assumptions made by the CELEBRATE partners at the start of the project in June 2002:

- a) CELEBRATE did not attempt to develop LOs in all subjects but tried to achieve critical mass in a small set of subjects (Mathematics, Science, Art, and Languages) in order that teachers could exercise some choice when reviewing and selecting LOs.
- b) While the project produced guidelines for LO content developers, it deliberately did not insist that they follow very precise criteria in terms of LO size, graphic design etc. CELEBRATE was meant to provide a real-life demonstration of how teachers respond to the wide variety of LO types currently being produced.
- c) The approach to developing LO authoring templates only emerged once the main LO development work had already commenced and it was difficult to complete work on the templates in time for them to be fully tested by teachers during the main pilot phase.
- d) As well as providing schools with access to a critical mass of LOs, the Demonstration Portal also included a large number of Learning Assets (images, audio files etc.). These were provided mainly to assist those teachers who wanted to create their own LOs using the authoring templates.
- e) It was assumed that some schools in the project would want to use a 'local' VLE. The project provided a VLE on the Demonstration Portal for those schools that did not have access to one but who might want to go beyond using LOs as standalone resources within a more structured learning platform.
- f) The CELEBRATE Brokerage System architecture was successfully demonstrated during the project. It allows schools to carry out federated searches for LOs across remote repositories, but was not fully implemented until the end of the project. During the main pilot phase, the focus was on the teachers' use of the LOs themselves.

1.3 The evaluation framework

The evaluation framework was built up at the beginning of the project and it was intended to help CELEBRATE team members understand how the evaluation contributed to the project, and what form the evaluation was expected to take. It outlined the general principles and structure of the evaluation design, upon which the details were then built. It also laid down the purposes of the evaluation and what would be evaluated. The basic questions that would be the subject of the evaluation were identified along with the instruments to be used for answering these questions. The roles of the evaluation team and the other WP teams in collecting data from the various instruments and sources were also specified.⁵

Based on the analysis of the project and work package requirements, with a focus on the actors in the system (i.e. the respondents to, or users of, the products of the project), the evaluation hypothesis was that:

Given suitable pre-conditions and working methods,

- learning objects can be created, translated, modified, distributed, presented,
- within a 'market' that can be created to protect the rights of creators and provide necessary income where appropriate; and that
- learning objects can be selected and employed usefully and efficiently,
- in a range of subject areas and classroom contexts reflecting diverse education systems,
- by teachers of varying backgrounds and interests,
- using a variety of pedagogical models and
- working with students of selected ages, ethnicities, social backgrounds, levels of previous achievement, and diverse first languages and cultures.

This hypothesis identified the areas of the project that would be evaluated, expressed in general terms, and in a positive way, such that the evaluation team could determine how far and in what ways the project had been successful.

The purposes of the evaluation were thus to:

- examine each of the areas of the hypothesis to determine if it has been achieved, and where there have been problems or issues arising, to determine as far as possible, what the reasons were for this;
- identify whether there were significant differences in the judgments of usefulness and efficiency made by different categories of users and developers, and if so why;
- provisionally identify what changes in the pre-conditions and working methods would be needed to make the CELEBRATE system outcomes more effective and useful to all users and developers in the future.

These implied that the evaluation would not evaluate all work packages,⁶ but focused on the outcomes of Work Package 3 (Brokerage System), Work Package 4 (Creation

⁵ More information can be found in Deliverable 1.2.

⁶ More information about each Work Package can be found in CELEBRATE Bid: Annex 1.

of Learning Objects), Work Package 5 (Demonstrator Portal) and Work Package 6 (Broadband Pilots). Because we evaluated how teachers used LOs in terms of pedagogy, we also indirectly considered some outputs from Work Package 2 (Pedagogical Models).

We did not include evaluation of the project *per se* (e.g. whether it was directed efficiently), as the way the project was set up was not itself meant to reflect the way the ideas explored in the project would be implemented subsequently. However, the deliverables for each work package contain the information upon which others can judge the success of the project.

1.4 Evaluation methods

The evaluation used both quantitative and qualitative methods and had a number of instruments for collecting data:

- *Questionnaires*
 - Registration questionnaire
 - Teacher as user questionnaire
 - Portal questionnaire
 - Pop-ups associated with individual LOs that enabled each LOs to be evaluated by teachers
- *Routine data taken from the Demonstration Portal*
- *Interview studies*
 - Teacher interviews
 - Content developer interviews
- *Classroom studies*
 - Classroom observation case studies
 - Experimental study of the use of LOs in classrooms.

For each of the major data instruments relating to teachers, a separate ‘data report’ has been produced:

- Teacher registration questionnaire report
- Teacher as user of LOs questionnaire report
- Teacher as user of Demonstration Portal questionnaire report
- Pop-ups questionnaire report
- Teacher's views on Learning Objects: A report with teachers in schools in Finland, France, Hungary, Israel, Norway and the United Kingdom (referred to as *Interview Studies*)
- Learning Objects in classroom settings: A report of 13 case studies conducted in Finland, France, Hungary, Ireland and United Kingdom (referred to as *Classroom Studies*)

- Learning Objects – a lot of smoke but is there a fire? Academic impact of using Learning Objects in different pedagogical settings (referred to as *Experimental Studies*)

In general all the data referred to in this Evaluation Report are taken from these data reports. More details about these instruments, response rates and reports are presented in Appendix 2 (Evaluation Methodology).

1.5 The structure of the report

This report consists of eight sections. This first section is the project overview, while Section 2 describes the LOs created, by type, subject, age range etc. This includes both the LOs provided initially and produced subsequently by the content developers and those later added by teachers and students. The ways in which content developers created new LOs, modified existing ones and organised the translation process is also discussed.

Sections 3 to 7 then test different aspects of the hypothesis formulated in the evaluation framework, based on both quantitative and qualitative data collected by using various instruments and sources from teachers and schools. These sections are:

- Section 3: Distributing and Presenting Learning Objects to Teachers
- Section 4: Teachers' Evaluation and Selection of Learning Objects
- Section 5: Use of Learning Objects by Teachers and Students with different Backgrounds and Interests
- Section 6: Use of Learning Objects in different Subjects, Classroom and Education Systems
- Section 7: Use of Learning Objects by Teachers using a Variety of Pedagogies.

Finally Section 8 looks back across the analyses in earlier sections and identifies the key action-guiding issues relevant to decisions by different stakeholders. Where they can be justified recommendations are made to developers, teachers, headteachers, local, regional and national and international agencies, teacher trainers, and the European Commission.

1.6 Implementation of the project

Here we outline the way the project was implemented that would affect what can be learned from the evaluation.

The period of the trial was originally planned to be from November 2003 until March 2004. Initial training of teachers began in November 2003, though the Demonstration Portal was not fully operational, and did not become so until January 2004 (see Section 3 for a more detailed account). This Portal was the main way for teachers to gain access to LOs. During this period LOs were being added continually and so there may not have been suitable LOs available for teachers who had started in November 2003. (See Section 2 for a more detailed account of the development of LOs). Unfortunately connectivity between the Demonstration Portal and the Brokerage System was available at the time when the teachers were piloting the system. The

particular implications of this for the evaluation are that we are unable to offer any evidence of how this would be received by teachers.⁷ Finally, although authoring tools were available, and some teachers had training on their use, these tools were ‘templates’ for creating particular kinds of LOs (e.g. a ‘crossword’ or a slide sequence). No tools were available to modify existing LOs.

The combined effect of these conditions was to effectively shorten the actual period of the main trial to the period to March-May, 2004. In fact some teachers were using the system later than this period and data were collected up until mid-July 2004, by which time most schools had begun their summer holidays. It also meant that some teachers were commenting on the use of LOs, based on experience earlier in the development of the system than others. Where we are able to distinguish this we have done so, but it does mean that some teachers evaluated a less sophisticated system than others.

The original intention was to have a large number of UK teachers in the pilot group. As will be evident in later sections, this did not materialise. This means we were unable to test the impact of a large number of LOs (many LOs produced in other languages and translated into English) with a group of teachers who already had access to a large amount of free digital material through a government –funded scheme (*Curriculum Online*).

1.7 Case Study of the use of LOs

The following is an example of how LOs have been used in schools. We decided to use this particular case study from a school in France as it shows how some of the objectives of CELEBRATE were manifested in schools⁸. This case study we describe as a ‘voyage of LOs’ as it shows the teachers as the developers of LOs, using the tools of CELEBRATE and their imagination in creating LOs that they can use in their classes. This *case study* shows the possibilities for teachers who are part of CELEBRATE.

It covers the voyage of two LOs used and created jointly by two French teachers. One LO is called *Fabrication du pain* or *Bread making* and the second LO was a crossword related to that process. Both these LOs were created for use in a natural science/biology lesson with a class of fifteen students. We use the journey of these two LOs to illustrate teachers’ experience of developing and using LOs in the project, particularly because they were examples of CELEBRATE teachers’ creation of LOs. It can therefore act as a context within which to think of the detailed findings we present in the following sections.

1.7.1 The Authors of the Case Study LOs

The LOs were developed by two teachers in a French secondary school for eleven to fifteen year olds. Both teachers had five years teaching experience and had used ICT in their lessons for about two to three years. One of these teachers received personal training on how to develop LOs, using LOBE (Learning Object Builder and Editor)⁹

⁷ A pilot usability study of the Brokerage System, whose connection to the Portal is now operational, was conducted in November 2004, and a separate evaluation is contained in Appendix 4.

⁸ This is based on the French case study in *Classroom Studies*, Case 6.

⁹ The LOBE template is a program developed in JAVA as an authoring tool designed and developed by Hachette Multimédia.

(see Section 1.7.2) and the Digitalbrain templates. The ICT level of teachers was in line with the French national average, though one teacher appeared to be more advanced. The school where the LOs were used had five hundred students and approximately fifty teachers. There was one ICT suite with fifteen terminals and a high-speed Internet connection.

1.7.2 The creation process of the LOs

The teachers created the bread making LO using LOBE, an authoring tool that allows one to build, and edit LOs using 3 templates of Hachette Multimédia's range, namely *Simple Transition*, *Association* and *Media Show*.¹⁰ The teachers shared the creation tasks: one teacher took various photographs in the local bakery, with the agreement of staff, while the other teacher dealt with the more technical side of creating the LO.

This LO can be found at:

<http://learning-assets.eun.org/lo/fabrication%20du%20pain.zip>¹¹



Figure 1.1: an exploration LO on bread making

The teachers decided to create a crossword LO to use as a game that assesses students' knowledge of bread making. It was created with the Digitalbrain template¹² and can be found at:

<http://eundp.digitalbrain.com/emeline.eundp/web/fabrication%20du%20pain/crossword/?verb=view>.

¹⁰ The three are among 15 of the templates Hachette Multimédia provides.

¹¹ Throughout this report we make reference to the CELEBRATE LO web addresses. Access to such LOs is only available for those who are members of CELEBRATE or the follow-on activity (CELEBRATE II).

¹² This template allows words and their associated clues to be entered and it will automatically arrange the crossword layout. Additionally it can make several versions of the same basic crossword to minimise the possibility of students simply copying from one another.

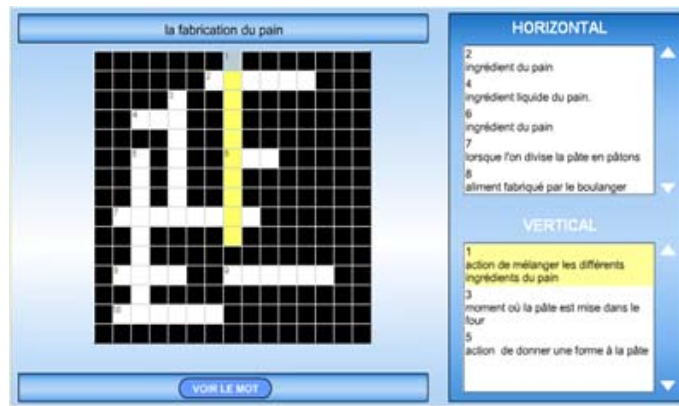


Figure 1.2: a crossword for testing what has been learned about bread making

Both teachers used their LOs in two separate natural science classes with two groups studying in parallel. The teachers prepared a complementary exercise sheet with questions and tables for students to fill in, using information solely obtained from the bread making LO. The goal of these lessons, defined by the teachers, was for the students to:

learn the basic bread-making principles: the recipe, the various steps, machines used and different types of bread.

1.7.3 Use of the LOs in a lesson

The LOs were used in a lesson of two parts. The first part concentrated on the LO activities and was set in the ICT suite. The class had forty to forty-five minutes to navigate freely through the bread making LO in order to find the answers to complete the exercise sheet. They had to find:

- the bread-making ingredients;
- the various steps/the recipe: the name, the purpose of the step, temperature, etc.;
- the different bread types and their differences;
- the definition of a word situated in the LO tool bar.

When the students had completed this first task they played two ‘games’: one was from the bread making LO and the second was the crossword LO. These games tested what they had learned.

The class moved to an ordinary classroom for the second part of the lesson. This lesson involved the whole class with their teacher correcting the answers they had put in their exercise sheets in a collective feedback process. All the students, with the exception of one with learning difficulties, obtained the correct answers to the LO.

1.7.4 Pedagogy of the lesson

The students used the LO to learn autonomously. The teacher had little interaction with the students in the first part of the lesson other than giving instructions for the task and answering LO questions, and problems linked to using the LO. However, the lesson itself was highly structured. Knowledge was presented in a very factual way and students mostly transcribed information provided on the screen. The information

was given in the same order as the questions asked, which facilitated the student's 'pseudo-research' task.

1.7.5 Teachers' views of creating LO

Our teachers in this French case study thought that the ability to create LOs was to their advantage as they had the independence to create ones that suited their syllabus and their class curriculum, and which integrated the LOs perfectly with what was previously covered.

However, the independence of being able to create LOs was limited by the tools available and resulted in a less interesting lesson in their view because:

- a) The information in the LO was provided in the same order as the questions and in most cases this only necessitated the simple task of copying the text.
- b) The students had no extra information other than that provided by the LO. Thus, they were unable to acquire a more critical insight into the information provided.

These drawbacks were linked to the functional limitations of the version of LOBE they used, although in the case of (a) above they were in control of both the nature and type of questions. The template did not permit the creation of particularly interactive exercises, and it did not allow for the creation of a simple link from an image. This functionality would have been greatly appreciated by the teachers. The teachers involved seemed very interested in having future versions of LOBE made available to them.

This case study shows how teachers have worked together to create LOs that can be used and re-used in classes and shows the potential advantages of teachers as creators of LOs. The teachers have since uploaded their LO to the Demonstration Portal where it can continue its voyage into other classrooms across Europe.

Teachers of this case study have been able to use CELEBRATE material for 'exploration' and assessment. Students were able to learn autonomously from the teacher, although the knowledge processing was low and limited by the tools that created the LO. However, teachers clearly saw the potential in such tools and enjoyed the independence of creating LOs to suit their students' needs. The case study also highlights how CELEBRATE materials are reusable as both teachers used the LOs in different classes.

References

[Classroom Studies] Ilomäki, L, & Lakkala, M., (eds.) (2004) *Learning objects in classroom settings: A report of 13 case studies conducted in Finland, France, Hungary, Ireland and United Kingdom*. CELEBRATE Work Package 7.

Section 2 Developing Learning Objects

2.1 Introduction

This section discusses the hypothesis that:

- *Given suitable pre-conditions and working methods, learning objects can be successfully created, translated and modified by content developers and teachers,*
- *within a 'market' that can be created to protect the rights of creators and provide necessary income where appropriate.*

In this section we look at the start of the process by which LOs were planned and developed. To do this we look at responses to the LO specification, describe the different kinds of LOs that were developed, explore the issues that arose in developing them and then, in the final part of the section, look at some developers' views on how the production process and market for LOs might be organised and funded in the future.

2.2 The project specification for the LOs

2.2.1 The specification

Content providers who designed the LOs for CELEBRATE were expected to conform to specifications and pedagogical outlines agreed within the project team. This was developed after a literature review carried out by WP1 and after discussions by content developers within WP4.

The technical specifications for content being submitted to the CELEBRATE project covered content type, download times/bandwidth, accessibility requirements, browser compatibility and interoperability specifications (D4.1 p. 2). The project team also emphasised the pedagogical importance of using small LOs in the belief that this would increase the possibility of teachers sequencing and building longer courses out of individual LOs (D4.1 p. 2).

A teacher survey (D1.1) showed that the teachers too recognised a need for small, granular, reusable LOs that were relatively context- and pedagogy-independent.

One developer also endorsed this view, arguing that small LOs:

...can fit into any sequence and the basic principle is that we should not be - we are not - pedagogy specialists. The teachers are. We should be providing resources, tools and the teachers should provide the pedagogical source, or the environment for the topping. It's more than just a topping actually. It's the whole structure.
(Hachette Content provider interview pp 11-12)

In Hungary the content provider was already using an approach to LOs based upon small content-only elements, which were then built up into larger units by adding pedagogic components. These were, in turn, designed to be combined flexibly into larger units.

The Israeli and Hungarian developers saw the specification as easy to implement, once translated. However, one noted that it was too long to be usable by teacher developers, so the national team just collected the necessary items and wrote a short version for the teachers summarising what to do and how to do it. This may indicate that any future specification needs to be provided in formats that recognise that both

teachers and new public or private organisations joining the programme will not have the kind of lengthy introduction to the issues that was possible in the original project.

2.2.2 Metadata

The project provided a LOM-based, metadata structure for the developers to use, combining compulsory and optional elements. This included one category classifying the LO as fitting into one or more of a set of pedagogic and software types:

- Information resources
- Drill and practice
- Exploration
- Open Activity
- Assessment
- Guide
- Tool
- Glossary

The project team's assumption was that this classification would help teachers select and use LOs. This classification was seen by one developer (NM1 p. 4) as costly and also difficult to apply because different parts of an LO might fit into different pedagogic and software categories. He also had doubts about whether teachers would be disciplined enough to enter the data when they themselves created LOs. There is therefore clearly a cost in entering metadata for these LOs, so the question is whether the value of doing this justifies the effort involved. The value of providing this classification of types mainly depends upon how far they actually helped teachers select and use LOs. This is a topic we will return to in Sections 3, 7 and 8.

2.2.3 The pedagogic model

The project promoted a set of constructivist pedagogic models for the LOs.¹³ One developer, whose company had had limited previous experience of LO production, commented that:

... the models are comprehensible but in many cases a bit too theoretical and the result of that is that we don't really know what to do with them. [...] I think more concrete examples would be useful.

On the other hand another developer, who had been working on LOs for some years, felt that they had already come across these models elsewhere. These two reactions illustrate the different positions from which developers can start. (Teachers' views on pedagogic models are looked at in depth in Section 7.)

¹³ The use of the term 'constructivist pedagogic models' stems from the CELEBRATE proposal, however, during the project discussions it became evident that the term 'constructivist' was unhelpful, and the term 'advanced pedagogy' was used. The elements of this are explained in Section 7.5.

2.3 The LOs produced

2.3.1 The planned and actual production schedule

The plan was for the developers to provide hundreds of LOs and several thousand Learning Assets (LAs) (D4.1 p. 3). The total number of LAs provided by September 2004 was about 2400. However, in this evaluation we focus only upon the LOs. For these the September 2004 total, as recorded on the Portal, was 1425 (See Table 2.1).¹⁴

Table 2.1: total LOs by developer

Content developer	No. of LOs
Norwegian Board of Education	287
eWSOY / OPIT (Finland)	272
Sulinet (Hungary)	186
National Board of Education, Finland	183
Giunti Labs (Italy)	83
Cité des Sciences et de l'Industrie (France)	80
Digitalbrain (UK)	71
Hachette Multimédia (France)	62
Skool (Intel)	40
Indire (Italy)	33
Teachers	14
Young Digital Poland	7
Others/no publisher information	107
Total	1425

(Data as of 22nd September 2004. Source: *Administration page on the Demonstration Portal.*)

However, this number included some that were translations of others. By early November the total number of translated LOs was 591 *plus the Hebrew ones- to come* (see Table 2.2). If we ignore the dual-language ones in Finnish/English and Norwegian/English, this gives 577 LOs that were translations of existing LOs. This meant that, in terms of subject-relevant topics covered, the number of LOs produced with different content (as distinct from being the same content in different languages) was probably between 850 and 900. (It is not possible to give a precise figure as the collection dates for the information differ.) This should be kept in mind when looking at the LO totals given in the various tables below.

¹⁴ We quote numbers available on the Portal as all LOs were loaded onto it because during the pilot period for teachers the connection to the Brokerage System and hence the repositories of the content providers was not operational.

Table 2.2: number of translated LOs, by developer and language into which they were translated

Developer	French	English	Norwegian/English	Finnish/English
MAKASH				
Digitalbrain	23			
Giunti		80		
Hachette		30		
eWSOY/OPIT	25	91		
Heureka		1		
Cité des Sciences et de l'Industrie		34		
Indire		13		
NBE Finland		64		12
Norwegian Board of Education		146	2	
Skool(Intel)				
Sulinet		70		
Young Digital Poland				
Totals	48	529	2	12

(Data as of 1 November 2004. Source: *Communications from LO Developers*)

2.3.2 LOs by subject

The project team chose Mathematics, Science, Art and Languages for special emphasis, to give a critical mass in some areas and to provide evidence across very different subject areas. The LOs actually produced were described in a wide range of subject terms. After combining some of these labels together the pattern shown in Table 2.3 emerged. As this shows, science subjects taken as a set formed about 70% of the total subject classifications (i.e. 1916), with Mathematics the only other subject to get to around 10% of the total.

Table 2.3: all LOs provided on CELEBRATE Portal, by subject

Subject*	No. of LOs
Natural sciences	657
Physics	325
Mathematics	210
Biology	162
Language and literature	142
Environmental education	105
Chemistry	80
Art	61
Geography	48
Cross-curricular education	46
History	34
Music	23
Informatics/ICT	14
Religion	9

(Data as of 22 September 2004. Source: *Administration page on the Demonstration Portal.*)

*Some LOs may be counted more than once, as they may be used in several subjects.

LOs were provided in eight languages. Table 2.4 shows that, as planned, nearly half of these were in English, mostly translated from other languages. (This emphasis upon having English versions was to facilitate subsequent translations between other languages, English being the commonest second language across the project.)

Table 2.4: all of LOs on CELEBRATE Portal, by language

Language	No. of LOs
English	619
Finnish	219
Norwegian	157
French	157
Hungarian	109
Swedish	40
Italian	38
Hebrew	2
Language-free	26

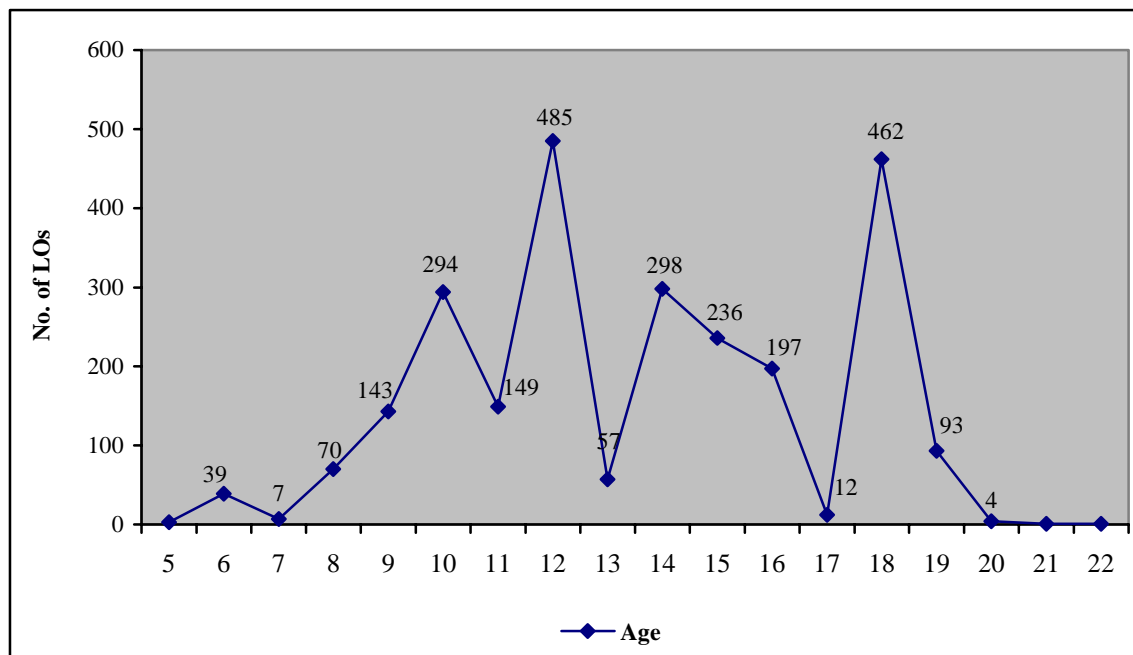
(Data as of 22 September 2004. Source: *Administration page on the Demonstration Portal.*)

Where teachers and students could both read English they clearly had access to more LOs, although as already noted, some of these would have just been English translations of ones already available in their own language.

2.3.3 LOs designed for students of different ages

Developers were asked to indicate the age range for which each LO was designed. From this it was possible to identify how many LOs were intended for each age group (Figure 2.1).

Figure 2.1: number of LOs identified by providers as suitable for students of different ages



(Data as of 22 September 2004. Source: *Administration page on the Demonstration Portal.*)

The distribution covers a wide range, but shows that the LOs cluster around the 10, 12, 14-15 and 18 year old points. This possibly indicates that the ages chosen were influenced by broad conceptions of suitability for young, early secondary and post-secondary students, rather than being seen as tied to specific year groups. This contrasts somewhat with teachers' perceptions, as we will show in Section 6.3.1.

2.3.4 LOs by type

As we have seen, the LOs were of six different pedagogic and software types, but nearly a quarter of all LOs were not labelled by type, the proportion varying from developer to developer. This reinforces the point made by one developer earlier that there was a time cost in providing this information. Of those LOs that were labelled, more than half were described as 'Drill and practice' and around a third as 'Exploration', with some overlap between the two (Table 2.5). The original aim of the project team to have LOs built largely around advanced pedagogy was therefore not realised, insofar as the types of LOs are indicative of this. How important that was in terms of the effects upon what happened in the classrooms cannot be directly inferred from this, as it depended upon what teachers actually did with the LOs they chose. As we will show in Section 7.6.2, teachers sometimes used the same LO to support quite different pedagogy.

Table 2.5: LOs provided by content providers on CELEBRATE Portal, by type

Type of LOs	No. of LOs
Drill and practice	652
Exploration	396
Information resources	191
Guide	68
Tool	48
Glossary	46
Open Activity	45
Assessment	13
LOs where type not defined by developer	301

(Data as of 22 September 2004. Source: *Administration page on the Demonstration Portal.*)

2.4 The take-up of LOs

Before looking at how these LOs were produced, we will briefly trace the progress of the LOs as a whole through the system. (How the system was organised to allow this is discussed in more detail in Section 3.)

LOs were added to the Portal up until the end of the project in November 2004 but, by the time the classroom work for the project had finished in September 2004, there were 1425 subject-related LOs available to the teachers, after draft LOs were removed. The teachers could view these and then save any that they presumably thought they might use by putting them into their ‘shopping basket’. Teachers were also asked to evaluate any LOs that they put into their baskets. Table 2.6 shows the numbers at each of these stages.

Table 2.6: production and take-up of LOs

	Number	% of total produced
LOs produced	1425	100%
LOs placed in ‘shopping basket’ by at least one teacher	1152	80%
LOs evaluated by at least one teacher	940	66%
LOs used by at least one teacher	474	33%

(Data as of 22nd September 2004. Source: ‘pop-up’ evaluations.)

These figures, as they stand, show that around a fifth of LOs were not actually selected by any teacher and a third were actually reported as used by at least one teacher. However, this needs to be interpreted with caution. Some of the LOs put up later may not have been seen by teachers already working with ones selected earlier and, just because a teacher did not provide an evaluation of an LO selected, does not automatically mean that they decided not to use it.¹⁵ In the same way it is likely that more teachers used LOs than reported this use in the ‘pop-ups’ (the evaluation form associated with each LO). Nevertheless, it appears that there was a high degree of selectivity exercised by teachers. This is not, however, an indication that the LOs as a set were unsuccessful. Success for such a system (as for a public library or an

¹⁵ Section 4 will give other data on use to set alongside these data.

encyclopaedia) depends not on the percentage of items used, but the absolute figure of use, and whether many different users were able to find something they wanted. In this case a third of the LOs were thought good enough by teachers to try in their classrooms. Given the fact that the total number added was growing during the pilot, and that for many teachers the pilot period was relatively short, this is a healthy short-term total. Whether it would be sufficiently high for commercial producers as a long-term usage figure is another question.

(The teachers' views on LOs, and what they liked and disliked about them, are discussed in Sections 4-6.)

2.5 The LO developers

2.5.1 The contributors

The project began with a number of content developers signed up, while others began their participation later. They included both commercial companies and government agencies. Twelve organisations contributed LOs, with, by July 2004, about 70% of the LOs coming from four of them (Figure 2.2). However, it should be noted that some developers provided small LOs while others contributed complex LOs that could be seen as containing several smaller ones. In addition some developers provided authoring templates while others contributed large numbers of LAs. These percentages do not therefore directly reflect the relative overall input of the different contributors.

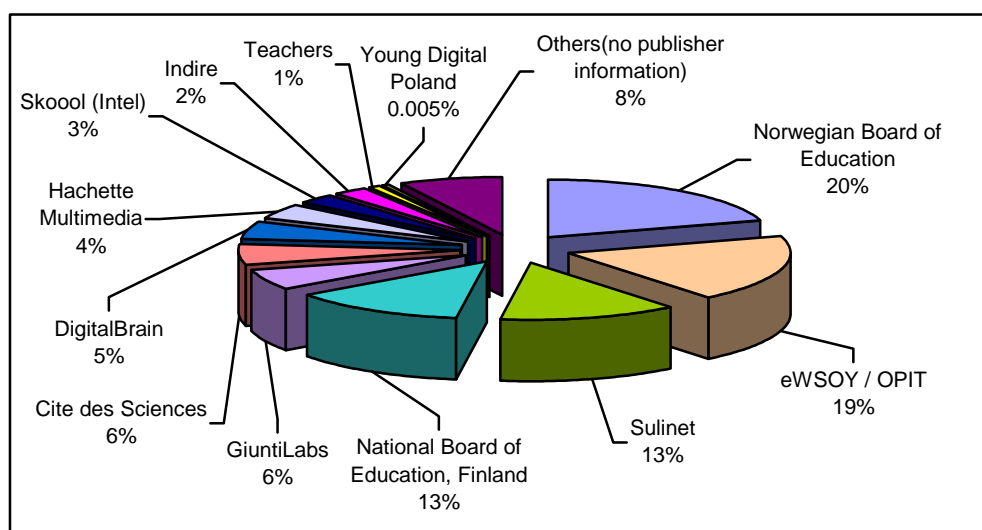


Figure 2.2: distribution of total LOs by provider (Data as of 22nd September 2004. Source: Administration page on the Demonstration Portal.)

The LOs were produced in various ways, most of which involved teachers. The approaches tried out included:

- Professional commercial teams;
- Professional teams working with teachers and central support from a government agency;
- School teams working with central support from a government agency;
- Individual teachers working with central support from a government agency;
- Individual teachers working independently.

Below we discuss each of these approaches.

2.5.2 Professional commercial teams

There were various approaches to development using professional teams provided by companies. In Hungary the original plan was for a small software development firm to work under ministry direction, with schools chosen by the ministry. In the event the firm (which included some ex-teachers) used their own teacher contacts instead. This approach produced, in the view of the ministry, consistently good LOs, but in relatively small numbers, and to a standard format.

In Israel several local software firms and agencies were initially interested in being involved in development, but it proved difficult to agree funding arrangements with the relevant content developer for permission to translate existing LOs into Hebrew, which was a key demand from the teachers.

In Norway the ministry contracted several software firms to produce LOs, working to a ministry specification. Example LOs were assessed and discussed with the firms and corrected. LOs were translated into Finnish, Swedish and Hungarian, all this work being done by a commercial translation agency. A key issue here was ensuring that text files were easily separable from other parts of the LO, so that the firms could take them out and send them to the translators without releasing the rest of their LOs to an outside body. It also eased the problem of constructing the translated LOs. This separation was relatively easy in the Norwegian case because they had all the LOs developed from new materials, so built this in as a requirement.

Digitalbrain used an existing team structure. After establishing the original requirements and obtaining any further information needed:

...the structural designers come up with the design solution which identifies the learning objectives, the general approach and [what the material must cover].... that's then broken down into LOs. Then we look to see if we have any existing materials or even readymade LOs which would work. [...] where we don't, subject matter experts would be used to generate new material. Then, from that, the instructional designers specify the pedagogical and the interactivity structure for the LOs. And scriptwriters create the text and specify the graphics. And then the graphics designers and *Flash* designers produce those to merge in with the script. (Digitalbrain LO Developer Interview)

In a third case, from Hachette, the development group was built around an existing team that worked on the development and updating of electronic encyclopaedias. The editorial work was done within this team, drawing upon existing educational publications from within the group for ideas and approaches. Software development and graphics were handled by a subcontractor that was part of the same commercial group. Translation was carried out by a single external translator. Finally the XML mapping and uploading was carried out within the encyclopaedia team, which both created links between their work and that of the software programmers, and also enabled the team to broaden its range of skills.

2.5.3 Professional teams working with teachers and central support from a government agency

The Board of Education in Finland initially worked with one contractor and produced around 35 LOs successfully. In an effort to get better LOs, they then tried working in partnership with a second contractor, using teams that included an educational researcher, teachers and a programmer. Here the emphasis was upon getting really

good ideas and developing them well, rather than, for example, producing a larger number of adequate but standard LOs. This strategy produced around another 20 LOs.

2.5.4 School teams working with central support

The main method used in Hungary was to identify subject teachers in nine schools. Each of these teachers was assisted by two other teachers from their school; an ICT specialist and an English teacher to help with the translation of the instructions for using the software tools. They were then trained by the national agency to produce LOs, working with commercially developed tools such as *Flash* and *Shockwave*, as there were at that stage no CELEBRATE templates to use. These were then centrally checked technically, pedagogically and in terms of subject content accuracy by a subject specialist consultant who commented on, for example, the amount of interactivity and the media used. The teacher team was advised on the changes needed. In the few cases where they and the consultant disagreed, a second consultant with the same subject specialism made the final decision. Around 90% of the Hungarian LOs and their English translations were created in this way.

The Hungarian experience was that, in some schools, setting up the teacher groups had additional indirect benefits, bringing teachers together in a cooperative task.

In a rather similar way, Norwegian schools worked with their central government agency to produce LOs (this was additional to the commercial provision already discussed). The schools committed themselves to create one LO in each subject that they would use during the project, developing a total of 30 LOs. Some schools used the authoring tools provided by the project while other schools used other tools they knew. There were no special workshops for teachers to create LOs and teachers worked either in groups or individually.

2.5.5 Production by individual teachers with central support

In Israel the strategy was to identify selected teachers to build LOs, using content provided by the teachers:

They are known by the Ministry as people that have developed good content and the Ministry wants to have the learning objects but, on the other hand, to give them recognition for their work and so on. They work individually, each one in the schools.
(Israel Content Provider interview)

A workshop approach was used to show them how to develop LOs covering:

Basically decisions about learning objects but mainly technical issues. How to take some files of *Word*, graphics etc., that are already curricular related [...] materials they are using now for teaching and that are considered by the inspectors as good materials. How to take these and prepare a manifest file and to describe them by the metadata and [...] to upload it. This is the first phase for already experienced teachers.
(Israel Content Provider interview)

2.5.6 Production by individual teachers working independently

In a few cases individual teachers independently developed their own LOs. For example, one experienced Israeli teacher:

...used mainly learning objects that she prepared by herself – *PowerPoint* presentations; American multiple-choice quizzes; she also developed a web site that is serving 500 students who study Information Sciences. Mostly she makes use of Web sites to support her teaching of Information Science and Language.
(Israel Content Provider interview)

It was unclear whether these LOs were actually included in the CELEBRATE set, or even directly inspired by the project. However, it does emphasise that any future development of the CELEBRATE initiative will take place within a wider context of similar developments that will affect and be affected by it. This will have implications for checking that they are compliant with the still evolving standards and specifications adopted by the next generation CELEBRATE system.

2.6 How the LOs were produced

The initial teacher survey report (D1.1) concluded that not all LOs in CELEBRATE then available (relatively early in the LO development process) met all the requirements of a given teaching and learning context and that it was important to be able to choose, (re) use, combine, modify, and implement learning objects. The report also concluded that decisions on these matters should be left to teachers and students, as they created the concrete learning environments where LOs were used. The question was how this should be done. In the event, a number of different ways of producing and altering LOs emerged from the project, discussed below.

2.6.1 Developers building individual LOs with non-CELEBRATE tools

In some cases developers had existing resources (such as electronic encyclopedia and CD-ROM content) already available and copyrighted. These they modified for LO production, using generally available editing and other tools. One commercial developer (Hachette) initially began work in this way, starting from their existing resources to create large complex LOs. These required the addition of completely new graphics and proved both costly and time-consuming, so they then moved to the development of a series of templates that allowed them, for example, to quickly modify existing animations for use in an LO. This proved more efficient and became their standard method of working. The only problem identified was that the use of templates tended to restrict them in the kinds of learning activities the LOs could support.

2.6.2 Developers building individual LOs with non-CELEBRATE tools

The *Reports from Pilots* (D6.2) and *Interview Studies* show that such tools have also been used in a similar way (either alone or in combination with CELEBRATE templates) by a number of French, Hungarian, Israeli and Norwegian teachers.

The use of non-CELEBRATE tools, such as *Flash*, *Macromedia* and *Shockwave*, is an important area for further investigation, as it potentially saves on teacher development time if they are working with tools they are already familiar with. Having a standard set of development tools in use across Europe would also create possibilities both for joint training and for teachers to liaise directly across national boundaries to exchange ideas and advice on LO development. This raises the question of what a *complete* set of CELEBRATE tools and templates would include. It also points to the need to consider whether existing tools and templates from different providers need to be modified and/or presented in ways that would turn them from an assemblage of different tools into what teachers would perceive as a usable and coherent set.

2.6.3 Teachers developing LOs with the CELEBRATE templates

A number of teachers also tried out the various templates provided by several of the developers to create new LOs by adding their own ‘filling’ to the template. This allowed them to adjust the content chosen for their own classes. One Finnish teacher emphasised the importance of such creation:

More often the teachers have made such applications in which LOs designed for older students have been used with younger ones. One lower-level comprehensive teacher contemplated that there are many LOs that would be more applicable to lower-level comprehensive school if small changes were made. Upper level comprehensive teachers also felt that there is room for further improvement in the LOs, for they considered many of the LOs too easy and limited with regard to their content.

(Finland Interview Studies)

This looks like a particularly useful line of development as it allows teachers to analyse the structure of an LO, and use this understanding with suitable LOs for themselves. Given easily usable templates this should offer an attractive route into LO development for many teachers.

2.6.4 Teachers’ views on using templates

When teachers were asked in the *Teacher as user of LOs questionnaire* whether they liked to use templates, 12 % reported that they didn’t know what templates were. Among the participants who understood the concept of a template, 26% had not up to then used them. For those who had used templates, the majority liked them, with only 3% reporting they didn’t like to use templates at all. Reasons for liking to use templates included:

- ‘because they can use templates for creating different teaching activities’ (39%);
- ‘because it provides pedagogical flexibility’ (33%);
- ‘templates are easy to use’ (23%).

It was clear also, from the *Interview Studies*, that teachers were keen to use templates to create their own version of LOs that would exactly meet their requirements. Indeed one teacher was more interested in the templates than in the LOs themselves, as they would make it possible to create resources that would correspond exactly to requirements.

2.6.5 Linking an LO with additional external resources

Several developers extended the possibilities of LOs by linking them with additional external resources. One noted that:

We have a pop-up menu [...] which can contain a glossary of terms or can contain what you could call facts and figures, more background information, which is like a course with text and pictures. It could contain links to websites, organising groups. And for those who are fortunate enough to have the online version of our encyclopaedia in French, there are links to articles within our encyclopaedia. So this is what we call all the background information which is available at any time by a simple click on the menu. So, whenever we [...] provide an LO which is a quiz, it’s not just a quiz, it’s a quiz plus the possibility to go into the background information to find out about things we don’t know and then go back to the questions.

(Hachette Content Provider interview)

This offers a valuable way of extending the possibilities of LOs, but would raise potential problems of translation of, and access to, the external materials once the LO itself is provided in a range of languages. This would be the case if, for example, the

external materials were accessible only through a VLE, or, if they were part of a much larger unit, such as an encyclopaedia, that was sold separately.

2.6.6 A specialised kind of modification: translating LOs

Translating LOs was another major kind of specialised modification. In the original bid the team had said that:

It is not the intention to do any work on machine translation. The purpose in the CELEBRATE project is to identify areas where machine translation can be used and then integrate it into the system in order to provide better 'recall' (*cf.* the information retrieval paradigm) to the search at hand.
(CELEBRATE Bid (2000), *Annexe 1*, p. 20.)

In the event after early discussions it was decided not to pursue the use of automatic translation.

As indicated above, one approach was to use teams of teachers including an English specialist who could help the others as required. While this help was described in terms of advising them on understanding the English instructions on some of the authoring templates, the idea could clearly be extended to providing English translations of LOs produced by teacher teams in their own languages first.

One commercial provider used a British national living locally who was a highly experienced translator. He worked directly to the leader of the team. The only problem was that because he was unique they could not get LOs translated quickly. This problem of speed was also mentioned by the Digitalbrain respondent.

The Hachette respondent strongly supported translating CELEBRATE LOs into all or most of the participants' languages. He suggested this could probably be best done through an agency in the other country that could identify and supervise a mother tongue speaker who was able to translate existing LOs into that language. The text could then be sent back to the developer to be incorporated (in edited form if necessary) into the LOs.

However, there were also technical issues around translation. Both Hungarian and Hebrew use partially or completely different character sets from those of, say, French or English. Unless these distinctive features are supported technically in the tools and templates used to modify LOs, access for teachers and students working in these languages will obviously be disadvantaged.

In their original bid the team noted that:

The approach to translation depends on the following dimensions: (a) what is the volume, (b) what is the volatility, (c) the speed of translation, and (d) the quality.
(CELEBRATE Bid (2000), *Annexe 1*, p. 20.)

In the case of CELEBRATE, volatility would seem generally low across most of the curriculum, and speed of translation would not be critical. High quality would, however, be essential. In the pilot phase the volume of translation was not large, but the methods described above already show some signs of strain. This suggests that there may be a need for additional approaches to be tried if the volume of translation increases markedly, as a strategy based upon translation into English and then out to a third language implies.

2.6.7 Students producing LOs

There was also an interest in the project team to see students developing LOs, while some Norwegian teachers and the developer interviewed also emphasised the importance of a student producing his or her own resources and knowledge, and so let students produce videos and learning materials. This was seen as a pedagogic strategy, designed not to produce widely usable LOs, but as a way of enabling students to learn by doing in an interesting and different way. There were no reports from the interview or case study schools of students producing CELEBRATE LOs, but the Hungarian developer reported that in half of their schools students have produced easy interactive tasks for each other, using the Digitalbrain templates. The Digitalbrain developer also mentioned this¹⁶. One developer also pointed out that students too needed to have a set of tools to help them produce LOs, implying that those designed for teachers would not necessarily be suitable.

2.6.8 Training teachers to use the tools and templates

Some teachers were given the opportunity to train in the use of the tools and templates, with support being provided by the commercial developers of the tools and templates and/or the national agency. The most common pattern appears to have been for the teachers to work through the tasks starting with the use of the Demonstration Portal and then going on to the use of templates. The Finnish training schedule, for example, is shown in Table 2.7.

Table 2.7: content of the Finnish training sessions for CELEBRATE teachers

Type	Content
Orientation	Familiarisation with the Demonstration Portal, retrieving LOs in the basket; Virtual Classroom; NBE Discussion forum.
Continuation course	Searches for LOs; authoring templates.
LO creation course	Creating new LOs; authoring Templates.
Training provided by ICT Coordinator	Varied according to school.
Other Training	OPIT and Moodle e-learning.

(NBE = National Board of Education; OPIT is the VLE of eWSOY and Moodle is an open source course management system for creating online courses.)

In Hungary the teachers were divided into beginners and advanced groups:

The beginners were familiarizing themselves with the usage of the whole Demonstration Portal, including creation and modification of LOs (they used three simple templates, for example crossword), and [...] upload. Advanced teachers got to know five from the ten Digitalbrain templates (two were guided, and three were freely chosen), and they also had the opportunity to become acquainted with the Giunti and Hachette Multimedia tools. They also tried the upload. Unfortunately the Giunti website was not operating and the Hachette templates turned out to be very complicated.

(Hungary *Interview Studies*)

This need for different provision for advanced and beginning teachers was also reflected in the Norwegian teachers' view that the project needed to have simple tools for teachers who were beginners and more advanced tools for experienced teachers.

¹⁶ The UK training of teachers run by the Open University found that teachers were keen to use the Digitalbrain 'crossword' template with their students.

2.7 Issues for the future

2.7.1 Models for future funding and copyright

The project hoped that it would be possible to evolve long-term public sector and commercial models for the future funding and copyright arrangements in relation to LO development. While the project was not directly designed to address this issue, several developers suggested future ways in which this might be done, reflecting discussions started near the end of the project about future developments (see D8.5).

One commercial developer distinguished between being a distributor of LOs and an originator, favouring a mixed model in which a national distributor carried resources from a number of providers and provided a paid subscription service to schools wishing to take it up. It was thought that this model could be expanded across a number of countries through cooperative links among the distributors involved.

Both this developer, and another commercial provider, pointed out the importance to them of future sales outside their country, either in other countries or to parents or agencies other than schools, whatever post-CELEBRATE arrangements were made.

A public service model was offered by Hungary. It favoured government funding and the provision and the distribution of LOs through a government agency, free to schools at the point of use and available free to anyone else who wanted them.

The role of teachers as contributors to LO development (discussed earlier) led one Israeli teacher developer to suggest that teachers should be compensated for this work. He saw this as the best way to ensure that a sufficient number of LOs were created. This was taken up as future policy in Israel, where it was agreed that the Ministry would pay teachers the equivalent of 100 euros per LO produced.

This indicates a range of possible models in terms of the roles of public and commercial partners, and the position on copyright and IPR will therefore vary from one model to another. At least five different possibilities are suggested by, but not all demonstrated in, the strategies used in the project:

1. Sale of tools, templates and LOs by commercial providers, who retain full copyright on these products and on everything produced with them.
2. Sale of tools and templates commercially, but with the LOs produced by other providers, who would hold the copyright entitlements and liabilities for their own LOs. These providers might be companies, public agencies or individual teachers.¹⁷
3. Public sector provision of tools and templates, together with support and training for teachers using these, to produce LOs for free distribution within schools in that country. This could be combined with sale or barter of LOs between national agencies in different countries and/or payment to teachers for LO production.
4. As in (3), but with the free and non-copyright distribution of the resulting LOs to whoever wanted them, including commercial companies, who would then be able to modify/translate and sell their versions of the LOs?

¹⁷ It has to be acknowledged, however, that copyright entitlement is only as secure as the individuals or organisations who own it have the financial capacity to defend it in the courts. This is a particular problem for teachers.

5. As for (4), but with a copyright arrangement that allowed anyone to modify and freely use the original LOs only if they made their LOs in turn available to others free and on the same terms.¹⁸

What is meant by “selling”, and what is sold, could also vary. It might cover outright sale, or licensing to specific schools or organisations and be a permanent sale or a sale for a specified period only. Similarly the sale of tools and templates might or might not affect what the user could do with the resulting LOs.

There was also an important difference, noted by the Norwegian developer, between LOs developed from totally new material and those which reused existing materials. For existing materials there were often already copyright arrangements that naturally had not been agreed for later cross-national use and the possibility of disassembling the materials.

The choice between these approaches involves taking an informed view of the problem in specific situations, so answers to the key questions might well be different from case to case. However, four basic questions seem to arise:

1. If maximising long-term income and maximizing long-term access to LOs are incompatible, which should have priority?
2. What combination of skills and resources are potentially available to envisage, design, create, market and distribute tools, templates and LOs? How are these distributed between the different potential partners?
3. What mixture of benefits (direct and indirect) would the various potential partners need, to encourage them to make a long-term commitment to an LO development programme?
4. What distribution and type of copyright and IPR entitlements is most likely to sustain long-term provision and improvement, in ways that will maximise long-term income and/or access to LOs?

Beneath these questions is another - how many LOs are actually needed? We turn now to this issue.

2.7.2 How many LOs are needed?

Two relevant points on this emerge from the figures categorising LOs by subject, language, type and age. One is that for any given teacher the number of relevant and accessible LOs was likely to be small, especially if the teacher and students were not fluent readers of English. The second is that in most cases the distribution across each category was very uneven.

This meant that the number of useable LOs available was very variable from one group of teachers to another. We have already noted that a teacher who taught a number of subjects was likely to find more relevant LOs in the present set than one who was a single subject specialist. But even if we ignore that difference, in terms of choice of LO, any non-English speaking Israeli teacher and class would, for example, be in a very different position to a Finnish science teacher and class fluent in English. The way in which both LOs and teachers were distributed across the categories was therefore, as later sections show, an influential factor in determining how the initiative

¹⁸ Such ideas were discussed at CELEBRATE dissemination event (EMINENT IV).

eventually developed.¹⁹ It is important to note that, as indicated earlier, the purpose of translating all LOs into English was more to do with aiding the eventual translation of LOs into other languages (e.g. from Finnish to Hungarian), rather than to create a pool of LOs for teachers to use in a second language.

Three broad answers can be distinguished in order to answer the questions: how many LOs are needed, and why?

At one end of the scale an Israeli content developer emphasised the importance of going for quality rather than quantity, arguing that this would ensure the LOs would be very widely used. He also thought that teachers would be broadly agreed on which LOs were good: "...if it is good in the North it will be good in the South." Taken together these views led him to think in terms of tens of (very good) LOs rather than hundreds as the requirement across the whole curriculum.

This contrasted with the view of the Hungarian LO developer who pointed out that complete curriculum coverage was the aim of the plan for national content development. The first version of all the core materials for this coverage are planned to be available by the middle of 2005. Her estimate was that nationally this would require the building of around 300/400 LOs per subject. She also noted that it would be better if teachers had a choice of types of LOs for a topic, through the provision of double or treble that number.

In the Pilot Study one Finnish teacher may, however, have been proposing a different model:

LOs should be produced course by course through the whole curriculum of the upper secondary education. Even 10 LOs per course on the central and easily demonstrated issues would be a very good thing. [If they were ones that covered topics] difficult to illustrate with just plain chalk and talk...

So instead of providing total coverage of a curriculum it would be possible instead to focus upon priority topics only. These might be defined as those topics already known to be difficult to teach and learn using conventional methods, and where there is some reason to think that the use of LOs would be more effective.

(D6.2: Finland)

A final possible position is to see LOs as something that would ideally be modified by each teacher for use in their own situation. This would of course imply a very large number of LOs indeed as the final target figure, though the number created initially could be more modest.

Deciding the planned long-term target figure for numbers of LOs is a central policy decision. This is because nearly all major future decisions about resourcing, organisation, system development and training for any follow up to CELEBRATE will depend upon the answer that is given to this question.

To establish such a figure is in part to reach an agreed view on the best position to take up on the spectrum represented by the three views above. But another task is to find out just how different the existing national curricula are in terms of topic coverage.

This is particularly relevant to the middle option - the provision of full national curriculum coverage. As we move from the national to the European level we cannot

¹⁹ Given the very small number of English first-language teachers in the project, these imbalances have also limited the kinds of statistical analysis possible for this evaluation.

just factor up a national LO total to a European one by simply multiplying it by the number of nations involved.

This is because, firstly, there will be considerable overlap in topics from country to country, secondly because the degree of this overlap probably varies very much from subject to subject and finally because, where a country allows a lot of local variation in topics learned, the number of LOs needed to adequately cover a subject will obviously be much greater. (This is an issue of the degree of centralisation of curricula, which we return to in Section 6.2.3.)

This suggests that one very useful next step would be to find out (if it is not already known) what degree of overlap actually exists between the set of curriculum topics needing coverage in different countries and where exactly these topic overlaps exist. This list could be made available to potential content providers, together with an updated list of what topics were already covered by CELEBRATE LOs, and LOs in other repositories at any one time.

Even if the decision was to aim for total curriculum coverage, a second important step would be to systematically identify those topics that were both particularly difficult to teach using conventional methods, and where there was research evidence and/or substantial classroom experience that suggested that they could be better taught and learned by using LOs. In combination these two criteria of wide relevance and demonstrable benefit would give a powerful indication of the most suitable LOs to start with to get the best possible early coverage.

2.7.3 LOs: How small is small and why does it matter?

As mentioned earlier, the size and complexity of the LOs provided varied. This affects a number of other features. Two possible ways in which LOs and their interrelationships are viewed, can be identified in the CELEBRATE development to date.

The first favours developing relatively large internally complex LOs, each covering a unique topic, conceptually related to other LOs, and linked to other external learning resources. The advantages of this approach are that it enables complex ideas and processes to be represented and fits relatively well into a structure based upon planning lesson-sized activities. Linkages to other external resources, whether conventional or electronic, also provide ways of adjusting the depth and style of treatment for particular groups and individuals. This approach in some ways fits well with a traditional academic approach to education (i.e. one that sees knowledge as complex inter-related concepts, ideas and understanding into which a learner must be initiated), but using electronic resources rather than conventional ones.

An alternative approach is to make the LOs provided as small, numerous and as conceptually separate from each other as possible. To meet the needs of different students there would be several separate LOs for each small topic, varying perhaps as much in the study styles they support as the level of difficulty they offer. There would be no built-in links to other external learning resources, the aim being to provide a largely self-contained set of resources. The advantages of this approach are that, given sufficient numbers of LOs, it is highly flexible. Success (and failure) in learning are easy to see and can be linked to specific LOs, making it easier to see which LOs need improving and how to do this. Such small LOs, unlike larger ones, are also likely to be easier for teachers to develop or modify for themselves or as part of a wider team.

Overall, this approach is rather similar to the model used in conventional skills training.

From the start CELEBRATE generally favoured the use of small LOs, but also emphasised the importance of promoting exploratory, cooperative and active modes of learning. Yet these more investigative ways of working have usually been linked to the use of complex curriculum resources. One way of describing the project then is to say that it has taken a central concept from the training tradition and tried to find ways of using new technologies to make it work within much more learner-centred and participatory settings.

But does there need to be an agreed view on LO size and how an LO relates conceptually to others for a programme such as CELEBRATE to work and grow?

Technically, storing, searching for, and presenting different sized LOs may offer no obvious problems. But such differences may possibly create difficulties for curriculum planning, classroom practice and the development of a viable long-term business model for the programme. This is because the rationale for the programme is that it will enable teachers to easily combine LOs from several different sources to implement their curriculum. But the larger and more complex the LOs available, the more likely it is that those from different providers will not fit together coherently. This will leave gaps and overlaps that it is hard for the teacher, both in planning and in classroom practice, to deal with. This in turn is likely to reduce the attractiveness of the programme to teachers. If this reduces demand for the programme that in turn threatens both a public sector business model, based on maximising student access, and a commercial model based upon generating adequate income to sustain and develop the programme further.

These problems of gaps and overlaps seem unlikely to appear when a single large-scale provider is creating complex and interrelated LOs for a national curriculum, because the provider can plan in an integrated way, telling each contributor what the others will be developing. But, where large numbers of LOs are coming in from multiple providers, all working independently, each provider has to design their LOs on the basis that they do not know what other LOs a teacher will use alongside theirs, or even within which national and local curriculum contexts it will eventually be used. In those circumstances small conceptually independent LOs again seem to be more likely to be useable.

This rather speculative discussion has, of course, to be seen in the light of how the CELEBRATE teachers actually wanted to use LOs and we will return to this when we consider blended learning in Section 7.6.1.

2.7.4 CELEBRATE: brokerage system or VLE?

The granularity and degree of integration of LOs, discussed above, have a bearing on how we view the way LOs are provided for teachers. Crudely we have, on the one hand, a system that is highly integrated offering courses, or the facility to construct courses, in a 'purpose-built environment'. In effect this is to turn the CELEBRATE system into a virtual learning environment (VLE). On the other hand, the modular option (small numerous and conceptually separate LOs) requires LOs to be produced that are able to operate in a variety of environments. Thus, as well as issues about the LOs being provided, there are also questions about what kind of delivery and use system CELEBRATE might become in the future.

A key point here is that it will be operating within a complex environment. In the last 25 years the range of ways in which teachers can obtain classroom resources has increased dramatically. At the start of that period the choice was mainly between conventional text and picture-based resources and real-life experience. To those were later added a number of separate kinds of electronic resources based upon standalone computers. The introduction of networking to schools and homes added two more sources. One was the Internet, the other the various kinds of closed systems (or “walled gardens”) in which selected electronic resources were assembled and distributed. Some of these involve VLEs of various kinds, others are closer to repositories of usable content.

The CELEBRATE portal and brokerage system represents an important new version of such a closed system, in which a number of different providers can make their LOs jointly available to schools through this shared channel as well as, in many cases, through their own repositories and often within their own VLEs (Figure 2.3).

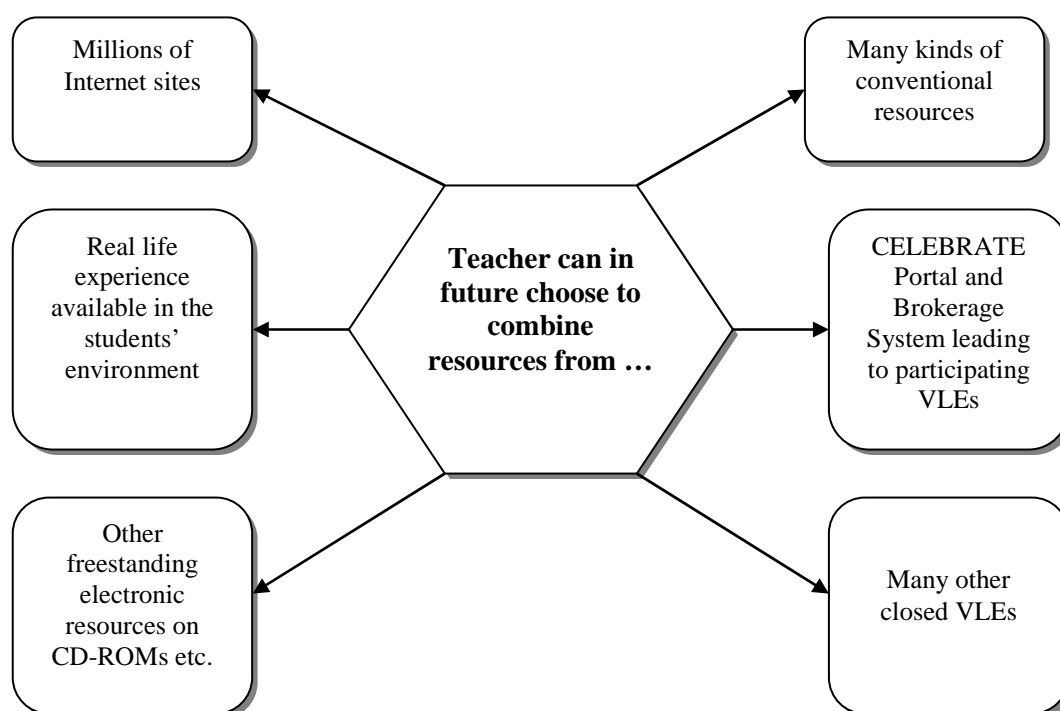


Figure 2.3: selecting resources; the future range of choices available to teachers

The relative strengths and limitations of these various sources for curriculum materials will be discussed in Section 8.2.3, but here we need to look specifically at the question of the relationship between the CELEBRATE system and existing competing VLEs.²⁰

A 2003 EUN review of VLEs (Vuorikari, 2003, p. 9) saw the future of VLEs in these terms:

Our expectation is that, as VLEs evolve, they will increasingly provide seamless integration of many or all of the following tools and services:

²⁰ Here do not distinguish between VLEs, Learning Management system (LMS) or Learning content management system (LCMS).

- Both synchronous and asynchronous tools for communication and collaboration.
- Access to repositories of digital learning resources, particularly standards compliant Learning Objects (LOs).
- Templates and authoring tools to create, edit and re-use LOs and other types of content.
- Automatic generation of metadata for learning resources.
- Tools that allow users to sequence LOs to create modules and courses.
- Tools for knowledge building.
- Tracking of student/student progress through content.
- Assessment tools for learning progress.
- Access to online help and tutoring.
- Linking to student data and administrative information.
- Diagnostic tools that detect where learners experience difficulty and provide intelligent remediation by re-sequencing content and personalising assessment.

The services that VLEs provide are aimed at teachers, students, administrative personnel, and parents. Access to the VLE is via the Internet or an intranet, and there is usually an option to work offline. A key characteristic of a VLE is that learning can, potentially, take place "anytime anywhere" and is not dependent upon the traditional school timetable or whether the learning is taking place inside or outside the school building.

A VLE with all these capabilities represents a future possibility rather than a description of what most VLEs currently do. Nevertheless there are considerable numbers of simpler VLEs in existence already; the same report (Vourakii, 2003, p. 11) identified at least 320 VLEs from its European School's survey responses.

Many CELEBRATE teachers too were aware of existing VLEs. Over two hundreds had already used a VLE before seeing the Demonstration Portal, and 70 were using another VLE alongside the Portal. Overall they found the Demonstration Portal as useful as the others they knew of. There were, however, considerable variations in levels of experience with VLEs from country to country (Table 2.8)

Table 2.8: teachers' previous experience of using a VLE, LMS or LCMS

Country	Number and percentage of teachers				total
	Yes		No		
Finland	112	34.7%	211	65.3%	323
France	5	5.4%	87	94.6%	92
Israel	53	50.5%	52	49.5%	105
Hungary	6	5.7%	99	94.3%	105
Norway	48	48.5%	51	51.5%	99
U.K.	8	25.8%	23	74.2%)	31
Others	4	26.7%	11	73.3%	15
Total	236	30.6%	534	69.4%	770

(Data source: *Teacher registration questionnaire*)

In the future four main possible relationships between CELEBRATE and other closed systems can be envisaged:

- CELEBRATE moves towards becoming an additional full VLE with all the features listed in the EUN report;

- CELEBRATE moves closer to becoming a full VLE, but does not seek to replace teachers' classroom diagnostic and remediation roles, and sees teachers as major partners in LO design and development;
- CELEBRATE provides a useful, but basic VLE, as an additional service for those resource developers who do not wish to provide VLEs of their own;
- CELEBRATE acts as brokerage system, portal provider and support system to participating LO developers (including those with their own VLEs), and does not maintain a VLE of its own.

It is evident that the polarity of highly integrated and modular systems is not tenable in the face of the choices on offer to teachers depicted in Figure 2.3. Further, the relationship of CELEBRATE and other closed systems proposed above, means weighing up the growth in VLEs in schools (and the 'national' character of them), as well as the commercial imperatives. The latter may mean that some content providers would prefer to create LOs that only operate fully in their systems rather than be more universal. This is not a simple technical issue of interoperability (although, as later sections will show, these are not trivial at the school level), but one where important student information that supports their learning is lost when the LO is taken out of context. The analogy is with an Integrated Learning System that, if disassembled into its constituent instruction and student activities, would lose the very thing that it offers as its benefit, namely: integrated student information to help the program select and sequence material and activities for the learner; and to help the teacher see student progress and their supplementary needs. The choices involved for the development of the CELEBRATE idea are thus far-reaching. While this is going beyond the scope of what was evaluated or piloted within CELEBRATE, we will return to some of these issues in later sections (e.g. Sections 3 & 7), and to consider issues and recommendations in Section 8.

2.7.5 Indirect benefits from LO production

Finally, the design of the evaluation emphasised how far it was possible to meet the expected requirements. This under-emphasizes various indirect benefits. Two mentioned in relation to LO production were that content developers could gain a better understanding of what was involved in LO production and that, in some cases, where teams of teachers from a school worked together, this had beneficial effects in the schools more generally. However, this is potentially a much wider issue, as the work involved in linking currently separated groups and individuals around the task of creating mutually acceptable LOs could prove a major catalyst for further partnerships and learning.

2.8 Summary

To sum up: this section has discussed how far the hypothesis has been confirmed that, given suitable pre-conditions and working methods:

- learning objects can be successfully created, translated and modified by content developers and teachers;
- within a 'market' that can be created to protect the rights of creators and provide necessary income where appropriate.

LOs were indeed created, and in significant numbers. They were also produced for a range of subjects, across the full age range planned and in different styles. Around a

third of the LOs were thought well enough of by teachers to try out in their classrooms.

LOs were successfully translated into a number of second languages and a number of authoring templates were provided that allowed a number of teachers to create and modify LOs. However, the vision of teachers each modifying LOs for their own use did not generally appear. Nor was our own initial assumption that LOs would be produced only by central agencies or individual teachers correct. Instead a number of different mixtures of approach were tried.

What preconditions and working methods were most favourable to LO production? In fact a range of strategies were tried out. In general it appeared that the approaches that were most successful in generating large numbers of LOs, of an acceptable quality, involved teams. These needed to have members with expertise in programming, classroom teaching with ICT, and subject knowledge. Some way of getting LOs translated was also, of course, essential.

Teachers were able to develop LOs using templates (usually within the sorts of teams just described), but this involved a level of systematic face-to-face training that (if it is essential) suggests it will not be possible to enable all teachers to take on this role.

The development of models for future funding and copyright could only be partly explored within the project, as it ended before long-term arrangements were in place for the future. However, several models were being actively discussed and it was possible to identify some of the underlying options and questions that could focus decision making in this area.

It is also clear that there are a number of interconnected decisions to be made about: the target number of LOs, LO size, interrelationships between LOs and the future role of the CELEBRATE system in relation to other kinds of resource provision, especially that provided by VLEs. Many of these issues are discussed further in later sections.

References

[D4.1] Ayre, J., (2004) *Criteria for selection, Deliverable 4.1 CELEBRATE Work Package 4.*

[D8.5] Ayre, J., (2004) *CELEBRATE Sustainability: Feedback from the interview with the Ministries of Education – Deliverable 8.5 CELEBRATE Work Package 8. Content Developer Interviews CELEBRATE Work Package 7.*

CELEBRATE (2000) *Bid, Annexe 1 – Description of Work.* Brussels: European Schoolnet.

[D6.2] Durando, M., Raymond, C., Leclèr, P., Salminen, M, Hunya, M., Pedersen, L., Winer, D., Jeavons, H., (2004) *Reports from Pilots - Deliverable 6.2 CELEBRATE Work Package 6.*

[D1.1] Nurmi, S., (2003) *The CELEBRATE Final Report on Teacher User Needs – Survey Report Deliverable 1.1 CELEBRATE Work Package 1.*

[Pop-ups Evaluation Questionnaire] Li, N. (2004) *Pop-ups Evaluation Questionnaire Report.* CELEBRATE Work Package 7.

Vuorikari, R. (2003) *Virtual Learning Environments for European Schools: a survey and commentary.* Brussels: EUN Consortium.

http://insight.eun.org/eun.org2/eun/en/Insight_Policy/content.cfm?ov=19414&lang=en

Section 3 Distributing and Presenting Learning Objects to Teachers

3.1 Introduction

This section discusses the hypothesis that:

- *Given suitable pre-conditions and working methods learning objects can be distributed and presented successfully to teachers.*

The teachers' views on the ways in which LOs were distributed and presented by the system are the main focus in this section and will be examined in detail. However, it is necessary to understand the system teachers are using. Therefore, the purposes, structure and design of the CELEBRATE system, especially the Demonstration Portal and Brokerage System, are briefly described.²¹ The changes that were made in the system as it developed are also discussed.

3.2 The CELEBRATE system

The CELEBRATE system consisted of two subsystems: the Demonstration Portal and Brokerage System. The former gives an interface to search for and select LOs, the latter connects the Portal search to the various repositories of LOs, thus giving teachers access to them.

3.2.1 The Demonstration Portal

The Demonstration Portal itself consists of a number of sub-systems that were developed and implemented during the project including: the Learning Management System (LMS) and Learning Content Management System (LCMS), the intelligent predictor system and the translation tools. They were integrated via a dedicated Portal at the European Schoolnet with the already existing systems, namely, publishing and the Translation Management tools. The Demonstration Portal can be found at <http://demoportal.eun.org>.

The aim of the Demonstration Portal was to make available hundreds of LOs and LO 'components' provided by project partners (publishers, national networks) to up to 500 schools in the six pilot countries (Finland, France, Hungary, Israel, Norway and the UK).

It is important to note that the Demonstration Portal was concerned not just with the *delivery* (downloading, re-use and uploading) of content to and from schools, but also it could provide users across Europe with an advanced suite of communication and collaboration tools that enabled schools to implement the learning strategies and explore the pedagogical models identified in WP2. The Demonstration Portal was conceived, therefore, as an environment where content and context come together and where new paradigms for eLearning could be enacted. Therefore, from the user point of view, the Demonstration Portal was a:

²¹ For more technical details about the two systems, see Deliverables D5.1- D5.3 and D3.1-D3.4

- virtual place where end-users were introduced to Learning Objects, Learning Assets, Learning Management Systems, Authoring Tools and other aspects of the Demonstration Portal functionality.
- virtual platform to experiment and test LOs and the tools provided by the system.
- full system where the user could search, browse, inspect a list of the resulting LOs, evaluate these, retain any required (in a basket), download or use directly from the Portal or save them to the Virtual Classroom. The Portal was not designed only as a central repository, but as giving access to the Brokerage System that connected the remote repositories.

There are various features of the Demonstration Portal that are linked to the Homepage <http://demoportal.eun.org> (see Figure 3.1):

- *Search*: this is available in two parts of the Demonstration Portal; the Homepage and Advanced Search. The Homepage offers a browse by subject and a search by specific LO (title). The advanced search refines the search into categories of Keyword, Age, Subject, Language, Learning Object/Learning Asset, and Publisher.
- *Basket*: this is the virtual space where learning resources found in a user's search can be stored, organised and managed.
- *Authoring area*: users can work with templates in this area; for example, a 'crossword' template can be used to construct a crossword as a closed activity that requires students to fill in a missing word or phrase. Other templates include multiple-choice questions, slide shows that present sequences of images (Learning Assets) etc.
- *Virtual Classroom*: this provides a way for teachers to create and manage an electronic environment for students to participate in a learning experience.
- *Create/Contribute*
 - Add a learning resource: this is used to upload LOs and LAs created by any system user to the Portal repository.²²
 - Edit Metadata: this is used to edit the metadata of LOs or LAs that are uploaded to the Demonstration Portal (metadata describe the LO for the system).
 - Evaluate a LO: this section is used to for teachers to give feedback on their use of the learning resources provided by CELEBATE and this feedback can be seen by other teachers.
- *Overview*: this provides background information about the project.
- *News*: this provides news of the latest developments in the project.
- *Advice*: this provides teachers with pedagogical suggestions and guidelines for the use of LOs, project questions and answers, glossary of terms useful links, the technical specification for LOs, and the CELEBRATE metadata.
- *Community*: this provides a discussion forum where teachers can share ideas, comments, and experiences with other teachers of their own country, as well

²² In Section 2.2.3 we noted that during the pilot period all LOs were loaded onto the Portal, rather than users gaining access to the various repositories via the Brokerage System.

as ask questions, find colleagues online and seek partners for collaborative projects.



Figure 3.1 the homepage screenshot of the Demonstration Portal V2.0²³

<http://demoportal.eun.org>

The history of the development of the Demonstration Portal is summarised and presented in Table 3.1.

²³ The improved interface, V2.1, was released in 17 September, 2004, but the interface presented to teachers at the time of evaluation was V2.0, as shown here.

Table 3.1: Portal development history*

Version	Release date	Functionality/Feature
1.0	4 November 2003	<ul style="list-style-type: none"> a) User interface in six languages b) Search for LOs and LAs and preview in basket c) Virtual Classroom d) Upload new educational resource or metadata
1.1	19 January 2004	<ul style="list-style-type: none"> a) New version of the basket b) More refined search engine using the multilingual thesaurus (search engine returns only items in the languages spoken by teacher) c) Reporting tools for users, LOs and LAs present in the Demonstration Portal d) Reporting tool which creates data [CSV] files from the teachers' questionnaires e) Better synchronisation system between Phase 1 LO repository and Demonstration Portal repository f) Nightly indexing of LOs g) Complete LO metadata set visible in the results page
1.2	28 January 2004	<ul style="list-style-type: none"> a) Learning Object management system enabling content providers to edit and update metadata b) Connection of Demonstration Portal to Brokerage System [with one repository connected] c) Implementation of the Hebrew version of the interface d) New help files including easy scenarios for teachers
1.3	10 February 2004	<ul style="list-style-type: none"> a) All reported bugs corrected b) Improved data migration from Phase I interface
2.0	2 June 2004	<p>Improved administration interface</p> <ul style="list-style-type: none"> a) All project partners can: <ul style="list-style-type: none"> - view LO age statistics - view LO user statistics (which user uploaded what) - view LO publisher statistics (which publisher uploaded what) - View usage statistics (who did what on the DP) - view user type statistics (authors, teachers, etc. by country) b) WP4 can: <ul style="list-style-type: none"> - Edit resources their organisation submitted - Contribute resources with are automatically approved (online) c) WP6 can: <ul style="list-style-type: none"> - Approve/delete teacher resources (for their countries only) - Edit resources (for their countries only)
2.1	17 September 2004	New interface was released

* See D5.3

3.2.2 The Brokerage system

The CELEBRATE project developed a system to support a European Learning Network (ELN)²⁴ being developed by European Schoolnet. The backbone of this network is the Brokerage System (BS).²⁵ As noted in Section 1, the Brokerage system was fully developed and ready, but connectivity between the Demonstration Portal and the Brokerage System was not available at the time of the pilot. A pilot usability

²⁴ This was the initial name for the Demonstration Portal, Brokerage System and connected repositories. It was later renamed.

²⁵ For more technical details about the Brokerage System, refer to Deliverable 3.1-3.4.

study of the Brokerage System, whose connection to the Portal is operational at a later stage of pilot phases, was conducted in November 2004. A separate evaluation of the usability of the Brokerage System search is contained in Appendix 4.

3.3 Teachers' views on the Demonstration Portal²⁶

Teachers' opinions of the Demonstration Portal were divided, depending on the interval between when their training occurred, and when they used the Demonstration Portal. Each pilot country project coordinator organized various types of training for teachers across the project within their own timescales. The content of training varied somewhat across the countries, but generally it aimed to help teachers to become familiar with the features of the Demonstration Portal. The interview studies suggest those teachers who attended the early training sessions in the period of November 2003-January 2004 were more likely to have experienced technical problems than those who attended the later training in the period of March-June 2004. This was mainly caused by the status of development of the Demonstration Portal at the different stages of the project (see Table 3.1). At the official start period of the pilot phase the Demonstration Portal was unstable and not completely developed, although it improved during the project pilot period. This resulted in teachers' mixed reactions to the quality of the training, and the Demonstration Portal itself. For example, the interview studies revealed that teachers who attended early training sessions often experienced technical problems that resulted in them becoming irritated:

In one orientation course in autumn 2003, it was discovered that access to the Demonstration Portal [DP] did not function. A call was made immediately to the Demonstration Portal Developer, in Brussels, and it was discovered that the DP had been closed. Fortunately, the portal could be re-opened in the afternoon in order to continue with training. This may have at first [adversely] affected the early enthusiasm among some teachers.
(Finland *Interview Studies*)

Again in Norway, teachers who had attended the early sessions felt that they had not received enough training and this was coupled with the system not working properly. Teachers who wanted to use the Portal after these early training sessions were prevented from doing so, again because of the persistent technical problems at this early stage. A typical report was:

Many of the teachers say it is too little and the system not functioning made it more difficult. There were no possibilities to go home and try it out later after the first session in November 2004. There were too [many] technical problems with the Demonstration Portal at the time the training took place.
(Norway *Interview Studies*)

Although there were these early problems affecting teacher attitudes, the Demonstration Portal has improved based on teacher feedback. The second version was much more stable and had new features based on teachers' and project partners' feedback. Teachers' reactions to this version of the Demonstration Portal were therefore much more positive. For example, at a UK teacher-training day in May 2004 a teacher found it '*really good*' and at the '*right level*' as it allowed teachers to

²⁶ An expert-evaluation on the earlier version of the Demonstration Portal was conducted by WP1. Omitur focus is on the CELEBRATE teachers' reactions to using. For more details about the 'expert-evaluation', see WP1 D1.3.

'experience' the Portal and this teacher came away with an LO he created using the templates and found the training 'fun' (UK *Interview Studies*).

3.3.1 Usability of the Demonstration Portal

The above positive view was borne out in a survey of teacher opinion, where they were asked to evaluate the Demonstration Portal by completing the Portal questionnaire. Of the 397 who had used the Portal to look at LOs, 176 (i.e. 47%) completed the questionnaire. These respondents were representative of all users.²⁷ In interpreting the following analysis it should be borne in mind that the teachers' responses to the questionnaire might have been influenced by the particular experience of the training they had had and the period during which they used the Demonstration Portal.

Two-thirds of teachers thought the Portal was useful. In general teachers thought it was well designed and appreciated its ease of use. Over 50% of the teachers agreed that the Demonstration Portal was visually appealing and attractive, and a similar proportion agreed that it was consistent and functional in its design and layout. 55% of the teachers felt it had a clear structure and the icons and graphical symbols were clear and easy to understand.

However, about 30% of the teachers reported that they had some problems with the interface. The interview studies revealed that these related to language issues. For example, a French teacher who tried to upload a learning object on the Demonstration Portal, had difficulty in understanding instructions in English. Similarly, some teachers in Hungary wanted a Hungarian version on the 'Help' page of the Portal to overcome problems that they were having with navigation, but this was unavailable at the time. Another Hungarian teacher had problems with understanding an error message that was in English.

Some teachers reported that they had encountered a number of problems with the Demonstration Portal, with 50% of them having experienced problems occasionally, 25% often and 10% very often. Typically these problems were related specifically to materials available in the Demonstration Portal, not to the functionality of the Portal itself; over 60% of teachers said that they did not find materials to suit their needs. Further, the interview studies suggested some problems were mainly localised technical issues and were not directly related to the Demonstration Portal. For example:

There may be problems with the network and Firewall when downloading resources.
(Norway *Interview Studies*)

Related to the availability every answering teacher announced that the availability of the Demonstration Portal made up only part of the problem. The schools' own network, the internet speed and the quality of the school computers were also problematic.
(Hungary *Interview Studies*)

²⁷ For more details of the Demonstration Portal questionnaire, including the nature of the sample responding, see Appendix 2: Evaluation methodology.

3.3.2 The kinds of activities for which teachers used the Demonstration Portal

As Figure 3.2 shows, teachers largely used the Portal for LO-related purposes and classroom work, rather than for sharing material. Teachers also reported that they very rarely used the Demonstration Portal for student (student) activities outside the school.

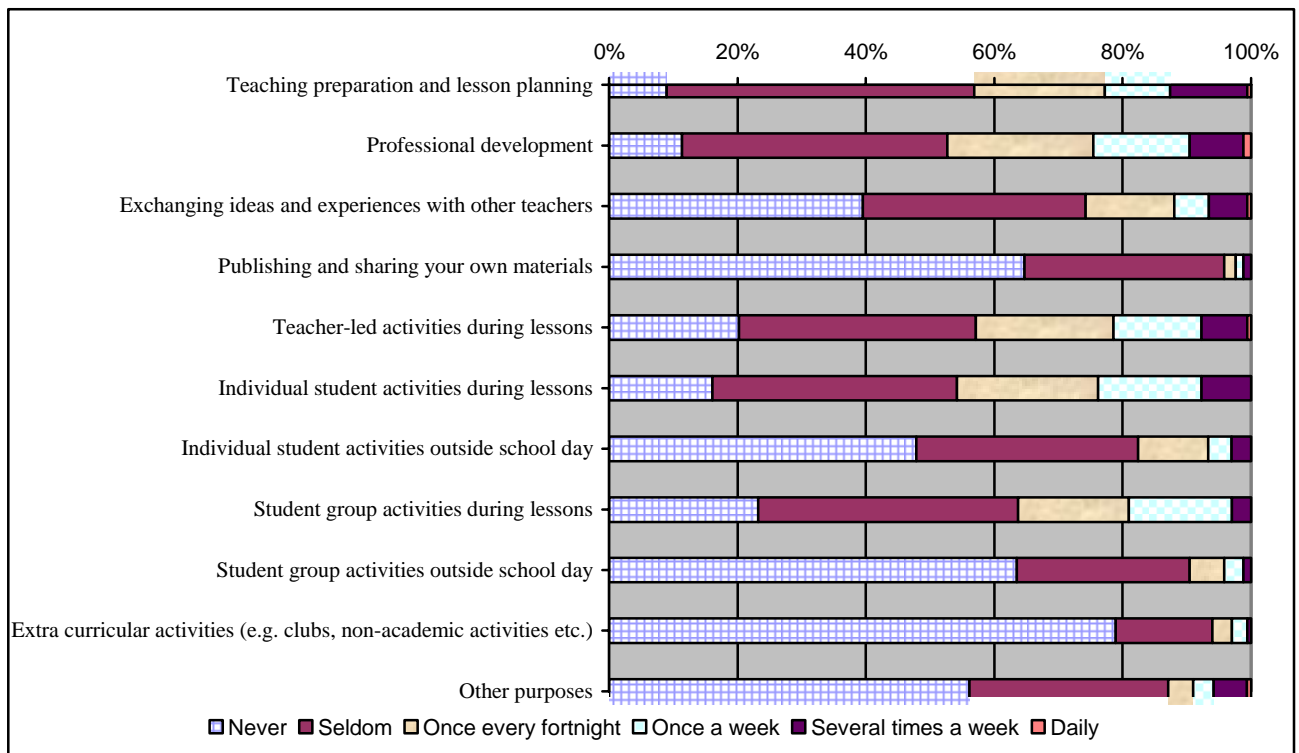


Figure 3.2: kinds of activities for which teachers used the Demonstration Portal

Interestingly the interview studies suggested that teachers particularly appreciated that the Demonstration Portal provided a safe environment for their students to use, so much so that, for example, according to the Finnish *Interview Studies*, teachers allowed their students access to it:

The Demonstration Portal has provided a good solution as a tested and restricted area for the students, enabling the possibility to log on to the Portal without a risk of going astray. In one school the children have particularly enjoyed that they have had a common virtual classroom and personal user IDs for login.
(Finland *Interview Studies*)

3.3.3 Usefulness of the Demonstration Portal functions

It is not surprising that the most used functions of the portal were search functions, including the basic text search, advanced search and searching by browsing, the latter being the option of the majority of teachers (65%). Despite it being more sophisticated, the ‘advanced search’ was least popular. As *Google* is a common search engine, teacher’s reactions were coloured by expectations of such a sophisticated engine, where searches are ordered etc., an ideal which the Demonstration Portal

could not reach.²⁸ One teacher mentioned that there are already established web sites available to teachers and students on the world wide web:

There were already half a dozen science sites available, and students were used to using these and looking on *Google* for sites with specific subjects.
(France *Interview Studies*)

This comparison with *Google* begs the question as to where the CELEBRATE search engine stands when compared to other commercial companies who have the finance at their disposal to invest in their search engines and compete in today's competitive market. The Hungarian *Interview Studies* indicates that their CELEBRATE teachers who are experienced users of the Internet know exactly what to expect from a search engine. The *Interview Studies* in Finland indicate an alternative reason why the CELEBRATE search engine was unpopular amongst teachers:

The search engine was tested at the NBE [National Board of Education], and as it was discovered that it did not function logically, direct www links were sent to the teachers.²⁹ In one school, it had been assumed that the Portal was under construction, as it had functioned only on one computer.
(Finland *Interview Studies*)

Nevertheless, teachers regarded the advanced search as easy to use (82% of the respondents). They also thought that search terms were easy to understand. Opinions about the relevance of the search terms and results were more divided. Half of the respondents were positive on both of these aspects, but one third held negative views. Teachers thought that additional search terms were needed and were unhappy that irrelevant search results were produced (i.e. unwanted LOs).

Teachers also commented that there were still some problems in terms of navigation. In the Norwegian *Interview Studies* report, some thought that the '*basket was too small and it was also difficult to find*'. One of the major problems in navigation, mentioned by a number of teachers, was that teachers are unable to return to previous pages of the Portal. When they tried to return to a previous page they often returned to a page that was no longer relevant to what they wanted; this was both frustrating and time consuming for teachers.

Some teachers reported that the search results were tedious to navigate and felt that going through pages of results to obtain an LO of interest was inefficient and time consuming. They also felt that they had to preview each LO that may have appeared interesting even after reading the short description (provided in the search results).

You know the language issue wasn't really a problem, you know just hunting through. You know showing 10 pages then having to click to see another ten, click to see another ten and your learning object that you might want is at page number 40 of each ten then you have to click through, you don't remember where exactly where it is, you know that sort of thing.
(UK *Interview Studies*)

Because of the format in which you enter the site, you had to literally search through and look at individual learning objects and see what it was about. There was a short description but then that

²⁸ There is some evidence from Nielsen/NetRatings reported in BBC News shows that while Google's competitors are investing more money in their search engines; Google has the advantage as it has become part of 'people's search habits'. (<http://news.bbc.co.uk/2/hi/technology/3515620.stm>).

²⁹ This meant that the teachers did not have to search for LOs but could simply use the web address to go directly to the Portal repository of LOs to view and use it.



is okay, finding a good learning object took a little bit of time but then coming back to it and finding it again.
(UK *Interview Studies*)

One teacher felt that the basket was inefficient as it could be overloaded with LOs and thus he would again have to search through it to find the LO that he wanted at a later stage. This teacher suggested that the search/ basket should have a hierarchal menu of LOs from which the teachers can choose.

You could actually save it as one of your favourites but then very quickly if you were actually using this over the course of a term you would end up with a 150 hits in your favourites and you are trying to find where was that one that you just wanted before. I don't think that I am alone in that as well. I was certainly discussing it with a couple of my colleagues and it was kind of once you find something good you thought right I will use that for my Year 8s [12-13 year old students] next week and then you have got your Year 8s in front of you and you have got them in settled and quiet and then you are standing at the board for five or ten minutes trying to find that exact learning object and by that stage you know the flow of the lesson is interrupted you know.
(UK *Interview Studies*)

The other options of the portal (help section, discussion forums, and other users' comments on LOs) were regarded as having limited importance, with negative responses from teachers. The lack of sharing of materials by the majority of teachers (70%) may indicate that the possibilities for collaboration provided by the Portal were not seen as important functions or the responding teachers were not ready to collaborate and interact with others via the Portal. It has to be remembered that, because many teachers used the Portal only occasionally, and focused on the LOs and their use in the classroom, they may not have had time to develop the use of these wider functions. Of course there may be a more basic lack of time to develop any collaborative activity.

3.3.4 Authoring tools

Although there is no evidence from the Portal questionnaire to suggest that teachers' had positive experiences of using the authoring tools, the *Interview Studies* report did. In interviews many teachers expressed appreciation of the authoring tools and felt they were useful. For example, one teacher in the UK talked of how the templates enabled him to illustrate a procedure he could not do without difficulty using traditional means, going on to praise them:

And one that I've created, the one actually on the course that it's on, I use that art one. Because that's now something I was keen to do. It's about some research I was doing on questioning skills with children and the teachers. And so ... nicely interacts. And the children really appreciated it. So it's worked really well. So I was quite pleased with that, so. (Laughs.) That was a good stuff and they got some good resources out of it.
(UK *Interview Studies*)

A French teacher mentioned his interest in templates

It should be noted that one teacher said s/he was more interested in the templates than in the learning objects themselves, because s/he wanted to create resources which would correspond exactly to her/his requirements.
(France *Interview Studies*)

Teachers who had not used the templates at the time of the interview studies, mentioned that they were interested in them and would use them; some mentioned

they would like more training to use the templates. The Israel report stated one teacher's requirements were:

All templates must have a Hebrew interface - if not teachers will not use them; the school has much difficulty in coping with English.
(Israel *Interview Studies*)

3.3.5 Virtual Classroom

As noted in Section 2.7.4, the results of the *Portal questionnaire* suggested that teachers' use of the Digitalbrain Virtual Classroom was very rare, with half of the teachers provided never having used it. From the interview studies it seems that teachers had difficulties in setting up a virtual classroom, especially at the early stage of the project, at the time the Demonstration Portal was not fully developed and stable. For example, teachers in Norway reported:

The teachers registering early in the period did not automatically get access to Digitalbrain with the same username and password. Many teachers also had problems with creating virtual classrooms in order to get access to the tool.
(Norway *Interview Studies*)

Teachers in Hungary seemed to have had similar problems:

The functioning of the classrooms was unstable: 10 minutes earlier it was possible to create a virtual classroom, 10 minutes later it wasn't. It's also a problem, that the related instructions are ambiguous.
(Hungary *Interview Studies*)

Furthermore, some teachers, especially in Norway, reported that most schools already had their own LMS/LCMS and did not need the one offered by CELEBRATE project. This confirmed the thinking of WP3, namely that the Digitalbrain VLE was for those without their own access to a VLE.

Teachers lack of use of the Virtual Classroom might reflect a lack of understanding of its purpose and lack of training in how to use it.³⁰ Interestingly they saw a competing virtual classroom:

I don't understand the aim of the virtual classroom, because the LOs might be used [by students] also from the basket, and it is easier to use them this way, too.
(Hungary *Interview Studies*)

This is yet more evidence of the use of the Portal as a kind of virtual classroom.

While many teachers in the Finland interview studies had not used the virtual classroom they did express interest in it:

The Virtual Classroom had been an object of some interest. However, there had not been enough time for a closer study. Nevertheless, there is one school where the Virtual Classroom is taken in active use. One of the teachers also mentioned having used the Lesson Planner and read the News.
(Finland *Interview Studies*)

These mixed reactions suggest that many teachers would be interested in using the Virtual Classroom, but they need training on how to use it, and also required it to be intuitive and easy to use. We will return to this in Section 7, when we consider the

³⁰ Digitalbrain normally offers three days of training to schools to be able to use its VLE.



'blended learning' approach of teachers, rather than an approach exclusively based on e-learning.

3.3.6 Teachers' views on usefulness of the Demonstration Portal for teaching and learning

Over 60% of the teachers felt that the Demonstration Portal was useful for supporting their teaching practices and had the potential to improve their practices. This suggested that teachers strongly believed that the Portal was useful for their teaching and that it could be used as an effective tool supporting teaching and learning. Over 75% of the teachers responded that the Portal was a valuable place to gain access to variety of learning resources. Thus, the responses regarding the professional usefulness of the Portal were very positive indeed and only 5% of teachers considered the Portal as useless and a waste of time. These results were supported by the interview studies; for example; teachers in Norway and Hungary found that through their use of the Portal in class, students were more engaged and more motivated in the lesson.

Interestingly the results of the questionnaire suggest that many teachers had reservations about using the Portal to exchange ideas and communicate with other teachers. However, the reasons for this remain unclear. Nor was it possible to find answers from the interview studies that threw light on this. Further exploration is needed to understand this reluctance of teachers to share ideas.

3.4 Summing up

Overall, teachers were positive about the Demonstration Portal and felt it was very useful for teaching and learning. They used it to gain access to variety of learning resources and to motivate their students to learn. They appreciated that the Demonstration Portal provided a safer online learning environment for their students. Negative comments on the Demonstration Portal were mainly related to the instability of the system during the early stages of the project. Nevertheless, both the questionnaire survey and the interview studies suggest the hypothesis was largely true – *given suitable pre-conditions and working methods, learning objects can be created, translated, distributed, and presented.*

The evidence presented in this section shows that the Portal was indeed a successful mechanism for distributing and presenting LOs, once the initial problems were overcome. Indeed many teachers went beyond just using the Portal as a way of finding and storing LOs, and went on to see its use as a basic virtual classroom. Some suggestions for change, such as a more structured storing in the basket, were signs of teachers moving toward this virtual classroom. Also, suggestions for further development of Demonstration Portal in the future will be discussed in Section 8.

References

CELEBRATE (2000) Bid: *Annex 1 - "Description of Work"*

[D3.3] Massart, D. & Van Assche, F., (2003) *The Brokerage system design - Deliverable 3.3 Part A CELEBRATE Work Package 3.*



[D1.3] Jaakkola, T. & Nurmi, S., (2004) *The CELEBRATE Report on Demo Portal Requirements – Deliverable 1.3* CELEBRATE Work Package 1

[Interview Studies] McCormick, R. & Clifford, C., (eds.) (2004) *Teachers Views on Learning Objects: An Interview Report with Teachers in Schools in Finland, France, Hungary, Israel, Norway and the United Kingdom*. CELEBRATE Work Package 7.

[Teacher Registration Questionnaire] Li, N. (2004) *Teacher Registration Questionnaire Report*. CELEBRATE Work Package 7.

[Teacher as User of LOs Questionnaire] Li, N. (2004) *Teacher as User of LOs Questionnaire Report*. CELEBRATE Work Package 7.

[Teacher as User of Demonstration Portal Questionnaire] Jaakkola, T. & Nurmi, S., (2004) *Teacher as User of Demonstration Portal Questionnaire Report*. CELEBRATE Work Package 7.

[D5.1] Scimeca, S., Hartinger, S., Sonvilla-Weiss, S., (2003) *Design of the Demonstration Portal, including the specification of the LMS and LCMA to be Adopted Deliverable 5.1* CELEBRATE Work Package 5.

[D5.2] Scimeca, S., Hartinger, S., Sonvilla-Weiss, S., Rehnström, I., Madsen, L., Terzan, M., (2003) *Design and the Development of the User Interfaces of CELEBRATE's Demo Portal Deliverable 5.2* CELEBRATE Work Package 5.

[D5.3] Scimeca, S., Hartinger, S., Sonvilla-Weiss, S., Rehnström, I., Madsen, L., Terzan, M., (2004) *Demonstrator Portal Beta version 1 (Interim deliverable) Deliverable 5.3* CELEBRATE Work Package 5.

Section 4 Teachers' Evaluation and Selection of Learning Objects

4.1 Introduction

This section describes the processes by which teachers searched for, and selected LOs, and the patterns of their selections of LOs across the project, by investigating the hypothesis that:

Given suitable pre-conditions and working methods, learning objects can be selected and employed usefully and efficiently by teachers.

It discusses how satisfied the teachers as a whole group were with the LOs that they saw and how they perceived these fitting into their classroom practice. It also covers what they looked for in suitable LOs for their teaching. The context differences and the relationships between different aspects of the teachers' experience and their perceptions of the LOs will be discussed in later sections.

4.2 The process by which teachers selected LOs

As we saw in Section 2, a total of 1425 subject-related LOs were available on the Demonstration Portal for the use of CELEBRATE teachers.³¹ The typical scenario of searching and selecting of LOs on the Demonstration Portal is illustrated in Figure 4.1.

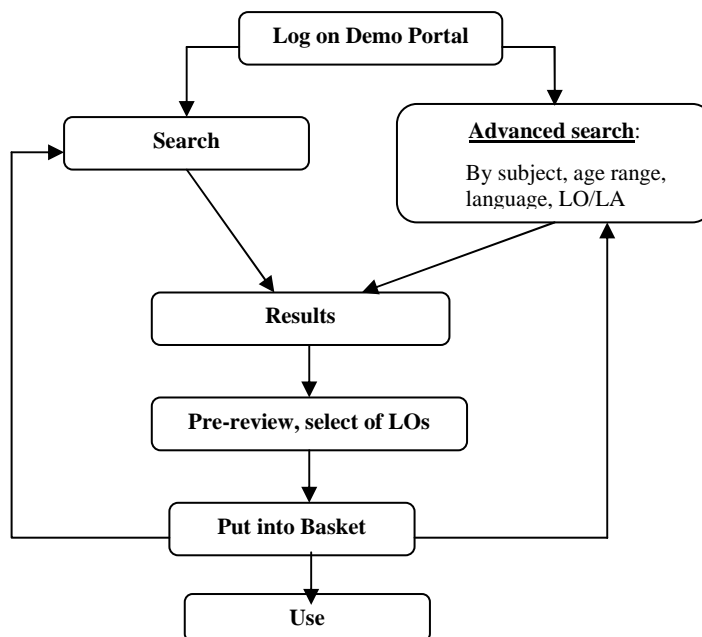


Figure 4.1: typical scenario for searching & selecting LOs on the Portal

³¹LOs statistics provided by EUN <http://demoportal.eun.org>, retrieved on 22 September, 2004.

4.3 The pattern of selection of LOs

Here we look at what kinds of LOs were selected and saved in teachers' baskets, and build up a detailed profile of the LOs teachers selected across the project.³² Of the 770 teachers registered, 363 selected and saved 1152 LOs in their baskets. The numbers produced by each content developer and selected by teachers are shown in Table 4.1. It indicates that, for most of the major developers, there is a high rate of usage, thus the system has been successful in terms of ensuring that it makes available the LOs in the repository for consideration by teachers. For most providers in the pilot countries at least one or other of the CELEBRATE teachers has selected a high proportion of their LOs. The exceptions are the French producers (Hachette Multimédia and Cité des Sciences et de l'industrie), and this may have implications for how French teachers view LOs, implications we will consider in Section 6.2.2.

Table 4.1: teachers selection of LOs, by content developer

Content developer	Total LOs provided	No. Selected	% Selected
Norwegian Board of Education	287	261	91
eWSOY/OPIT	272	243	98
Sulinet	186	176	95
National Board of Education, Finland	183	161	88
GiuntiLabs	83	63	76
Cité des Sciences	80	14	18
DigitalBrain	71	53	75
Hachette Multimedia	62	27	44
Skool (Intel)	40	39	98
Indire	33	17	52
Teachers	14	11	79
Young Digital Poland	7	7	100
Others/no publisher information	107	80	75
Total/average	1425	1152	81

Section 2 discussed the provision of LOs in different languages and it is evident that those selected by teachers reflect the predominance of the number of English language LOs (these made up 44% of the total LOs selected). These figures are surprising, as only four CELEBRATE teachers who are users declared themselves as native English speakers. This may indicate that teachers were not afraid to use LOs in foreign languages, although they may still have problems in using them. Alternatively it may be that teachers *consider* a range of LOs in different languages even if they do not *use* them. Evidence from the pop-up evaluations indicates that this explanation is more likely, because 100% of the LOs available in English are *selected* (i.e. looked at)

³² No data are available on the process of selection of LOs, as the Demonstration Portal does not track these data. Originally it was planned that the Brokerage System would collect such data but, as this was not connected to the Portal at the time of the pilot, these data were not collected.

and 30% are *used*.³³ These figures are comparable to those in Finnish and Norwegian (90% and 88% *selected* and 43% and 40% *used* respectively). Hungarian and French language LOs contrast both with each other and the other three major languages. French language LOs are *selected* at a rate of 30% of those available and *used* at a rate of 11% of those available. Unsurprisingly they use a higher percentage of those selected (51%) than the other languages, except Hungarian. Hungarian language LOs were selected at a rate of 96% of those available and 83% of those available were used (i.e. 87% of those selected). This represents an anomalous situation, which we can in part examine in Section 6.

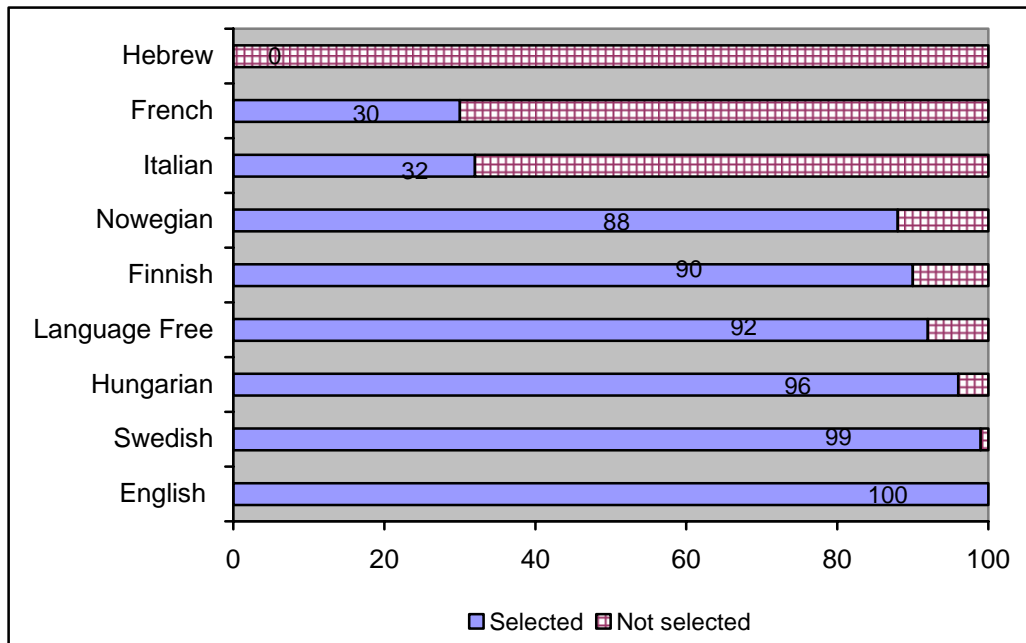


Figure 4.2: percentage of LOs selected, by language³⁴

Not surprisingly several LOs were more popular than others and were selected more frequently. These LOs were mainly in Language, Mathematics and Science subjects (see Table 4.2).³⁵ This selection reflects the subjects taught by teachers. For example, 44%, 40%, 32% and 22% of teachers who selected LOs taught mathematics, science, computer science and language respectively. Most of those LOs selected are ‘Drill and practice’ type, which reflects the types of LOs available to teachers in the project (e.g. 37% and 22% of LOs are ‘Drill and practice’ and ‘Exploration’ respectively; see Section 2, Table 2.5). Most of these ten most popular LOs were selected by teachers from all six pilot countries, although Finnish teachers select more LOs than do those from other countries, reflecting their dominant proportion of CELEBRATE teachers.

³³ As indicated in earlier sections, individual teachers are invited to evaluate the LOs they have selected in their Portal basket; we refer to these as ‘pop-up evaluations’.

³⁴ Total LOs available on Portal is taken from Table 2.4.

³⁵ This list of top 10 LOs selected excludes four LOs (*Chagall*, *Goya*, *Botticelli*, and *Braque*, all produced by GiuntiLabs) as we suspect students may have selected and saved LOs using teachers’ user names.

Looking at the language and content providers of these ‘top ten’ LOs, indicates that teachers may not have a preference to select LOs by local content providers (Finnish LOs dominate, but there are still ones from non-Finnish providers in the list), but there is insufficient evidence from the study to support this conclusion. Among those ten LOs, the majority of them were produced by government or a government agency. Only two LOs were produced by commercial companies. These are very interesting findings, but need further exploration. It is important to realise that the reasons why those LOs are more popular than others are not evidently explained by the data collected in the project. Such explanations need further exploration through more detailed and focused studies.

Table 4.2: the ten most popular LOs selected

No. of teachers selected	Title	Content provider	Language ^a	Subject	Type	Age range
44	Open Questions	Heureka ^b	Finnish	Mathematics Computer science, Science	N/A	12-
29	BurgerWriter	National Board of Education, Finland	Finnish English Swedish	Language	Drill and practice	9-13
28	A parabola	Sulinet	English Hungarian	Mathematics	Drill and practice	12-18
27	Kertolaskuharjoitus: taivas putoaa!	National Board of Education, Finland	Finnish English	Mathematics	Drill and practice	8-13
27	Bioenergy	Norwegian Board of Education	English	Biology Chemistry	Exploration	12-16
26	Desimaalilukujen pyöristys: maisema muuttuu	National Board of Education, Finland	English Finnish	Mathematics	Drill and practice	8-13
24	The orchestra	Indire	English	Music	N/A	6-11
24	Flying with prepositions	National Board of Education, Finland	English Finnish Swedish	Language	Drill and practice	9-15
21	Greenhouse effect	Norwegian Board of Education	English	Chemistry Natural Science Physical Science	Exploration	10-16
21	Kulman arviointia ja mittaamista [eWSOY/OPIT	Finnish	Biology	Drill and practice	9-12

^a Note that where more than one language is indicated, the number of teachers who select them are combined.

^b The Finnish Science centre.

4.4 Teacher satisfaction with the LOs they saw and used

This section draws a general picture of teachers’ perception of LOs across the project. To do this we consider their general reactions to LOs in terms of the quality of the design and content, the usability, flexibility, and their perceived effectiveness in teaching and learning. The *Teacher as user of LOs questionnaire*, completed by 190

teachers, serves as the basis for the discussion in this section.³⁶ Some results from the *Interview Studies* are also used to support the discussion.

Generally, teachers across the project were very positive about the CELEBRATE LOs; over 70% of the teachers believed that LOs were useful in teaching and, answering a question posed in the negative, a similar percentage did *not* think that most were a complete waste of time. This was confirmed by the interview studies. For example, teachers in Finland noted an improvement in students’ learning that they have linked to the use of LOs, as the following example illustrates:

Some students had improved their listening comprehension skills during the LO teaching period, which was discovered in the national listening comprehension examinations. This involved students who do not watch television at their homes and hear English from there. They benefited from the LO teaching greatly.
(Finland *Interview Studies*)

(We consider in more detail the impact on student outcomes in Section 6.3.2.)

Below we examine teachers’ reaction to LOs in aspects such as the quality of design, content, usability, flexibility and effectiveness in teaching and learning.

4.4.1 The quality of the design and content of LOs

Around 50% of teachers are positive about the design of the LOs, with only a small number of teachers having reservations (see Figure 4.3).

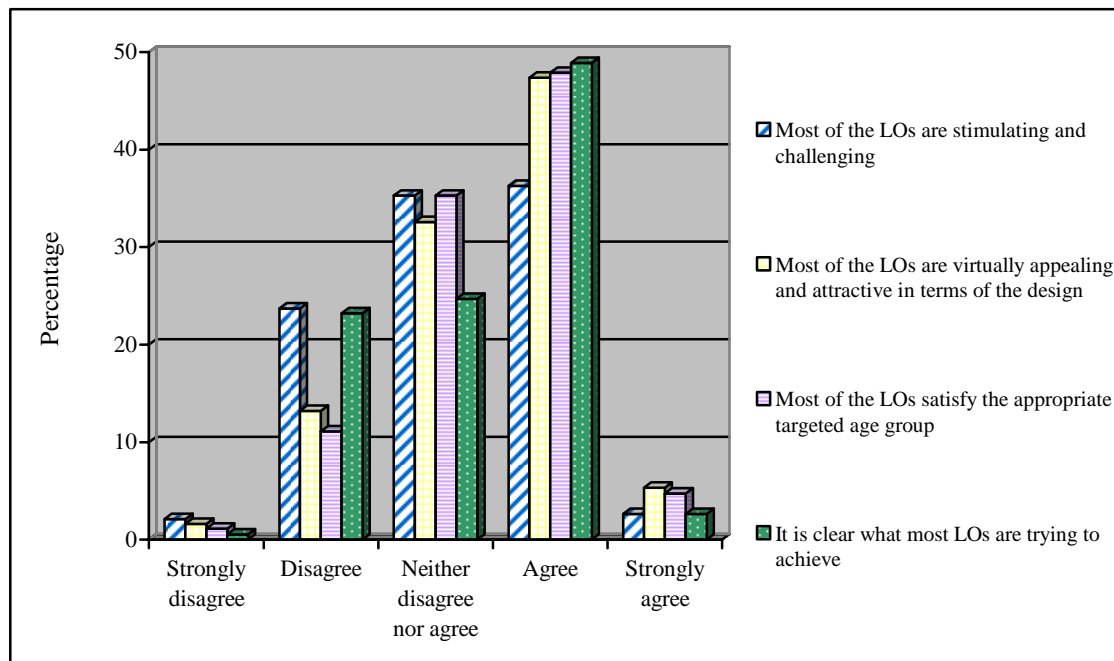


Figure 4.3: teachers’ views of the quality of design and content of LOs

However, the *Interview Studies* revealed that teachers’ reactions to the quality of the design were closely linked to the specific LOs they used and the subject teachers taught. For example, some teachers in France thought that the design of LOs was very good, and for others, the design was rather plain (e.g. the learning objects did not have

³⁶ See Evaluation Methodology (Appendix 2) for further details.

animations for illustrating scientific phenomena). Science teachers in Norway on the other hand were impressed by the animations in science they encountered and teachers in primary schools particularly liked the animations of the different parts of the body in biology and the recycling game. Some teachers in Finland were impressed by the Hungarian LOs though they indicate very particular tastes:

The Hungarian LOs have also been well-liked and used in teaching the 2nd-year students of upper secondary school, even though one teacher did not find the black-and-red colouring appealing.
(Finland *Interview Studies*)

The range of specific views on design indicates that, although half the teachers are positive, it does not offer much guidance on the types of design that attracts them.

However, some teachers suggested that they were not interested in the design of an LO and thought that the content was more important. Some of the Finnish teachers reported that they were more interested in the content and the functionality of the LOs than the appearance of LOs. Some French teachers thought that learning objects did not require high-tech visual design as they were educational, and were not intended as games.

The appropriateness of the LO for the intended student group is one indication of the quality of the design and content and nearly 50% of the teachers were satisfied that the LOs targeted the appropriate age group. But they also suggested that the targeted age range of LOs provided by content developers could only be used as advisory information because the curricular match, school phase and age range differed from one country to another.

4.4.2 Usability and flexibility of LOs

Overall, teachers in the project showed mixed reactions to the usability and flexibility of LOs. Here it is important to distinguish technical and pedagogic considerations. For example, more than 56% of teachers reported that they encountered technical problems in using LOs (see Figure 4.4), and about a quarter of the total number of teachers felt that most LOs needed to be used with some special software such as *Flash*, *Media Player* etc.

However, the interview studies revealed that the main causes of the technical difficulties were related to the ICT infrastructure in the local context. For example, the school network and general Internet connection speeds caused problems, rather than the LOs or Demonstration Portal themselves. (Section 3.3.1 has already noted that Norwegian teachers reported that there were problems with the school network and firewall when downloading LOs from the Demonstration Portal.) Also some schools in Norway used the Linux operating system, which was not compatible with some of LOs, and this caused great difficulties for teachers in accessing some of the LOs.

In some Finnish schools, students' rights are limited such that they cannot save anything to 'drive C', although some LOs required that. Initially, this caused extra work for one ICT co-ordinator, because he had to install the LOs separately for each student. The situation improved as soon as the publishers, NBE and Lingonet Oy,³⁷

³⁷ The latter are a contractor for the Finnish National Board of Education (NBE).

changed the default settings of these particular LOs. (*The Classroom Studies* show examples of this and the impact on teachers and their lessons.) Here we are moving into pedagogical issues that relate to preparation and having advanced awareness of possible problems.

Some LOs required additional ICT resources, especially digital projectors. Obviously these issues to some extent relate to the availability of resources in local contexts, but they had a negative impact on teachers' reactions to LOs, and have implications for the baseline technical requirements to use LO (see Section 7.2.1).

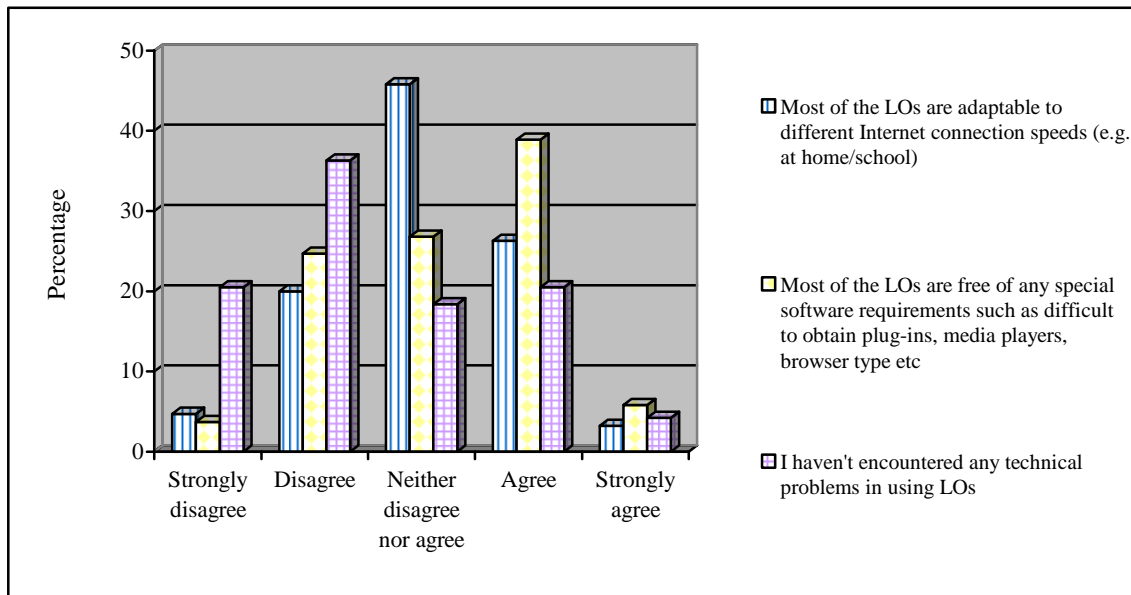


Figure 4.4: teachers' views on the usability and flexibility of LOs

4.4.3 Effectiveness of LOs in teaching and learning

Overall, teachers showed very positive attitudes toward the use of LOs in teaching and learning, with over 70% of them reporting that LOs were useful in their teaching. This positive reaction to LOs was also observed in the interview studies:

It is conspicuous by the analysis of the answers, that everybody's opinion – without any exceptions! - was positive about the effect of the use of LOs. They think that, through using LOs, they can hold their students' attention more successfully and they can persuade them easily into individual work and thinking. It is also important that, according to teachers' opinion, not only higher motivation level of students in and outside of the class could be observed, but also significant improvement of exam grades.
(Hungary *Interview Studies*)

Over half of teachers (56%) believed that the use of LOs improved their teaching practices (see Figure 4.5), also confirmed by the interview studies:

The LOs are useful from teaching point of view, because through using them the leading of the class is easier, tests are very motivating.
(Hungary *Interview Studies*)

According to the interviewed teachers, the LOs bring diversity in learning by presenting the topics to the students by means of multimedia, such as animation and sound effects. An LO can be more visual than a traditional textbook.
(Finland *Interview Studies*)

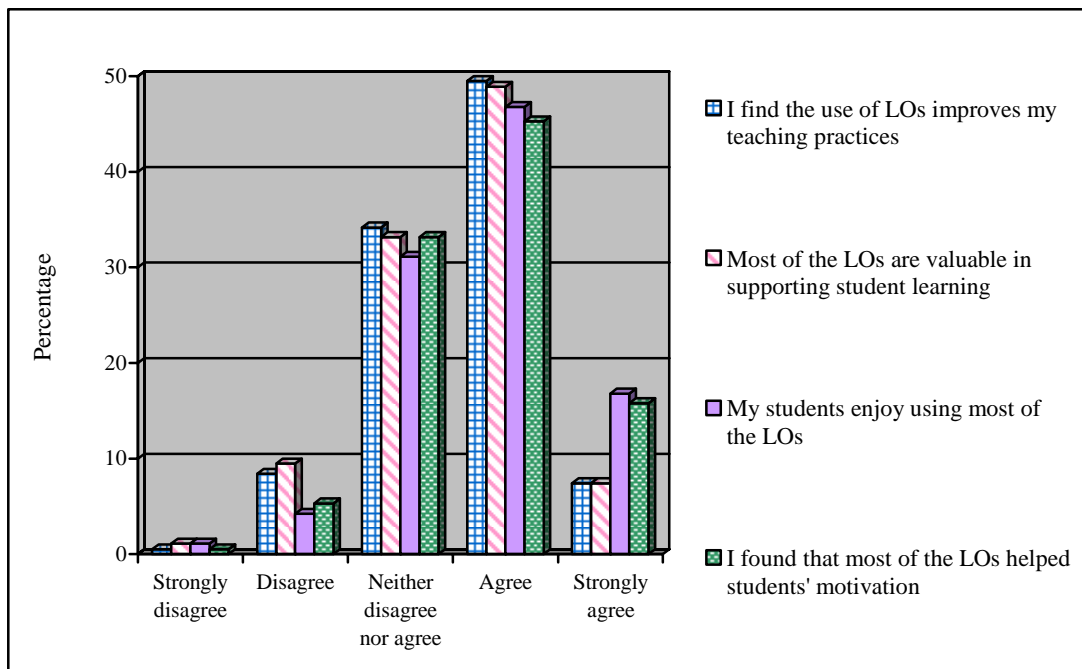


Figure 4.5: teachers views on usefulness of LOs in teaching and learning

Figure 4.5 also shows that teachers agreed that student learning benefited from using LOs. For example, 55% of teachers agreed that most LOs were valuable in supporting student learning.³⁸ Over 60% of teachers also believed that their students enjoyed using most of the LOs they had used see Figure 4.5. These positive reactions were corroborated by teachers' responses in the interview studies:

After using the LOs during the class students remembered more information in the exams. The guiding of the class is also easier. It is also useful from pedagogical point of view. One of the students became so enthusiastic that he started to prepare educational programs for his peers with help of the *Klick & Play* program.
(Hungary Interview Studies)

They can concentrate on other things, the students are more active, there is more variation during a lesson and the students are active without being conscious they are working with a topic at the same time as having fun.
(Norway Interview Studies)

Similarly 61% of teachers felt that most of the LOs helped student motivation (see Figure 4.5), even when they might be more cautious about LOs improving their learning

She [a teacher] likes to use it, because it is more motivating for the students, animations are more spectacular and useful.
(Hungary Interview Studies)

The enthusiasm of the students has had a great influence on the working environment. In two teachers' opinion, it was difficult to evaluate the influence of the LOs on learning, however, they also find that the use of LOs brings pleasant variety into the teaching practices, and they have been able to observe how even the poorer students have begun to make an effort in their learning.
(Finland Interview Studies)

³⁸ We realise that in making such statements teachers are drawing on their professional judgement, not necessarily substantiated by evidence from assessments of achievement.

(Teachers' views on motivation will be further discussed in Section 6.3.2.)

However, a considerable number of teachers were not convinced by these benefits of LOs, having chosen 'neither disagree nor agree'. The reasons for this were not revealed in the survey and this needs further exploration.

There were some mixed reactions on the use of LOs for different learning activities (see Figure 4.6). Almost three-quarters of teachers agreed that most LOs were flexible and could be used for both individual student work and collaborative work in class. They also agreed that LOs could be used for different activities in classrooms. For example, some Norwegian teachers reported that they had used LOs as an:

introduction to a new topic, explanations, experimentation, practising and rehearsing depending on the topic and type of LO.
(Norway *Interview Studies*)

Some Finnish teachers interviewed reported

The use of the LOs complement teaching. The LOs are used for either revising an earlier learned theme, practising a new topic, or searching for new information. With one teacher, the impact of the LOs on teaching has been immense, for she has taught some issues only by means of the LOs, i.e. the complete teaching event has been founded on the LOs, and the topic has not been revisited by conventional methods.
(Finland *Interview Studies*)

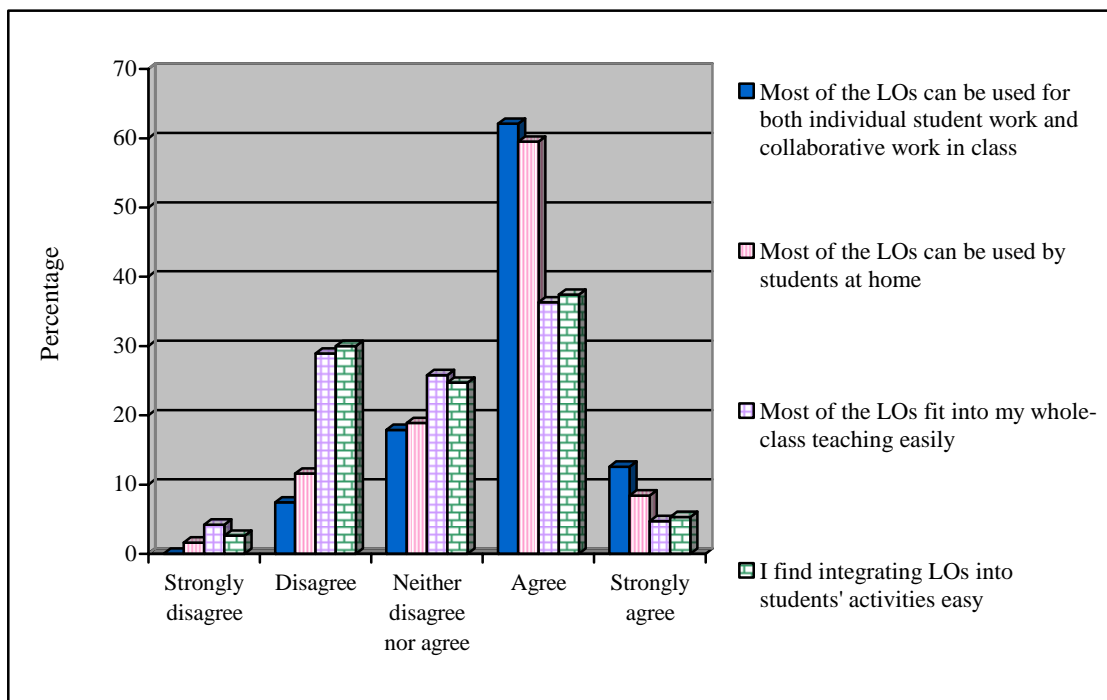


Figure 4.6: teachers' views on the use of LOs for different activities

However, 30% of the teachers had reservations about the ease of use of LOs for whole-class teaching, reporting that LOs did not fit into this type of teaching easily. Equally some teachers (30%) felt integrating LOs into students' activities was not easy (see Figure 4.6). But the interview studies suggested these negative reactions might be closely linked to teachers' ICT skills and experience. Many teachers in these studies believed those who were experienced ICT users would find it easier to integrate LOs into their teaching, but they also saw the requirement for pedagogic discernment:

Integrating a learning object into a lesson is fairly simple for teachers who are used to using ICT. However, they tried to make sure, as far as possible, that these activities replaced book-based activities, rather than simply being an add-on extra. This required a great deal of time and effort at the beginning, especially as some learning objects are more interesting and relevant than others.

(France *Interview Studies*)

This then shows how pedagogic considerations combine with technical ones to determine the ease of use of LOs. Again this is reflected in the *Classroom Studies* and this evidence is examined in Sections 7.2.2 & 7.2.3.)

The use of LOs in teaching requires the use of computers and data projectors etc. Gaining access to such ICT facilities requires time and effort, and sometimes causes difficulties. For example, the Finnish report indicated a common problem:

one teacher mentioned having had problems in reserving the computer facilities due to the coinciding of another teacher's class. Another teacher saw it as a problem that when changing classrooms they needed to leave teaching material in their own classroom that was rather far from the computer facilities. A few teachers commented on the school facilities: that there should be more computers and there is a demand for a wide-screen television projector.

(Finland *Interview Studies*)

Again Section 7 examines the impact of this on teachers' classroom practices.

When teachers were asked about whether they needed help in guidance on pedagogy, 76% felt they did not need it. It seems that most teachers were confident in the use of LOs (see Figure 4.7). For those who wanted help, 26% felt they needed to use LOs more appropriately, and 23% wanted to use them more effectively (Figure 4.8). These reactions are likely to be related to their ICT skills and experience rather than their experience of teaching, something we explore in Section 5.2.2.

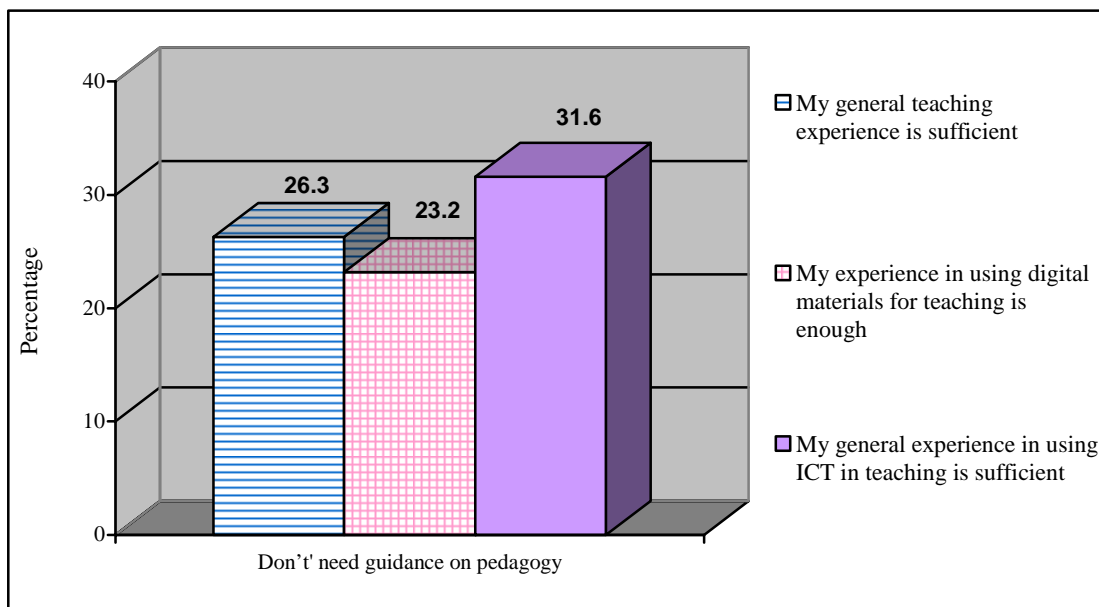


Figure 4.7: teachers who don't need guidance in pedagogy

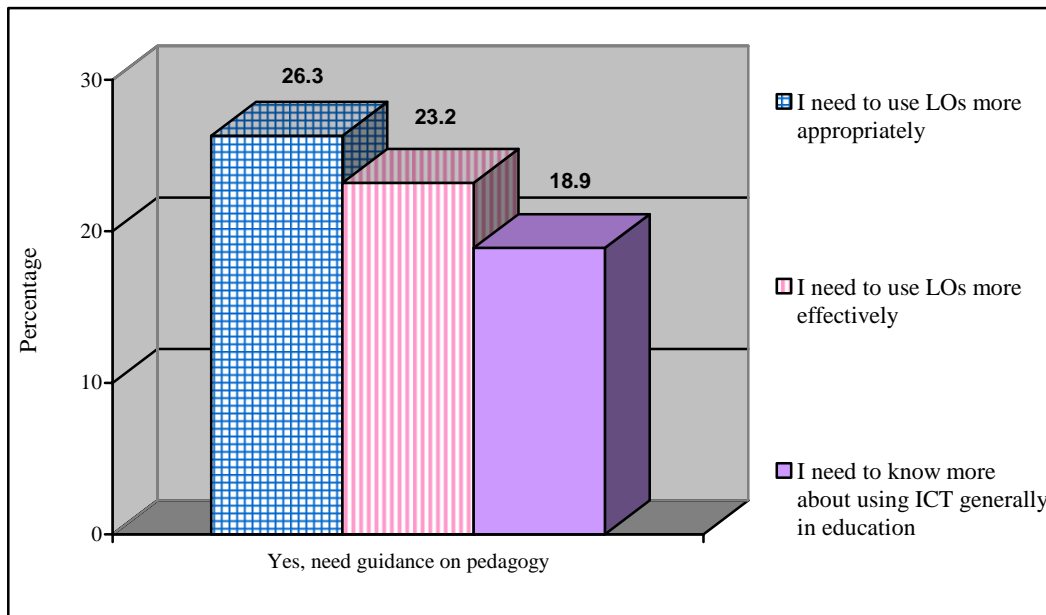


Figure 4.8: teachers who do need guidance on pedagogy

4.5 What teachers looked for in suitable LOs

We investigated what teachers looked for in suitable LOs, to help content providers in the creation and development of LOs in the future. It is not surprising that teachers in the project preferred to use LOs developed or recommended by their colleagues and other teachers. In terms of specific types of LOs they preferred to use, three types seemed to be more popular than others; Drill and Practice; Information resources and Simulation (See Figure 4.9).³⁹ These broadly reflected the balance of LOs types provided across the project (see Table 2.5). Because this balance is weighted in favour of ‘Drill and practice’, LOs will not necessarily help to encourage the use of ‘advanced pedagogy’.

Teachers agreed that CELEBRATE LOs could be used for different types of activities (see Figure 4.10), a view confirmed in the interview studies. They were most likely to be used by teachers for two types of classroom activities, for:

- teaching the whole class together;
- individual or small-group working with their help in class.

³⁹ These types are those used in the LO metadata: see Section 2.2.2.

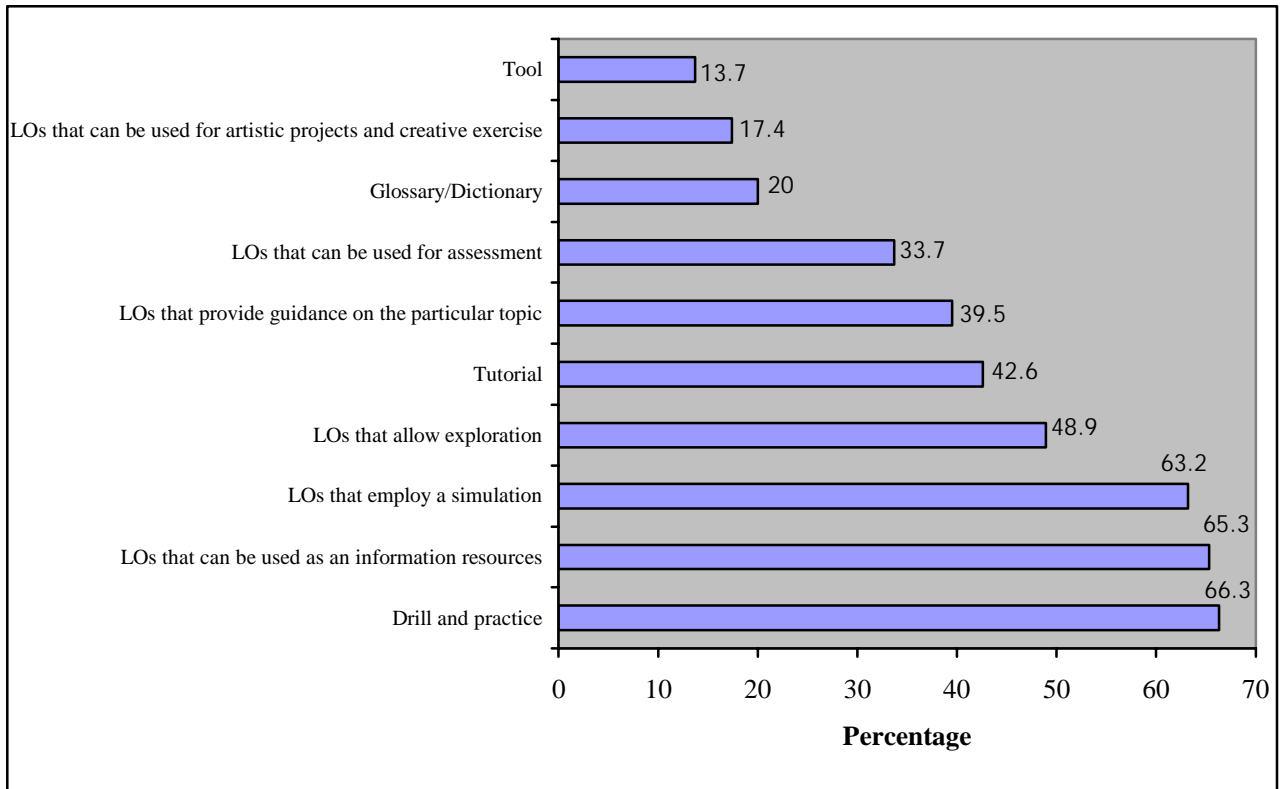


Figure 4.9: the kinds of LOs teachers liked to use

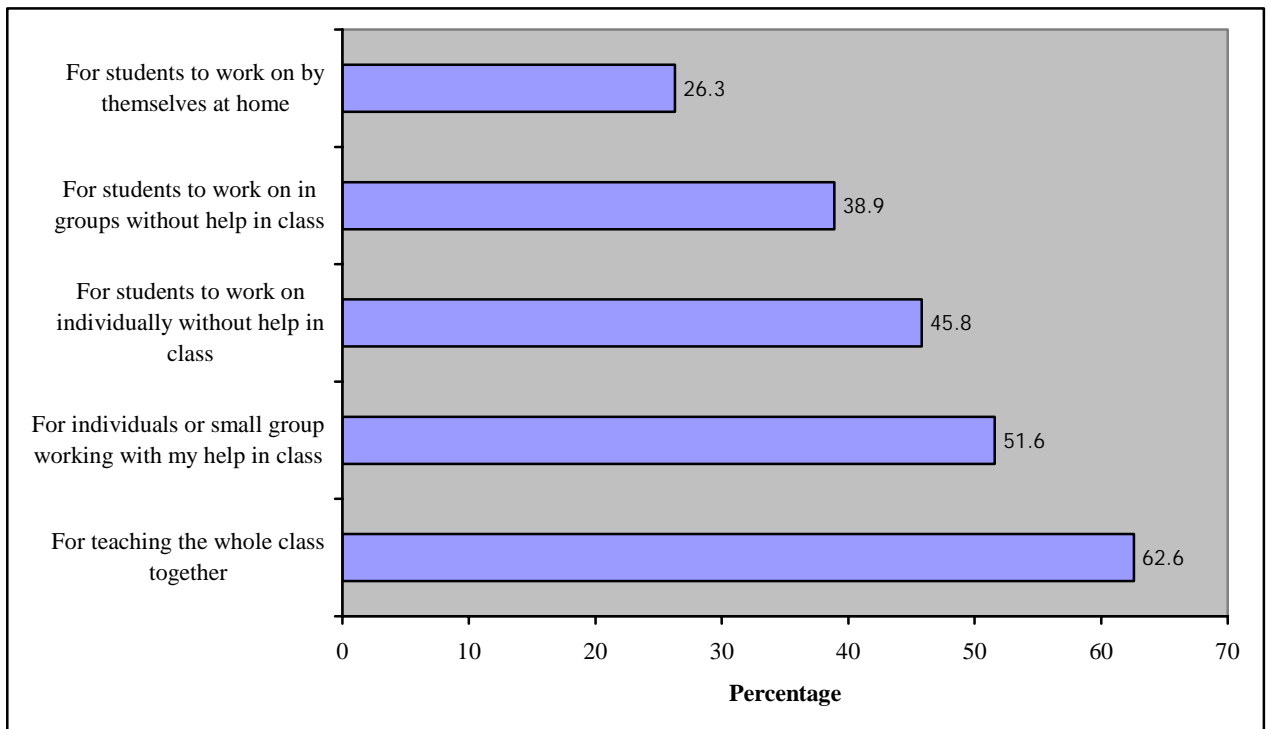


Figure 4.10: the kinds of activities for which LOs have been used

Teachers' exhibited mixed views on learning as reflected in their pedagogical criteria used for their choice of LOs (see Figure 4.11). LOs supporting student-centred discovery were the most important, LOs conveying information effectively to

students, the second most important, and use outside school was third. (There are differences among teachers in these choices and these will be examined in Section 3.)

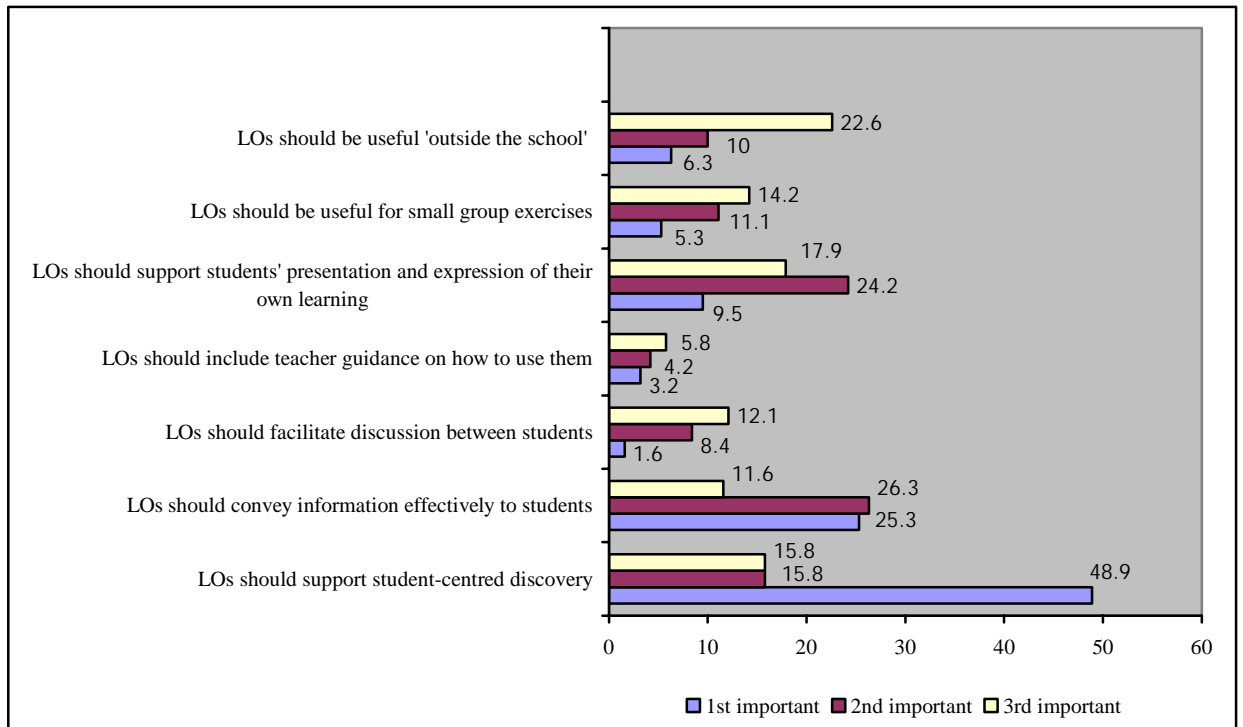


Figure 4.11: the three most important pedagogical criteria of choice

4.6 Snapshots of specific LOs evaluated by teachers

As we have already indicated, overall teachers' reactions to LOs across the project are generally positive in terms of the quality of the design, flexibility, usability and effectiveness in teaching and learning, although some teachers had modest reservations. However, when teachers were asked to evaluate specific LOs, which they selected and used or intended to use in future, via the pop-up questionnaires,⁴⁰ they showed more positive attitudes compared to their reactions to LOs in general. The aggregation of the results of 169 teachers evaluating 940 LOs are presented in Figures 4.12 and 4.13. Comparing the earlier questionnaire ratings with the equivalent ratings in these figures, it can be seen that the general positive views of around 50% in Figure 4.6 are translated to over 70% in Figure 4.12. Similarly under 60% ratings in Figure 4.5 become 80% in Figure 4.13. Thus it is possible that the questionnaire data quoted earlier are seriously under-rating how positive teachers are when they find LOs that they want (indicated by their having selected and evaluated them).

⁴⁰ See the Evaluation Methodology (Appendix 2) for details.

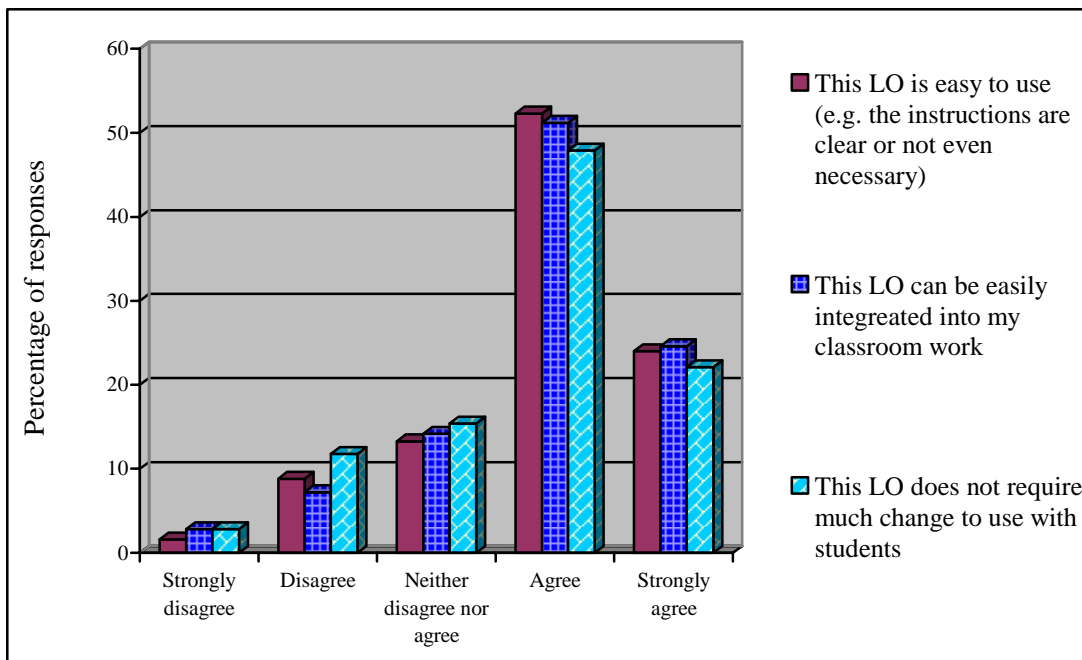


Figure 4.12: ease of use of LOs

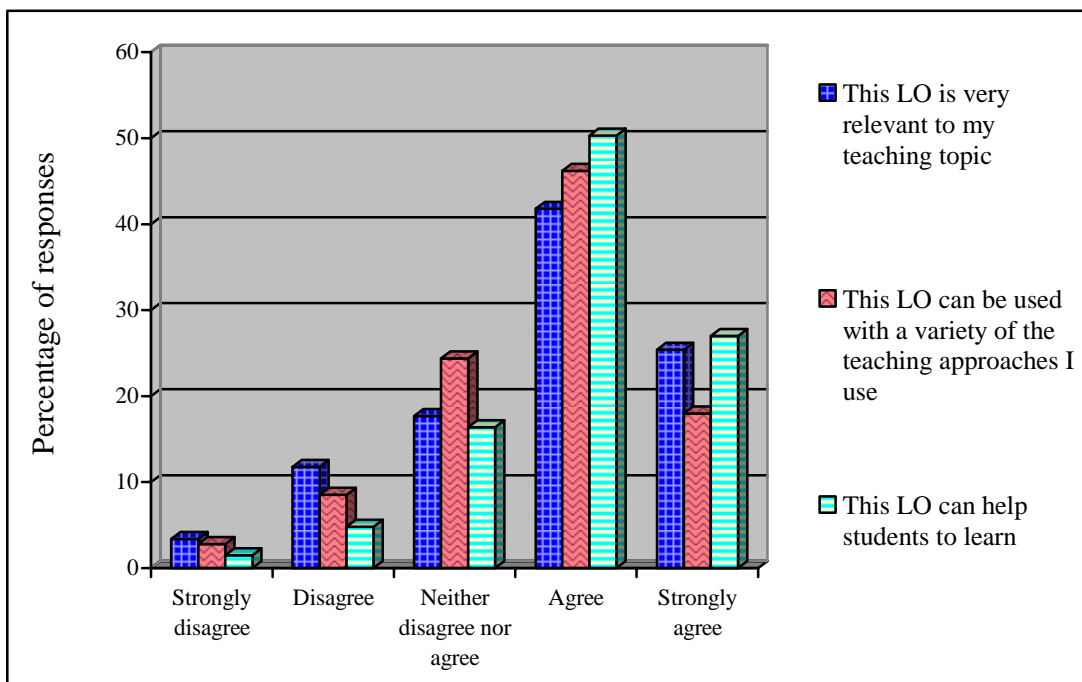


Figure 4.13: use of LO in teaching and learning

It is possible to construct a ‘top ten’ list of LOs based on the pop-up evaluations, though as each LO is only evaluated by relatively few teachers (12-18), it has to be treated with caution. However, it allows some interesting comparisons (see Table 4.3). Three of the LOs in this top ten also occur in the top ten LOs *selected* on the Portal (Table 4.2), indicating a degree of confidence in Table 4.3, reflecting something more general than the inclinations of a small number of teachers.

Table 4.3: the ten most popular LOs evaluated through pop-up questionnaires

No. of teachers who evaluated LO	No. of teachers used this LO	Title	Content provider	Language	Subject	Type	Age range
18		Kertolaskuharjoitus: taivas putoaa! ^a	National Board of Education, Finland	Finnish English	Mathematics	Drill and practice	8-13
14		Bioenergy ^b	Norwegian Board of Education	English	Biology Chemistry	Exploration	12-16
14		Autokilpailu	eWSOY/OPIT	Finnish	Mathematics	Drill and practice	12-15
14		Annetun suoran piirtäminen	National Board of Education, Finland	English Finnish	Mathematics	Drill and practice	15-19
13		Greenhouse effect	Norwegian Board of education	English	Chemistry	Exploration	10-16
13		Desimaalilukujen pyöristys: maisema muuttuu	eWSOY/OPIT	English Finnish	Mathematics	Drill and practice	12-19
12		Open Questions ^c	Heureka (ECSITE)	Finnish	Mathematics Computer science, Science	N/A	12-
12		Distillation	Norwegian Board of Education		Chemistry Physical Science	Exploration	10-16
12		Binary and hexadecimal numbers	Norwegian Board of Education	English	Mathematics	Drill and practice, Guide, Information resource	16-19
12		A parabola***	Sulinet	English Hungarian	Mathematics	Drill and practice	12-18

^a ranked 4 in Table 4.2 (popularity of selection)

^b ranked 5 in Table 4.2

^c ranked 1 in Table 4.2

Among the 940 LOs that teachers evaluated, some were evaluated more frequently than others with 10 LOs being evaluated by more than 12 teachers (see Table 4.3). As with the results of the data on LOs selected by teachers, more LOs were evaluated in the subjects of mathematics, science and computer science, reflecting the backgrounds of teachers involved in the project. For example, the most evaluated LO was *Kertolaskuharjoitus: taivas putoa!* (Multiplication exercise: the sky is falling), chosen by 18 teachers. This LO is a ‘Drill and practice’ (produced by National Board of Education, Finland) and requires students to do multiplication exercises. (This was forth in the list of selected LOs using the routine Portal data; see Table 4.2). All of the 18 teachers who evaluated this LO were Finnish; 16 of them taught mathematics at primary schools and saw mathematics as their major subject. Twelve out of 18 teachers had used this LO in their teaching. All 18 were very positive about this LO in terms of its design and usefulness in teaching and learning, though slightly less so

about questions related to use, as Table 4.4 shows. (A screen shot is shown in Figure 4.14.)

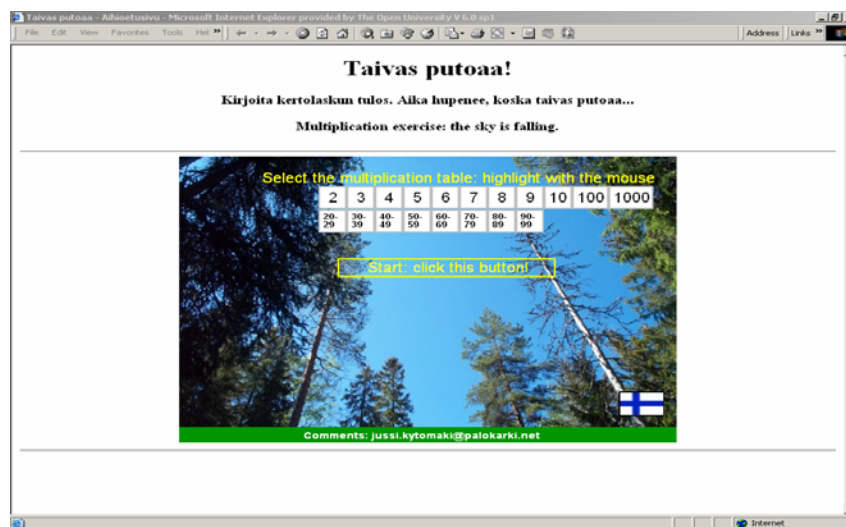


Figure 4.14: screenshot of homepage of the most evaluated LO (Kertolaskuharjoitus)

Table 4.4: teacher evaluations of *Kertolaskuharjoitus*

Evaluation question	SD	DA	NDA	A	SA
This LO can be easily integrated into my classroom work	0	1	2	6	9
This LO is very relevant to my teaching topics	0	1	1	9	7
This LO can help students to learning	0	1	1	11	5
This LO is easy to use	0	1	2	12	3
This LO does not require much change to use with students	0	4	2	9	3
This LO can be used with a variety of the teaching approaches I use	0	1	2	12	3

SD=strongly disagree; DA=Disagree; NDA=neither disagree nor agree; A=Agree; SA=strongly agree

Another example of one of the most frequently selected LO is *Open Questions*, provided by Heureka (the Finnish Science Centre). The aim of LO is to give an overall picture of the state of present fundamental research by presenting several open questions related to a number of branches of science(e.g. the secret of DNA, the Black Hole etc). It was ranked first on the list of LOs selected on the Portal; see Table 4.2. Twelve teachers evaluated this LO, and ten of them were Finnish teachers and 2 Norwegians. This LO was designed for use in mathematics, science and computer science. Eight out of the 12 teachers evaluating this LO taught mathematics and science. Interestingly, only 3 teachers who evaluated this LO used it in their teaching, suggesting that teachers had some reservations about this LO despite having put it in their baskets and taken the trouble to evaluate it. These reservations are reflected in their evaluations (Table 4.5), where both content and form of the LO are rated lower than evaluations of LOs overall. (A screen shot is shown in Figure 4.15.)



Figure 4.15: screenshot of homepage of evaluated LO (Open questions)

Table 4.5: teacher evaluations of Open Questions

Evaluation question	SD	DA	NDA	A	SA
This LO can be easily integrated into my classroom work	1	4	2	4	1
This LO is very relevant to my teaching topics	2	2	4	3	1
This LO can help students to learning	0	0	6	5	1
This LO is easy to use	0	1	4	5	2
This LO does not require much change to use with students	1	4	2	4	1
This LO can be used with a variety of the teaching approaches I use	1	2	4	5	0

*SD=strongly disagree; DA=Disagree; NDA=neither disagree nor agree; A=Agree; SA=strongly agree

4.7 Summary

Overall, the selection pattern of LOs by teachers reflected the project's LO subject profile, which focused on mathematics, science, art, and language. The evidence collected from the *Teacher as user of LOs questionnaire*, pop-up questionnaires and the interview studies all suggest that, in general, teachers were positive about the CELEBRATE LOs and felt they were useful for their teaching and student learning. Teachers had some reservations about the flexibility and usability of LOs. Some reported that they encountered technical difficulties when using the LOs, but these mainly related to the local ICT infrastructure rather than the LOs themselves. But there are also pedagogic issues in relation to usability with some teachers not being able to fit them into their teaching. This affects the 'efficiency' with which teachers could use them. Therefore, the hypothesis '*given suitable pre-conditions and working methods, learning objects can be selected and employed usefully and efficiently by teachers*' is confirmed, but with some reservations about how 'efficiently' this can be done. Section 7 will explore some of the issues that bear on these reservations.

The results from both the questionnaires and interview studies suggest that the specified pedagogy of the LO was less important from the teachers' point of view. The majority of teachers felt they did not need guidance on pedagogy and for those



teachers who say they did, this is more related to their ICT skills and how to use LOs rather than their more general lack of teaching experience. These issues will be examined further in Sections 5 & 7.

References

- [Classroom Studies] Ilomäki, L, & Lakkala, M., (eds.) (2004) *Learning objects in classroom settings: A report of 13 case studies conducted in Finland, France, Hungary, Ireland and United Kingdom* CELEBRATE Work Package 7
- [Interview Studies] McCormick, R. & Clifford, C., (eds.) (2004) *Teachers Views on Learning Objects: A Interview Report with Teachers in Schools in Finland, France, Hungary, Israel, Norway and the United Kingdom* CELEBRATE Work Package 7.
- [Teacher Registration Questionnaire] Li, N. (2004) *Teacher Registration Questionnaire Report*. CELEBRATE Work Package 7.
- [Teacher as User of LOs Questionnaire] Li, N. (2004) *Teacher as User of LOs Questionnaire Report*. CELEBRATE Work Package 7.
- [Pop-ups Evaluation Questionnaire] Li, N. (2004) *Pop-ups Evaluation Questionnaire Report*. CELEBRATE Work Package 7.

Section 5 Use of Learning Objects by Teachers and Students with different Backgrounds and Interests

5.1 Introduction

Section 4 looked at how CELEBRATE teachers as a whole viewed LOs. This gave a generally positive picture, but there could still be groups within the total set of teachers that were less positive about the role of the CELEBRATE LOs. To check this, in the next two sections we look further into the data to see if there are divergences within that picture when we compare particular groups of teachers and, to a lesser extent, students. This present section of the report assesses the evidence for and against the hypothesis that:

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers of varying backgrounds and interests.

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers working with students of selected ages, ethnicities, social backgrounds, levels of previous achievement, and diverse first languages and cultures.

To do this we will look at how teachers' perceptions of LOs related to their previous experience, and whether there were differences in what teachers reported about the value of LOs when used with students of different backgrounds.

5.2 How did teachers' perceptions of LOs relate to their previous experience?

We first report how teachers' perceptions of the usefulness of LOs related to:

- age range taught and whether they taught in primary or secondary schools;
- whether the teachers had core or high ICT skills;
- the amount of use the teachers made of ICT;
- the length of time they had been teaching;
- their gender.

Unless otherwise stated the data used in this section are taken from the *Teacher as users of LOs* questionnaire, analysed where appropriate using the registration data of the 170 teachers who completed the questionnaire. Teachers who taught at schools we labelled as 'both primary and secondary' and 'others' in the *Teacher registration questionnaire* were excluded from the analysis, so responses from a total of 161 teachers were used. While this section concentrates upon identifying differences in response between categories of teachers, it should be noted that, in general, similarities tended to be more common than differences.

5.2.1 Ages and stages: primary and secondary teachers

The CELEBRATE teachers worked across the full age range, but reported individually covering 70 different age ranges between them. This made any useful analysis by age range impossible, so we turned to the broader categories of school stages (excluding teachers who said they worked in both stages) to see if any variations emerged between the responses of primary and secondary teachers.

The age of transfer from primary to secondary varies from country to country, so the conclusions here relate not to age range effects as such but to school types. However, in general the responses of the primary and secondary teachers were similar. For example, a majority of both groups disagreed with the view that *most of the LOs were a complete waste of time* (76%, 79% respectively), and teachers in both groups agreed that *most of LOs satisfied the appropriate targeted age* and thought that *it was clear what most LOs trying to achieve*. However, there were also some significant differences.

Although both chose ‘*LOs should support student-centred discovery*’ as their most frequent first preference for the most important pedagogy criterion, they differed on their second and third choices (Figures 5.1 and 5.2).

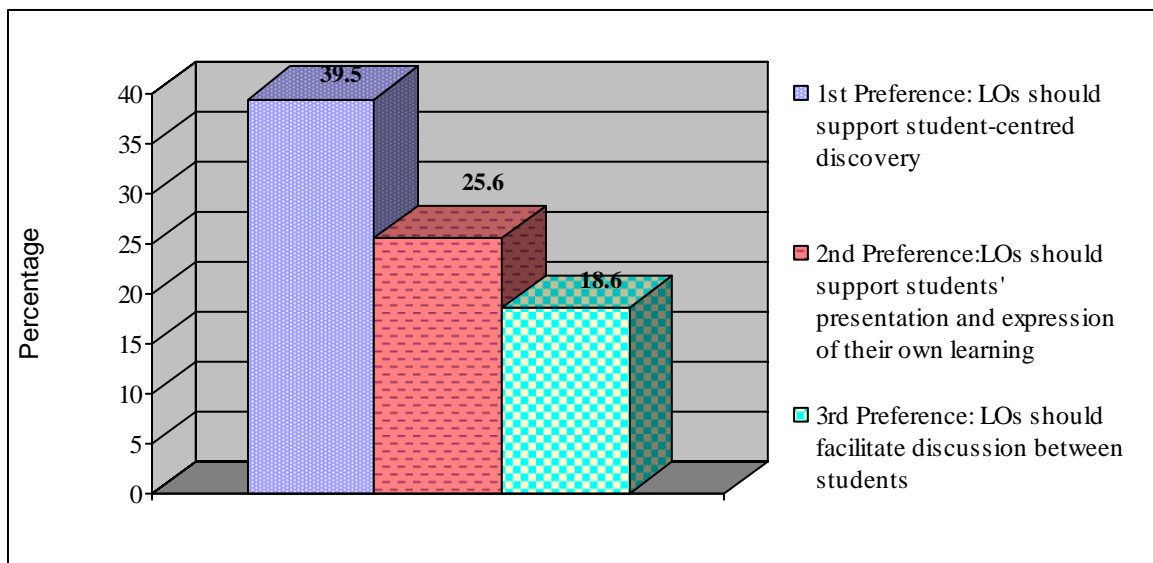


Figure 5.1: primary teachers' preferences of pedagogy criteria

Primary teachers' second and third criteria were that ‘*LOs should support students' presentation and expression of their own learning*’, and that ‘*LOs should facilitate discussion between students*’. This contrasted with the secondary teachers, whose second and third criteria were that ‘*LOs should convey information effectively to students*’ and that ‘*LOs should be useful outside the school*’.

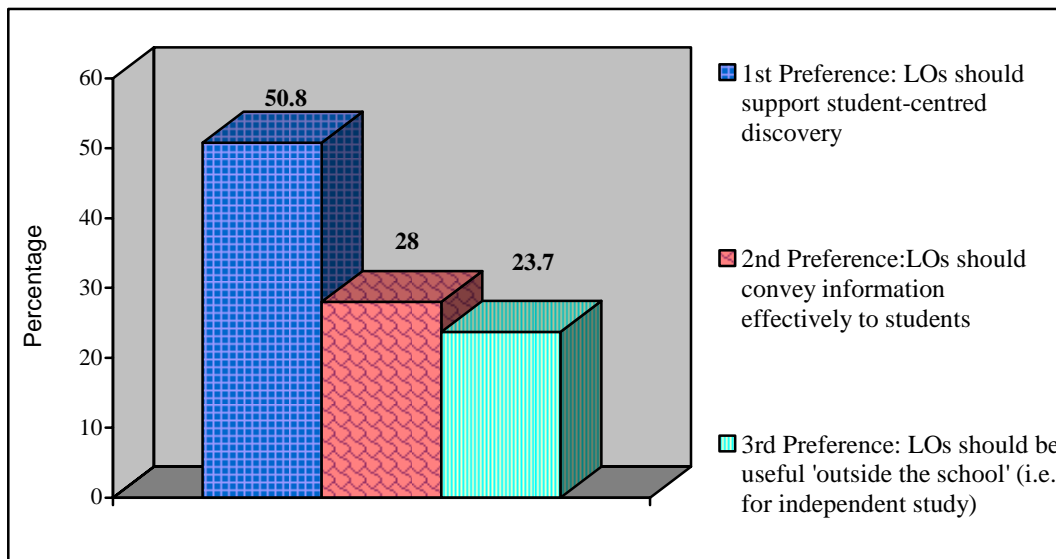


Figure 5.2: secondary teachers' preferences for pedagogic criteria

These figures show that the primary and secondary teachers shared a commitment to the active and exploratory pedagogies the project supported, but that this view was more strongly represented amongst the primary teachers. The second and third preferences of secondary teachers probably reflect the knowledge orientation and more independent requirements of the secondary curriculum and older students. This interpretation is supported by the differences in primary and secondary teachers' attitudes to LOs more generally in relation to such things as match to teachers' and their schools' curriculum objectives and the ease with which teachers could use LOs to support their lessons.

Overall, the primary school teachers had more positive attitudes toward the CELEBRATE LOs in teaching and learning than their secondary counterparts. They were more likely to:

- believe that the CELEBRATE LOs were *stimulating and challenging*;
- believe that *most of the LOs were valuable in supporting student learning*;
- agree that *most of the LOs can be used for both in individual student work and collaborative work in class*;
- think that *most of LOs fitted in well with their curriculum objectives*.

However, the primary teachers were more likely than secondary teachers to use 'Drill and practice' and 'Glossary/Dictionary' LOs. They also had a significantly higher preference for using LOs for '*individual or small group working with my help in classes*'. The greater use of the glossary and dictionary may just reflect a higher level of vocabulary work with younger students. Similarly the primary teachers greater preference for students working with their help could reflect a more general difference in teachers' ways of working with older and younger children. Possibly the 'Drill and practice' LOs provided were seen by some secondary teachers as not sufficiently demanding (we examine this in more detail in Section 6.3.1), whereas more open-ended LOs could be used across a wider age range.

Another way in which primary and secondary teachers differed significantly was that primary teachers were more likely to report themselves to have more technical problems in using LOs. There was also a significant difference between the two groups relating to the kind of guidance needed on pedagogy, with primary teachers more likely to report a need for guidance in using LOs more appropriately, compared to secondary teachers.

This indicates a need for rather different approaches to providing LOs and support for primary and secondary teachers, with primary teachers in particular needing more help with the changes in pedagogy that ICT use involves, as well as more technical support. However, despite having more technical concerns, the primary teachers were still more positive about the LOs than the secondary teachers. This could be because in many cases primary teachers teach a wider range of subjects than secondary ones, which means that, more of the LOs provided are likely to be usable by them than by a secondary specialist. This suggests that there is also a need is to improve and extend the range of secondary LOs in future.

5.2.2 Teachers with High or Core ICT Skills

We have already indicated the importance of teachers' ICT skill, noting their technical and pedagogic elements (Section 4.4.3), and so this warrants further analysis. Using statistical analysis (see Appendix 2) two major clusters of teachers were identified in terms of their level of ICT skills. The core-skills group reported being able to make use of a basic set of ICT skills, while the high-skills group also had a number of more complex capabilities (Table 5.1). There were virtually none that claimed very low ICT skills.

Table 5.1: different ICT skills claimed by teachers in two skill clusters

Teachers with core ICT skills	Teachers with high ICT skills
Writing and editing text with a word processor	Writing and editing text with a word processor
Searching information on WWW/Internet	Searching information on WWW/Internet
Basic skills of file management (<i>delete, copy, paste etc.</i>)	Basic skills of file management (<i>delete, copy, paste etc.</i>)
Sending and reading E-mail	Sending and reading E-mail
Using presentation programs (<i>e.g. PowerPoint</i>)	Using presentation programs (<i>e.g. PowerPoint</i>)
Installing new programs (<i>software</i>)	Installing new programs (<i>software</i>)
-----	-----
	Programming (<i>with programming language e.g. JAVA, Php</i>)
	Creating and updating web pages
	Image processing/drawing with graphic program
	Editing video materials
	Producing learning materials with an authoring program.
	Changing computer hardware (<i>e.g. adding new sound card</i>)

There were no significant differences between the high and core skills clusters in the kinds of LOs they liked or the types of activities they used LOs for.

However, a difference was found between the two groups in terms of their reasons for liking templates. Teachers in the high-ICT skills group were more likely to report that they liked using templates because they were easy to use, compared to their core-ICT skills counterparts. Given that some high-skills teachers had already tried programming and using authoring programs, this may indicate that it was compared to these that they found the templates easier. For teachers who did not have that experience, the templates may have seemed comparatively difficult to use.

Differences were also found in terms of needing guidance on pedagogy. The high-ICT skills group teachers were more likely to report that their experience in using digital materials for teaching was sufficient so that they didn't need guidance on pedagogy, compared to their core-ICT skills counterparts. They were more likely to report that their general experience in using ICT in teaching was sufficient, than were the core-ICT skills group. By contrast, teachers in the core-ICT skills group were more likely to report they needed to use LOs more effectively and know more about using ICT generally in education. This does not, of course, indicate that the core-ICT skills teachers were seeing themselves as any less competent than the high-ICT skills group when teaching in conventional settings.

This indicates that the CELEBRATE LOs, as a set, worked equally well whether teachers had high or core ICT skills, although the latter naturally reported needing more help. What cannot be said is anything about teachers with lower than core-ICT

skills, as the design of the present project largely left them out. However, the French and Irish classroom case studies, which describe the experiences of such teachers, suggest that less technically experienced teachers might have some initial difficulty in using LOs (see Section 7). Whether they would find the use of LOs more or less difficult than other kinds of software we cannot say. What it may suggest, however, is that if LOs are to be used universally, there will need to be a more basic level of training and support provided. This could probably best be done by modifying existing initial teaching programmes for basic classroom ICT training to explicitly include help with, and experience of, the use of LOs.

The similarity in response of core and high ICT skills teachers also suggests that, as teachers get more experienced in using ICT in classrooms, they do not need completely different types of LOs but that the kinds of LOs used in CELEBRATE generally provided a wide enough range of kinds of LO to support both groups. What does change with growing experience, is the perceived ease with which teachers can use templates to create LOs for themselves. This implies that a future strategy for quickly maximising teacher development of LOs should concentrate, even within CELEBRATE teachers, upon those teachers who are already in the high-skills group.

5.2.3 Frequency of use of ICT in teaching

A slightly different picture emerged when teachers were grouped according to their frequency of use of ICT in teaching, although again in most respects there was no significant difference. So, for example, *'LOs should support student-centred discovery'* was again the first preference for pedagogy criteria by all of the groups, with no significant differences between them for their second and third preferences.

However, significant differences were found among the groups in that the teachers who used ICT more frequently were more likely to use LOs for *'students to work on individually without help in classes.'* Difference was also found in terms of use of LOs for students to work in groups without help in classes. Teachers who used ICT in their teaching less frequently were significantly more likely to *need to know more about using ICT generally in education.*

This could indicate that, where teachers are using ICT less, they are aware of a need for more knowledge, and that this perceived lack of knowledge may be the reason they use ICT less. On the other hand it is also possible that it is the lower levels of use that lead to the reported lower levels of knowledge. The more frequent teacher users would also have more opportunities to help students learn how to make independent use of LOs, and perhaps therefore have a greater confidence in their students' ability to do this. Or maybe those more experienced teachers had just seen that their students could use LOs independently.

Given the widely held preference for promoting student-centred discovery noted in Section 5.2.1, this predisposition to promoting student autonomy is important, and we will return to it in Section 6.3.3.

5.2.4 Length of time teaching

To see if length of time teaching might be an important factor, teachers were divided into four groups, ranging from those with less than five years teaching to those with more than 20. However, there was only one minor difference between the groups,



namely that teachers who had more than 20 years experience were more likely to prefer to use LOs that provided guidance (e.g. hints) on the particular topic. The LOs as a set therefore appear to be equally useful to CELEBRATE teachers at every career stage.

5.2.5 Gender

Only a few gender differences were found. For nearly all the kinds of LOs male and female teachers had very similar responses. However, men were more likely to prefer to use LOs that employed a simulation than women, and women were more likely to think that LOs were stimulating and challenging. These differences have no obvious explanation or indeed implications.

One other difference was that male teachers were more likely to ask students to work on LOs by themselves at home. However, secondary teachers were more likely to value LOs that were useful outside schools, so this may simply reflect the fact that male teachers were more likely to work in secondary schools.

5.3 How did use of LOs relate to differences in their students' backgrounds?

As the focus of the evaluation was upon how teachers used and viewed LOs, we have much less information about students' responses to them. In principle the pop-up questionnaires could have provided this but, as some teachers used a single whole-class ID to access the Portal, it was not possible to identify individual student responses separately. However, we do know that the students using the LOs differed in school stage and achievement, and we can identify from the teachers' reports how some aspects of these factors can be seen in the data.

Around 19% of students were in primary schools, 64% in secondary and 9% in schools covering some parts of both with 8% others. In general teachers thought the LOs were suitable for their students, with only 11% of primary teachers, 11% of secondary and 3% of primary/secondary 'disagreeing' or 'strongly disagreeing'.

A majority of teachers across the sectors also 'agreed' or 'strongly agreed' that students enjoyed using most of the LOs (54% secondary, 73% primary/secondary and 78% primary teachers 'agreed' or 'strongly agreed' with this). A similar pattern emerged when we looked at whether teachers thought most of the LOs helped student motivation. They also thought (less strongly) that LOs made difficult concepts easier to understand.

Teachers saw the LOs as largely free of racial, gender or ethnic stereotypes (Amongst primary teachers 72% agreed or strongly agreed, as did 71% of primary/secondary and 67% of secondary teachers, with overall only 3% disagreeing or strongly disagreeing.) These quantitative results also provide some indirect evidence that LOs can be useful across the full achievement range. From the interview and case studies, it would appear that the CELEBRATE teachers as a group were working with a full range of achievement levels. But we also know that these teachers were also far more likely than not to think that the LOs they knew of were suitable for their students. This suggests that the LOs were, as a set, useful across the achievement range.

The interview studies also provide some indications that point in the same direction. However, three reservations should be noted. The first is that these indications come only from a small number of teachers. The second is that they cannot be taken to mean that all the CELEBRATE LOs were suitable for students of all achievement levels, as these judgements were based on the LOs that the teachers has specifically considered for use with their classes. The third is that the improvements they noted were not always ones that showed up immediately in terms of traditional testing results.

The following extracts between them illustrate these points:

The class was carried out in a computer room. Students should have reported about their knowledge on paper [but] many of them could not do it [...] although later on they were getting used to this method and the exams turned out to be better and better. After a while the improvement of their performance became obvious.
(Hungary *Interview Studies*)

Supports both students with high capacity or students with problems with the school framework; on the other hand present difficulties for students who are unable to take responsibility for their learning tasks and in any case need a close intermediary for working in an ICT environment'
(Israel *Interview Studies*)

As for the students, it seems that the use of learning objects had a positive impact, notably on less able ones: it made them more active than usual. Working in pairs allowed them to pool their knowledge and think together. Some points which were understood by one of the pair were passed on to the other.
(France *Interview Studies*)

A biology teacher told that the students find learning by LOs a pleasant way to study, however, when she had held a test, it had not proven good results. The group in question has not shown good results in general, thus the teacher found it difficult to evaluate how much the method affected the test results. However, the students found the studying meaningful, and even the poorer began to study.
(Finland *Interview Studies*)

Against this an Israeli teacher found LOs much easier to use with students at the middle or upper levels, students with difficulties tending to get lost. Another Israeli teacher did not find the LOs available adequate for special education, a judgment echoed by one of the Finnish teachers:

Among the user groups, the youngest children, special education students and teenagers should also be catered for. For the youngest students, the most suitable material would have spoken and visual instructions; and the special education students would require visual clarity without *Flash* elements, which easily distract. When producing LOs for the teenagers, it is essential to pay attention to themes interesting to them, as well as to design a quality layout, since many teenagers create their own websites. Even more of the potential of the multimedia should be exploited, and the interactivity of the LOs should be increased.
(Finland *Interview Studies*)

The flexibility in use of LOs was also commented upon as a feature that broadened their range of usefulness. A Finnish teacher noted that LOs often had different levels, which produced challenges for both poorer and better students. Other Finnish teachers found that they could adapt assignments to contribute to the suitability of the LO for students of different achievement levels.

Overall there are few indications that the CELEBRATE LOs as a set were not equally well suited to primary and secondary students. The set also included LOs suited to students of different achievement levels, although there are some indications that

students with special needs may require better provision. This suggests that one important development would be to look for ways of versioning LOs and the Portal to make them accessible to students with particular kinds of physical disabilities. Making more LOs accessible to students with learning difficulties would be another important development.

5.4 Summary

This section has considered whether:

- Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers of varying backgrounds and interests.
- Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers working with students of selected ages, ethnicities, social backgrounds, levels of previous achievement, and diverse first languages and cultures.

The judgements of the teachers suggest that, while there are some important differences between teachers, most groups in most respects view the use of LOs in broadly similar ways. Given the findings from Section 4 that, teachers overall view LOs favourably, this suggests that there are no large subgroups of CELEBRATE teachers, who take a strongly negative view. However, it is important to emphasise that the CELEBRATE teachers were generally either experienced users of core ICT systems, or of these and of a wider range of systems as well. The project does not therefore tell us much about the views on LOs of the least experienced teachers in the pilot countries. There could well be, for example, different relationships between responses to LOs and gender and length of experience amongst teachers who have so far not made much use of ICT in their classrooms.

Where students are concerned, again the indications are that the CELEBRATE LOs already include a sufficient range to be used successfully across the full age and achievement ranges, although lower achieving students may be one group that needs better provision.

Despite this, taken together these responses suggest that, as CELEBRATE teachers saw it, differences in student backgrounds and characteristics were not, in general, a problem in using LOs successfully, although some groups were not seen as being sufficiently well served at present.

References

[Classroom Studies] Ilomäki, L, & Lakkala, M., (eds.) (2004) *Learning objects in classroom settings: A report of 13 case studies conducted in Finland, France, Hungary, Ireland and United Kingdom* CELEBRATE Work Package 7.

[Interview Studies] McCormick, R. & Clifford, C., (eds.) (2004) *Teachers Views on Learning Objects: an Interview Report with Teachers in Schools in Finland, France, Hungary, Israel, Norway and the United Kingdom*. CELEBRATE Work Package 7.

[Teacher as User of LOs Questionnaire] Li, N. (2004) *Teacher as User of LOs Questionnaire Report*. CELEBRATE Work Package 7.

Section 6 Use of Learning Objects in different Subjects, Classroom and Education systems

6.1 Introduction

This section discusses the hypothesis:

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently in a range of subject areas and classroom contexts reflecting diverse education systems.

Section 4 gave the general reactions of teachers to the system and the use of LOs, and Section 5 examined the issues of experience, gender and school sector as part of teacher characteristics in relation to the CELEBRATE system and use of LOs. This section takes up the reactions of teachers examined in the last two sections, through a consideration of the different contexts within which they work. These contexts can be seen in terms of the subject (of the teacher) and 'country' features. The former is considered as a feature of context as 'subject classrooms' are different (they have different norms and ways of working; Cobb *et al*, 1997). Where possible, we will also examine particular school differences, though the evidence suggests that this appears only to affect technical issues of access to ICT (and in any case where this is evident, the major effect is in differences between countries rather than between schools).

The data in this section will be examined in two ways: first according to the elements of context just indicated; second in terms of issues that have been pointed out by teachers, particularly from the interview studies.

6.2 Context differences

First we consider the subject differences, and then the general reactions of teachers to LOs to examine any country differences. We then seek to explain any of these differences through what might be the 'country as context' issues, namely language, curriculum and the number of LOs available.

6.2 1 Subject

In terms of general reactions to the use of LOs, there are no significant subject differences and the data from usage of LOs indicate no subject differences.⁴¹ There are variations among the subjects on some questions in the survey, and it is evident that the teachers of Design and Technology (which of course has different manifestations in each country) are more positive than other subject teachers (17% of teachers taught this subject). There is, however, no consistent pattern of those subjects where teachers are least happy, though history teachers comment unfavourably on visual design, appropriateness of age range and support for student learning. LO providers are likely to maximise their market by trying to make LOs fit a number of subjects, whereas teachers, especially secondary teachers, are likely to want quite

⁴¹ In the registration of teachers, which we use to cross-tabulate with the *Teacher as user of LOs questionnaire*, teachers can give more than one subject as their teaching subject. This means that there will be more subject categories than teachers (primary teachers gave several, whereas secondary teachers typically gave one), and this makes any statistical tests somewhat uncertain, but not invalid.

specifically focused LOs. (Section 5.2.1 has already indicated that primary teachers are more likely to feel that LOs fit their curriculum and, the fact that they have to cover many subjects, means that they are more likely to be satisfied with this broader focus.)

Mathematics teachers found the LOs: least stimulating and challenging, least being appropriate for the target age, and having less clarity of objectives. Because of the range and number of LOs available in this subject this view may therefore reflect a problem more generally with the LOs (we will return to this when we examine pedagogy in Section 7).

We can only speculate about whether there would be significant subject issues for those subjects not (or little) represented in the CELEBRATE LOs; e.g. for those subjects or topics where there may be controversy. It is possible that, for example, issues of match to the curriculum and cultural appropriateness will come to the fore.

The interview studies provide us with teachers' views about LOs of particular subjects, but few of the studies contain sufficient number of teachers of any particular subject to make meaningful comments.⁴²

6.2.2 General reactions to LOs by country

The data, particularly from the *Teacher as user of LOs* questionnaire, shows imbalances among the various respondents by country (reflecting the large differences in country participation), such that it is not easy to statistically examine 'country effects'.⁴³ However, teachers across all countries show a positive view towards LOs in their questionnaire responses and this is confirmed in the *Interview studies*. This view is evident in their general reaction to the usefulness of LOs (see Figure 6.1), which indicates a very positive reaction on the part of Hungarian teachers and a much more muted one from Norwegian teachers. (Because of the differences in response rates to the questionnaire across the countries, reflecting different teacher participation, only data from four countries are given in this section of the report.)

This positive view of Hungarian teachers is illustrated from the interview studies (a quote used in Section 4.4.3):

It is conspicuous by the analysis of the answers, that everybody's opinion – without any exceptions! - was positive about the effect of the use of LOs. They think that through using LOs they can hold their students attention more successfully and they can persuade them easier to individual work and thinking.
(Hungary *Interview Studies*,)

The interview studies do not indicate that Norwegian teachers in that small sample were generally unhappy, though there were specific issues related to the match of LOs

⁴² They did of course say something about LOs in particular subjects, but this was dealt with in Section 3.

⁴³ The sample who responded reflect the original population profile (i.e. who completed *Teacher registration questionnaire*), except that Finland is slightly over represented and the other countries under represented; see Appendix 2. This means that it is not possible to statistically examine differences and we only use particular differences where there are other data to confirm (primarily from the *Interview Studies*).

to the curriculum, and the availability of LOs for older students and in subjects outside mathematics and science, which will be considered later.

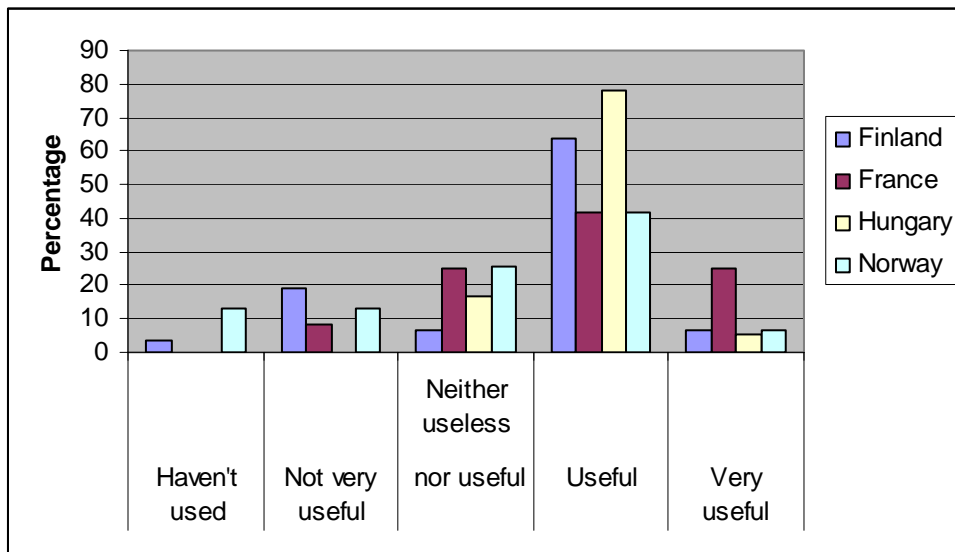


Figure 6.1: usefulness of LOs in teaching, by country

When teachers were asked to rate the statement ‘*Most of the LOs are a complete waste of time*’ the responses are slightly different across the countries (see Figure 6.2); Hungarian teachers are again the most positive about LOs (i.e. disagreeing), but about the same as Norwegian (French teachers are the least positive and strikingly different from the others and from their more positive view on ‘usefulness’).⁴⁴ One worrying indication in this question is the fact that over 12% of Norwegian teachers have not used LOs, a relatively large proportion, particularly if they are representative of all the teachers from that country involved in the project. However, the data from Section 4.3 indicate that there was an anomalous situation and this may be a sampling problem for the questionnaire. In Section 4 we showed that French teachers were low selectors and hence users of LOs (Figure 4.2), with Norwegian teachers as higher selectors, being only slightly lower than Finnish and Hungarian teachers (assuming that teachers choose LOs in their first languages; Section 6.2.3 confirms this). There are several explanations of the behaviour of French teachers, all of which could be happening simultaneously:

- The Hachette Multimédia LOs, a main supplier of those in French, has many LOs that are made up of a collection of small LOs and these small LOs are each available individually on the Portal as well as the collection. So a teacher can select the ‘collection’ or the individual LOs in the collection. If they select the integrated LO made up of the collection of the small LOs, they will not use the individual ones which are already included, and hence a low proportion of

⁴⁴ Even allowing for the fact that a small shift in teachers from one rating category to another can make a large difference (because there are only 12 French teachers), this does not explain why there should be such a contrast in the two questions that are apparently tapping the same attitude. The fact that in the questionnaire response one question (usefulness of LOs) is only a 4-point scale (when teachers have used the LOs), whereas in the other (LOs are a waste of time) it is a 5-point scale, may be the reason for the difference. But in this case we cannot ascribe any significance to this difference.

the LOs will apparently be selected. In fact all of the LOs may have been selected either in the individual or integrated LOs.

- New French LOs have been uploaded to the system throughout the trial period, with the individual LOs that were part of a collection (noted in the last point) coming later. These later LOs will have less of a chance of being selected.⁴⁵
- Some French LOs (e.g. those from ECSITE) are close to being learning assets as they consisted of a title and a paragraph of text. It is likely that French teachers would see less value in such LOs and therefore not select them.

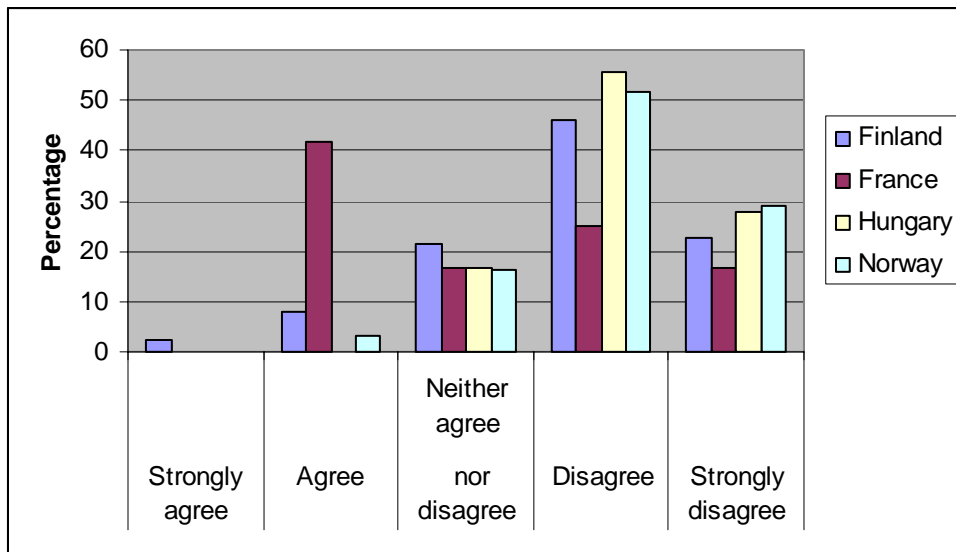


Figure 6.2: most of the LOs are a complete waste of time

In the statements about teachers' views of whether LOs were stimulating and challenging, and visually appealing (see Figures 6.3 & 6.4), Hungarian teachers were again the most positive and this may be explained by them saying that CELEBRATE gave them access to much higher quality LOs than was normally available (a specific reference to this is given in the *Interview studies*); indeed this could be a general issue underlying all their positive responses as Hungarian teachers are consistently the most positive. It is not so easy to explain why French teachers were often more negative than those in other countries. It may reflect their views on LOs (given they selected so few), and unhappiness about language issues (discussed in the next part of the section).

The interviews of teachers indicated a range of views on the design aspects of LOs, though it appears that their educational role was more significant; for example Norwegian teachers, commenting on layout and design, combined this with educational functionality:

Teachers found the animations in science very useful and teachers in primary school specially liked the animations, in biology, of the different parts of the body and the recycling game.
(Norway *Interview Studies*)

⁴⁵ Thus any comparisons with other countries could only be made with a comparison of the uploading regimes for each provider being known, and these data are not available.

and some Finnish teachers were happy to ignore appearance:

The Hungarian LOs have also been well-liked and used in teaching the 2nd-year students of upper secondary school, even though one teacher did not find the black-and-red colouring appealing.

(Finland Interview Studies)

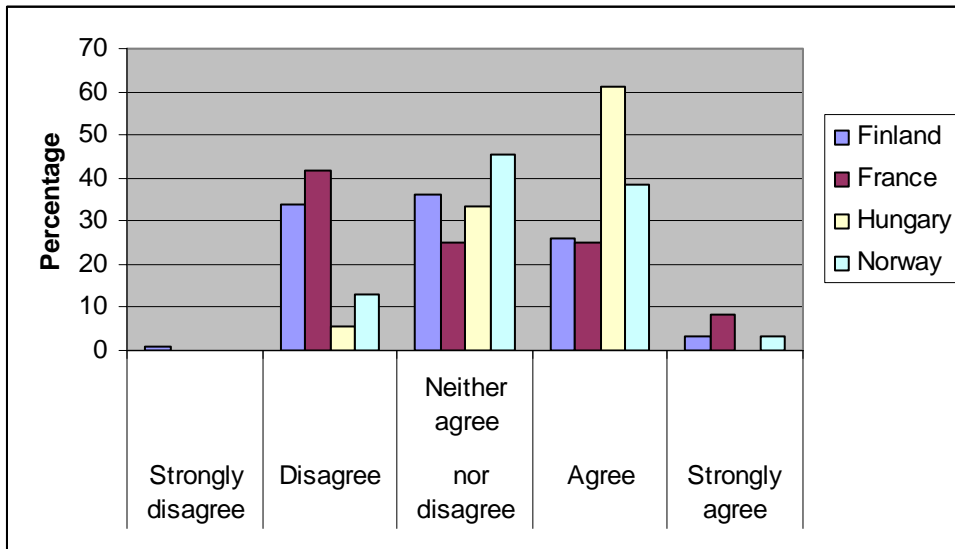


Figure 6.3: most of the LOs are stimulating and challenging, by country

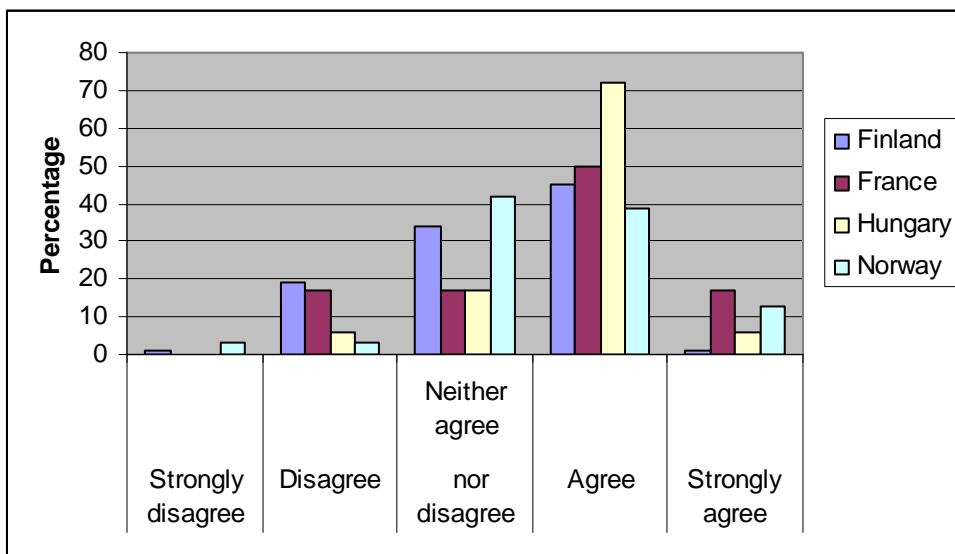


Figure 6.4 most of the LOs are visually appealing and attractive in terms of the design, by country

As we will see in the next section, there are some differences in reactions on particular issues that indicate country differences, but none particularly deriving from the nature of the education system. For example, teachers in all countries requested more LOs in a variety of subjects or for different sectors (see below).

6.2.3 Country as context

There are obviously a large number of potential factors that give rise to ‘country effects’ and here we seek to examine those in as far as we have the data available. From these data there are three inter-related issues:

- Language of the LOs and of teachers and students;
- The extent to which LOs match the curriculum;
- Whether or not there are sufficient LOs for teachers in a particular country.

It is not possible to ask teachers to give a figure for the number required to form what we will call a ‘critical mass’, and so we will return to this final issue in Section 8, when we reflect on the data from all the sections.

Language

The majority of teachers (70-80%) in most countries indicate that there are insufficient LOs in their first language, except in Hungary, where about 55% agree there are insufficient. French teachers indicate the least satisfaction with the number in French and are least happy with using those in a foreign language (17% are happy using LOs in a foreign language compared with the average of 40% across all countries). This is particularly striking when the evidence for language use is considered. Most of the pilot country languages are not used by others (e.g. 93% of Norwegian teachers don’t use French), but most use English, except teachers in France; 67% of them do *not* use English compared with the average of 20% across all countries. The interviews with French teachers substantiated this:

Finally, certain teachers categorically limited themselves to learning objects in French only, which considerably narrowed the field.
(French *Interview Studies*)

Apart from their own unhappiness to operate in another language, it is particularly difficult for their students, especially when the number available in French for each subject and age group is taken into account. Younger children (11-15 years of age) are especially unable to work in English.

Section 4.3 and Section 6.2.2 above, however, pointed out the anomalous position of French teachers, who selected and used a very low percentage (in contrast to teachers in other countries) of the LOs available in French. Thus ‘language’ is not the only factor operating in this situation and some element must relate to other factors; their view of the quality of LOs or their general commitment to the idea of using them in their classrooms. Certainly the data presented in Section 6.2.2 supports the view that they do not rate highly the quality of LOs.

The Norwegian teachers are happiest with using LOs in the English language. However, teachers in all countries stressed in the *Interview Studies* the importance of having LOs in their mother tongue, even where they had been able to use those in a foreign language. Hungarian, Norwegian and Israeli teachers all expressed a concern about the lack of LOs in their own language. As Figure 6.5 indicates, this is directly related to the number of LOs available; as, for example, the number in Finnish is greater than the others. (These figures were discussed in Section 2.)

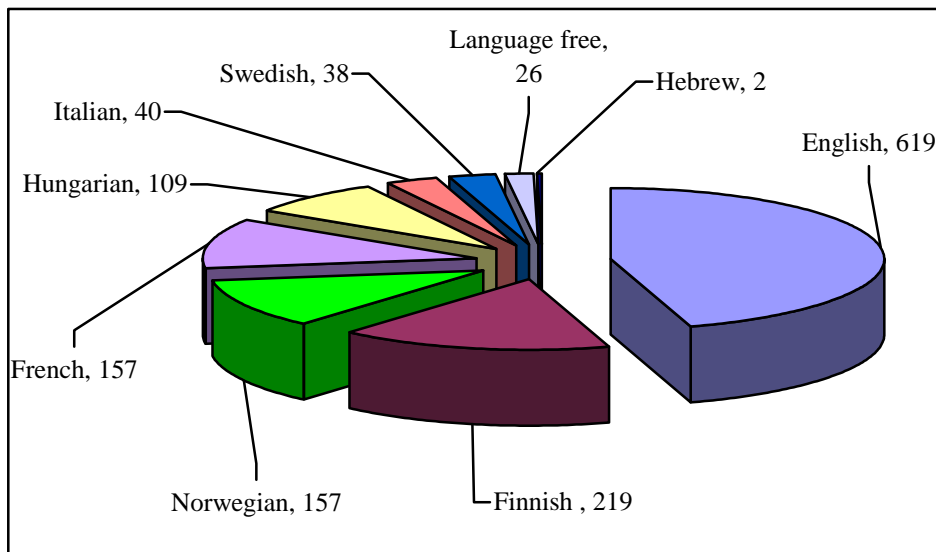


Figure 6.5: number of LOs available in each language

One solution is to consider the use of LOs that do not rely on language (26 LOs are classified as such in the metadata), or to rely on the fact that in some subjects this might be less of an issue.⁴⁶ Some teachers of science and mathematics interviewed in Norway expressed less of a concern about language than their colleagues in other areas where language was more critical, but it is evident that some subjects are very language dependent as indicated in this comment on the use of LOs in another language:

They do not really suit the history curriculum. They are not very appropriate for teaching history of art. It is not translated therefore it would be very circuitous to use it. [Otherwise] it might be well used to demonstrate [a] painters' life.
(Hungary *Interview Studies*)

This use of 'language free' LOs is likely therefore to be only a partial solution as teachers in the main have used LOs in their first language and in any case there are relatively few. Hence if there are to be enough in a particular language, then translation will have to be the route taken, if duplication of effort is to be avoided. The large pool of English language LOs, was intended as the source for translated material, and Section 2.6.6 discussed translation as a specialised kind of modification to encourage LOs in participants' languages.

⁴⁶ There is some indication of this from an examination of the subjects of the teachers who say they don't use LOs in their own language (either where they use one in a foreign language, or in subject not highly reliant on language, e.g. mathematics).

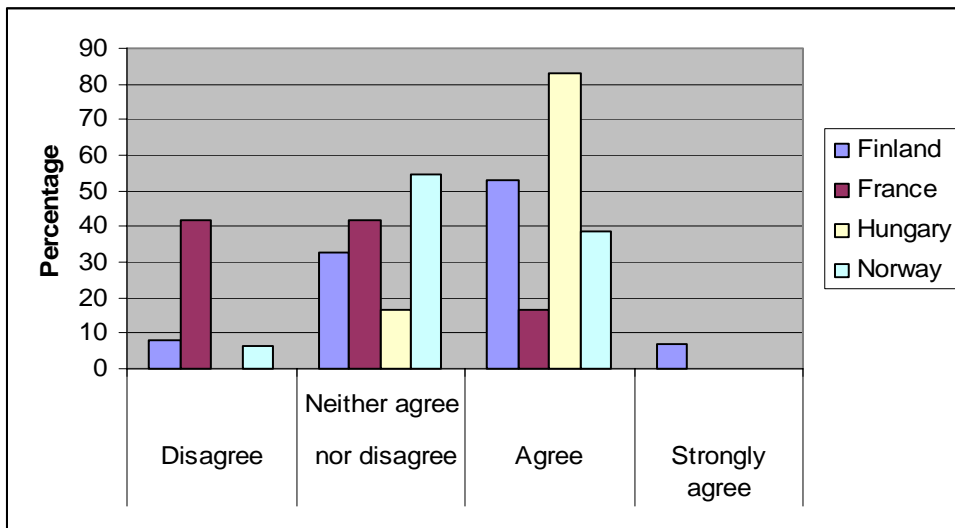


Figure 6.6: translated LOs fit in well with the objectives of my school curriculum

More than half of all teachers (55%) were happy with those LOs that were translated into their mother tongue. There is, however, great variation across the countries with French teachers being least happy and Hungarian teachers most happy (see Figure 6.6). The data on whether LOs fit the local cultural context is not very positive (on average around 40% ‘agreeing’ or ‘strongly agreeing’, though there is a large ‘undecided’ group) and shows only small country differences, again with Hungarian teachers being slightly more positive, and Norwegian teachers the least positive (see Figure 6.7). The concern about the match to the curriculum is therefore more likely to be a specific one related to the teaching topic rather than to more general issues. This is reinforced by a lack of concern on the part of French teachers about the LOs containing stereotypes, and most concern on the part of Hungarian teachers (the reverse of the other curriculum concerns). This leads towards the issue being a specific one of the nature of the LOs available perhaps in general and in particular subjects.

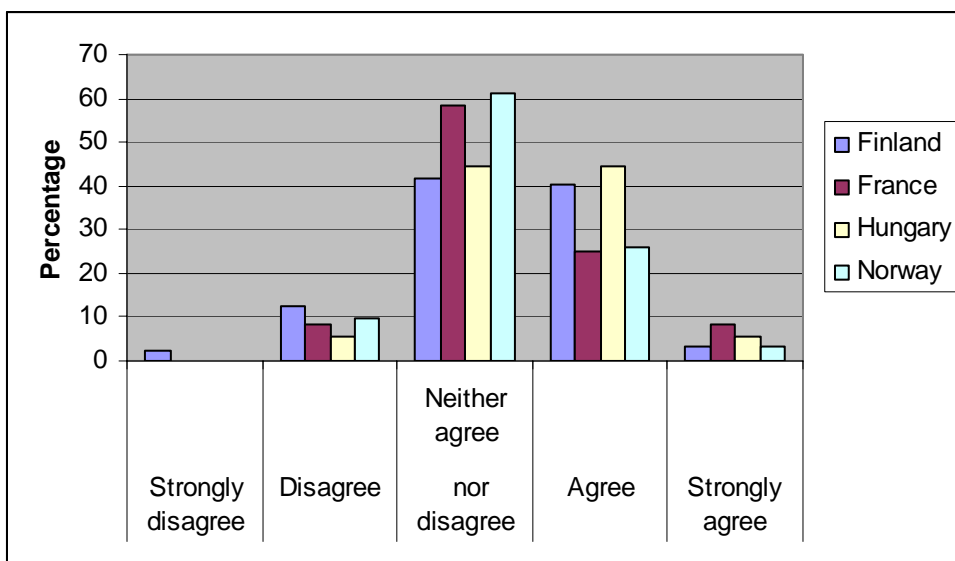


Figure 6.7: most of the LOs fit in well with the local cultural context

The evidence from this evaluation suggests, however, that French teachers may be unhappy with the ‘translation’ approach. It is notable that in Finland the Board of Education involved teachers in choosing which LOs to translate, so that the best or the ones fitting Finnish teachers’ needs could be translated.

A possible explanation for the relative lack of concern about language on the part of Hungarian teachers is that their focus is with the lack of match to the curriculum (noted in the *Interview Studies*), but that the general increase in access to good quality LOs outweighs even this concern. We next examine these country differences in terms of responses to match to the curriculum.

Match to the curriculum

Only just over 40% of teachers are generally happy with the match of LOs to their own curriculum objectives, with Hungarian teachers being most happy (French teachers are close behind – see Figure 6.8); however in interview responses some Hungarian teachers indicated concern about the match to the curriculum. The situation for Norway, whose teachers were least happy with what was offered (only 26% being happy), was confirmed in the interview studies where they made a point about the lack of match to the curriculum.

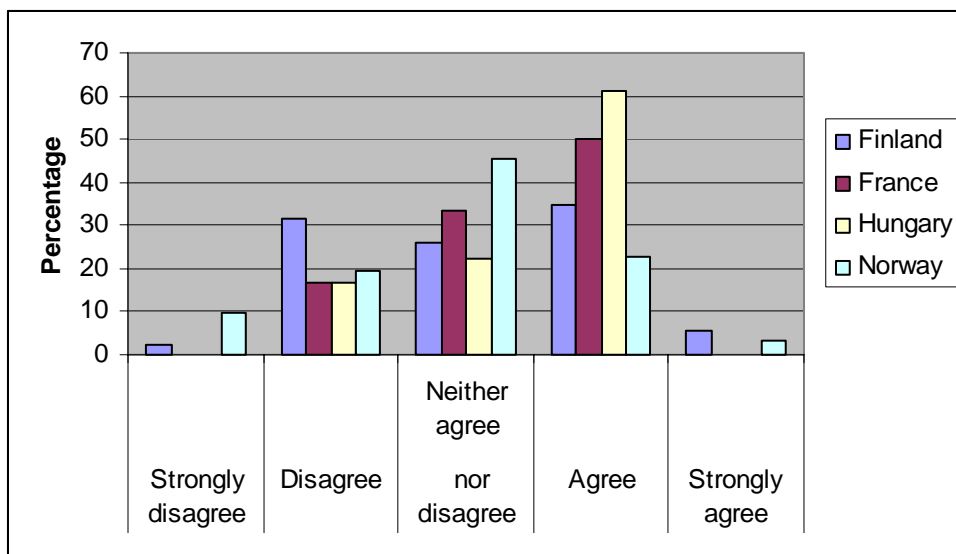


Figure 6.8: most of the LOs fit in well with my curriculum objectives

Our analysis of how well LOs fit with teachers’ curricula, show no difference for high and core-ICT skilled teachers, and for those with previous use of LOs. Those who have previous experience of LMS/VLEs were less positive about the fit of LOs to their curriculum (see Figure 6.9), perhaps indicating an effect of this specialised prior experience of the use of digital material. Possible explanations might be that those teachers who have used LMS/VLEs prefer other working practices (e.g. students’ own collaborative knowledge production) or are used to producing their own material, rather than using ready-made digital learning materials. (We have no independent way of estimating what material is available to teachers in relation to this issue.)

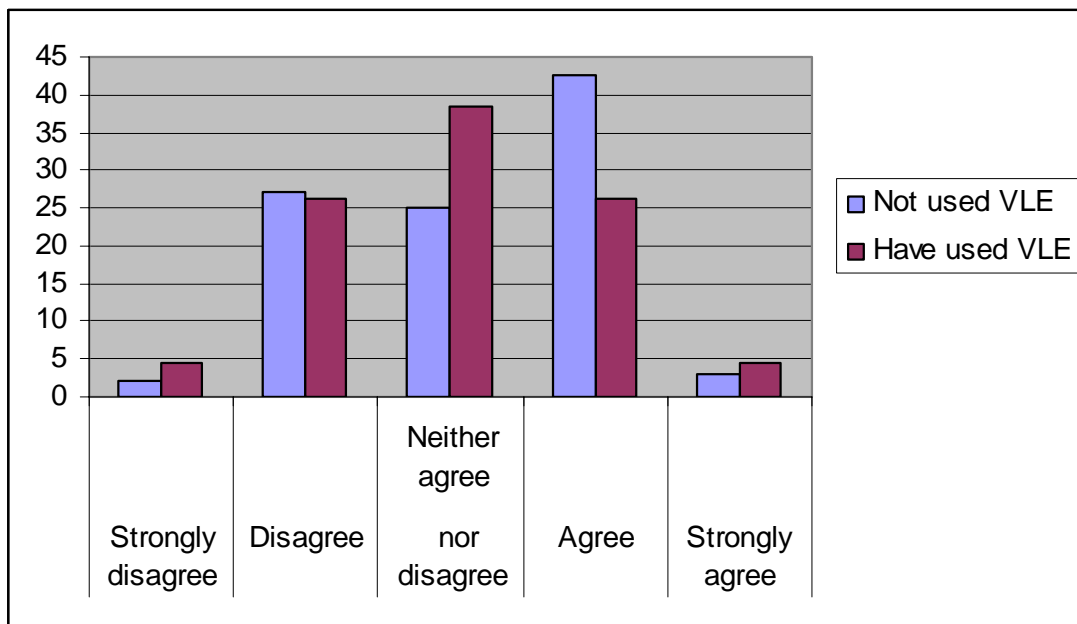


Figure 6.9: percentage who rate on fit of LOs to teachers' curriculum cross tabulated with prior use of LMS/VLE

One way round this lack of match is of course for teachers to make up their own LOs, and we know from the initial survey of CELEBRATE that this was something teachers were interested in (D1.1, pp. 31-32). This was expressed in the *Interview Studies* as a solution to curriculum fit:

It should be noted that one teacher said s/he was more interested in the templates than in the learning objects themselves, because s/he wanted to create resources which would correspond exactly to requirements.
(France *Interview Studies*)

This leads to a consideration that the issue may be more to do with the kind of people producing LOs. Thus where teachers were more centrally involved in their production (as in Hungary), then teachers should be most happy, but where ministry people or commercial publishers do this they are least happy. However, the evidence is not straightforward. In the case of French teachers, half are happy that the LOs fit their curriculum and most of their LOs are produced by a commercial producer; only 25% of Norwegian teachers agree to some degree that LOs fit their curriculum and most of these were produced by the Board of Education.

Another possible explanation relates to the degree of centralisation of the curriculum. In France and Hungary the curricula are more centralised than in Norway and Finland, hence it should be easier to satisfy teachers in the former countries than in the latter, where the curricula are more diverse.

Teachers in some countries made a variety of requests for more LOs in particular subjects, as indicated below. However, it is important to remember that the resource constraints in CELEBRATE and the focus on maths, science, art and languages meant that these requests are an unreliable indication of what might be needed by teachers and they will inevitably point to areas we made no particular effort in which to produce LOs.

Finland: biology and geography were seen to be where more were needed, whereas chemistry and mathematics were seen to have plenty. This does not reflect the relative numbers available in Finnish, with biology having 7, geography 16, chemistry 8, and mathematics 40. It may be that biology LOs require more language than chemistry, and hence chemistry teachers are able to use those in other languages. There are plenty of mathematics LOs, and of course using those in other 'languages' is likely to be easier to use.

France: teachers felt that more LOs were required in history, geography and civics.

Hungary: humanities teachers were more concerned about the LOs available than their science colleagues, and about the match to the curriculum.

Norway: teachers of science felt best served, with those in language, media, chemistry and religious studies asking for more LOs. This again reflects the numbers available in Norwegian in these subjects (there were no LOs in media or religious education).

In the end it is also important to realise that teachers are making choices to fit particular needs for a particular task or classroom need:

For the other teachers, the choice was just as difficult, if not more so.

Logically, they either tried to find learning objects related to their subject and to their syllabi, or, more precisely, learning objects capable of performing certain repetitive tasks, such as mathematical calculations. This allowed students to test themselves, and freed up the teacher for other tasks. For others, learning objects allowed them to test students' knowledge and to carry out a final evaluation.

(French *Interview Studies*)

There is also the added problem in interpreting the evaluation data because of the timescale of the project and, the fact that it was a 'project', affected the degree of choices that teachers had:

Most teachers were reluctant to use English, and the number of learning objects available in their subject thus dwindled to almost none. Moreover, the learning objects did not necessarily correspond to the way the year progressed, and teachers had to adapt their lesson plans in order to accommodate learning objects.

(French *Interview Studies*)

Are there sufficient LOs?

Section 2.7.2 posed a slightly different version of this question: 'How many LOs are needed?', and examined three broad answers in terms of what content developers and policy makers might do. The answer to the question posed in the title of this subsection cannot of course be an absolute figure, but is likely to be related to the relative wealth of material to which teachers have access, prior to, and outside of the CELEBRATE project, and probably to their prior experience with digital materials. We have already indicated that there was little effect of either their ICT skill or previous use of LOs, but it is related to their prior experience of VLEs.

It is also related to the numbers available in their language and produced by a local content provider (the Section 2 stance), assuming that the latter is in the best position to know the needs of local teachers. It may also relate to what is available for each subject group or sector of teachers (primary school teachers have more choice in that they can draw on LOs from all subjects). However, there is unlikely to be that much of a country difference, at least from which we could confidently draw conclusions.

Only teachers in Norway and France (who have comparable numbers of teachers and LOs) noted the need for a critical mass of LOs in the *Interview Studies*, and the Finnish teachers were not as well served as the Norwegian ones and, in interviews, primary teachers voiced concern:

Some lower level comprehensive teachers have felt that there has not been a vast number of suitable LOs available in the CELEBRATE project, thus all the potential LOs have been exploited in the teaching.
(Finland *Interview Studies*)

The Hungarian teachers are not so advantaged, yet their positive views have consistently been revealed in the above discussion; they have access to relatively low numbers outside CELEBRATE and hence welcome more. Despite the relatively favourable position of Norwegian teachers, they have indicated in interviews unhappiness with the LOs produced (as noted in the discussion of *Match to the curriculum*). An added complication in their case is that many of the Norwegian LOs are small JAVA applets, thus granularity may well be an issue with regard to the 'required' number of LOs.

Thus, the situation with regard to whether there are enough, is complex in relation to country and subject differences, and we will return to this issue in Section 8.2.4, when we consider what might be a critical mass, as there are a number of factors and different strategies that can be considered in relation to arriving at the size of this 'mass'. However, despite the importance of the question 'Are there sufficient LOs?' it is necessary to reiterate that there were limits to what CELEBRATE could achieve given the available project budget for LO development.

6.3 Issues identified by teachers

The *Interview studies* helped identify some important issues. These were to some extent prompted by the questions we raised, but open in the extent to which they allowed teachers to identify the importance and nature of the issues. From these interviews a number of issues were identified:

- the appropriateness of the target age range of LOs;
- the kinds of outcomes that are achieved by students;
- the support for autonomous learning and the extent of support for collaboration.

These are dealt with in the sub-sections that follow, all of which are based on what teachers think about these issues.

6.3.1 Target age range of LOs

Section 2.3.3 indicated that the intended age range of LOs spanned the compulsory schooling age and beyond, and Section 5.2.1 ended by suggesting the need to improve and extend the range of secondary LOs. As indicated in that latter section, there were some country differences in how the target age was viewed by teachers. Figure 6.10 shows again that Hungarian teachers have the most positive view of the age appropriateness of LOs, and French teachers the least positive (though not strongly so; note also the high number of uncommitted Norwegian teachers). In the *Interview Studies* teachers in France said they used LOs with younger children than the

‘designed’ age specified in metadata, whereas in Israel there was a desire for more primary material. In addition, the questionnaire data indicated more problems for secondary teachers (55% of secondary teachers were satisfied compared to 61% of primary teachers), and this was confirmed in the *Interview Studies* by both Finnish and Norwegian teachers:

More often the teachers have made such applications in which LOs designed for older students have been used with younger ones. One lower level comprehensive teacher contemplated that there are many LOs that would be more applicable to lower level comprehensive school if small changes were made.

(Finland *Interview Studies*)

Upper level comprehensive teachers also felt that there is room for further improvement in the LOs, for they considered many of the LOs too easy and limited with regard to their content.

(Finland *Interview Studies*)

The Norwegian resources were adapted mostly for primary and secondary school. The interviews show that teachers in upper secondary school complain about too little resources for their grades. Teachers participating in the project were not teachers in mathematics or science only and that’s why some of them were disappointed. It seems that teachers in science were the most satisfied ones.

(Norway *Interview Studies*)

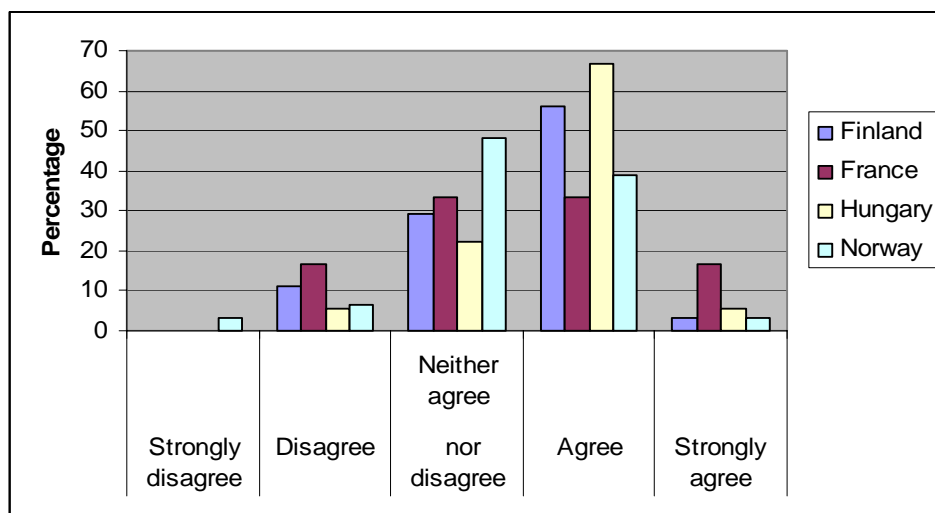


Figure 6.10: most of the LOs satisfy the appropriate targeted age group

There are at least three responses to these kinds of worries about appropriateness of the age range indicated by content developers:

- content providers should be more precise in their target age,
- to be less concerned and, either let teachers decide, or get them to indicate in some form of rating when they have used them (these two are not mutually exclusive);
- allow teachers to change LOs to make them more age appropriate (e.g. to be able to change the text to make it more or less difficult).

There is of course an issue about the different ethos and transitions between primary and secondary schools that make this a difficult area to resolve. More significant, is the need to cater for the needs of older students, as requested by the teachers above.

Comparing the effects of these different approaches (and gathering available information on how well these approaches are already working in other leading initiatives) would be a useful small-scale follow-up project.

6.3.2 Outcomes achieved by students

Teachers commonly stated that an outcome of LOs was their effect on motivation. The data from the two questions in the questionnaire, about whether teachers think their students enjoy using most of the LOs and those who think it helps student motivation, show the same country differences; French and Hungarian teachers were the most positive on both, with Norwegian being the least positive. Finnish teachers interviewed talked of an improved atmosphere, and this supports Hungarian teachers' views of LOs holding students' attention. One Finnish teacher interviewed noted how this improved motivation led to engagement of students in learning vocabulary (using the *Healthy Diet* LO), which would have been difficult to do using other means. This was more than just making learning enjoyable, but in providing conditions that would help learning, not just the completion of tasks. The evidence from these interviews indicate that *some* LOs can help with 'intrinsic motivation', which is seen as a form concerned with learning (Passey & Rogers, 2004), and it might be that this is not just a novelty factor of the use of a 'new' kind of resource.⁴⁷ For many students LOs will feel just like internet resources, though they are less likely to be those used for their own research, which Passey & Rogers' (2004) report are most likely to help with intrinsic motivation. But it is also true that we have a report of the decline novelty after the first lesson and hence in motivation (Case study 3, *Senses and the Brain*). The classroom studies indicate other examples of students clearly enjoying their work, even when the LO in question is rather problematic for them to use (e.g. Case study No. 5, *Water cycle*). This latter example does not of course mean that their learning benefits, just that they can remain engaged.

While the teachers in CELEBRATE were largely positive about the motivational effect, the evidence of the effect of LOs on achievement is more equivocal, a similar finding to the general research on ICT (e.g. Harrison *et al*, 2002).

The survey question on LOs supporting student learning indicates only just over half of teachers thinking that they do (Figure 4.5), though again Hungarian teachers are much more positive, with three quarters agreeing. Teachers in Finland said that there was some anecdotal evidence of improvement in achievement: in language teaching a boy who hitherto had been unable to learn the use of 'was/were', but was able to by using an LO; a group whose listening comprehension skills improved in a public examination. However, there were other reports of improved motivation but no improvement in test mixed results in addition to the one given in Section 4.4; given the short pilot period this is not surprising:

It is also important that according to teacher opinion not only higher motivation level of students in and outside of the class could be observed, but also significant improvement in exam grades. (Hungary *Interview Studies*)

⁴⁷ Passey & Rogers (2004, p. 5) found that interest in ICT was maintained over a year of use of software, such as writing software and in the presentations offered by interactive whiteboards.

According to a mathematics teacher, it is difficult to evaluate the influence of the LOs on learning, at least up to the present, as she has been able to use LO [-based] teaching only once with her students. She sees that those students who showed good results during the use of LOs in teaching would also do so at other times, and the less advanced students do not necessarily benefit from the method to the extent that their studying would transform into skills..... A biology teacher said that the students find learning by LOs a pleasant way to study, however, when she had held a test, it had not [shown] good results. [Because] the group in question has not shown good results in general, thus the teacher found it difficult to evaluate how much the method affected the test results. However, the students found the studying meaningful, and even the poorer [students] began to study.

(Finland *Interview Studies*)

When asked about LOs making difficult concepts easier to understand or helping with problem-solving skills, two particularly important student outcomes, again only around 50% of teachers agreed that they do, with Hungarian teachers being more positive and Norwegian teachers being the least positive (though on problem solving the latter are much the same as French and Finnish teachers). Interestingly, in the Irish classroom study on the spreading of the HIV virus (Case study 12), the teacher was able to engage in the students' understanding of ideas in the LO because the 'test' element had a mistake in it, giving rise to a productive discussion:

Now again there some glitches in the question but you know students should not just swallow information whole and feel there's a definite answer. They picked that up quickly that there was a problem and you know I think that's good because they're problem solving and they're not just ... accepting things.

(Case 12 *Classroom Studies*.)

This is not a reason to put mistakes into LOs, but it does indicate that there is a need to interject opportunities to challenge student thinking and to give opportunities for the teacher to interact on content. (This latter issue is one we discuss further in Section 7.6.3.)

There was more agreement about LOs being able to help students of different achievement levels, with teachers in Finland, France and Israel noting that those of lower achievement do well (discussed in Section 5.3). Teachers in Finland noted the fact that LOs could cope with students of a variety of levels. This could be attributed to the nature of the feedback provided by LOs; Finnish teachers commenting on its immediacy, and the fact that students can monitor their own progress. Hungarian teachers also noted the idea of the LO controlling student progress, where success is necessary for progress, and that, even when students were incorrect in their response, the feedback on this was useful. There were, however, times when the LO assessment system did not provide control over progress when students adopt a 'game-playing' strategy (see Section 7.6.5, drawing on the the UK case study, Case 13 *Reproduction*). French teachers were struck by the fact that the feedback was non-judgemental, unlike that of a teacher (even if it is not by what is said by the teacher but by her presence: *'the student does not have the teacher breathing down his or her neck'*; France *Interview Studies*). This was also connected to the fact that students could administer assessment (where this existed) themselves and as often as they liked without worrying about the teacher thinking them too slow.⁴⁸ This links to the next topic of student autonomy, of which this 'self-testing' is a modest start.

⁴⁸ There is increased interest in the effect of feedback on learning in classrooms stemming from the 'assessment for learning' literature and, although ICT-based material has a relatively low level of

In addition to the role of feedback and assessment, teachers interviewed mentioned that the advantages of using multimedia are clear from students' use of the LOs. The advantages of multimedia material are well known and teachers mention some of these: to demonstrate complex ideas graphically, which hence can help low achievers. The motivational aspects noted earlier are also importantly related to the multimedia nature of LOs.

A great feature pointed out in the LOs is the potential of the multimedia. On the whole, learning objects are regarded as irreplaceable tools.
(Finland *Interview Studies*)

All the students are active with learning objects, and they understand better when there are models. For example, learning objects are very practical for illustrating the water cycle: students see that water is in constant movement.
(France *Interview Studies*)

Moreover [the multimedia nature of LOs] ... has ... a direct impact on certain less able [*sic*] students: teachers have seen that they succeed better by using learning objects. Being in front of a computer is more fun for them than being with their schoolbooks. Less able students can therefore understand a little better thanks to the greater interest of learning objects in comparison with class-work. An incorrect answer results in a response such as, "No, that's not right: start again". With a computer, they can make several attempts, wrong answers are less important, and sometimes they manage to understand, even if at times they find the right answer by chance.
(France *Interview Studies*)

A Hungarian teacher summed up her view of LOs and learning thus:

A good digital learning object is motivating, suits the class and explains the essence. It corresponds with the students' individual needs. In the case of tests the feedback is inspiring even if it is about a mistake.
(Hungary *Interview studies*)

The evidence from the experimental studies indicates support for the potential of LOs to provide improvement in learning. One of these studies, focusing on electrical circuits, uses an LO with a simulation of a circuit allowing students to build a circuit and take measurements of current, voltage and resistance. This simulation parallels the kind of work students can do in the laboratory. The results of this study show clearly that a simulation can lead to statistically significant improvement in achievement over just using work in the laboratory with wires batteries, bulbs etc. The study also compared the use of the LO simulation alone with that of a simulation plus practical work of the kind that would be done in the laboratory (in fact the wires, batteries etc., were taken into the computer suite where the LO was used). The findings from this were that, on most measures the two were the same, except with regard to teaching the conceptual understanding of how current 'divides' in circuits that contain, for example, parallel and series resistors (bulbs). The mixture of a simulation and 'laboratory' work produced significantly better results than the simulation alone. In addition the study showed that the use of the simulation LO helped students who were initially lower achievers (i.e. as indicated by the pre-test), thus substantiating the interview evidence noted above, which drew on teachers impressions of use of LOs.

feedback, its contingency is likely to be important (McCormick, 2004a). Despite the call for less use of 'Drill and practice' LOs, the evidence of effectiveness is strongest for this kind of LO (Hattie, 2004).

This provides robust evidence of the possible effects on learning of an LO in a difficult conceptual area, but also gives an interesting pedagogic insight into the importance of mixing work on the computer with ordinary classroom work (in this case laboratory work). The implications of this will be examined in Section 7.

6.3.3 Autonomous and collaborative learning

Just because LOs focus on individual work, does not mean that they therefore support student autonomy, and here we examine teachers' views on this. On the other hand, the fact that the numbers of computers a teacher can use with a class is such that students usually have to share, gives an opportunity for collaboration. Our evidence on this is, however, slight, and so we can only briefly consider collaboration here. First then, autonomy.

The LOs, where students were able to control their pace of learning, were recognized as allowing low-level autonomy by Norwegian teachers. Another example is where they can choose a task to match their progress:

Studying by means of LOs, the students learn to take responsibility for their learning. While practicing multiplication, the students of one teacher have recorded in their notebooks which LOs they have solved correctly. Thus, they have been able to follow their own progress. One teacher allowed the students to choose the level of the exercises independently.
(Finland *Interview Studies*)

There is evidence that some LOs may make it difficult to control pace, if students do not have complete control in a way that they think is necessary. Thus, in the French classroom study on the water cycle (Case study 5), the LO navigation prevented students from going back to a previous screen if they found they did not have all the information they needed. This turned out to be a design fault, and it was to be corrected.

Although few Israeli teachers have used LOs in the classroom, they see the potential to support independent learning in the classroom in terms of students taking responsibility for their own work.

Provide independence in the learning process...

Supports both students with high capacity or students with problems with the school framework; on the other hand they present difficulties for students who are unable to take responsibility for their learning tasks and in any case need a close intermediary for working in an ICT environment.

(Israel *Interview Studies*)

Norwegian teachers believe LOs can allow students to learn independently in their own time and in their own way.

After having explained a new topic in the classroom, the students may go to the group room to work on their own with suitable LOs for both exploring, testing and rehearsing later on.

With LOs it is easier to let students work on their own in their own speed and with a different approach.

(Norway *Interview Studies*)

Hungarian teachers talked of individualization as being important for LOs. More important manifestations of autonomy were noted by Finnish teachers: one teacher allowed older students to find their own material when they were given access to a range of LOs through the Portal (see also comments on the use of the Portal as a safe

environment, Section 3.3.1, and the example in Section 7 of a teacher who set her students the task of analysing LOs for ‘types of intelligence’, Case study 4). The quote above, on students being able to choose the level of the LO exercises independently and monitoring their own progress, is an example of higher level autonomy. Independent work is seen as an important factor in the use of LOs in Israel and teachers in France went as far as to talk of students as researchers in working with the Portal, or as producers of LOs (in Norway). Hungarian teachers also talked of students wanting to create LOs.

A common theme in teachers’ discussions of the nature of the learning was the importance of active learning on the part of the student. At times this may be a modest ‘learn by doing’, as when a Finnish teacher used the *Protractor* LO for measuring angles, which, done in a text-based way, is harder for some students to absorb. The resulting enlivening of the lesson is part of the motivating effect of LOs noted in Section 6.3.2. Seeing the student as researcher or producer of LOs is of course a call for more meaningful activity on the part of learners. Teachers in Norway noted the need for more LOs to support student active learning, in the sense of engagement not just ‘doing’, and we will return to this in Section 7, when we consider types of LOs and their impact on pedagogy.

Section 4.4.3 (Figure 4.5) indicated that teachers could use LOs for both individual and collaborative work, but we have few reports in the interview studies about this. This was, however, especially noted in the French report, pointing to the help to lower achieving students and the sharing of knowledge:⁴⁹

As for the students, it seems that the use of learning objects had a positive impact, notably on less able ones: it made them more active than usual. Working in pairs allowed them to pool their knowledge and think together. Some points which were understood by one of the pair were passed on to the other.

(France *Interview Studies*)

Such work in pairs was also mentioned in the Hungarian report, but it noted the difficulties of ICT facilities that did not favour collaborative methods. Further, observations in a classroom in England (Case 13) revealed that such practical requirements do not necessarily result in collaboration unless the teacher sets the task up and students know how to collaborate.⁵⁰

6.4 A summary statement

The Finnish *Interview studies* report provides a useful summary statement that encapsulates teachers’ views of some of the issues about student learning encountered in this section:

⁴⁹ In Section 7 we will deal with the survey data about the use of LOs to support both collaborative and individual student work.

⁵⁰ This latter point is reported in the more general literature on collaboration (see McCormick, 2004b)

[The] use of LOs promotes different learning styles, deepens learning, and encourages independent work. Some students have studied the LOs even at home with their parents. The LOs also have a positive effect on the working environment: the students are happier while working on the LOs, and the special education students have found themselves to be able to work harder. A great feature pointed out in the LOs is the potential of the multimedia. On the whole, learning objects are regarded as irreplaceable tools.
(Finland *Interview Studies*)

Reflecting on the hypothesis that guided this section, it is evident that there do not appear to be subject-related factors preventing the useful and effective use of LOs, except in as much as the LOs fail to match the curriculum topic of the teacher, rather an issue across, than within countries. (This may not be the case in subject areas other than those upon which CELEBRATE focused.) It may well be that, with a larger number of LOs in any one subject, the match to specific topics can be overcome. But, even the relatively modest numbers of CELEBRATE LOs, which required considerable effort and resources, did deliver satisfaction in the subjects covered using hundreds, rather than thousands, of LOs. Whether issues of age range are so easily overcome is uncertain, and in particular there is a need to focus in future production on older students (previously noted in Section 5.2.1).

Teachers are convinced of the effect of the use of LOs on motivation, though there is less general evidence on whether it improves achievement. Where we were able to carry out a specific study of the impact on achievement, we have robust evidence that they can be more effective than traditional means of teaching. However, we require a wider range of targeted studies than could be resourced in the project to say any more than 'they can be effective'. There is thus promising evidence and, like the general research on ICT, blanket statements about the effectiveness of LOs in improving achievement are unhelpful. The evidence for improvements in particular types of learning is modest, for example to support 'problem solving' and 'conceptual learning', though again the experimental study does show that some elements of conceptual understanding can be effectively dealt with.

Whatever the limitations in our evidence of improvements in achievement, the effect on student autonomy and active learning are evident and useful, but these need more experimentation with types of LOs to extend our understanding of these aspects of learning.

References

- Cobb, P., Gravemeijer, K., Yackel, E., McClain, K., & Whitenack, J. (1997) 'Mathematizing and symbolizing: the emergence of chains of signification in one First-grade classroom'. In D. Kirshner and J. A. Whitson (eds.) *Situated Cognition: social, semiotic, and psychological perspectives* (pp. 151-233). London: Lawrence Erlbaum Associates.
- Harrison, C., Comber, C., Fisher, T., Haw, K., Lewin, C., Lunzer, E., McFarlane, A., Mavers, D., Scrimshaw, P., Somekh, B. & Watling, R. (2002) *ImpaCT2: the impact of Information and Communication Technologies on Student Learning and Attainment*. London: Department for Education and Skills/Becta.
- Hattie, J. (2004) 'Factors that influence children's learning: results from a study involving 500 meta-analyses.' *Knowledge and skills for learning to learn, ESRC Seminar Series*, 8 July, Newcastle University, UK.



- [Classroom Studies] Ilomäki, L. & Lakkala, M., (eds.) (2004) *Learning objects in classroom settings: A report of 13 case studies conducted in Finland, France, Hungary, Ireland and United Kingdom* CELEBRATE Work Package 7.
- [Experimental Studies] Jaakkola, T. & Nurmi, S., (2004) *Learning Objects – A lot of smoke but is there a fire? Academic Impact of Using Learning Objects in Different Pedagogical Settings* CELEBRATE Work Package 7.
- McCormick, R. (2004a) 'ICT and student assessment.' *The Curriculum Journal* **15** (2), pp. 115-137.
- McCormick, R. (2004b) 'Collaboration and the challenge of ICT.' *International Journal of Technology and Design Education* **14** (2), pp. 159-176.
- Nurmi, S., (2003), *The CELEBRATE Final Report on Teacher User Needs – Survey Report, Deliverable 1.1.* CELEBRATE Work Package 1.
- [Teacher as User of LOs Questionnaire] Li, N. (2004) *Teacher as User of LOs Questionnaire Report.* CELEBRATE Work Package 7.
- [Interview Studies] McCormick, R. & Clifford, C., (eds.) (2004) *Teachers Views on Learning Objects: An Interview Report with Teachers in Schools in Finland, France, Hungary, Israel, Norway and the United Kingdom* CELEBRATE WorkPackage7.
- Passey, D. & Rodgers, C. (2004) *The motivational effect of ICT on students.* London: Department for Education and Skills.

Section 7 Use of Learning Objects by Teachers using a Variety of Pedagogies

7.1 Introduction

This section discusses the hypothesis:

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers using a variety of pedagogical models.

This section draws together what has emerged about the sorts of pedagogies teachers used, and how far they thought LOs supported these. A particular emphasis will be upon the ways that different kinds of LOs enabled teachers to use the new kinds of pedagogies the project favoured. We take pedagogy to mean issues relating to teaching and learning, though we will discuss the different ways teachers, content providers and theorists express ideas on pedagogy. The section starts by examining the suitable pre-conditions, then considers what teachers saw LOs offered to their pedagogy and what they wanted from LOs to support their pedagogy. From this we are then able to consider the nature of the teachers' and LOs' 'pedagogic models' and in particular how 'advanced pedagogy' is supported by the use of LOs.⁵¹ We then examine a number of pedagogic issues that are raised by the use of LOs, particularly from our observations of classrooms. These issues give us insights into how teachers employ LOs in the context of their pedagogies. Our focus is on the nature of the issues they raise, rather than trying to arrive at a view as to what teachers in general might think about, or do with, LOs. Nor do we express a view about whether the uses of LOs by teachers represent the kind of practice we think teachers in general should aspire to. Our use purpose is to explore this practice and the issues it reveals.

7.2 Conditions of use of LOs

The conditions that were found from the evaluation data are common ones with most uses of ICT, and will not surprise those familiar with its use in schools. The conditions evident in the data are: the restrictions and possibilities arising from the kind of access to ICT facilities (computers, projectors etc.) that teachers and their students have; ICT skills of the teachers that enable them to successfully use LOs and deal with problems that arise; the preparation time that LOs entail to ensure an efficient use of them.

7.2.1 Access to ICT

This access to ICT facilities is probably the prime condition of use. Where students use computers individually, or even in pairs, this requires most teachers to go to an ICT suite in the school. This has at least four problems:

- rooms have to be booked (France: Interview and classroom studies; Cases 5 & 6), with the restrictions of time and timing of the use of LOs;

⁵¹ Section 2.2.3 noted that, although the project proposal had used the term constructivist pedagogy, we had adopted the term 'advanced pedagogy'. One reason for this was to avoid confusions about different types of 'constructivism' (e.g. cognitive or social), and to allow a more flexible view.

- inconvenience of moving from one classroom, where the lesson is started or normally carried out, to the suite (or the reverse), including the physical movement and that of the teacher's materials (France, Hungary & Finland *Interview Studies*);
- particular pedagogy is constrained to maximise the facilities in each location rather than to do what is desirable (Hungary & UK *Interview Studies*);
- the difficulty of closely relating the work in the suite to other work in the classroom (France *Interview Studies*).

Hungarian teachers complained that this latter problem restricted work on projects. Even with the use of suites, teachers in Hungary and France had to split the class to allow the correct student:computer ratio. The situation in Hungary seemed to be most acute, as recorded in the *Classroom studies* 'National conclusions', with one teacher in a computer suite having insufficient computers to ensure small groups (instead having to tolerate up to four students at a computer), and insufficient chairs for the class (Case 10, lesson 2, Hungary). The Finnish classroom studies showed an example of how access to ICT affected a teacher: she had access to five computers and hence several students working on a computer and even then had to take some students to other classrooms to use two computers (*Classroom studies*, Case 3, *Senses and the Brain*, Finland). On one occasion this teacher could not get access to the additional computers and students were left with unsatisfactory tasks. (There may have been an issue of lack of prior planning on the part of the teacher.) Again, in a Hungarian classroom study a teacher used a room where half of the class worked on the computers and half on individual work (Case 11, lesson 2). When one room has a computer and projector, teachers focus on whole-class teaching, leaving individual or group work until they move to the computer suite (*Classroom studies*, Case 10, lesson 2, Hungary). A Hungarian teacher captured the restrictions of access, and defined conditions of use:

The mathematics LOs might be embedded into the syllabus, but they are not compatible – some of them include exercises for more classes, so during class it might be used in parts or by review as a whole. I suggest the use in class only if every student is able to sit next to a computer and there is also a blackboard in the classroom. This way I could use 5-10 minutes long segments.” (Hungary *Interview Studies*)

The experimental study illustrated how it was possible to take elements of the normal classroom to the computer suite. The teacher in this case took bulbs, batteries etc., to the computer suite to integrate the normal classroom work with that involving the LO. This is not of course always possible and, had the teacher been using a simulation of a chemistry experiment, health and safety issues would have precluded it. It is also commonly the case that computer suites are not well designed for any work not involving the computer, offering limited space to put books or other material.

On the other hand, a classroom study showed how the use of laptops with wireless connections can overcome this by allowing work on the LOs to be integrated with the rest of the work in the classroom (*Classroom Studies*, Case 13, *Reproduction*, UK). All of the classroom studies, except one, the UK one (Case 13), exhibit the use of a suite, which entails whole lessons being given over to the use of the LOs that may affect, not only the integration of the work, but also the links that are made among LOs. (We discuss this latter point below: *Issues, Blended learning*). This case study also helps to give a sense of perspective on the ICT access issue, because the

limitations of suites will diminish as wireless and portable devices become more ubiquitous in schools.

Hungarian teachers also expressed concern about students working on different LOs, particularly when audio is involved, though we have no observations of such classroom situations. Not all schools have computers that are equipped with headphones on all machines (even in computer suites), which would remove this problem.

There are also some technical issues about particular school systems. For example, the French classroom studies show schools with firewall difficulties and with lack of plugins that enable the LOs to operate properly. There are also problems with line speeds to access and download LOs for student use. These kinds of problems often lead to the need for teachers to have ICT skills to cope.

7.2.2 ICT skills

Sections 4 & 5 have already discussed the general relationship of teachers' skills and previous experience and their views on LOs. Here we consider some of the experiences teachers had with LOs that required a degree of skill that may not be found in the teaching force more generally. The Finnish 'National conclusions', in the *Classroom Studies*, argued that one of the most important reasons for LOs being integrated as natural parts of the teaching and learning sequence in the classroom was that the teachers in Cases 1, 2 and 4 had good ICT skills and that they were used to using technology with their students. They cite the work of Lim and Barnes (2002) to support the view that the necessary attitude, skills and knowledge are needed to: identify the cognitive opportunities and limitations of LOs; plan and organise activities to take up their affordances and address their limitations.⁵² In these cases, the teaching and learning activities related to each other in a flexible and meaningful way. The less advanced teacher in Case 3, they argue, had problems in organizing the process; the activities didn't form a cohesive whole.

Similar experience was found in the French classroom studies, where in Case 5 (*Water cycle*), the teacher could not start without considerable technical support to install relevant software etc., to permit the use of LOs. Even in cases where the technical skills were not the issue, inexperience in the use of LOs meant that the teacher had not become familiar enough with the software to enable her to ensure a successful lesson (*Classroom studies*, Case 3). There was also a case where a teacher gave over control of a lesson to a researcher who was trying to encourage the use of LOs (*Classroom studies*, Case 12, Ireland).

Teachers' good ICT skills and understanding also help to overcome the general technical problems in using LOs (and other technical problems such as wireless connections and downloading as in UK classroom study, Case 13). Particularly in the Finland classroom study Case 4, where several technical problems occurred, the importance of the teacher's ICT skills was apparent. The problems did not confuse the teacher; he knew how to solve them and, for example, he made direct contact with the

⁵² An affordance was originally coined by Gibson (1979) and refers to the opportunity that an environment offers to the learner, such that they can act in a way that takes advantage of what the environment offers. In this situation the LO represents the 'environment'.

collaborative network providers (though the LO in this case was not a CELEBRATE one). In Cases 1 and 4 in Finland, and Case 13 in the UK, the teachers had no problems in helping the students with technical problems, and the students obviously relied on the teachers in problem situations. In Case 3, the teacher managed the use of the Portal and the LOs, but she had some problems with more advanced technical issues, such as the functionalities of a new operating system.

These issues are not of course unique to the use of LOs, but they do need to be borne in mind when consideration is given to a more wide-spread use of LOs outside the rather more 'advanced' group who participated in CELEBRATE. The skilled teacher in the UK classroom study was reported as saying:

he believed that technical problems might make other teachers with low ICT skills, and who have only a certain amount of time to prepare a class, reluctant to use the material.
(UK *Classroom Study*, Case 13)

Teachers in Hungary, where ICT skills are generally more limited, voiced concern in interviews about the level of ICT skill needed to use LOs, and the Hungarian *Classroom studies* 'National conclusions' point this out.

It was evident that the teachers observed were above average in skill and most were able to handle the technical needs. This was confirmed by an analysis of high and core level skilled teachers against whether they experienced technical problems.⁵³ (Note that, while ICT skills distinguish teachers' reactions, ICT usage in the classroom does not; see Section 5.2.2 & 5.2.3.) In some senses the use of LOs reproduces the kinds of conditions that teachers experienced in the early days of ICT usage when there was a higher degree of unreliability than currently is the case. However, even in the case of skilled teachers, slow downloading of LOs for use can disrupt a lesson, and a failure of the Portal requires back-up plans, such as prior downloading of LOs or use of digital material more generally available on the web (Hungary *Classroom Studies*, Case 10, lesson 2). Such technical issues require additional elements of preparation time to prevent wasted lessons (*Classroom studies*, Case 10, lesson 2 and 'National conclusions', Hungary). Although the teacher in the Ireland classroom study (Case 12) was not technically expert, he was able to switch to using another LO, when there were downloading problems with the intended one, the expertise to do this being largely related to being familiar with the content of the new LO.

These accounts confirm the view discussed in Sections 4.4.2 and 5.2.2 that distinguished between the technical and pedagogic elements of ICT skills. They show how awareness of a technical issue (the possibility of the Portal 'going down' or the need to download an LO onto students' machines) means that pedagogic planning is required (more time for preparation or alternative activities or sources of LOs). The elements blend into each other and it is evident that teachers with experience of using LOs, and other such digital material, can handle the technical issues or, where they cannot, have pedagogic strategies to work round them.

⁵³ Section 5 described these two groups (see Table 5.1) and examined their responses about whether they had encountered any technical problems. The core-ICT skills group were more likely to have encountered technical problems, compared to the high-ICT skills group, the difference being statistically significant.

7.2.3 Preparation time

The questionnaire evidence on the additional workload of using LOs in relation to their benefits is mixed. Figure 7.1 shows that there is a significant minority who think that the extra work is greater than the benefits. Inevitably, when teachers use them for the first time, this work is above normal. (It may also be that using them for a limited pilot period increases the sense of lack of return for the preparation work, given that the LOs may not be available in the future.)

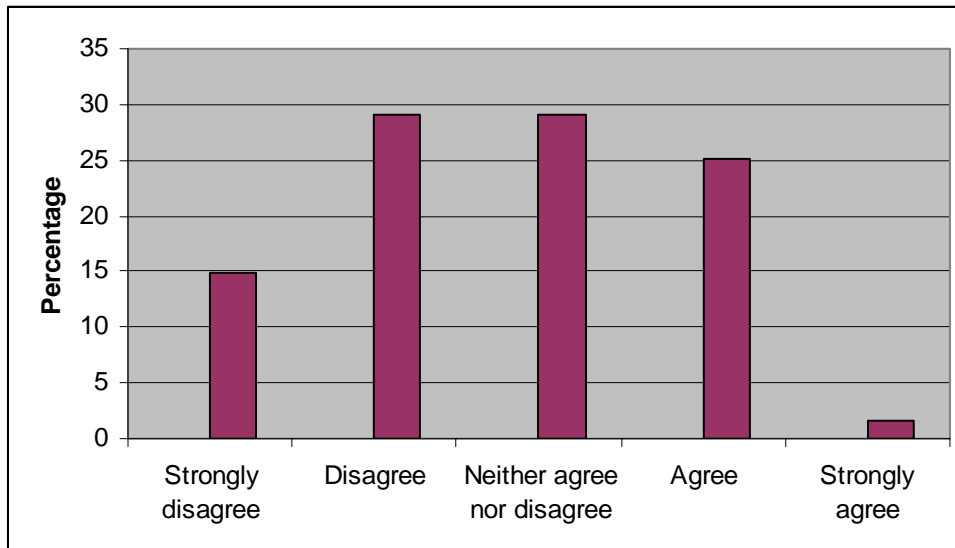


Figure 7.1: teachers' views on whether additional workload of using LOs is greater than the possible benefits

Nevertheless a need for additional preparation time was evident in a number of classroom studies, and was part of the advice teachers interviewed offered to teachers using LOs for the first time. Such advice includes:

The teacher is urged to study the material first by her/himself, and to reserve enough time for that.

Preparations include plans regarding the facilities. It is advisable to reserve the necessary room and computers well in advance before the LO teaching period.

It is also worthwhile to make a proper lesson plan specifying the teaching method: demonstration by the teacher, pair work etc.

(Finnish and French *Interview Studies*)

This last point is important for experienced teachers used to working without formal written plans; research in general use of ICT indicates the importance of planning how the lesson will proceed and how ICT resources will be used, which might involve a change in classroom practices (Cox *et al*, 2004).

Where teachers spent time downloading LOs onto student machines prior to lessons (*Classroom studies*, Case 6, France), then, although preparation time was increased considerably, precious time was saved in the computer suite, a limited resource. It also short-circuits any time wasted trying to download an LO that is causing problems. Even the familiarisation with the LO, noted above, is important to alert the teacher to pitfalls and shortcomings of it (e.g. the mistakes as found in *Classroom studies*, Case 8, France).

7.3 What LOs offer to a teacher's pedagogy

Teachers commented on the importance of being able to add to the mix of student activity in the classroom, and LOs add to this mix by extending their repertoire (Finland & Norway *Interview Studies*). This is evident in the range of activities for which LOs have been used, including whole-class teaching, group work, individual work (with and without help), as we indicated in Section 4 (see Figure 4.10). For teachers this offers a boost to their teaching, coupled with the motivating effect for students we discussed in Section 6, with teachers overall saying that it improved their practice (57% of teachers agreed with this; see Figure 4.5). The kinds of advantages they noted were the fact that it allowed multi-media approaches (Finland) and that it could add value to (Norway *Interview studies*; *Classroom studies* Case 11, Hungary), or even replace, books (France). Simply doing activities in a different way (e.g. to illustrate practical aspects) was seen to be important (France), as we noted in Section 6 for an individual student learning English (Finland). There was also mention of LOs allowing for different 'learning styles'.⁵⁴ For Hungarian teachers the fact that LOs allowed experiments that were complex, or where equipment was lacking in the school, was an important benefit.

There are apparent country differences in the types of activities that LOs are used for⁵⁵, with Finnish and Hungarian teachers rating their use for whole-class teaching well above other uses and French teachers rating individual or small group working (with teacher's help) highest. Norwegian teachers also rated individual and group working highest, but they evenly distributed their ratings over all possible activities.

However, the questionnaire data are equivocal. When asked about their views about fitting LOs into whole-class teaching (something over 60% of teachers said they did), only around 40% agreed that it was easy to do this (see Figure 4.6). Similarly integrating LOs into student activities is not easy, with 49% of primary, and 40% of secondary, teachers agreeing. (We have already noted in Section 6 that teachers did not think that LOs would support problem-solving skills.) One of the issues that might explain this reaction to integrating LOs into student activities, is the view teachers take of how the inherent structure in an LO supports the work of the student. At the lowest level with LOs, in the context of the aims of CELEBRATE, it is easier to keep the students on task (Finland *Interview studies*; *Classroom studies*, Case 10 lesson 1, Hungary), and focuses learning, especially compared with working on the Internet (Israel *Interview studies*; *Classroom studies*, Case 9, lesson 3, Hungary). Teachers welcomed this because it made teaching less demanding (Hungary), and helped with classes with behavioural problems (*Classroom studies*, Case 10, lesson 1, Hungary). A positive example of this was shown in a Hungarian classroom study, where students had to work through a sequence of six LOs that required them to solve exercises in the order defined by the teacher, and students hence did not deviate from this order (*Classroom studies*, Case 11, lesson 2). However, students interviewed in a Hungarian case study thought that the fact that these computer-based activities were new was

⁵⁴ We are aware that, although this idea is popular with teachers, it is controversial, with little consistent robust empirical evidence for such styles in relation to the various models and inventories available; see Coffield *et al* (2004).

⁵⁵ Note that because of the differences in the size of the country samples for the questionnaire we cannot legitimately tests for statistical significance in this case.

responsible for holding their attention; when this newness wore off then any additional holding of attention would disappear (*Classroom studies*, Case 10, ‘Summary of experiences’). Section 6 noted the evidence that novelty is not necessarily the source of the motivation. The motivation could be such that when there are problems using the LOs, students do not drift off task and become disruptive (*Classroom studies*, Case 5, France).

The conflict occurs when the tight pedagogy of an LO contrasts with the open tasks that a teacher might have set. Thus, in one of the Finnish classroom studies (Case 3, *Senses and the Brain*), the teacher had set students an open research task, which they defined, yet the supporting LOs were tightly focused around functions, construction and terminology of the eye, ear, brain etc. This may be a reflection of the specific learning objectives of the LO compared to that of the teacher; this was a general problem as indicated in the questionnaire response where a minority of teachers (just over 40%) thought LOs matched their curriculum objectives (see Figure 6.8). There may also be an issue of the relatively low level of many LOs (a common complaint of secondary school teachers we reported in Section 6, and noted in the Finnish classroom studies, ‘National conclusions’).

It was also the case that the lack of control over the sequence, or over how many times particular pages can be visited, may reduce the pedagogy available to the teacher. In the French classroom study Case 5, the water cycle program was not flexible enough and the teacher had to construct a handwritten set of instructions for students. In another of the French studies (Case 8, *Relations*), the LO pedagogy was apparently a discovery learning one, to explore ‘fractions’, and neither the LO nor the teacher made it clear to students what strategy was to be used to work out rules for the balancing of fractions. The result was a lot of trial and error by students, which, though it was a deliberate teacher strategy, resulted in students having difficulties in constructing a rule.⁵⁶

Another aspect that LOs brought to pedagogy was authenticity, with Hungarian teachers commenting on the material being more realistic. Even where realism may have been somewhat limited, as in the Finnish classroom study (Case 1 *Are you a healthy eater?*), the fact that students could use the LO to test if their own diet was healthy (by entering what they ate over a ten-day period), allowed it to be used in an authentic activity (the limitation was that some of the common Finnish foods eaten by students were not available in the LO menu). We will return to this when we consider elements of advanced pedagogy that are supported by LOs.

7.4 What do teachers want from LOs to support their pedagogy?

The *Teacher as user of LOs questionnaire* asked which types of LOs teachers preferred, using the metadata categories. The most popular types had an ‘instructional’ bias, namely LOs as ‘Information sources’, to provide ‘Drill and practice’ and ‘Simulations’ (65%, 66% and 63% respectively indicating ‘the kinds of LOs do you like to use’; see Figure 4.9). There were no apparent differences in these three most popular types across countries, or levels of ICT skill and usage. Despite the

⁵⁶ However, this was exacerbated by a mistake in the software that required an erroneous rule.

focus on ‘Drill and practice’, teachers did ask for a wider set of types and in particular, not just ‘Drill and practice’. (Section 2 has already indicated that ‘Drill and practice’ is by far the most common type available on the Portal, and the three types that are best liked account for almost all of the LOs available.⁵⁷) Teachers in Norway asked for animations for science and those in France asked for interactive LOs. (These requests are related to teachers’ views on active learning, which we deal with under *Issues, Enhancing active learning.*)

LOs are seen as discrete entities that are to some ‘free standing’ both for the students and for the teacher. Because of this some LOs come with little in the way of instructions for students, and none have instructions for the teacher.⁵⁸ The survey evidence indicates that teachers, particularly primary teachers, are split about the LOs not standing alone (see Figure 7.2).⁵⁹ Teachers in France, Finland and UK expressed concern about the lack of student instructions, and thought that such instructions were necessary for their students. We have already noted that in a French classroom study (Case 5, *Water cycle*) the teacher had difficulties in setting up instructions for her students with a complex LO containing a lot of information to be found from pages that were not very friendly for students to work from. (There was an issue of LO design, but it is perhaps indicative of the lack of user sensitivity and the need to support teachers and students as users.) The experimental study also indicated the importance of instructions and in Section 7.6.5 (*Focus on tasks rather than ideas*) we give details of this.

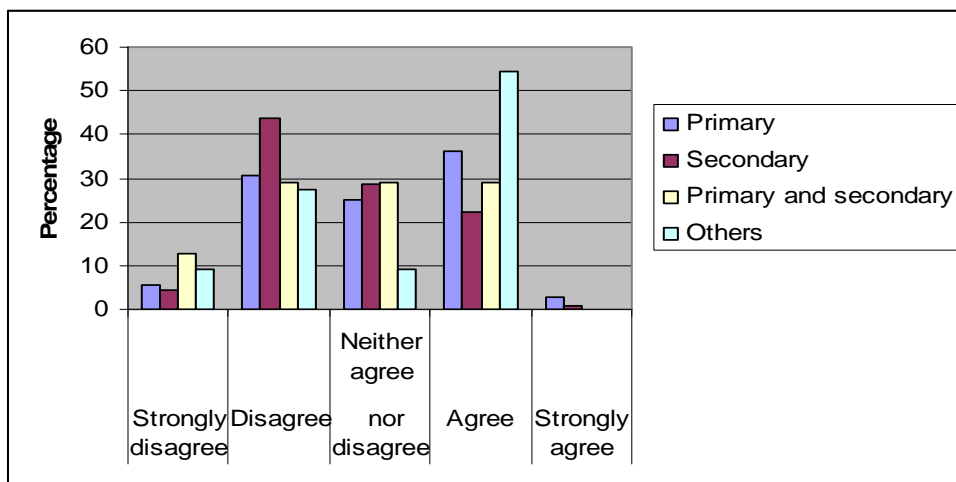


Figure 7.2: most of the LOs do not need additional support material

The lack of pedagogic advice for teachers does not seem to be a large problem. Asked if they need guidance on pedagogy when using an LO, 76% of teachers said they did not need guidance. Figures 7.3 and 7.4 indicate the reasons, with those not needing

⁵⁷ However, it is important to realise that most LOs have multiple types in the metadata, some of which appear to be incompatible; e.g. ‘Drill and practice’ and ‘Exploration’.

⁵⁸ Work Package 2 has developed an area on the Demonstration Portal (*Lesson Bank*) for teacher accounts of the use of particular LOs, though this will be a selective set compared with the number of LOs available.

⁵⁹ There were no evident country differences in teachers’ responses to the question on need for support. Nor indeed difference according to ICT skill or usage levels.

advice having enough ICT experience, and those who do need it worrying about appropriate and effective use. We indicated in Section 5.2.2 that those with high ICT skills consider they have enough experience in using digital materials not to need this advice. (There was no difference, however, in the types of LOs they used, the kinds of activities they used them for, or their pedagogic criteria of choice of LOs.)

In discussing the pedagogic advice given on the Portal, French teachers interviewed said that it was not needed, whereas Norwegian teachers thought it was (the country analysis of Figures 4.7 and 4.8 data confirms these differences). The Portal questionnaire indicates that only 32% of teachers want more pedagogic support (44% did not). Part of this might be the type of language of the guidance given on the Portal, and indeed Hungarian teachers mentioned that the Portal pedagogic advice was not in teachers' language (see *Issues, Differing representations of pedagogy*, below). Teachers in Finland were the only ones who received a pedagogic element in their initial training.

7.5 Differing representations of pedagogy

If we are to understand how teachers employ LOs using different pedagogies, we need ways of thinking about pedagogy. Work Package 2 has already reported on how to represent pedagogy in relation to the tasks of content providers in creating LOs.⁶⁰ That work package tried to provide content providers with ways of thinking about LOs so that the latter could create ones that matched different pedagogies and in particular 'constructivist' or advanced pedagogy. These types of pedagogy were also needed to classifying LOs in metadata.⁶¹ This was not without its difficulties, and some content providers had hoped for more guidance on design (see Section 2.2.3). The discourse about pedagogy associated with LOs is framed by the metadata list, discussed above. This list, called Learning Resource Type in the application profile, is a combination of pedagogical functions (e.g. 'Drill and practice' or 'Exploration') and features of the way the LO operates i.e. software types (e.g. 'Simulation').

The models of pedagogy produced also have to be seen in the light of the views of teachers, thus adding another layer of complexity, particularly when seeking their views on the pedagogy of the LOs or the context within which they will be used. These views are taken from the interview studies and are not to be taken as evidence of accepted views in a country. For example, the Hungarian report talks of there being traditionally three categories of 'teaching methods':

- Prussian, whole-class instruction (i.e. presentations);
- Co-operative and collaborative (possibly combined with the above);
- Alternative reform pedagogies (e.g. Montessori, Waldorf, and Kagan).
(Hungary *Interview Studies*)

Such categories are likely to frame the discussion of pedagogy about the use of LOs, along with practical issues such as the limitations of the facilities and access to ICT

⁶⁰ D 2.1 Interim report on pedagogical models.

⁶¹ This metadata specification was the subject of a separate report (Nirhamo, Artacho, & Van Assche, 2002).

(discussed above). Teachers talked about LOs using some of the CELEBRATE metadata categories, but also others; for example:

Finland: teachers talk of different uses of LOs, for example, a new topic handled by an LO, revision, a break in the teaching (by the teacher), to broaden the repertoire of teaching, and to use multi-media. This is again a combination of how it adds to pedagogy, and its role in a lesson.

Norway: LOs were seen to have different purposes, for example, introduction, explanation, experiment, drill and practice, and assessment. These combine some of the metadata types and the role of an LO in relation to a lesson function.

It is important to reiterate that these views should simply be seen as examples of the way teachers talk about pedagogy.

Neither content providers, nor teachers, were used to the language of those who study the theoretical aspects of pedagogy. This makes it difficult to be clear about what features of pedagogy to discuss or to report on. We have already given teacher views in terms of the metadata categories, but it is evident that these categories are neither exclusive (and hence not a definitive identification of the LO's pedagogy), nor indicative of the way teachers have used or could exploit them. For example, the Finland classroom study Case 4 shows how a teacher, in asking students to analyse the way LOs contribute to different 'intelligences', can completely side-step the pedagogy 'defined' within the LO. (The activity and hence the pedagogy defined by the teacher rendered irrelevant any pedagogy within the LO.) In many of the classroom studies we see teachers building pedagogical practices round the LOs, especially where none is evident; for example the LOs in the French classroom studies, Case 8 (*Relations*) and 5 (*Water cycle*), where the LO assumed some kind of discovery learning, while not making clear how this should be conducted. Teachers in such situations resort to creating instructions that are a combination of how to use the LO and tasks that they are to perform. This allows them to make best use of the LO for their students, and to integrate its use into their pedagogy.

An analysis of the classroom studies can, however, bring to bear some of the theoretical ideas, especially in trying to see the extent to which LOs can support advanced pedagogy. The 'Cross-country conclusions' in the *Classroom studies* refer to this as the *affordances* of the LO, and indicates how various types of LOs may or may not support this pedagogy. The analysis of the classroom studies indicated that some features of advanced pedagogy were evident in the implementation of the use of LOs by teachers and shows the extent to which LOs support this pedagogy. Thus some activities:

- were *authentic* e.g. the use of student's own diet to input to the *Healthy Meal* LO (Finland, Case 1) and the use of a real bakery (France, Case 6);
- allowed some *student responsibility for learning* i.e. recognised the agentic learner (Bruner, 1996), e.g. allowed the student to define the task to research (Finland, Case 3), required students to create strategies for finding out a rule for fractions (France, Case 8) and seeking out information on the water cycle (France, Case 5);

- drew on outside expertise and hence allowed *different representations* e.g. produced diagrams from different points of view from that of the teacher (UK, Case 13), and drew in other experts (Finland, Case 1);
- enabled *collaboration*, even though the tasks were largely individual (Finland Cases 1-4);
- encouraged *student reflection* e.g. through discussion (Finland No. 4) and requiring students to create a rule for fractions from the effects of a simulation (France, Case 8).

However, some of these features were achieved by the teacher adding activities or other materials to allow the overall pedagogy to exhibit these features. For example ‘student reflection’ was seen in a Finland classroom study (Case 4); through the use of a special piece of software not part of the CELEBRATE LOs, nor indeed an LO (*IQ-Forum* and mind mapping software, *The Mind Manager*). Even where an LO could directly support one of these features (e.g. the first example above of *Healthy Meal* providing authenticity), there were limits, because the LO could not anticipate the unique responses that students would want to make (e.g. to use food items not held by the menu on offer in the LO). This discussion implies that it was the *use* of the LO rather than exclusively something inherent in the LO that defined the feature of the pedagogy associated with the LO.⁶² This is compounded by the fact that LOs were not usually used within a virtual environment but, even where they are, elements in the environment contribute to the pedagogy as much as the nature of the LOs (see *Blended learning* below).

Nevertheless, it is evident that LOs can encourage pedagogy that might be considered as ‘innovative’ in particular circumstances. For example, in Hungary LOs encouraged more individual work than is usual; whole-class instruction being the predominate form of teaching (*Classroom studies*, Case 9). Equally it is possible that the instructional model embedded in the LO may be too rigid, in terms of say the routes through the material, such that the teacher is almost helpless in trying to fit a suitable pedagogy to the situation. Again, a point made in the *Classroom studies*, ‘Cross-country conclusions’. This appeared to be the case in the third French classroom study, where the teacher was powerless to alter the sequence and pace of the presentation of information, which was necessary to cope with the particular needs of her younger learners.

Thus, it is possible to conclude, on the basis of the evaluation evidence, that it is possible to support a constructivist or advanced pedagogy through the use of LOs, but that this is more likely to be a feature of a teacher’s classroom than the LO. Clearly the LO type may have some impact on this (i.e. it has affordances), but it is evident that even the most apparently ‘non-constructivist’ or ‘non-advanced’ LO (e.g. Drill and practice) could be used as *part* of advanced pedagogy, if the teacher has the skill of use and the repertoire of approaches in her teaching. (Below we discuss the specific aspects of student agency and collaboration under *Enhancing active learning*.) However, our evidence is too limited to be able to systematically match LO types and

⁶² This is an illustration of the general argument made by McCormick (2003), which has been discussed by the CELEBRATE partners. See also Ilomäki *et al* (2004).

their affordance for advanced pedagogy from this evaluation, but we explore examples drawn from the evaluation in Appendix 3.

At the workshop to consider the evaluation report (D7.1), participants requested that this interplay between the variety of factors that could govern a successful pedagogy should be represented by a triangle of theoretical ideas that can influence pedagogy, the LO type, and the pedagogic practices that can result.⁶³ To this we have added some features to indicate the interplay (see Figure 7.3). Thus theoretical ideas, such as ideas on agency, authenticity etc. (the features of advanced pedagogy we examined above), can be seen to influence the LO development and the metadata that are used to describe the type created. But they also to some extent influence the teacher's pedagogic practice. This practice is mediated by the teacher's ICT skills, ICT experience and ideas on learning. In turn the interaction of the LO type and the pedagogic practices is a two way interaction with the LO giving affordances, and the teacher's expectations of what LOs can do and their own conceptions of learning helping to form the resulting way the LO is used in the classroom.

The 'Cross-country conclusions' in the *Classroom studies*, argued that the theoretical ideas about advanced pedagogy could be instrumental in changing teacher pedagogy, hence the arrows of influence at the apex of the triangle are downwards, influencing both LO types and teachers' pedagogic competence.

However, at the workshop there was an alternative view given, thought to particularly describe the situation of teachers who might be starting on the road to the use of LOs: that LOs should be constructed that corresponded with teachers' ideas and practical knowledge. This is represented in Figure 7.4, where it is teacher *pedagogic content knowledge* that drives both the nature of LOs and of pedagogic practice. Such knowledge is professional knowledge built up through experience and consists of knowledge about:

- the subject curriculum rationale, goals and content;
- how students learn;
- and pedagogic strategies based on the above to be able to plan and implement effective classroom approaches.

(Banks *et al*, 1999)

This model sees LOs trying to assimilate teacher's pedagogy and endorsing their current conceptions of teaching and learning. These two views of the role of the development and use of LOs are discussed further in Section 8.2.5.

⁶³ The initial idea came from Erno Lehtinen, though adapted by the Open University team.

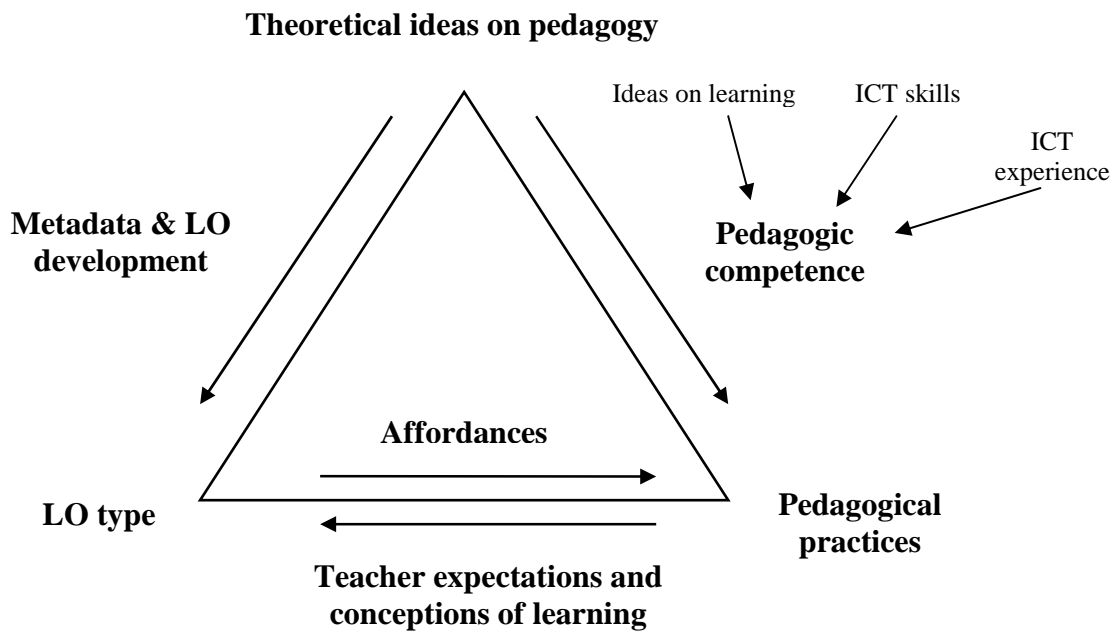


Figure 7.3: interplay of theoretical ideas, type of the LO, and teacher's pedagogic practices

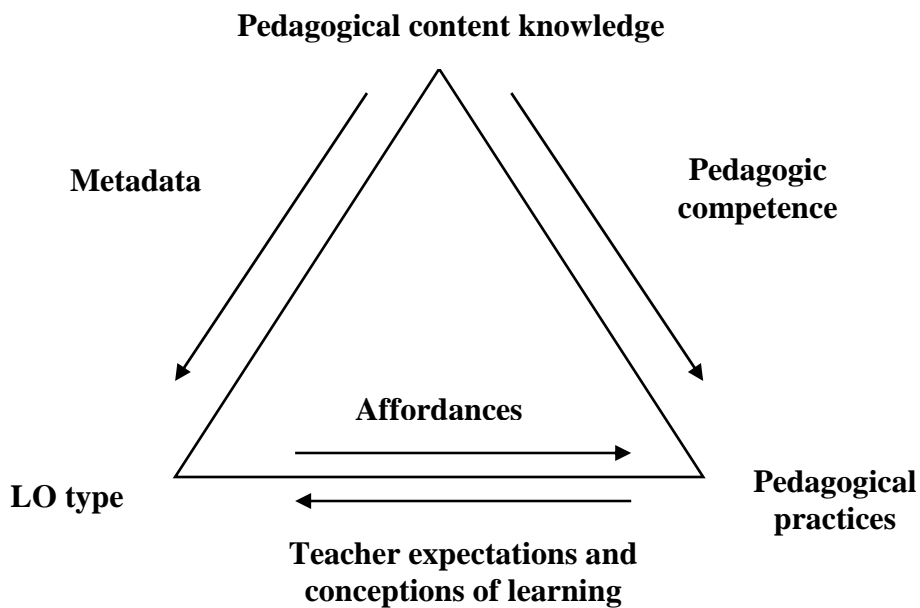


Figure 7.4: interplay of professional knowledge, type of LO and pedagogic practices

These two approaches can be used to explore not only the ideas of pedagogic practices, but also the way in which the basic steps in the whole process that the CELEBRATE project has been involved in are conceived. Thus the creation, searching, use and modification, can be thought of differently depending upon which model governs the whole of the 'learning object enterprise'. For example, they affect how producers of LOs should think about the development process (to try to create LOs with advanced pedagogy or simply replicate what they know how to do already), and how they should then describe LOs in the metadata. This in turn affects how



teachers will search for and choose the LOs that match or push forward their pedagogy.

7.6 Issues in the employment of LOs

Here we consider the issues that arise from the teachers' use of LOs that relate to pedagogy:

- how they blend learning with LOs with other classroom activities, and how that relates more to resource-based learning than to the way we usually think about the use of ICT-based learning;
- how the same LO can be used by teachers as part of different pedagogy, reinforcing the idea that the pedagogy may not reside *within* the LO;
- the teacher's role in the classroom when using LOs;
- how active learning, a central feature of constructivist pedagogy,⁶⁴ is enhanced;
- and finally, how some features of LOs give rise to some unexpected or unhelpful results.

Each of these has a bearing on how LOs are employed and the way they interact with the teachers' pedagogical practices, and hence how usefully and efficiently LOs are used.

7.6.1 Blended learning

Earlier (Section 2.7.3) we postulated a spectrum of LO provision with a 'modular ideal' of LOs at one end and an 'integrated ideal' at the other. This earlier discussion noted that CELEBRATE was trying to take the modular ideal from the training tradition in the direction of what we have termed 'advanced pedagogy'. The literature on LOs, drawing mainly from this training tradition and that of educational technology, seems to have a vision of learning objects being largely used in a virtual environment (McCormick, 2003). Thus an instructional designer can construct the integrated teaching sequence from individual LOs. It is this integrated whole that content providers might see themselves offering to teachers. Indeed, within the project, some had to breakdown complex LOs to their modular elements. The CELEBRATE pilots did not use this integrated approach, based on teachers operating in an exclusively virtual sense, even though some of the lessons were spent exclusively working on the computer. By and large teachers embedded work in a virtual environment into ordinary classroom activities; what is usually referred to as *blended learning*.

Nevertheless one of the concerns of the project was to see if LOs could be linked together to form a complete learning experience, which would perhaps be largely virtual. Several of the content providers in the CELEBRATE project have virtual learning environments (VLEs) where this kind of approach could be realised, and indeed teachers had access to the one provided by Digitalbrain (one of the content providers) through the Demonstration Portal. A large proportion of teachers never or

⁶⁴ Here we have adopted the term 'constructivist' to align the idea of agency with the likes of Bruner (1996).

rarely used this environment, as is evident from Figure 7.5, and no one referred to its use in the interview study evidence. The Demonstration Portal questionnaire indicated that for almost 70% of teachers the Portal was their first VLE experience.⁶⁵ (We will shortly examine the idea of the Portal as a VLE, picking up on the evidence in Section 3.3.3.)

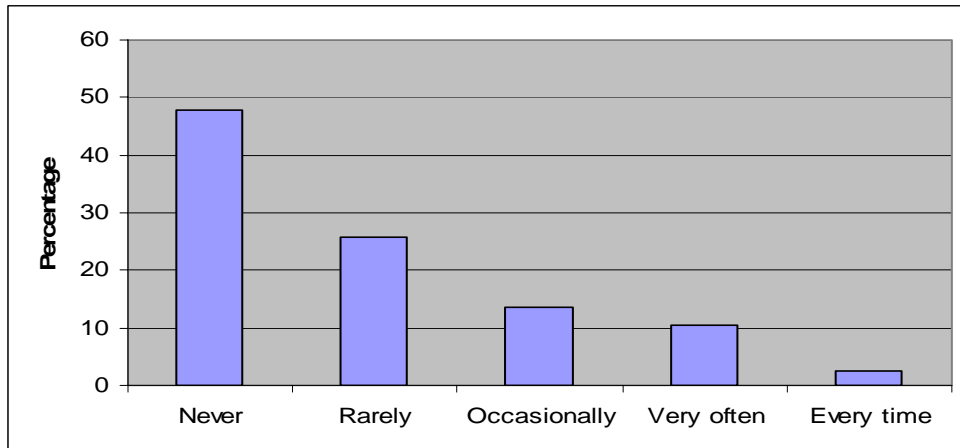


Figure 7.5: When you use the Demo portal, how often do you use the following functions of the portal? (for the Virtual Classroom)

Even where we have classroom studies that observed teachers using a number of LOs, they were not always connected in a close sequence, and where they were, this was orchestrated by the teacher. Thus in Hungary a teacher used a sequence of LOs to structure a sequence of work on the ‘interaction of living beings with the environment’ as a practice and summary session (Case 11, Lesson 2). Another allocated LOs and tasks to students who then worked on them separately (Case 9, lesson 4). Some of them used e-mail to communicate with students (e.g. to allocate tasks as in Case 9, lesson 4, or to get students to send in work; Case 9, lessons 3 & 4), and this is the nearest Hungarian teachers came to the use of a virtual environment, but still under the direct control of the teacher. In France when a language teacher had students work on a series of LOs, she controlled and monitored progress through these, using her own assessment. In a classroom in England (*Classroom studies* Case 13, UK), the teacher used one LO for student work in pairs, with him in a supporting role, and one as part of a questioning sequence with the whole class (based around a crossword). (There was also a considerable amount of input from other kinds of resources, including a video and a *PowerPoint* presentation constructed by the teacher.) Similarly in a Finland classroom study (Case 3), the teacher used a series of LOs on the senses and the brain, and students used them as independent inputs to their understanding of the topic.

Evidence from all of the classroom studies indicated that many teachers treated LOs as independent elements or at best a series of LOs linked by them in the classroom. We have already noted how teachers created instructions to support students’ work through LOs. This is not just that they do this for convenience, but they are trying to maximise the effectiveness and efficiency of the use of the LO. The experimental

⁶⁵ The evidence for this has already been discussed in Section 2.7.4 and Section 3.3.5. [Teacher as user of LOs Questionnaire A&B; Data analysis Section 3.5

study supports this combination of the LO with their own pedagogy, as it indicated that a combined approach, using an LO (a simulation of a circuit) and classroom work, was more effective in all aspects of the development of student learning than classroom work alone.

This blended learning approach, is in contrast to the discussion in the LO literature, largely based on work with LOs in an electronic environment. However, a recent survey of VLEs in Europe notes that this blended approach predominates (Vuorikari, 2003). This is reinforced by the evidence considered earlier; that teachers are happy to use LOs for a variety of types of classroom activities even though most are Drill and practice (i.e. of a particular apparent pedagogy; see Section 4.5). It is also reinforced by the fact that content providers give quite different metadata tagging on the same LO, e.g. 'Drill & practice' and 'Exploration', indicating that there is no single pedagogy associated with an LO. (A point drawn attention to in the *Classrooms studies*, 'Cross-country conclusions'.)

The fact that the use of LOs to support work at home by students was the least used (see Figure 4.10) perhaps relates to how teachers think about LOs. Such independent work requires some simple virtual environment, even if it is only a work space for the students that can be accessed remotely, to pick up and place work. Although we did not investigate the extent of schools' facilities in providing such remote access, it is evident that this could be seen as the situation for the development of a set of LOs linked within a virtual environment. (This was of course limited to some extent by the fact that teachers could not modify an LO in the Portal and hence link them by combining them.)

One of the classroom studies did, however, show elements of an approach that used a virtual environment to support the nature of the use of the LOs (*Classroom studies*, Case 4, Finland). In this study there were a variety of kinds of 'LOs' used, not all from CELEBRATE (and not all necessarily conforming to the interoperability and modifiability characteristic of LOs), and they were also supported by a virtual discussion environment. This created something of a virtual experience, but even here the LOs were not all embedded within this environment. But, with this particularly experienced and skilled teacher in the use of ICT, it was possible to build a strongly virtual experience, albeit not an exclusively virtual one. It is unlikely that this would be within the range of most teachers. At training sessions observed by some of the evaluation team, it was evident that when the virtual environment was introduced, it caused some problems to the teachers and they clearly needed considerable time to do this.⁶⁶

Section 3.3.3 indicated that there were early signs of a need to see the Demonstration Portal as a form of organisation of their use of LOs with students, even though it had not been envisaged to be used in this way:

I was certainly discussing it with a couple of my colleagues and it was kind of once you find something good you thought right I will use that for my Year 8s [students aged 12-13] next week and then you have got your Year 8s in front of you and you have got them in settled and quiet and then you are standing at the board for five or ten minutes trying to find that exact

⁶⁶ Digitalbrain allow 3 days for initial training of teachers in the basic use of their virtual learning environment.



learning object and by that stage you know the flow of the lesson is interrupted
(UK *Interview Studies*)

This plea for some way of storing LOs for use by particular groups of students is one feature of a virtual learning environment. A number of teachers in Finland, France and Hungary were using the Portal as a form of virtual environment by giving their students access to their basket where they had assembled a number of LOs for student use:

Many of the teachers have used the Basket with the students; one teacher has allowed the older students to search the LOs themselves, while another has guided the students to their own virtual classroom.
(Finland *Interview Studies*)

One teacher went on to postulate a possible 'VLE' use for the Portal:

The experience of using the CELEBRATE Portal inspired one teacher to make it a point of departure, or to include it in course plans for each subject. The idea was therefore to try [to] find a module where children would systematically have to visit the Portal every week, with the teacher selecting the learning objects and putting them in the basket. Each child would then dip into it and choose a learning object corresponding to his or her level.
(France *Interview Studies*)

This would limit what students have access to and allows teachers to focus their attention and control the learning situation. Others were prevented from doing this because they were concerned about the possible failure of their connection to the Portal during use with students, and so were downloading LOs onto their network or directly onto students' machines. The teacher in a French classroom study (Case 7, *Exploring the comparative form*) could have used the Portal with students, so they could work through the sequence of 'Drill and practice' LOs. But, she felt it important to personally control progress through the sequence based on her assessment of student achievement after each LO; she then, for example, told them to repeat an LO if she felt they had not learned sufficiently. (This would not be easy to set up in a virtual environment.) It may also mean that the size of LOs would have to be short enough to allow the sequence and speed of progress through the sequence to be controlled in a lesson. In the case of this French classroom study the length of use of the LO was about 10 minutes. (This has important implications for the size of LOs, an issue we return to in Section 8.)

It was never the intention of CELEBRATE to evaluate the use of LOs by teachers in VLEs, either the one on the Portal or any they have access to through their school. The state of development of these environments is such that this would have been premature.⁶⁷ In any case, it seems to us that a completely different project would be needed to investigate this kind of context, for example, one with more teacher training added. Given the number of teachers with access to virtual learning environments currently, this kind of study may have to be conducted later.

⁶⁷ We were struck by some similarities in the findings of the European Schoolnet survey of VLEs in 2003 (Vnorikari, 2003), where some of the aims of ministries etc., in providing for the use of VLEs, were also directed at promoting 'advanced pedagogies, in the same way as CELEBRATE. We have more to say on this in Section 8.

This treatment of LOs as a set of resources for students to be given access to, not just to carry out research (a common role for web sites that are set up for students to access), but to do other activities, creates a sense in which the ICT is providing a wider set of *resource-based learning*. LOs provide not just information sources, but also more instructional or exploratory resources. This may give many teachers a new insight into ICT than they conventionally get from usual classroom use. The use of computer suites, discussed earlier in relation to access to ICT, may of course mitigate against this, given the difficulties they present to teachers who want to integrate LO work with other classroom activities.

This also relates to the discussion in Section 2, about the different business models and the degree to which an LO can be separated from the electronic environment for which it is designed.

7.6.2 The same LO, different pedagogy

Continuing on with the theme of where the pedagogy might reside, we have examples of where LOs can be similar or even the same, which are used with quite different pedagogy. Evidence from the survey indicated that almost three-quarters of teachers thought LOs could be used for both individual and collaborative work; on the face of it these are two quite different requirements.⁶⁸ Evidence from classroom observations also supports this multiple view of pedagogy of LO. Thus we have the two classroom studies from Finland (Cases 1 & 2), where the same LO was used (*Healthy meal*), one in Finnish and one in English. The teachers had quite different objectives and nested the same LO in a different pedagogical setting. In one set of lessons the LO was used to check if students' diets were healthy, and in so doing students would understand the nature of their diets (and what a healthy diet means) as well as the conceptual ideas related to nutrition. In the other lessons the LO was to support the development of an authentic English vocabulary about nutrition for Finnish students learning this language. The conceptual ideas around nutrition were incidental. In the first case the LO was indeed exploration, whereas in the second it could be seen as a resource for language use, to complete, for example a personal dictionary, much as a book might be. The experience of Digitalbrain, in the creation of LOs that were designed with one situation in mind being used in many others, was also made evident in the content provider interview. The example cited was the *Colour wheel*, intended to support work on colours, which has been used with a wide age range of students and in many different subjects.

This of course complicates the issue of metadata indicated at the end of Section 7.5, as it means that any intentions that the provider builds into the metadata categorisation of pedagogy, could be 'overturned' or just ignored by the teacher. Of course the intention in the classification must be to indicate the affordances that might be associated with a particular type, but in the absence of a good analysis of affordances in relation to the existing types, this is unhelpful advice! We will return to this in Section 8.

⁶⁸ We have already indicated in Section 6.3.3, that real collaboration may not result without a deliberate design of such activity by the teacher.

7.6.3 Teacher role in the classroom

We have already noted that the survey of teachers indicated that opinion is split as to whether LOs need additional support material (Figure 7.2). However, our observations in the classroom indicate that careful consideration needs to be given to the role of the teacher, and this formed an element in the *Classroom studies* 'Cross-country conclusions'. Where the LO has a strong instructional role, with a content focus, the teacher had little role in supporting the students in relation to the content. For example, in the England classroom study (Case 13), the teacher made a total of 84 interactions with students as they worked on the LO in pairs, and in only a few instances did he say anything about the content. These few interactions were attempts to scaffold student learning, but only at a superficial level. Although this teacher used a number of strategies to get students to think (e.g. asking questions, elaborating upon their responses) in other parts of the lesson, none of these strategies were used during work on the LO.

Similarly in three of the Finland classroom studies (Cases 1, 3 & 4) and the Ireland study (Case 12), the teachers had little role in relation to the content. In these cases the LOs and other resources (including outside speakers) provided this role. The assumption is that the LO (among other resources) carries the burden of the content. Interestingly, the one example we have of a teacher being involved in the content is when there was a mistake in the LO. In this Irish classroom study (Case 12), we observed how a teacher used the mistake as an opportunity for students to learn and was pleased to see that they had spotted a problem and he discussed with them the ideas involved.

At times when using LOs, the preoccupation of the teacher in the classroom is with making sure there are no technical problems (whether in the general use of the computers or arising directly from the LO) and in checking progress. Again, in the England classroom study, 40% of the number of interactions with students were of this kind. This checking, in some other cases, extended to ways of working and what might be considered as meta-cognitive comments etc., to facilitate productive thinking. This was the facilitator role discussed in the *Classroom studies* 'Cross-country conclusions'. The structure provided by the LO, or the way tasks were constructed tightly around the LO, focused the teacher role on prior planning and activity design, rather than in working hard on the content during the lesson. (It is probably this that motivated teachers to say that teaching is less demanding when using LOs.)

There are obviously some issues here for both LO designers and teachers to consider. For LO designers they may need to build in activities that go beyond the LO for students to try out their understanding (with each other and the teacher). For teachers, there is the need to realise that they must be more proactive in investigating the level of students' understanding, through questioning and scaffolding if necessary.

7.6.4 Enhancing active learning

Section 6 has already indicated the importance teachers attributed to students' active learning. The preferences for LOs, indicated in the questionnaire that we discussed earlier in this section, although perhaps appearing to favour a passive student (e.g. LO used as an information source), is not viewed as such by teachers. For example, from

the point of view of what pedagogic criteria teachers use to choose LOs, it is evident that primary and secondary teachers in all countries want them to support student-centred discovery (this is the first preference for all, see Figures 5.1&5.2). However, there are country differences in how many student-oriented criteria are used; Finnish teachers give supporting student presentations and being useful for independent study as second and third preferences, respectively, whereas the other countries' teachers all include 'conveying information effectively' as a first or second preference. But these latter preferences need not be seen to be passive, as a classroom study from Hungary indicates. In this case a teacher set up over ten 'instructional' LOs that either contained information or were trying to teach through explanations and questions (Case 10). Students worked in groups on one or more of the LOs to try to understand the way waves operated in a variety of situations, including musical instruments, they were then required to be involved in reciprocal teaching (one from a group explaining to another group; Brown & Campione, 1990). Even in the England classroom study (Case 13), where students worked through an LO to attach labels of parts of the human reproduction system, this is more active in terms of thinking than any book-based method might allow.

The first Finland classroom study (*Healthy meal*) shows how this activity can be built into the LO, provided it is put in a context that emphasises student agency that is at the heart of active learning. The third case study from Finland (*Senses and the brain*) shows how activity is only evident in the way the LOs were used; by students creating their own research question as a basis for work that included the LOs. This also relates to features of the LO and to how these may encourage a focus on tasks rather than ideas (see the next sub-section). The evidence from the *Classroom studies* (see the 'Cross-country conclusions'), and from the quantitative data in Section 5, is that the exploitation of such agency is more likely to be done by those teachers who have more ICT experience.⁶⁹

One other way to enable agency is through collaborative activity involving LOs. Hungarian teachers noted that practical circumstances relating to access to ICT resources resulted in pairs working on an LO together, but that the LOs do not always support collaboration. Lack of support for collaboration in the LO design was also mentioned in a Hungarian classroom study (Case 9, *Energy*). However, as noted earlier, the generality of teachers surveyed thought that LOs could be used both with individuals and in a collaborative fashion. Whether they have in mind working together on a task rather than genuine sharing and joint knowledge construction, is unclear. The Finland classroom study, Case 4 is an example of genuine collaborative activity with an LO.

7.6.5 Features of LOs

The way LOs are designed can of course frame the way students interpret the learning situation. Three particular features of LOs that were evident in the classroom studies will be discussed here:

⁶⁹ Section 5.2.3 indicated that teachers who were high users of ICT in the classroom were more likely to use LOs with students working independently or in a group, but without the help of the teacher, and we take this student autonomy as an indication of active learning and agency.

- LOs and ‘game playing’;
- the focus on tasks rather than ideas;
- LOs as tools.

LOs and game playing

LOs that give students scores, or use a clock to record time taken on a sequence of activities, create the feel of a game through the element of competition, a familiar genre for children today. The essence of scores is a form of feedback on learning (time to complete could also be seen indirectly in this regard). However, scoring systems can set up problems for the teacher by interfering with her view of how the learning task should be treated. We have three examples of this in the classroom observations.

In the classroom study in England (Case 13) the students worked on an LO that required them to drag and drop a label onto a diagram to indicate a biological part of the human reproductive system (see Figure 7.6 for a screen shot of the LO). Each time a correct answer was given the student is given a point and this is added to a total; marks are deducted for incorrect answers. Some students realised that they could get a higher score by ‘right clicking’ on the label when it was correctly placed and became preoccupied with getting a high score, sometimes in the hundreds (maximum score was supposed to be 10). The LO does tell the student at the end of the activity that they should try again if they have made incorrect answers, which should indicate a lack of understanding. This happened to the extent that the teacher, in his interactions with the students, had to focus them on the learning. He was conscious of this as he noted in the post-lesson interview:

There was a couple of the ‘less focused students’ who quickly found that whenever they clicked on the label in it’s right place that it added to their score so the scoring in particular for some students was a distraction where for other students it was a motivation because they’d go through and they get 4 out of 10 and think that I want to go through it again and get more. But for some of them it was a distraction because when they click, click and click – they’d get a score of 250.

(UK Classroom Study, Case 13)

As the lesson progressed he realised the impact of this and adopted different strategies. For his first strategy he simply told them that they should try the activity again, urging them to ‘see if you have remembered it’; in his second one he said that they should make sure that they were reading the descriptions of the labels (available if students want them); and the third strategy involved him telling them that they would be tested on this through the crossword activity to follow, and hence they should focus on the learning. This indicates that such scoring has to be more sophisticated, or that alternative means of indicating misunderstandings might be given (e.g. not giving a score but a list of parts of the reproductive system incorrectly labelled)⁷⁰. ‘Drag and drop’ exercises, which require students to place a label or part in a location, are prone to ‘trial and error’ processes applied without conscious

⁷⁰ This would also be in keeping with the assessment for learning literature, which indicates that ‘comment only marking’, rather than scoring, is more effective to enhance learning (Black & William, 1998). See McCormick (2004) for a discussion of these ideas in the context of ICT.

thinking (there was evidence also of students guessing).⁷¹ (This is an issue for the LO design to encourage reflection on strategies for exploration or learning.)

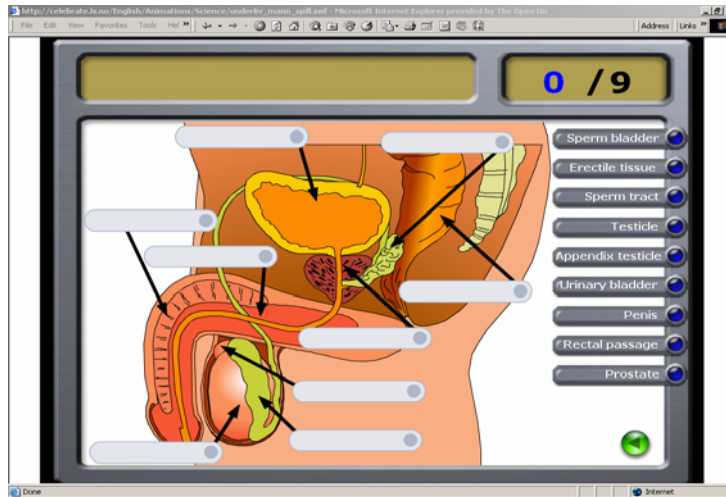


Figure 7.6: screen shot of the biology LO: Abdomen – man

The second example is from a Hungarian classroom study (Case 11), where the LO timed students as they solved exercises, and this created a competitive atmosphere in the classroom with students calling out their timing. While this apparently did not concern the teacher, it did mean that some students focused on trying to solve the exercises as quickly as possible. This may detract from their concern for their learning. Again, perhaps the timing could be only made available to the teacher through a print out (much as happens in Integrated Learning Systems), though this would need a different approach to LO design and may need integration with a VLE (and perhaps defeat the interoperability criterion). LO designers are concerned to keep the ‘content’ separate from the functioning of the LO to ease modification (e.g. translation), and any data that might be generated by the LO would reduce the ‘independence’ of the LO. Where this kind of information is necessary then objects are designed specifically with the virtual environment in mind.

The third example of game playing is evident in a French classroom study (Case 7) on English grammar (*The comparator form*). The teacher used the ‘threat’ of her assessment of their achievement (by reminding students that their learning would be tested) to try to prevent students from focusing on the game, i.e. the score, rather than their learning.

Focus on tasks rather than ideas

Ordinary teaching practices concentrate on students' tasks and activities, and so the behaviour described above about students focusing on solving problems to complete them, rather than on their learning, is not surprising. There is a danger, noted in the ‘National conclusions’ of the Finnish classroom studies, of student activity focusing

⁷¹ This problems with ‘Drag and drop’ activities that encourage continual trying until a correct is found, was discussed at the Board of Education, Finland, seminar with LO developers, in relation to the *Healthy meal* LO.

on the doing of such activities. The processing of the content becomes less important, unless the design of the activities focuses on high-level outcomes of learning, something very difficult to do. This was evident in Cases 3 and 4 in the Finnish studies and similarly in the UK study (Case 13). In part, this occurs because the students have to do so many activities that processing the content is perhaps seen as less important. The *Classroom studies* report draws on Law, Lee, and Chow (2002), who argued for working with *ideas* rather than the *doing* of activities.⁷² It may be that this is an issue of the role of the teacher in stimulating thinking, as indicated earlier, or an issue of how the LO is designed. Given the relatively passive role of the teacher we reported above, there is clearly scope for the teacher to encourage more of a focus on ideas, whatever the design of the LO.

The importance of scaffolding and structuring students' activities was evident in experimental studies. In the electricity study student activities were guided with structured assignments that helped them to stay on task and explicitly concentrate on the learning content, whereas in mathematics and language studies, where students' activities were not tightly structured, students were in hurry to complete tasks without reasoning. This way of working was reflected in students' learning outcomes. In the electricity study students using the LO outperformed students working with traditional methods, but in the two other studies the tendency was the opposite, although there were no statistical differences between LO and non-LO group's learning performance. However, it should be mentioned that, even though structuring of the student working played a key role, undoubtedly the features of the LOs also had an impact on outcomes and activities. In the electricity study the LO used was an 'Exploration' type (a simulation), and in mathematics and language studies students used 'Drill and practice' LOs. Thus, when implementing and evaluating the working with LOs, it is important not to focus only on one aspect of the learning environment, but on the environment as a whole.

Such a focus on tasks can of course result in motivated students, but will not necessarily support their learning, a point made in Section 6.3.2.

LOs as tools

One way of moving the design away from tasks and 'information giving', is to focus on the development of LOs that are tools for learning. There are a number of examples of this in the classrooms studies:

- The calculation of the nature of the students' meals allowing them to investigate their own diets (Finland classroom study, Case 1, *Healthy meal*).
- The creation and investigation of a circuit to understand the effects of particular conditions and the resulting voltages and flow of current (Finnish experimental study, *Electric circuits*).
- The exploration of a model of how a virus spreads, by allowing the student to manipulate variables in the model to try to understand the mechanism involved (Ireland classroom study, Case 12, *The spread of the HIV virus*).

⁷² This builds on the work of Scardamalia (2002), who made a distinction between idea-centred and tasks-centred education.

- Exploration by trying to establish a rule that governs the relationship of fractions, using the metaphor of a balance (French classroom study, Case 9, *Relations*).

These ‘tools’ are quite content dependent and the degree of control over the situation varies, with the *Relations* and *The spread of the HIV virus* LOs allowing limited control (*Relations* almost none), and the *Healthy meal* and *Electric circuits* the most. We have an example of software used in one study, *Multiple intelligences* (Case 4, Finland), where a mind mapping tool is used (*The Mind Manger*), and this is an example of a general purpose tool to visually map ideas. It is evident from the study that this tool contributed much to the reflection process and focused student attention on their thinking and learning.

The issue for content providers is the extent to which their ‘content’ provision in the form of LOs will be both technically possible and represent part of their normal business. For example, providers such as eWSOY/OPIT that developed from book publishers, are more likely to see themselves as electronic content publishers rather than software developers. Digitalbrain may see itself in the latter category.

There is also an issue of whether such tools require a virtual learning environment to support their use.

7.7 Summary

It is evident that, given current conditions of ICT access (including local conditions of line speeds and network capabilities), ICT skills and teacher time for preparation, limit the employability of LOs. However, ICT use in general in the classroom has been wrestling with these problems and has progressively found ways round them. More importantly, it is likely that access will be a temporary problem as computers become more common in all classrooms and as wireless and portable devices spread.⁷³ Similarly, ICT skills are continually improving and becoming more widespread. In some schools, for example in the primary sector, technical support will still be an issue,⁷⁴ and this will limit the improvement in some conditions. Although enthusiasts may be willing to master both technical and pedagogic skills of using ICT, it is likely that teachers in general will only see pedagogic ones as their domain. Preparation time is of course soluble, but given pressures on teachers it is less tractable. The argument will be that the time invested in preparing for the use of LOs allows a more focused approach on students learning in the classroom (and hence a better use of teachers’ classroom time). But finding that time creates resource issues as large as those associated with ensuring ICT access.

When these conditions are improved, however, the employability of LOs is evident, and they can support advanced pedagogy. Any single LO is unlikely to do more than contribute to a teacher’s repertoire, rather than radically change it (though it can equally constrain it). Currently that means a blended approach with LOs contributing to the pedagogic setting created by the teacher. We argued for seeing an interplay between the affordances of an LO’s pedagogy and the pedagogical practices the

⁷³ There is, however, a danger of a two-speed system developing, where schools that invest heavily in ICT resources move ahead of those who retain old equipment and do not upgrade.

⁷⁴ Section 5.2.1 indicated that they were more likely to experience technical problems in using LOs.

teacher is able to construct, given her pedagogic competence with using LOs, and her underlying conceptions of learning. LOs can, in this context, enhance active learning by students, collaboration, authentic material and activity, and provide multiple perspectives on knowledge. Thus, in the debate about the pedagogic content of LOs, it is clear that the locus of 'control' or design of that pedagogy is in the hands of the teacher. All these factors have implications that we will explore in Section 8. Nevertheless, there are issues of pedagogic design that relate to game playing, a focus on ideas, and developing tool-like features in LOs, that will exist. Such design features will enable the affordances to be greater.

Finally, underlying this discussion of the role of the pedagogy of LOs and their introduction into classrooms is the debate about whether the intention is to change teachers' pedagogy. The use of LOs can be seen as a way of transforming the learners experience and their learning (e.g. by increasing agency, collaboration or authenticity), or as a task of assimilating and supporting existing practice. We will return to this issue in Section 8.

References

- Banks, F., Leach, J. & Moon, B. (1999) 'New understandings of teachers' pedagogic knowledge.' In J. Leach, and B. Moon, (eds.) *Learners and Pedagogy* (pp. 89-110). London: Paul Chapman.
- Black, P. and Wiliam, D. (1998) 'Assessment and classroom learning.' *Assessment in Education: Principles, Policy and Practice* 5 (1), pp. 7-71.
- Brown, A. L. and Campione, J. C. (1990) 'Communities of learning and thinking, or a context by any other name.' In D. Kuhn (ed.) *Developmental Perspectives on Teaching and Learning Thinking Skills. Contributions to Human Development* (pp. 108-126). Basel: Karger.
- Bruner, J. (1996) *The Culture of Education*. Cambridge, MA: Harvard University Press.
- Coffield, F., Moseley, D., Hall, E. & Ecclestone K. (2004) *Learning styles and pedagogy in post-16 learning: a systematic and critical review*. London: Learning and Skills Research Centre.
- Cox, M., Webb, M., Abbott, C., Blakeley, B., Beauchamp, T. & Rhodes, V. (2004) *An investigation of the research evidence relating to ICT and pedagogy*. Coventry: Becta. http://www.becta.org.uk/page_documents/research/ict_pedagogy04.pdf (Checked 8/11/04)
- Content Developer Interviews CELEBRATE Work Package 7.*
- Gibson, J. J. (1979) *The ecological approach to visual perception*. Boston: Houghton-Mifflin.
- Ilomäki, L., Lakkala, M. & Paavola, S. (2004) *Virtual Learning Objects in Advanced Pedagogical Settings*. Annual conference of the British Educational Research Association, 16-18 September, University of Manchester, Manchester, England.
- [Classroom Studies] Ilomäki, L. & Lakkala, M., (eds.) (2004) *Learning objects in classroom settings: A report of 13 case studies conducted in Finland, France, Hungary, Ireland and United Kingdom*. CELEBRATE Work Package 7.



[Experimental Studies] Jaakkola, T. & Nurmi, S., (2004) *Learning Objects – A lot of smoke but is there a fire? Academic Impact of Using Learning Objects in Different Pedagogical Settings*. CELEBRATE Work Package 7.

Law, N., Lee, Y. & Chow, A. (2002) 'Practice characteristics that lead to 21st century learning outcomes.' In *Journal of Computer Assisted Learning*, **18**, pp. 415-426.

Lim, C.P. & Barnes, S. (2002) "Those Who Can, Teach" – the pivotal role of the teacher in the information and communication technologies (ICT) learning environment.' *Journal of Educational Media*, **27**, pp. 19-40.

McCormick, R. (2003) *Keeping the pedagogy out of learning objects*. Paper presented at the 10th Biennial Conference of EARLI *Improving Learning, Fostering the will to Learn*, University of Padova, Italy, 26-30 August 2003.

McCormick, R. (2004) 'ICT and student assessment.' *The Curriculum Journal*, **15** (2), pp. 115-137.

[Interview Studies] McCormick, R. & Clifford, C., (eds.) (2004) *Teachers Views on Learning Objects: A Interview Report with Teachers in Schools in Finland, France, Hungary, Israel, Norway and the United Kingdom*. CELEBRATE Work Package 7.

[Teacher as User of LOs Questionnaire] Li, N. (2004) *Teacher as User of LOs Questionnaire Report*. CELEBRATE Work Package 7.

[Pop-ups Evaluation Questionnaire] Li, N. (2004) *Pop-ups Evaluation Questionnaire Report*. CELEBRATE Work Package 7.

[D7.1] McCormick, R., Scrimshaw, P., Li, N. & Clifford, C. (2004) *Deliverable 7.1: Report of Evaluation Workshop*. CELEBRATE Work Package 7.

Nirhamo, L., Artacho, M. R., Van Assche, F. (eds.) (2002) *CELEBRATE Metadata Application Profile*. (Draft 0.3) CELEBRATE internal project document.
(<http://community.eun.org/content.cfm?area=169&ov=19944&sa=3051&oid=19944>)

Scardamalia, M. (2002) 'Collective cognitive responsibility for the advancement of knowledge.' In B. Smith (ed.) *Liberal education in a knowledge society* (pp. 67-98). Chicago: Open Court.

[D2.1] Sligte, H., D'Halluin, C., Ilomäki, L., Lakkala, M., Lehtinen, E., Paavola, S., Rahikainen, M. and Roozen, F. (2003) *Interim Working Report on Pedagogical Models Deliverable 2.1* CELEBRATE Work Package 2

Vuorikari, R. (2003) *Virtual Learning Environments for European Schools: a survey and commentary*. Brussels: EUN.
(http://insight.eun.org/eun.org2/eun/en/Insight_Policy/content.cfm?ov=19414&lang=en)

Section 8 the Outcomes of the Evaluation

In this section we bring together the findings of the evaluation that we have examined in the earlier sections. We then go on to consider issues that were raised in a number of places in the report, but which have important implications particularly for future developments in this area of work. From there we move on to consider recommendations that arise from both these issues and the discussions elsewhere in the report, and indeed from other data sources that we have examined. We make these recommendations with particular audiences in mind. Finally we make some methodological reflections about the evaluation process, for the benefit of those who may undertake such evaluations in the future.

8.1 Hypothesis

Section 1 of the report has already detailed the hypothesis that guided this evaluation, and each section ended with a summary statement, which reflected on whether a particular part of the hypothesis examined in that section had been supported. Here we draw these summaries together and make a general conclusion about the outcomes of the evaluation in terms of the hypothesis. (The relevant sections where each part is discussed are given in parenthesis.)

Given suitable pre-conditions and working methods, learning objects can be successfully created, translated and modified by content developers and teachers. (Section 2)

LOs were indeed created, and in significant numbers. They were also produced for a range of subjects, across the full age range planned and in different styles. Around a third of the LOs were thought good enough by teachers to try out in their classrooms.

Translation into English was achieved and a number of authoring templates were provided to allow teachers to create LOs. This involved a level of systematic face-to-face training that (if essential) suggests it will not be possible to enable all teachers to take on this role. However, the vision of teachers each modifying LOs for their own use did not generally appear. Nor was our own initial assumption that LOs would be produced only by central agencies or individual teachers correct. Instead a number of different mixtures of approach were tried.

What preconditions and working methods were most favourable to LO production? In fact a very wide range of strategies were tried out. In general it appeared that the approaches that were most successful in generating large numbers of LOs, of an acceptable quality, involved teams. These needed to have members with expertise in programming, classroom teaching with ICT, and subject knowledge.

Given suitable pre-conditions and working methods, learning objects can be successfully created, translated and modified within a 'market' that can be created to protect the rights of creators and provide necessary income where appropriate. (Section 2)

The development of models for future funding and copyright could only be partly explored within the project, as it ended before long-term arrangements were in place for the future. However, several models were being actively discussed and it was



possible to identify some of the underlying options and questions that could focus decision making in this area.

Given suitable pre-conditions and working methods, learning objects can be distributed and presented. (Section 3)

Overall, teachers were positive about the Demonstration Portal and felt it was very useful for teaching and learning. They used it to gain access to a variety of learning resources and to motivate their students to learn. They appreciated that the Demonstration Portal provided a safer online learning environment for their students. The data suggest that LOs were successfully being distributed and presented through this Portal once initial problems were overcome. Indeed many teachers went further than just using it as a way of finding LOs, but saw it as a basic 'virtual classroom' that could store LOs and give students access to them.

Given suitable pre-conditions and working methods, learning objects can be selected and employed usefully and efficiently by teachers. (Section 4)

Overall, the selection pattern of LOs by teachers reflected the project's LO subject profile, which focused on mathematics, science, art and language. The evidence suggests that, in general, teachers were positive about the CELEBRATE LOs and felt they were useful for their teaching and student learning. Teachers had some reservations about the flexibility and usability of LOs and some reported that they encountered technical difficulties when using the LOs, but these mainly related to the local ICT infrastructure rather than LOs themselves. But there are also pedagogic issues in relation to usability with some teachers not being able to fit them into their teaching, affecting the 'efficiency' with which teachers could use them. Therefore, this part of the hypothesis is confirmed but with some reservations about how 'efficiently' this can be done.

The conditions for this confirmation do not seem to rely on the need for general guidance on pedagogy. For those teachers who need help, this is more related to their ICT skills, and how to use LOs, rather than their general lack of teaching experience.

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers of varying backgrounds and interests. (Section 5)

The judgements of the teachers suggest that, while there are some important differences between teachers, most groups in most respects view the use of LOs in broadly similar ways. Given that teachers overall view LOs favourably, this suggests that there are no large subgroups of CELEBRATE teachers who take a strongly negative view. However, it is important to note that the CELEBRATE teachers were generally either experienced users of core ICT systems, or of these and of a wider range of systems as well. This represents an important pre-condition. The project does not therefore tell us about the views on LOs of inexperienced teachers, in terms of ICT skills and usage.

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers working with students of selected ages, ethnicities, social backgrounds, levels of previous achievement, and diverse first languages and cultures. (Section 5)

Where students are concerned, again the indications are that the CELEBRATE LOs already include a sufficient range to be used successfully across the full age and achievement ranges, although lower achieving students may be one group that needs better provision. Taken together these responses suggest that differences in student backgrounds and characteristics were not, in general, a problem in using LOs successfully, although some groups were not seen as being sufficiently well served at present.

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently in a range of subject areas and classroom contexts reflecting diverse education systems. (Section 6)

It is evident that there do not appear to be subject-related factors preventing the useful and effective use of LOs, except in as much as the LOs fail to match the curriculum topic of the teacher, an issue across, rather than within, countries. (This may not be the case in subject areas other than those upon which CELEBRATE focused.) It may well be that, with a larger number of LOs in any one subject, the lack of match to specific topics can be overcome. But, even the relatively modest numbers of CELEBRATE LOs, did deliver satisfaction in the subjects covered using hundreds, rather than thousands, of LOs.

Teachers are convinced of the effect on motivation, though there is less general evidence on whether it improves achievement. Where we were able to carry out a specific study of the impact on achievement, we have robust evidence that they can be more effective than traditional means of teaching. The evidence for improvements in types of learning is modest, for example with 'problem solving' and 'conceptual learning', though again the experimental study does show that some elements of conceptual understanding can be effectively dealt with.

Whatever the limitations in our evidence of improvements in achievement, the effect on student autonomy and active learning are evident and useful.

Given suitable pre-conditions and working methods, learning objects can be employed usefully and efficiently by teachers using a variety of pedagogical models. (Section 7)

It is evident that, given current conditions of ICT access (including local conditions of line speeds and network capabilities), ICT skills, and teacher time for preparation, limit the employability of LOs. It is likely that access will be a temporary problem as computers become more common in all classrooms and as wireless and portable devices spread. In some schools, for example in the primary sector, technical support will still be an issue, and this will limit the improvement in some conditions. Preparation time is of course soluble, but given pressures on teachers it is less tractable. But finding that time creates resource issues as large as those associated with ensuring ICT access.

When these conditions are improved, however, the employability of LOs is evident, and they can support advanced pedagogy. Any single LO is unlikely to do more than contribute to a teacher's repertoire, rather than radically change it (though it can equally constrain it). Currently that means a blended approach with LOs contributing to the pedagogic setting created by the teacher. There is an interplay between the affordances of an LO's pedagogy and the pedagogical practices the teacher is able to construct, given her pedagogic competence in using LOs, and her underlying

conceptions of learning. LOs can, in this context, enhance active learning by students, collaboration, authentic material and activity, and provide multiple perspectives on knowledge. It is clear that the locus of ‘control’ or design of pedagogy is in the hands of the teacher. Nevertheless, there are issues of pedagogic design that relate to the creation of affordances and also features such as game playing, a focus on ideas, and developing tool-like features in LOs, that will exist.

Overall judgement on the hypothesis

Given suitable pre-conditions and working methods:

- learning objects can be created and translated and, although there are examples of modifying them, we have little evidence on the impact of this;
- there are various models of a ‘market’ that can be created to protect the rights of creators and provide necessary income where appropriate,
- and that through the Demonstration Portal learning objects can be distributed and presented, but we do not know the impact of a federated set of repositories from the pilot trials;⁷⁵
- learning objects can be selected and employed usefully and efficiently by teachers though there is a need for a threshold level of ICT skill,
- learning objects can be selected and employed usefully by teachers of varying backgrounds and interests, but there are some reservations about how efficiently;
- learning objects can be selected and employed usefully and efficiently by teachers working with students of selected ages, ethnicities, social backgrounds, levels of previous achievement, and diverse first languages and cultures.
- learning objects can be selected and employed usefully and efficiently by teachers in a range of subject areas and classroom contexts reflecting diverse education systems, though there are issues of a match to the curriculum;
- learning objects can be selected and employed usefully and efficiently by teachers using a variety of pedagogical models once the conditions of access to ICT resources, ICT skill and teacher preparation time are overcome;

⁷⁵ See, however, the usability evaluation of the federated search using the Brokerage System (Appendix 4).

8.2 Issues, possibilities and options

In this section we examine issues that arise across the earlier sections of the report (Sections 2-7), grouped under five main headings:

- What the evidence says about some of the characteristics of LOs.
- Professional development needs of teachers.
- Whether there is a case for a European-wide system.
- The issues in determining a critical mass of LOs.
- The vision for the future of the 'learning object enterprise', i.e. whether we assimilate or change teacher pedagogy.

In doing so, we try to draw together strands that have been dealt with separately in the previous sections. Inevitably these issues are interconnected; for example, one of the characteristics claimed for LOs is that they should be small, and this has obvious implications for determining a critical mass of LOs.⁷⁶ We therefore discuss each of these issues recognising the inter-relationships, though we do not always spell them out, as so to do could result in an unhelpfully complex argument. Although we will be building on the earlier sections and hence on the data from the evaluation, there will be times that we become highly interpretive and indulge in some speculation.

8.2.1 Characteristics of LOs

We discuss three characteristics: granularity, reusability, and inclusion of pedagogy, examining the evidence of the earlier sections to see what the evaluation has to say, if anything, about each.

LOs have many characteristics attributed to them either through the way they are formally defined or the discussion about them. The CELEBRATE project proposal indicated some of these categories by talking of them as 'reusable chunks delivered across multiple platforms' (B3.1, p. 4) and indicating the size of these chunks: 'small, reusable "learning objects" (LOs)... supportive of more constructivist learning models.' The literature on LOs also attributes characteristics to LOs, most notably the fact that they have some identifiable pedagogy (Wiley *et al*, 2003). The size of the 'chunks' referred to above has become known as an issue of granularity: how large or small should LOs be? The need for reusability has at least three elements, firstly that it is interoperable and can be used in different platforms, secondly that it can fit into a variety of pedagogic situations, thirdly that it can be made more appropriate to a pedagogic situation by modifying it to suit a particular teacher's or student's needs.

Granularity

Section 2 posed the question 'What is small, and how does small help use?' (Section 2.7.3), offering two forms in which sets of LOs could be assembled that would give us a way of thinking about the answer to this question. The first form was

⁷⁶ One content provider, for example, decided towards the end of the project to split up their LOs to smaller units, thus creating many more LOs in the first language in which they specialised (see Section 6.2.2).

an integrated set of LOs, where the integration is both conceptual and pedagogic, and also where the information on students is passed from one LO to the other. The modular form of a set of LOs was thought to reflect the needs of students and teachers. This is in general borne out by the subsequent evidence presented in the report. However, before we briefly examine this evidence it is important to recognise that there is a degree of circularity in the evaluation evidence. The project set out with a predisposition towards modular approaches. Indeed, the fact that teachers were not able to modify LOs to integrate or disaggregate them, and that there was little emphasis on the use of VLEs, where this integration could be supported pedagogically, led them to see LOs as modular.⁷⁷ Thus in some ways it would be surprising if teacher and students use of LOs did not show this modular approach. Nevertheless the evidence indicates this preference for a modular approach.

First, and most obviously, the searching on the Portal proved to be problematic in terms of using a curriculum topic focus to locate LOs (Section 3). The definition of LO size in terms of curriculum topic focus (i.e. that it can teach a particular topic or idea, however this topic is defined), would lead to 'topic' being the most important defining characteristic for the teacher to look for (perhaps within a subject). But this proved to be an unhelpful way to search.⁷⁸ However, if the LOs were available over a longer period of time, teachers would have been able to build up a bank of LOs that supported the various topics in the curriculum and been able to assign LOs to these topics whatever search strategy they used. They would then need to be able to store LOs in an organised fashion and hence, as Section 3 argued, the Portal moves towards one function of a VLE.

The second element of evidence that supports the modular approach is that LOs proved difficult to match to teachers' curriculum (Section 6.2.3). If LOs were more integrated and larger, then it is likely that this match would be more difficult to find. The more LOs are focused on a topic the more likely that some will be relevant to a particular teacher (assuming of course that there topic is not 'missing' from the LO coverage). Integrated LOs would require teachers to be able to modify them to take out the aspects not relevant to their curriculum and add those that are.

The third element is perhaps the most compelling, as it stems from the variety of uses to which LOs were put in terms of extending teachers' repertoires in teaching (Section 4). This has to be seen, as Section 7.6.1 argued, in terms of 'blended learning'. Thus, if LOs are going to be used in a blended approach in the classroom, this will prove more difficult if they are integrated together. If they are integrated in a close sequence electronically, it may be difficult for the teacher to orchestrate the teaching and learning in the classroom. For example, the teacher who wanted to check student work at each stage of using a particular LO from a sequence (as in Case 11 in Hungary; see Section 7.3), could not do it easily if they were all integrated. This is the opposite case proposed for integrated LOs where the student information is interlinked from one LO to another; a situation that can prevail in a VLE where LOs are presented to students. Section 7.6.1 also made the point that for students to

⁷⁷ The project did not set out to test the use of VLEs and, although it provided access to one on the Portal, this was not an essential element of the project.

⁷⁸ If, for example, a key word for a topic is used it often produces no result.

progress through a sequence under the supervision of the teacher *requires* small LOs (in an absolute sense) so that pace and progress could be experienced by students during a lesson (rather than over several lessons or weeks).⁷⁹

This in turn relates to the fourth element of evidence, that of student autonomy (Section 6.3.3). If the student is to exercise choice of sequence, then having a pathway set out by an integrated series of LOs could be a problem (if it is at the extreme end of integration). Of course, if there was some way of making this sequence truly responsive to the students' learning, then this need not be problematic. We are, however, a long way from having a sufficiently sophisticated model of student understanding retained by the 'LO' (or a VLE) to be confident in this 'machine-based' approach. We are left with, as Section 7.6.1 noted, a resource-based learning approach, with discrete resources (LOs) linked either by teachers guiding students as they work in the classroom, or by students themselves through the choices they make related to their perceived needs.

However, the discussion in Section 2.7.4, on the nature of the Brokerage System and its relationship to a VLE, indicated that there were also larger-scale strategic issues. The idea of brokerage between a teacher and a large number of federated repositories inclines the argument to a modular approach. Alternatively, providers who are concerned to base their provision of digital material on the basis of use in a VLE, with LOs building on the pedagogic functions it can provide, will in effect support an integrated approach. Of course on the face of it they will be producing modular LOs, but ones that operate in a purpose-built environment (possibly reducing re-usability). Only in the degree to which they can separate 'content' and 'functionality', such that the student information discussed above and the operational characteristics are not contained in the LO itself, will they satisfy the idea of modular LOs that are re-usable in other environments. While this separation of content and functionality may be achieved (or at least striven for) by particular providers (e.g. Digitalbrain) to aid *their* production methods, it may still be for operation within, rather than across, VLEs.

Taken together this seems to argue for the modular approach, recognising the danger of the self-fulfilling prophecy indicated at the beginning of this discussion. This would lead us to a 'small' view granularity, while realising that this 'size' is not a standard or consistent definition. (Perhaps the focus should be on the degree of integration or modularity rather than granularity.) It may well be related to the various areas of the curriculum and more work is likely to be necessary to determine how it might vary. But it may also be related to the larger-scale commercial and government decisions related to VLE development.

Reusability

The three elements of reusability, namely, interoperability, flexibility in terms of pedagogic situations, and modifiability to suit a particular teacher's or student's needs, will be discussed here. The evidence we collected in relation to *interoperability* focuses upon technical problems that teachers encountered, rather than those that might arise in the Brokerage System. Section 4.4.2 (Figure 4.4) indicated that

⁷⁹ Set against this compelling argument is the possibility that one of the reasons French teachers appeared to be less enthusiastic about the LOs they experienced may be related to the fact that many were more like learning assets than LOs (see Section 6.2.2).

technical problems did affect the ease with which teachers were able to use LOs. It appeared that most of these were local problems. However, while technical problems were dealt with when they occurred (e.g. by Portal staff), there was insufficient detailed analysis of these issues to be able to determine if they reflect interoperability problems. Problems were seen to be local, in a sense the local machines or networks had to conform to standards just as the LOs themselves did. Whether this is a good basis for an ELOE system⁸⁰ is difficult to say, especially when the hardware and system investments across European countries are so different; i.e. that there will be enough uniformity of technical specifications for there to be minimal operational problems.⁸¹ Nevertheless, it highlights the need to think of interoperability not just in the specific standards and specifications (e.g. 'IMS content packaging'), but also in terms of local operational needs. It may be that, just as providers have to conform to a specification for LOs, schools have to similarly conform to a minimum network and computer (hardware and software) specification. For example, broadband access, availability of specific plugins, and local network configurations.

This aspect of interoperability does, however, relate to how easy it is for new members of an ELOE to meet the LO standard for use in the Brokerage System, but we have no evidence on this.⁸² As new providers with repositories join the system (in the latter months of the project and subsequently), this could be further investigated as part of dissemination activity (WP8).

The conclusion of the discussion on granularity was that LOs should be modular. This modularity is not just a feature of size, but of connectivity, or rather lack of it. In a similar way *flexibility* to fit into different pedagogic situations requires a parallel form of modularity. Section 7.6.1, on blended learning, argued for LOs as independent elements that allow teachers to combine them or connect them (including through student choice) in the ways they want to suit their pedagogy. (It did, however, recognise that some of this could be done in a VLE.) Section 7.3 also argued for LOs not having a 'tight' pedagogy, such that the teacher cannot control the sequence of activity. Each of these entails some thought to flexibility, though like 'granularity' it does not lead to a definite specification of the nature of the LO.

Our evidence is weak in terms of LOs being *modifiable*, because of the way the project developed and the limitations on modification that the tools and copyright issues placed on teachers (Sections 2.7.1 & 3.3.4). In effect this characteristic of LOs was not tested in the project, and it is therefore unclear whether this modification is technically possible, can easily be taught to teachers, or could be handled in copyright terms.⁸³

⁸⁰ As noted earlier, this European Learning Object Exchange (ELOE) refers to the system that will replace the CELEBRATE system that provides LOs to teachers from a federated set of repositories (i.e. what currently is provided by the Demonstration Portal and Brokerage System).

⁸¹ Given the complexity of the issues involved here, in 2005 the EUN will carry out a short feasibility project under the European Commission's eContent programme that will examine in more detail some of the pedagogical, technical, IPR and commercial issues related to the adaptation and localisation of LOs.

⁸² WP4 does, however, present some evidence on this.

⁸³ We are, however, aware that WP3 have succeeded in developing the 'rights management' aspect of the Brokerage System.

Include pedagogy

An accepted part of the definition of an LO is that it has some identifiable pedagogy, which in a sense gives it the curriculum focus talked about above (and in Section 2). A number of elements of the evidence indicate that this is not straightforward.

First, Section 7.6.1 argued that the classroom environment was where the control of the nature of the pedagogy resided, not the LO. This is most graphically illustrated by the fact that the same LO can be used in pedagogically different ways by the teacher in her classroom and can be related in different ways to other activities. So, although the LO can 'contain' pedagogy, this does not necessarily determine the way it is experienced by students. The argument presented was that there is an interplay between the affordances of the LO and the teacher's pedagogical practices (Section 7.5).

This element of the evidence is helpful in the context of the Project's desire to create a new generation of LOs that reflect constructivist pedagogy and that would support the likes of collaboration (as noted in Section 1.1).⁸⁴ Most of the LOs did not reflect many characteristics of advanced (constructivist) pedagogy as we called it; indeed a large proportion were 'Drill and practice' not generally supportive of such pedagogy. Nevertheless, teachers were able to create *elements* of advanced pedagogy in their classrooms where LOs were used (Section 7.5). But, the idea of 'affordances of LOs' carries an imperative to producers to build these elements into the design (see Appendix 3).

There is, however, a limitation to the extent of this argument. In the discussion of blended learning indicated above (drawing on Section 7.6.1), it was noted that if a VLE was used in a predominately electronic learning environment created for students, then it might be possible to consider an electronically designed pedagogy. The issue would still exist as to quite where the pedagogy resided, as any linking of LOs to reflect a particular pedagogy would not be within an LO, but be in the VLE. Teachers who were using the Portal to allow students to access LOs directly, that they had selected for a lesson, were setting up a basic VLE as noted earlier in this discussion (see also Section 3.3.5). Thus, if the Portal responded to this desire by developing the support for these kinds of activities, then teachers would move towards designing electronic environments and elearning pedagogy. The division between the pedagogy within or outside the LO would be effectively an academic rather than a real one.

To illustrate this point consider the 'classic' integrated LO, which has a sequence of instructional and activity elements connected together, each of which could be considered as an LO (see Figure 8.1). Students 'enter' the sequence at A and move through in a fashion (likely to be linear) determined by the integrated LO design. Figure 8.2 represents the blended learning situation, where either the student or the teacher (or both together) makes decisions about which LOs to use and in what order (and indeed what has to be done with them) and, in so doing, can use other resources and carry out 'non-electronic' activities. Humans are responsible for the pedagogy within the affordances of the LOs. Figure 8.3 illustrates the situation where these

⁸⁴ However, we are aware that not all content providers would necessarily share this desire, as they simply took existing LOs from their existing stock rather than try to create these new kinds.

decisions are transferred to the electronic environment (a VLE). Some will be automated, some operated by the teacher, but selected by or 'programmed' into the VLE. With the LOs integrated into the environment, the environment itself takes on some of the elements of the LO pedagogically and hence the distinction fades.⁸⁵

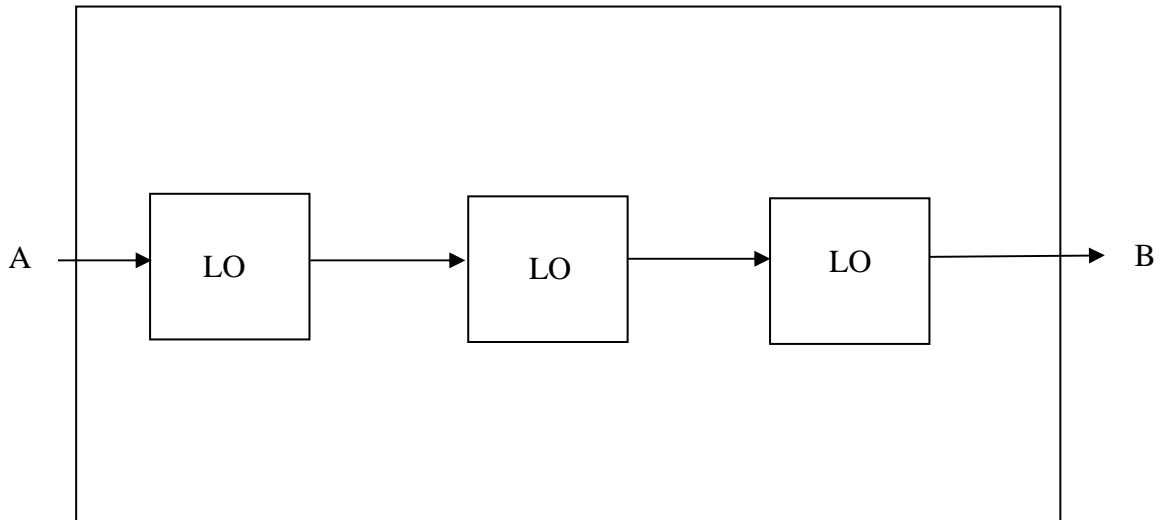
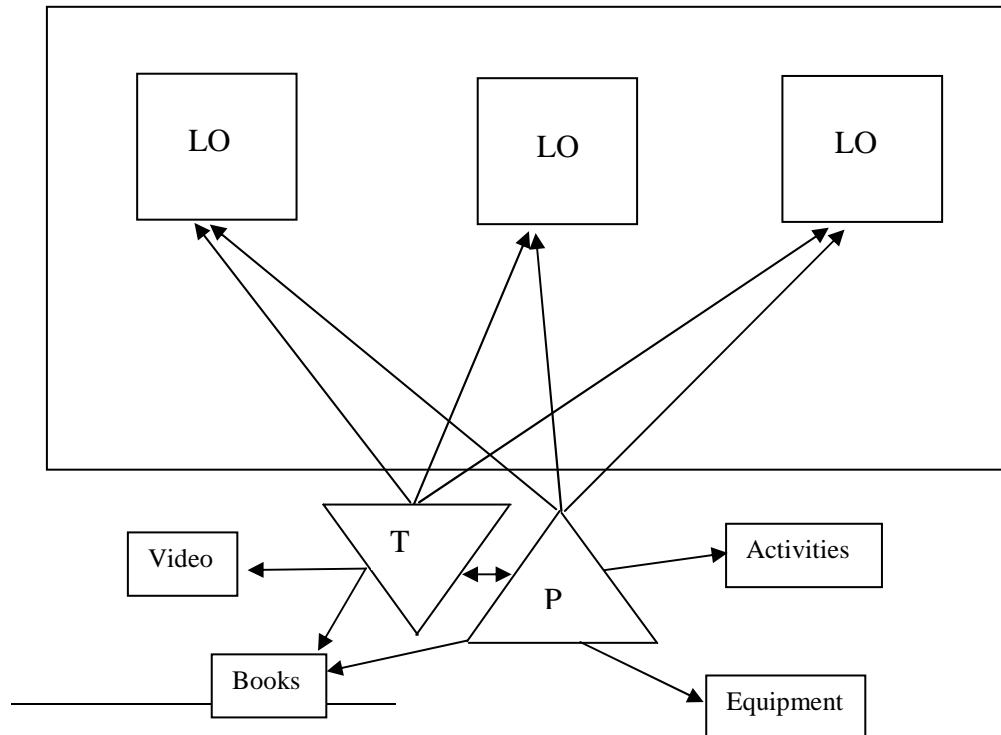


Figure 8.1: an integrated LO, made up of LOs in a predetermined sequence not operated in a VLE

Figure 8.2: modular LOs located in a virtual environment used in the classroom



⁸⁵ McCormick (2003) discusses this issue in terms of the degree to which LO pedagogy is decontextualised.

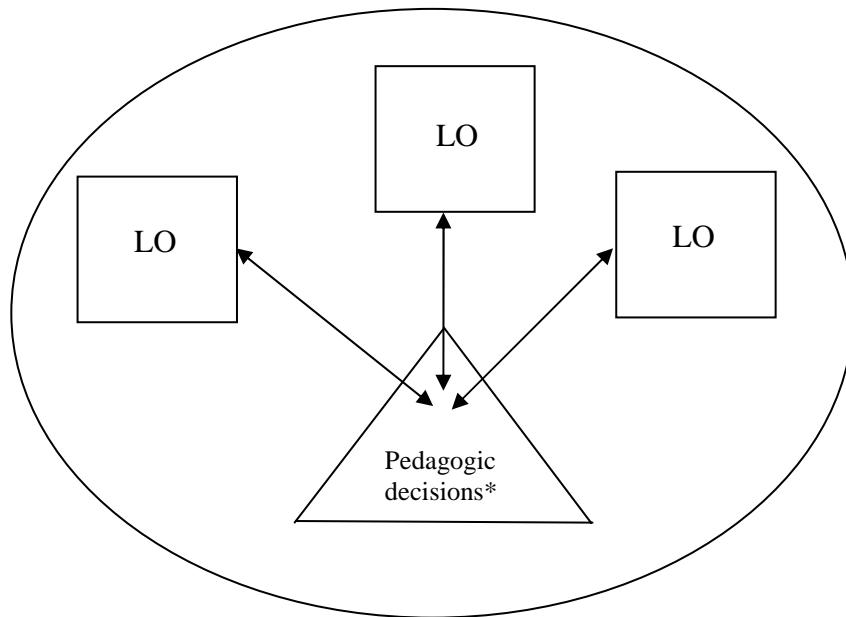


Figure 8.3: modular LOs in an electronic environment (VLE)

*These decisions are built into the VLE.

Following on from the general argument that it is difficult to identify with a particular LO some identifiable pedagogy, there is the issue of the status of the Learning Resource Type (LRT) in the application profile. This classification of type, which Section 2.2.2 described as a mixture of pedagogic and software types, is intended to help the teachers to search for and then choose LOs. The difficulties we identified in various parts of the report are:

- Content developers gave many of the LOs more than one classification, some of which were of a contrasting kind ('Drill and practice' and 'Exploration'; see Sections 2.3.4 and 7.4), and we have no evidence of how consistently they applied the classification.
- Pedagogy is discussed in different ways by content developers, researchers and teachers, and there is evidence that there is a lack of agreement (see Section 7.5).
- Over a quarter of LOs had no classification (in terms of LRT; see Section 2.3.4).
- It proved difficult for content developers, and perhaps for teachers as developers, to apply (see Section 2.2.2).
- It was not possible to search by type (see Section 3.2.1).

In addition, this categorisation is not machine readable, one of the desires of those who want to use it, nor was there any reason for this to happen in CELEBRATE (this is required only if a VLE is able to construct a 'lesson' automatically, using some kind of learning design; see McCormick, 2003).

Of course it might be possible to develop a better classification system than we currently have (perhaps using the elements of ‘advanced pedagogy’ discussed in Section 7.5). However, this will have to try to resolve the differences in languages between the three groups of content developers, academic pedagogy researchers and teachers, noted above, and would entail some kind of study to develop more appropriate categories than the CELEBRATE team was able to do (despite a considerable amount of time devoted to their exploration). Further, such a study will take time and meanwhile thousands of LOs will be entered into the ELOE and would need to be re-classified, and this is unlikely to be done in an automatic fashion. This leads us to the conclusion that this LRT should be dropped from the application profile or at least not to be used for the moment. A more fruitful way forward would be to associate with LO descriptions, teacher comments and descriptions of use or those provided by content providers (perhaps also derived in field trials with teachers).

8.2.2 Professional development

A number of times in the report we have discussed issues of training, both as part of the CELEBRATE project and as a condition for the implementation of any more general use and development of LOs. Although there are a number of specific issues that require ‘training’ (e.g. for basic ICT skills), we prefer to think of this whole area as one of *professional development* for both teachers and content developers. This is necessary because more general experience with large-scale programmes in countries to prepare, for example, teachers for a greater use of ICT in the classroom, have been conceived in this way. It is also unlikely that content developers would see preparing to produce LOs to the required standards as a matter of training. It is evident in CELEBRATE that many areas of development will require something more profound than that implied by the word ‘training’. For example, the use of LOs requires experienced teachers to develop new pedagogic competencies that may require teachers to share practice. It is also evident that teachers will have to develop new ways of working with LOs that do not currently exist, and so the idea that there is an ‘expert teacher’ somewhere who could train teachers to use them is not a good model to work with.

Hence, in this section, we make no general judgement about how the various professional development activities for both teachers and content developers should take place; rather we focus on what the evaluation tells us about the areas of need. We envisage that there would be a variety of methods, involving the work of individual teachers and whole schools. Given the differences in traditions of professional development across Europe, it is unlikely to be helpful to discuss such methods in this report. There is of course an issue of the role of the Demonstration Portal, as it develops subsequently to the CELEBRATE project, and we will make a comment on this. The evaluation for this project also identified that there are issues relating to professional development of content developers, especially those new developers involved in the production of LOs with little experience of such production or of using the system. Therefore, this issue will be discussed here too.

Teachers' professional development in using and developing Learning Objects

ICT skills

Section 7 identifies several conditions of use of LOs, ICT skills is one of the important conditions of successful use. Teachers' good ICT skills and understanding help them to ensure a successful lesson and overcome the general technical problems in using LOs. Therefore, before taking up any LOs for classroom teaching, it requires teachers to have a degree of skill that may not be found in conventional classroom practices, for example downloading LOs from the Demonstration Portal, installing plugin software (e.g. *Flash*) in order to play LOs. The level of CELEBRATE teachers' ICT skills was evaluated based on their self-assessment, and they were categorised as core-ICT skill and high-ICT skill groups (see section 5.2.2 for the definition of these two groups). The evidence we collected suggests that core-ICT skills group were less experienced in using ICT in classrooms and needed more support in using LOs, although the CELEBRATE LOs as a set worked equally well with teachers with high or core-ICT skills. However, as part of the design of the CELEBRATE project, teachers with low ICT skills were largely left out, and therefore we were unable to comment on them. But if the LOs are to be used more broadly, there will be a need for basic ICT skills training and support provided to teachers.

On the other hand, the *Interview Studies* report points out that teachers who had more experience of using ICT, preferred a different focus and approach of training such as using more complex LOs and authoring tools, while teachers with less experience need more basic training in terms of general use of ICT. In the project, commercial developers and government agencies provided workshops and training sessions covering various topics on both using and developing LOs, to a wide variety of teachers. They did not design dedicated programmes according to the level of teachers' ICT skills. Therefore, not all teachers found the sessions helpful. It suggests in the future a differentiated approach and content of training programme needs to be considered. Teachers inexperienced in using LOs, need guidance on the use of simple LOs and experience at working with LOs to become familiar with using LOs.

Furthermore, the experience in the project suggests that it is unnecessary to train teachers to use a user-friendly system, if they have a sufficient level of ICT skills that enables them to use the system quickly by themselves. This is confirmed in the *Interview Studies*. Some teachers with high-ICT skills preferred to learn to use the system by playing with the system instead of attending structured training sessions. This indicates there is a need to define an 'entry standard' of teachers' ICT skills and experience, then providing training to use the system may be unnecessary, with a well-designed system that is simple to use.

To use the system

Section 3.3 indicated that many teachers who attended earlier training sessions had many negative experiences, due to the instability of early version of the Demonstration Portal and technical failures, although the later trainings ran more smoothly. This echoes more general research findings that technical faults with ICT equipment or systems are likely to lead to lower levels of ICT use by teachers, especially those who had very little experience of ICT. Recurring faults, and the

expectation of faults occurring during teaching sessions, are likely to reduce teacher confidence and cause teachers to avoid using the technology in future lessons (Bradley and Russell, 1997). This indicates that, providing reliable and stable systems or ICT equipment is an essential condition for effective training sessions, and they should be fully developed and tested before being used in teacher training in the future. It is likely that, if the system is well designed and easy to use, then this should not require any training, provided the teachers have the pre-requisite basic ICT skills (using much the same principle as Internet shopping sites). There are of course specific functions such as previewing and running LOs, which may require initial training. It may be that when the Brokerage System is used there may be further training issues.

A number of times in the report we have pointed out the issues of VLEs, and in Section 8.2.1 noted that such environments underpin issues related to the use of LOs. It is important, therefore, to see training related to LOs closely associated with training in the use of VLEs. None of the current generation of VLEs, for example, are really intuitive enough (Vuorikari, 2003), hence the need for training on the core or generic functionalities of most VLEs. Given the arguments in Section 8.2.1, it is likely that training on how to search and exploit different LO content repositories and use LOs within a variety of different VLEs should both be provided to teachers.

To author and create LOs

Teachers who are experienced at using LOs, might want to use more complex and challenging ones or even create and develop their own LOs, so guidance and support on sequencing of several LOs or on LO authoring would be more appropriate for them. In the project, training on authoring and creating LOs was provided for a variety of groups of teachers, with some countries offering it to representatives of all schools. For example, in Norway 40 teachers attended a workshop as part of the general training for CELEBRATE in November 2003, but subsequently smaller-scale sessions were organised in March and April 2004 (D6.2, Norwegian pilots report, Section II). These were often short courses (e.g. in France only 3 hours long) and by their nature had to be intensive. Authoring is likely to be undertaken by a minority of teachers, and requires those with high-level ICT skills, thus training can be organised in small groups.⁸⁶

Teachers' awareness of the advantages of using and developing LOs in their teaching could be improved through professional development. We have already pointed out that more than half of the population of CELEBRATE teachers had not heard or used any LOs or authoring tools (e.g. templates) before participating in the project (Section 3.3.4).⁸⁷ It is clear from the WP6 report that those who participated in the training and were given demonstrations of the use of authoring templates, realised the

⁸⁶ In Norway a short manual was produced on the creation of simple LOs using a Digitalbrain template (D6.2, Norwegian pilots report, Section II).

⁸⁷ Informal conversation with teachers in various CELEBRATE training sessions and workshops confirms this.

benefits and advantages of templates, reporting an intention to use them for creating their own LOs in the future.⁸⁸

Pedagogy

Another strong message that came through the evaluation is that technical skills need to be combined with ideas on using ICT and views of learning (Section 7.5). This means that teachers need to be able to see real teaching scenarios which can demonstrate convincingly the effectiveness of LOs in teaching and learning. This will encourage teachers to integrate LOs in their classroom practices. A *Lesson Bank*⁸⁹ was introduced by WP2, which was intended to be a useful source of information and inspiration for teachers to use LOs in meaningfully pedagogic ways. But it was implemented at the later stage of the pilot study and teachers had little opportunity to use it. Therefore, we are not able to comment on it. But it can be used in the future as a possible way in which teachers can share experiences and have access to real teaching scenarios. There is no doubt that a considerable number of programmes and initiatives in using ICT have been provided to teachers by ministries of education across Europe, but few focus on LOs. Within the project the use of LOs in pedagogical meaningful ways was not the focus of any of the training programmes.⁹⁰ Hence there is scope for exploring the possible impact of such professional development activity.

As discussed in Section 7.6.1, CELEBRATE teachers mainly used a blended learning approach to integrate LOs into their teaching, which embedded work with a virtual environment into ordinary classroom activity. Therefore, providing a meaningful programme in pedagogical training requires careful thought to identify the distinctive roles and responsibilities of teachers in moving into this innovative blended learning environment. There are a number of factors relating to such teaching:

- views on learning;
- approaches to teaching;
- subject knowledge;
- pedagogical content knowledge;
- craft skills in classroom organisation and management;
- teachers' characteristics;
- context in which they are teaching.

Use of ICT, in this case involving LOs, would have a profound impact on the above factors, all of which are closely related to a teacher's choice of pedagogy. Section 7.5 discussed two views of the interplay between the above factors that could govern a successful pedagogy. One is that theoretical ideas on 'advanced pedagogy' should be

⁸⁸ There were, however, some technical problems, both with early versions of these tools and with using them via the Portal (D6.2; France and Norway reports).

⁸⁹ It was developed by teachers who had worked with Learning Objects and want to share their ideas.

⁹⁰ Only in Finland was there such an input, but this was limited to a lecture by two members of the WP2 team (D6.2, Finland pilots report).

instrumental in changing teacher pedagogy, and the alternative view is that LOs should be constructed to assimilate teachers' ideas and practical knowledge, and used as a medium to represent teachers' pedagogy. The former provides a model of a pedagogy-focused training programme, with teachers experiencing professional development in terms of advanced pedagogy to help them to improve their understanding of pedagogical content knowledge in an innovative classroom context. The latter (assimilation approach) provides a different model of professional development, which is more LO-focused. Teachers would be given opportunities to start to use those LOs that can fit in with their pedagogy and support their conceptions of teaching and learning. We are not able to suggest which model would be more appropriate for teachers across Europe, because there are different value choices in each approach, but it could lead to a new debate on the way teachers' professional development in pedagogy is planned in the future.

However, it is worth making some comment on the role of the ELOE, and in particular the Portal, in supporting teacher professional development in relation to LO use and pedagogy. We have already pointed out that we have no reliable data on the use of the *Advice* section or the *Lesson Bank* (Section 3.3.3), and that it was implemented too late in the pilots in order for significant data to be captured. The limited feedback that we have on the *Advice* section is not positive; for example, that the pedagogical advice and models are not expressed in a language that most teachers can easily understand (Section 7.4). Consequently, we cannot be sure that the Portal will be a means to enable professional development, although the *Lesson Bank* may have the potential to help teachers explore real teaching scenarios with LOs, as recommended above. Putting the creation and use of LOs together, it is evident that there are at least three elements to professional development. Teachers need to be able to:

- properly exploit new forms of learning content such as LOs (including their use within VLEs);
- develop their own resources using simple and more advanced authoring tools (a small percentage of teachers);
- contribute to and help build a knowledge base (e.g. through a *Lesson Bank* or some form of exchange of ideas) on the use of LOs.

The length and scale of training

The length of training or professional development activity needs to be considered when designing any future programmes. In the project, the length of training varied from half-day sessions to several sessions during a three-month period across different countries in the project. Although we did not evaluate the training given as part of the pilot activity, there is some evidence from the pilot countries that more time is required and that it should allow for trials in school and then further support or development activity (D6.2, Norwegian pilots report). For teachers with low ICT skills, this could be problematic and more time will be needed to be familiar with systems and use of LOs. Consequently the length of training should be matched to the different levels of ICT skills.

The provision of exclusively brief programmes can also be problematic for the professional development of pedagogy, as changing teachers pedagogy is a slow and

complex process, influenced by diverse factors. Half-day training sessions are limited in helping teachers' better understanding of advanced pedagogy with regards to LOs, and to be able to use it within their classrooms. It is likely that for the long term, pedagogical training in use of LOs and VLEs (e.g. at least some training in the basic functions of the environments in which the content will increasingly be provided) should be integrated into existing teacher professional development programmes.⁹¹ Furthermore, in the project, only a selected group of teachers were offered opportunities to participate in the training. If the LOs are to be used more widely, a systemic programme should be adopted and integrated with national policy of teacher professional development, which includes pre-service and in-service training.

Content developer professional development

Section 2 discussed the different approaches used for the production of LOs by different content developers, given their mixed expertise and experience of developing digital learning materials. For example, among them, there are well-known commercial content producers with many years experience of producing LOs in their own country, new commercial developers who were recently established in LO production, non-profit organisations (e.g. a museum and an education science centre) who had started to explore LOs, and ministries of education that worked with both teachers and professional content producers on LOs. Each faces different issues and challenges during the LO production process. The evidence we collected suggests that, those with experience of producing LOs in their own country, require specific help and support in producing LOs for different curriculum contexts across Europe. Those with little experience have to learn to develop LOs from the initial steps, requiring technical help, for example, with understanding still emerging standards and specifications such as LOM, IMS content packaging, SCORM etc. Therefore, different training is required for different content developers. In the present project all the content providers distributed their LOs either via Demonstration Portal and Brokerage system or through their own system or both, and therefore, there are common training requirements for commercial content providers; for example, the need to familiarise themselves with a new application profile and tools for submitting metadata.

In the project, WP2 provided pedagogical advice to teachers along with help for content providers, but the latter felt this was inadequate (Section 2.2.3). Section 7.5 made it clear that the affordances of an LO (see Appendix 3) are important for ensuring that teachers can use them effectively, and hence there may be parallel professional development for content providers. However, as with teachers, the nature of that training will vary depending upon which view of the LO enterprise providers take (assimilation or change).

8.2.3 Developing a Cross-European system

Given the understanding of LOs projected in Section 8.2.1, what form could a fully functioning version of the ELOE take and how would it relate to other kinds of provision?

⁹¹ This was a point made in the Finland pilots report (D6.2).



Within the project the focus was naturally largely upon the creation of a viable number of LOs (discussed in Section 2), the working of the ELOE system itself (described in Section 3) and the response of teachers to the LOs (covered in Sections 4 to 7). As the CELEBRATE project draws to a close it will be judged eventually by whether in future (as it evolves into the ELOE) it will provide a way of creating and distributing LOs that is attractive to teachers among the other possible sources from which teachers can choose.

Obviously we cannot draw firm conclusions about what will eventually happen, but in this and the following section we offer some speculative views on this future that seem to us compatible with the earlier findings. These should therefore be treated as hypotheses for further exploration rather than firm conclusions.

In this section we therefore look at how a portal and brokerage system like the ELOE might be judged (firstly by teachers and then by potential LO developers), when compared with other possible sources. Finally, we look at the implications of this for the ELOE partners.

ELOE: attracting teacher support

In Section 2 we identified six different kinds of sources that a teacher could go to for curriculum materials. Once the ELOE is generally available teachers will be able to choose between:

- LOs and LAs available through the ELOE portal and brokerage system (and any alternative system of this kind that might emerge);
- LOs and LAs available through other nationally-based closed LO delivery systems, or “walled gardens”;
- resources from real life natural and cultural settings (e.g. natural objects, observable natural and social processes, local buildings, musical instruments, science equipment and art materials) available within the school, home or locality;
- non-electronic curriculum resources (e.g. worksheets and textbooks);
- electronic curriculum resources directly available in the classroom (e.g. on CD-ROMs or preinstalled on individual computers) or school networks;
- resources of all kinds available on the Internet, accessed through a search engine.

The ELOE therefore needs to gain teachers’ attention and support; the question is not whether the ELOE is an attractive source, but whether it is more attractive than the other possibilities available to teachers. Furthermore, the ELOE will be operating within a very complex market. The diversity of the other possible sources for curriculum materials makes it hard to identify precisely the relative position of the ELOE system, as it needs to be compared not with other similar systems (which as far as we know do not yet exist) but with five other, quite different, ways in which teachers might decide to obtain their resources.

This is so even when we look at all of these types of sources individually. However, as some of the classroom case studies and the experimental study illustrate, different



kinds of resources can be combined together by a teacher in various blends, so it is even harder to make this judgment.

One way into this issue is to ask what teachers might be looking for when choosing where to go to obtain resources. Many of the relevant factors can be seen in the teachers' responses to the CELEBRATE Portal and Brokerage system (Section 3) and the sorts of judgements they made when using LOs in the classroom (as shown in Section 7, the *Interview Studies* report and the *Classroom Studies* report). From these, and other non-CELEBRATE sources, we would propose the following list of criteria as those that teachers seem likely to use:

- low or nil cost at the point of use
- stability and technical reliability
- cultural quality of resources
- social and physical safety of resources
- motivational relevance to students
- curriculum relevance
- speed of access
- easy to use interface
- easily combined with other resources
- range of resources available
- use of a range of sensory modes
- modifiability by teachers for individual students and classes.

Judged in terms of these criteria, each of the six types of source has a distinctive combination of strengths and limitations. How then does the ELOE system rate against each of the alternative sources in terms of these criteria?

It is obviously not possible for us to know this rating, but it is essential that the issue is addressed, as a number of important decisions will have to be made about the development of an ELOE on the basis of explicit or tacit assumptions about these matters. We therefore offer Table 8.1 as no more than a heuristic, or way of thinking about this, by suggesting what the pattern of these strengths and weaknesses might possibly be. (Bear in mind that, because this table is offered as a way of thinking about the judgments, the ratings given are not based on any systematically collected data.)

Table 8.1: speculative rating for each type of source against the criteria (highest ratings achieved on each criterion are shaded)

	ELOE system	Other closed LO delivery systems	Existing electronic curriculum resources	Existing non-electronic curriculum resources	Real life resources	Internet resources
low or nil cost at the point of use	high	high	high	high	high	high
stability and technical reliability	high	high	high	high	high	variable
cultural quality of resources	high	high	high	high	variable	variable
Social and physical safety of resources	high	high	high	high	variable	low
motivational relevance to students	high	high	high	low	variable	high
curriculum relevance	variable	high	high	high	variable	variable
speed of access	high to medium	high	high	high	variable	high
easy to use interface	medium (multiple providers)	high (single provider)	medium (multiple providers)	high	high	variable
easily combined with other resources	high	variable	variable	low	variable	variable
range of resources available	potentially medium	medium	low	low	low	high
use of a range of sensory modes	medium	medium	medium	low	high	medium
modifiability by teacher for individual students and classes	potentially high	High to medium	low	low	low	low

If the picture presented in this table is broadly right, what it suggests is that there is no one clearly preferable source that outranks all the other five on every desirable feature.

It also indicates that real life resources and the Internet differ from the other four possibilities in two ways. Firstly they overall get the highest rating on fewer criteria than the others. The second is that the ranking they get is far more often variable. That is to say, some resources may meet a given criterion very well, while others of the same type may not.



By contrast, variability is almost completely absent when we come to the other four sources (the ELOE system, other closed systems, existing electronic and non-electronic resources). From a teacher's perspective, curriculum materials from any of these four sources would therefore be more likely to meet predictable standards in terms of the criteria.

These four sources also appear to have roughly similar overall ratings, each gaining a top rating for seven or eight of the twelve criteria. Real life resources and the Internet do less well, but arguably make quite different educational contributions compared to the other four. This suggests that the major alternatives for teacher choice to a system like the ELOE will be other closed systems and existing electronic and non-electronic resources. How then does it compare with each of these?

Not surprisingly national closed LO delivery systems and the ELOE systems have similar profiles. However, national systems will be focussed strongly on a specific national curriculum context, so a higher proportion of the resources they offer will be seen as obviously relevant by the teachers in that country. This will apply both where curricula are closely defined from the centre and in countries where there is more scope for teacher choice of topics. However, it will be less of a factor in the latter case.

In the early stages of development of the ELOE system it should provide in principle both a speed of access and an ease of use in the interface similar to that which other closed systems would offer. However, as the ELOE expands it could well expand to contain far more LOs than other closed LO systems, unless it is assumed that nearly all providers will choose to use it as a shop window for a small number of their LOs. If, in the longer term, it did become much larger it could well take longer to search, as it would be checking, through the Brokerage System, a growing number of different LO providers' offerings. However, this assumes that other closed systems will not be themselves using some form of brokerage system architecture.

As we saw in Section 2.7.4, numbers of teachers are familiar with other VLEs, and rated the CELEBRATE system as highly as others that they knew.⁹² It is also clear from the description of the ways that teachers attempted to use the CELEBRATE Portal (in Section 3), that there is an interest in having access at least to a basic kind of VLE. The question here is how relatively attractive a ELOE 'VLE' will prove to be compared to others available to teachers.

On the other hand, the ELOE system has at least one distinct advantage compared to other closed systems. Through the authoring templates it offers teachers the opportunity to develop LOs. Even if the teachers who do this are a small minority this provides a valuable way of expanding the range of LOs, and increases the system's responsiveness to needs in different situations. This appears to be a distinctive advantage that the system has over all the other types of resource.

When the ELOE system is compared with existing classroom electronic resources the picture is rather similar. These resources fall into two broad groups. One is made up

⁹² Here (and in Section 2.7.4) the 'CELEBRATE system' is seen as the Demonstration Portal and the Brokerage System to allow access to, and storage of LOs for teacher or student use, and this can be seen as a form of VLE. There was, however, access to a fully-fledged VLE on the Portal supplied by Digitalbrain.

of open-ended packages used for such things as word processing, graphic design, video editing, spreadsheet analysis etc. These packages fulfil quite a different educational function from LOs, so are not in direct 'competition' with the ELOE system. However, the second group is made up of topic-specific packages such as 'Simulations' and 'Drill and practice' programs. These clearly are potential competitors to ELOE LOs.

Compared to the ELOE system, they too allow fast access, being often already available on students' computers, and they will have usually been designed for, and chosen by, teachers with a given national curriculum context in mind, making their curriculum relevance obvious. Against this, they too lack the potential modifiability of ELOE LOs. If they are large they cannot easily be combined with other resources and activities. They also suffer from having a number of different interfaces and methods of operation, making them harder for teachers in particular to evaluate and learn to use quickly.

Let us turn now to non-electronic curriculum resources. Their positive features are very similar to the national closed systems, and so show the same kinds of relative strengths and weaknesses as those when compared to the ELOE system. Where they are at an additional disadvantage is that they do not in general have the motivational appeal of their various electronic competitors.

These are very general judgments and of course a great deal depends upon the quality of the implementation of specific versions of such resources. However, from a user perspective it may suggest where the greatest threats to, and opportunities for, the ELOE could be. Essentially the ELOE system will have to maximise speed of access and ease of use, and provide the best possible means for teachers to locate quickly the LOs relevant to their own curriculum needs. It also suggests that the distinctive advantages of the CELEBRATE system are easy combination with other resources and activities that comes from having small LOs, and the possibility of easy modifiability of LOs.

Finally, it should be noted that there are no doubt differences from country to country in the range and quality of the sources available to teachers. This too will of course affect the relative attractiveness of the ELOE system, and would need to be taken into account in deciding development priorities. There are of course likely to be other initiatives that the European Commission, EUN and others may be undertaking that will affect this.⁹³

ELOE: attracting LO developers

As well as being attractive to teachers the system will also need to be attractive to LO developers. For potential future ELOE developers the main strategic choice in relation to the ELOE system appears to be whether to use it as the sole distribution channel, to develop their own completely separate approach to LO creation and delivery or, to both maintain their own channels for distribution, as well as participating in the ELOE. However, as indicated in Section 2 it is clear that current (and so presumably potential) LO developers can be divided into a number of different groups, with

⁹³ We are aware, for example, that the eTwinning action, the PENCIL project, or the new learning resources system MERLiN will change these judgements.

varying reasons for being interested in becoming ELOE partners. It also seems likely that their interest will be affected in some cases by whether or not the system incorporates a VLE of its own.

Table 8.2: different categories of LO developers and speculative judgements on their likely interest in an ELOE system with and without its own VLE

Developers in these categories			Likely interest in the system with VLE	Likely interest in the system without VLE
Private sector LO developers...	... with their own VLE interested in using system...	...for cross-Europe showcasing	High	High
		...as a major cross-Europe distribution channel for their LOs	Medium	High
	...without their own VLE interested in using system...	... for cross-Europe showcasing	High	High
		...as a major cross-Europe distribution channel for their LOs	High	High
Public sector LO developers...	.. with their own VLE, interested in system as a major national distribution channel for their LOs		Medium to low	Low
	...without their own VLE, interested in system as a major national distribution channel for their LOs		High	Low
	... with their own VLE, interested in system as a public sector cross-Europe LO exchange and barter mechanism		High	High
	...without their own VLE, interested in system as a public sector cross-Europe LO exchange and barter mechanism		Very high	High

Again we cannot know the future relative attractiveness of the possibilities open to developers. However, some assumptions about this will have to be made, so again we offer Table 8.2 a heuristic device for framing discussion on these issues. It therefore offers a speculative judgement on developers' likely level of interest in the system in its two possible forms.

If these judgements of likely interest are correct they suggest that the presence or absence of an ELOE VLE could make a difference to the attractiveness of the system, especially for public sector developers without their own. These might include some ministries of education, but they could also include a substantial number of agencies with an educational remit, such as science centers, museums, libraries and art galleries. Against that, its presence might possibly make the system marginally less attractive to some private sector developers with their own VLEs, if it were perceived as a competitor, but this would presumably depend upon how the developer's charging structure was related to use of its LOs and the VLE respectively. There are also local legislative conditions that govern what publicly funded bodies can do with

taxpayers' money in competition with commercial providers (e.g. in Finland and Norway). These two points may suggest that the provision of a fairly basic VLE would be the best option, but we do not know whether this would be sufficient for those LO developers without their own.

A third point to emerge is that the role of the system as a way for public sector agencies to exchange LOs is a major potential benefit. This, however, emphasises the importance of getting a quick, effective and substantial translation programme in place early on as a way of achieving this. Such a programme would also of course increase the attractiveness of the system as a whole to teachers.

Finally, it is important to realize that our discussion has been in terms of LO developers using the ELOE *service* rather than using its *architecture* upon which to build their own national service.

Implications for the ELOE partners

As the last point emphasises, the attractiveness of the ELOE system to teachers and to developers forms a symbiotic relationship. As more teachers are attracted in to use it so the system becomes more attractive to developers. This in turn increases the available resources, both by drawing in more developers and making it more worthwhile for existing developers to provide additional LOs. This then makes the use of the system even more attractive to teachers.

However, as we have seen in Sections 2, 5 and 6, teachers are not a single group of users but divided into many separate groups by subject interests, age ranges taught, language and level of competence and confidence in using ICT. It is for each of these separate groups that this growth cycle needs to be established if the ELOE system is to develop in the way that the project team envisage. Furthermore, for many potential developers particularly more specialised ones in the cultural sector, the level of involvement of specific groups of teachers (relating perhaps particularly to the size of existing language and subject groups) could be a key factor affecting their willingness to participate.

A related issue is the eventual range of geographical and linguistic coverage envisaged for the programme. There is also an issue about whether or not the programme is to be seen as available within Europe only. The other longer-term possibility would be to include developers, teachers and researchers from other countries where a European language is spoken (for example, in Central and South America).

All this suggests that a very careful evidence-based analysis of the opportunities will be needed, together with a clear initial prioritisation based upon this.

8.2.4 Critical mass and beyond

A term that has been used in CELEBRATE is 'critical mass'. In the CELEBRATE context we might initially define this as achieving a position from which the future growth of the programme becomes self-sustaining. This is an illuminating concept, but also a complex one. To reach programme self-sustainability there is not just one kind of critical mass to be achieved but a number of different ones, each of which is essential to the long-term future of the programme. Critical mass helps us to think



about what is required by teachers, by the developers and by the CELEBRATE partners as a whole, and also about how these different requirements interconnect.

Critical mass: the teacher perspective

As we saw in Sections 2 and 6, different groups of teachers had access within CELEBRATE to very different numbers of usable LOs, depending upon their language, subject interests and the age range they taught. For a teacher coming to the ELOE for the first time, the key questions are whether it appears to have some LOs and LAs that initially look worth trying out, and whether enough of these are successful in the classroom to encourage the teacher to keep on looking for more. For the CELEBRATE teachers there were enough, and a wide enough range, to get the teachers to explore them, and they also showed a generally positive response to them. However, because the period of use that CELEBRATE allowed was short we do not know how big a pool of LOs is needed to maintain teacher involvement over a longer period. This would, as indicated in the cross-European discussion above, no doubt partly depend upon what other kinds of resources a particular group of teachers had available to them. As Section 6 noted, the CELEBRATE teachers also varied in what other alternative digital resources they had access to, although here too we had no direct evidence on what the range of variation was.

From the demand side then, the demand for the system will be the aggregate of these various requirements from the potential teacher users, but we cannot say from the CELEBRATE data what the level of this is going to be.

Critical mass: the developer perspective

From the supply side, for individual LO and LA providers, what constitutes a critical mass depends upon why they wish to contribute to the programme. As we saw in Section 2, some private sector developers may want to be involved in order to showcase their products, particularly to a wider European audience. For this purpose contributing quite a small number of LOs or representative sample of their catalogue would probably be sufficient. The same is true if a company wants to try out ways of developing LOs as a preliminary to deciding whether to make a longer-term commitment to this approach, either through the ELOE or in other ways. Again, for some very small specialist developers, a relatively small number of LOs might be all they need or want to provide.

As was illustrated in Section 2, some private sector developers, such as electronic publishers and companies with existing electronic educational packages in non-LO formats, already have a large body of existing materials. For them, resource modification and translation rather than generation are the major production activities. If the purpose is to gain a financial return from involvement in the programme there is an incentive to make substantial numbers of LOs, as this spreads the set-up and overhead costs across more LOs, and enables the developer to reach various kinds of economy of scale. Here what counts as a critical mass of LOs for the developer is as many as can reasonably be produced while still ensuring a better return than from any other use of the staff and resources available. However, the economics of this will be affected also by the amount of previous relevant experience the developer has, and by any additional costs and benefits that would come from staff learning the new skills needed to move into LO production. On the private sector side, then, the number of



LOs a developer needs to produce to make it financially worthwhile to participate is going to be highly variable. This judgment will be in the context of what improvement the ELOA makes in their return on investment, given that it is unlikely that many developers would enter into LO production purely on the basis of a European initiative, without some national market.

Amongst the public service developers two groups can be identified. One is made up of what we might call the full-spectrum providers, such as the education ministries or other national public agencies responsible for work in this field. As the interviews with LO developers reported in Section 2 revealed, some of these agencies clearly see their responsibility to be to provide coverage of LOs across a full spectrum of the curriculum for their own schools. Here the notion of critical mass is linked to a concept of curriculum coverage; critical mass can be seen as the number of LOs needed to cover a subject, an age range or the whole curriculum. How many LOs would represent a critical mass here will vary from country to country. It will depend upon (amongst other things) how far there is a centrally defined national curriculum, and what view the agency takes of the desirability of offering a choice of LOs to deal with a given topic. For these full-spectrum public service providers, working with teachers to develop LOs seems likely to be the dominant model for production.

An important alternative option for full-spectrum providers (which was not explicitly represented in the CELEBRATE data), would be to go for a much more closely focussed strategy. In this the LOs developed would focus only upon those topics, concepts, ideas or processes in each subject that were known to cause students problems with learning when conventional resources are used, and where there were good reasons to think that the use of LOs would be more successful. For a full-spectrum public service provider this option would be therefore a way of selectively supplementing conventional methods rather than attempting to completely replace them.

In addition to the full-spectrum providers, there was a second public sector group, namely more specialised public-sector agencies with an educational responsibility, such as science centers, museums, national libraries and art galleries. This is potentially a very large group whose members might differ in their specialist areas of interest and/or in the geographical area that their remit covers. Their reasons for wishing to be involved might also vary. Some could see this as a way of widening their audience to a national or European one, while for others it might be rather a way of reaching schools and young people in their own locality more effectively (i.e. an institutional equivalent of blended learning). As young people's involvement with these institutions is voluntary, these agencies might be expected to judge the success of their involvement in the ELOE by the width of coverage of their specialist area their LOs provided and/or the numbers of additional real or electronic "attendances" generated as a result. The relative importance of these two criteria would vary from organisation to organisation, but these criteria represent two more kinds of critical mass.

The role of the partnership

All this raises two further questions that the ELOE partnership as a whole will need to address:

- What would constitute the programme as a whole achieving critical mass?



- What can the partnership contribute to achieving this, over and above the contributions of its individual members?

On the most basic level, the programme as a whole will achieve critical mass only if at every stage of its development:

- sufficient teachers want to use LOs;
- sufficient LOs are produced;
- the ones produced are the ones that are wanted;
- and the teachers are able to find and successfully use the LOs they want.

In addition the partnership will need to generate enough income to maintain the infrastructure needed to help the various partners meet these conditions.

Given the complexity of both the supply and demand sides of this process, this suggests that a key role for the partnership will be to take a highly strategic approach to identifying which groups of teachers to provide LOs for and which potential LO developers to involve. As this whole process will take some years it will also be essential to keep the kinds of demand and supply reasonably well matched over time, with new groups of teachers and the supply of the particular kinds of LOs they need being brought into the programme in a closely synchronised way. The experience of CELEBRATE indicates that this will not be easy.

8.2.5 Visions for the future of the ‘learning object enterprise’

In Section 7.5 we ended with two distinct models of how to conceive of the ‘learning object enterprise’ (represented in Figures 7.3 & 7.4).⁹⁴ One conception was that the production and distribution of LOs should be geared to changing teacher pedagogy to favour, and develop, advanced pedagogy in classrooms using LOs; the ‘change’ view. The second conception was more conservative, in that LOs would be produced that could be assimilated into teachers’ pedagogy. Further, it was noted that this would have implications for all aspects of the LO enterprise, namely creation, searching, using and modifying. This is worthy of exploration, as it has implications for the policies of both governments and commercial companies involved.

The change view would require content providers to focus on LOs that represent the ‘new generation’ of LOs mentioned earlier. They might want to put their energy and resources into developing good ideas that have the potential to move pedagogy on and to add unique elements that are not possible in other ways. When teachers search for LOs they will be encouraged to look for innovative LOs that will support student agency, collaboration, multiple perspectives etc., and this will have to be reflected in the metadata categories of LOs or the descriptions associated with LOs (whether produced by developers or teachers as users). Teachers would have to be supported through professional development and exchange to develop and share ideas on advanced pedagogic use of LOs, with possibly ‘lead teachers’ as a vanguard. (They might in turn also be involved in LO production with content providers; Section 2.5.)

⁹⁴ In Section 7 we depicted the whole activity of LO development, supply, use and modification as the ‘learning object enterprise’.

Teachers might work with existing LOs to modify them to enhance particular elements of advanced pedagogy.

The assimilation view requires content providers to be more sensitive to the market requirements in terms of responding to what teachers wanted in general. The evaluation has shown that teachers have selected and seemed happy to use large numbers of 'Drill and practice' LOs, which are not very supportive of advanced pedagogy. Thus, such a view would be slow to change pedagogy. Searching for LOs would focus on curriculum topics and not pedagogic types, and the LO descriptions may be more 'mundane' in simply reflecting aspects of classroom work (introduction to lesson, presentations of material, assessment of student learning etc.). The ELOE would need to develop data gathering and analysis that allowed this responsiveness to demand to be finely tuned and used to advise content providers where to focus LO production. Also the exchange of experience and development of the use of LOs would be more of an exchange catalogue, with perhaps an 'Amazon.com' model of user reviews being employed to advise or attract teachers to select an LO!⁹⁵

The flavour of the LO enterprise under each of these views is quite different. However, they could exist side by side, with different kinds of producers taking different roles that reflect different kinds of financial risks and aims in their being in the LO 'market'. (Governments as providers are more likely to want to take the 'change' view and commercial providers the 'assimilation'?) There is also the argument, voiced at the last CELEBRATE project meeting in Florence (D7.1), which says that teachers might have different needs at different stages in their use of LOs. Initially they may use 'Drill and practice' and then move on, when they are more experienced, to 'Exploration' types etc. What is not so clear is whether an ELOE can run both views with equal effectiveness. It may be then that there has to be a choice about what is the strategic vision behind the LO enterprise.

Alternatively, is it possible to identify a third approach that achieves a workable synthesis of the most valuable elements from these two models? We offer a possible model that has the following features:

- Decisions on how to improve LOs, the system for their delivery and the ways in which they are used in classrooms are all reached through a continuing dialogue.
- This dialogue draws upon the practical experience, reading, reflection and systematic investigations of all the participants.
- The participants in the dialogue include teachers, researchers, developers and ministry staff.
- Judgements on contributions to the dialogue are made on the basis of what is said and the reasons and evidence offered, not upon the status or official role of the contributor. What is said, and why, matters. Who says it does not.

⁹⁵ Indeed the Portal has the beginnings of this facility in terms of an evaluation option against each LO, which records ratings by teachers that they can use as a guide to selection.

The contributions of some of the main groups of participants and the ways in which their contributions on different topics might shape each other, are shown in Figure 8.4, what we call the ‘transformational model’.

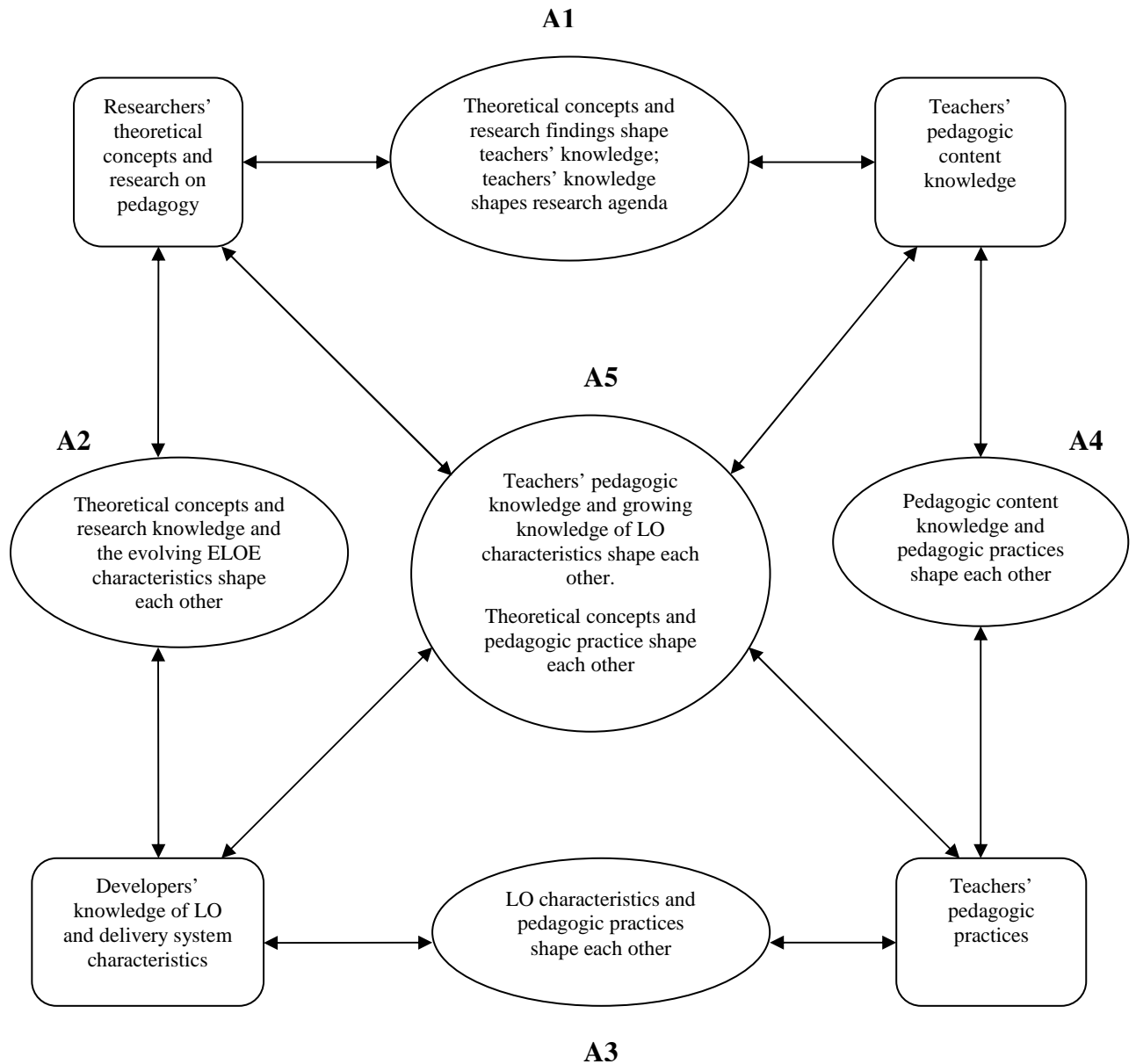


Figure 8.4: the transformational model

This ‘transformational’ model requires a network through which ideas for changes in both the LOs and their use would circulate in all directions, as would modifications of LOs designed to instantiate and make open to test the various views being presented. It would, in short, be a learning network for its members as well as an electronic resource production and distribution network. Developing and maintaining such a network would be a complex and demanding task, but it would arguably be the potentially most productive approach to adopt.

It is also clearly possible. To look no further, the sorts of relationships envisaged are already visible in ERNIST, which is an existing EUN network. As EUN puts it:

The purpose of the European Research Network for ICT in Schools of Tomorrow (ERNIST) is to create a network of leading experts and institutions in research and evaluation of ICT in learning and innovative schools, bringing together education inspectors, researchers and practitioners. They will explore elearning concepts such as new learning environments and virtual learning and identify the steps to be taken and indices of progress towards this aim that ministries would need for evidence-based decision-making. (EUN website: http://www.eun.org/eun.org2/eun/en/About_eschoolnet/content.cfm?ov=29612&lang=en accessed 22 Nov 2004)

Where the ELOE would differ is in the involvement of LO developers and its specific focus upon improving the ELOE in concrete ways. To do this would involve different activities and different combinations of partners for each of the links (A1-A5) shown in Figure 8.4.

So what sorts of activities would the ELOE take on if it were developed in this way?

In fact many of the kinds of joint activities that would be required have similarities to those used in this present evaluation. This is not too surprising, as an evaluation represents a particular kind of attempt to help an organisation, and those with an interest in its activities, to learn how it might work more successfully.

To start at the top of Figure 8.4 (A1), if theoretical concepts and research findings and teachers' pedagogic content knowledge are to shape each other then teachers and researchers must work together in the way that ERNIST indicates. In part the interview studies and the teacher questionnaire responses and their analysis in this evaluation illustrate ways in which teachers' pedagogic knowledge and a research agenda can interact. However, there are also literature reviews of the use of relevant ICT applications in classrooms that indicate the nature of teacher pedagogic content knowledge.

Similarly (in A2) researchers' knowledge of the working of other innovation projects and the developers' knowledge of the LOs and the delivery system were brought together in part in the evaluation interviews with developers. ERNIST-like activities could also be utilised here, with reviews of literature of types of LOs, perhaps in particular topic areas, being undertaken.

The developers also had, in the training sessions and in some of their own LO development strategies, ways of interacting directly with teachers to gain their views on LOs and to adjust their own perceptions of LOs accordingly. These activities (A5, lower half) thus represent ways of linking developers' knowledge of LOs and their delivery with teachers' pedagogic knowledge, as did the teacher feedback gained from the 'pop-up' evaluations and made available to developers and other partners through this report.

Teachers' pedagogic practices were also linked into this exchange of information (A5, upper half). The classroom case studies illustrate one way in which researchers can begin to understand this practice better and, through discussion with the teachers observed, also see how it links to teachers' pedagogic knowledge. The work done by teachers with the authoring templates, especially where it emerged from training sessions and work within a group of teachers, also indicates a way in which developers' knowledge of LOs and the delivery system were built into tools for the



teachers, who in turn, by the ways in which they made use of these, fed back experience from their own practice into the creation of the modified LOs (A3).

Finally, in any individual teacher's work his or her pedagogic knowledge and pedagogic practices also interact with each other in a process of personal development (A4). However, it is also worth noting that where teachers worked together on using or modifying LOs there was also a collective form of development emerging, in which teachers learned from each other's perspectives and actions as well as from their own. The ELOE Portal could have a role in this exchange through the *Lesson Bank* on the Portal and other exchanges of experience.

The methods needed in the longer term would differ in several ways from the set used in a formal evaluation. Firstly, an evaluation is designed to be completed by a fixed time point, whereas a learning organisation needs learning to be continuous and incremental, and as far as possible generated automatically and easily as a byproduct of the organisation's other activities. While there remains an important role for formal external evaluation and research, most of what needs to be learned is best learned by and from those directly involved. If the ELOE is to become a successful and self-sustaining organisation in a rapidly changing educational and technological environment, the central task is to find ways of becoming and remaining a learning organisation.

8.3 Recommendations and proposals for future research

In this section we present our main recommendations concerning the future development of the ELOE. These proposals are filled out in more detail in Appendix 1 (*Detailed Recommendations*). The recommendations cover seven interrelated topics:

- identifying and implementing the changes required to move to a full scale programme;
- planning and developing the ELOE as a learning organisation;
- improving and tightening the technical and educational specification for LOs;
- identifying long-term targets for the range and types of LOs to be provided;
- identifying and implementing ways of supporting advanced pedagogy;
- building the capability to use LOs into professional development and training;
- identifying key questions for future research and evaluation.

Recommendation A: Identifying and implementing the changes required to move to a full-scale programme.

As CELEBRATE evolves from a pilot project into a full-scale Europe-wide service, a number of the approaches used in the project will need modification or replacement. These approaches include:

- adopting clarity about the purposes of the ELOE in terms of the approach to the 'learning object enterprise', as assimilation, change or transformation, and the extent to which it can adopt any combination of these approaches;



- on the basis of the above clarification, to make strategic choices of which teachers to target, what LOs to develop and how supply will meet demand.

Recommendation B: Planning and developing the ELOE as a learning organisation

The ELOE should be developed in ways that make it a learning organisation, designed so that both the system and the partners can easily generate and analyse much of the data needed to improve it. This will involve:

- teachers taking part in LO development and piloting and in identifying an appropriate role for the ELOE VLE;
- selectively extending the range of data and information drawn from the Portal and Brokerage System for analysis, along with appropriate staffing;
- ministries interested in free provision of LOs being brought together to plan joint development, with a role to encourage knowledge exchange and partnerships between content providers.

Recommendation C: Improving and tightening the technical and educational specification for LOs.

The design of the LOs will also need some revision and closer specification to ensure that:

- all LOs should be interoperable on all systems meeting the entry standard recommended in A above;
- small modular LOs should be preferred to larger integrated ones, accompanied with basic teacher instructions on operational use.

Recommendation D: Identifying long-term targets for the range and types of LOs to be provided

During the pilot the aim was to provide sufficient LOs to make clear what the potential of this approach would be. In the longer term there will be a need:

- to specify (presumably at national level) whether the aim is to cover the whole curriculum or to focus on specific pedagogically difficult topics;
- for a selective and teacher-led expansion in the numbers of LOs translated.

Recommendation E: Identify and implement ways of supporting advanced pedagogy

One theme in the project was to explore ways of combining LO use with advanced pedagogy. If this is to continue as a key element in the ELOE it will require that LOs should be:

- available that support advanced pedagogy;
- accompanied by advice to teachers on how to use the LOs in these ways.

Teachers should be directly involved in generating the advice.

Recommendation F: Building the capability to use LOs into professional development and training

There are three major foci of this development:

- time for professional development and a larger involvement in sharing of best practice and LO evaluation and development;
- where the introduction of LOs is to be a major feature of national policy, LO use should be integrated into initial teacher training;
- cross-European information on how teachers are being trained to develop or modify LOs should be collected and made available to all developers.

Recommendation G: Identifying key questions for future research and evaluation

The evaluation has identified a number of gaps in our knowledge that require further exploration. Many of these have already been covered, but there are a number of strategic areas where further systematic research, literature reviews and evaluations are required. Topics for this programme are listed in Appendix 1. They include:

- why teachers choose the LOs they do, how they can be helped to make choices and how successful these choices are in terms of student learning;
- what the long-term effects of LO use are upon teachers and students;
- what new problems would emerge if the use of LOs was extended into more culturally challenging areas such as history and religious education.

Stakeholders' focus for recommendations

There are a number of stakeholders involved in each of the recommendations A-G above:

- Schools and teachers (S).
- The ELOE (i.e. the companies, agencies and ministries involved as partners in the running and development of the new portal and brokerage system and the LOs and LAs that will be provided through them) (P).
- European Ministries of Education, including both those who are CELEBRATE partners and those considering joining (M).
- The private and public sector LO developers, both current and future (D).
- Researchers and evaluators (R).
- The European Commission (EC).

Nevertheless, it is possible to attribute to each of them to one or two stakeholders, who would be the main focus of implementation. These are as follows:

ELOE	Public and private sector content providers	Ministries	European Commission	Researchers and evaluators
A, B	C, D, E	E, F, G	G	G

8.4 Reflections on future project design and evaluation

While the CELEBRATE project was a complex one in other ways it was fairly typical of many school-related research and development projects. Two of the problems encountered in carrying out and evaluating the project are therefore of wider relevance, namely the pressures that involvement put upon schools and the difficulties of planning and conducting an evaluation across several countries.

The schedules for projects and evaluations of this kind need to be planned around the different patterns of teachers' and students' work across the school year in the countries involved. The schedules for projects and evaluations of this kind need to give enough time for teachers to experiment with, plan and use and evaluate the systems being tested. A contingency reserve of time is also essential for complex projects that have closely related elements and a sequential line of development. The impact of participation on teachers' workloads must also be fully recognised and ways found of making the very best use of their time.

Within those constraints, funders and researchers also need to organise planning and scheduling for future projects like this so that both formative and summative evaluation are practicable. Providing early feedback to participants near the start of a development project is particularly important. This may require a mix of quick collection and evaluation of limited data followed by a more rigorous and detailed long term approach for the final summative evaluation. It may also require funders to recognise the value of rather longer timescales for projects and evaluations; these could both spread the load for teachers and allow evaluators time to provide both formative and summative results.

School-level studies that work across countries where the researchers do not share all the national languages involved also raise particular problems. These include standardising data collection and presentation and the detailed cross-country analysis and comparison of large amounts of qualitative data across language barriers. Experience across past EC-funded projects on this matter should be collected from the research teams involved and analysed to see what solutions have been found. The results of this should be made widely available to potential future research teams, funding agencies and bid reviewers.

References

Bradley, G. and Russell, G. (1997) 'Teachers' computer anxiety: Implications for professional development.' *Education and Information Technologies* 2, pp. 1-14.

CELEBRATE (2000) *Bid Annexe 1 – Description of Work*. EUN

Content Developer Interviews CELEBRATE Work Package 7



- [*Classroom Studies*] Ilomäki, L. & Lakkala, M., (eds.) (2004) *Learning objects in classroom settings: A report of 13 case studies conducted in Finland, France, Hungary, Ireland and United Kingdom*. CELEBRATE Work Package 7.
- [D6.2] Durando, M., Raymond, C., Leclèr, P., Salminen, M, Hunya, M., Pedersen, L., Winer, D. & Jeavons, H., (2004) *Reports from Pilots - Deliverable 6.2*. CELEBRATE Work Package 6.
- [D7.1] McCormick, R., Scrimshaw, P., Li, N. & Clifford, C. (2004) *Deliverable 7.1: Report of Evaluation Workshop*. CELEBRATE Work Package 7.
- [D8.2.1] Ayre, J., (2003) *CELEBRATE Dissemination and Use Plan: Version 1 – Deliverable 8.2.1*. CELEBRATE Work Package 8
- [*Interview Studies*] McCormick, R. & Clifford, C., (eds.) (2004) *Teachers Views on Learning Objects: A Interview Report with Teachers in Schools in Finland, France, Hungary, Israel, Norway and the United Kingdom* CELEBRATE WorkPackage7.
- McCormick, R. (2003) *Keeping the pedagogy out of learning objects*. Paper presented at the 10th Biennial Conference of EARLI *Improving Learning, Fostering the will to Learn*, University of Padova, Italy, 26-30 August 2003.
- Vuorikari, R. (2003) *Virtual Learning Environments for European Schools: a survey and commentary*. Brussels: EUN Consortium.
- Wiley, D., Padron, S., Lambert, B., Dawson, Nelson, L., Barclay, M. and Wade, D. (2003) 'Using O₂ to overcome learning objects limitations.' In E. Duval, W. Hodgins, D. Rehak and R. Robson (eds.) *Learning Objects 2003 Symposium: lessons learned, questions asked* (pp. 61-67). ED-MEDIA 2003 World Conference on Educational Multimedia, Hypermedia & Telecommunications, Honolulu, Hawaii, USA, 24 June 2003. (Online at <http://www.aace.org/conf/edmedia/LO2003Symposium.pdf>, checked 28 November, 2004.)

Appendix 1 Detailed recommendations

These detailed recommendations fill out the general recommendations made in Section 8.3. The relevant source for each recommendation is indicated. If it is based upon the final report the number of the relevant section is given. The other sources used are the case study report (CS), the Interview studies (IS) and recommendations emerging from team discussions, and particularly the CELEBRATE team's Florence Workshop (indicated by 'FW'; see D7.1).

The key groups that we assume would need to be directly involved in reaching decisions/taking action upon each recommendation are also shown. These are:

- Schools and teachers (S).
- The ELOE (i.e. the companies, agencies and ministries involved as partners in the running and development of the new portal and brokerage system and the LOs and LAs that will be provided through them) (P).
- European Ministries of Education, including both those who are CELEBRATE partners and those considering joining (M).
- The private and public sector LO developers, both current and future (D).
- Researchers and evaluators (R).
- The European Commission (EC).

The European Commission is shown as a key group only in relation to a few decisions; however, it obviously has an important general role in relation to funding and authorising action on many of the other decisions.

A. Identifying and implementing the changes required to move to a full scale programme	Source(s)	Key groups
1. Adopt clarity about the purposes of the ELOE in terms of the approach to the ‘learning object enterprise’, as assimilation, change or transformation, and the extent to which it can adopt any combination of these approaches.	8.2.5	P
2. On the basis of Recommendation 1, to make strategic choices of which teachers to target, what LOs to develop and how supply will meet demand.	8.2.4	P
3. An ‘entry standard’ should be defined for the ICT facilities required to successfully use LOs, defining system and machine requirements (e.g. plugins, browser standards). This should be done for all the major operating systems used by schools in Europe.	7, 8.2.1	P
4. The design and documentation of the portal and brokerage system should make it quick and easy for new LO developers to create and disseminate their LOs (tagging and uploading LOs, for example, needs to be easy to do). This applies both to commercial providers developing new LOs and teachers creating modifications of existing ones.	2	P
5. Present and planned types of LOs should be reviewed to see if any additional authoring templates are needed. Existing templates from different providers should be reviewed to see if they can be modified and presented in ways that would turn them from an assemblage of different tools into what teachers would perceive as a usable, easily learnable and coherent ‘toolkit’.	2.6.2	P, R
6. Investigate the use of ‘non-CELEBRATE’ tools for creating LOs to arrive at a possible standard set across Europe, which will allow interoperable LOs to be produced.	2.6.2	P, R

B. Planning and developing ELOE as a learning organisation	Source(s)	Key groups
7. To involve high ICT skill teachers in the development and piloting of LOs such that developers and teachers build up expertise in both production and use of LOs.	5.2.2, 8.2.5, CS	P, S, M, D
8. Financial and logistic means will have to set up to ensure that a quick, effective and substantial translation programme can be put in place as soon as possible.	8.2.3	P, M, D
9. Which LOs are chosen for translation should be automatically monitored and analysed to see what common LOs or features of LOs appear. The results of this monitoring should be made available as a guide when selecting further LOs for translation into English and hence inclusion in the ‘translation pool’.	6.2.3	P
10. Work should be carried out with teachers to develop and make explicit the ‘VLE role’ of the Demonstration Portal, such that teachers can store LOs for different student groups and can give them access to the LOs. The relationships between this kind of activity and teachers’ use of purpose-built VLEs should also be explored.	2.7.3	P, S, R
11. The countries interested in free provision of LOs should be brought together to discuss developing these jointly. The strengths and limitations of this approach should be monitored both to assist the group itself, and for its relevance to other cross-European educational initiatives.	2.5	P, R
12. Ministries of education should take the initiative to organise networking or training programmes for various kinds of content providers, and encourage them to exchange ideas and build up partnerships in terms of professional development in the production of LOs, especially to help non-profit organisations.	8.2.2	P, D, M
13. The design of the ELOE should ensure that it maximises speed of access and ease of use to ensure teachers obtain the LOs they want, through some kind of intelligent search and retrieval mechanism.	8.2.3	P

C. Improving and tightening the technical and educational specification for LOs	Source(s)	Key groups
14. LOs should be designed so that they are technically interoperable on systems that meet the ‘entry standard’ specification in Recommendation 3 and should be tested by developers and/or the EUN before being made available on the ELOE.	8	P, D, S
15. LO designers should always specify any additional plugins needed to run the LO, and specify where to obtain them	CS	D
16. LOs should be modular such that the size allows it to cover a specific curriculum topic, form one part of the lesson (if intended for use in a blended approach), and can be part of selection of LOs (or other resources) for students chose from. Such LOs are to be preferred over more integrated LOs with components that have a structure and sequence predetermined by the LO provider.	8.2.2	D
17. All LOs should come with basic teacher instructions on operational use.	8	D
18. Designers should avoid those elements in an LO that encourage game playing without contributing to learning.	6, 7	D

D. Identifying long term targets for the range and types of LOs to be provided	Source(s)	Key groups
<p>19. A comparative analysis of national curricula should be located/carried out to identify:</p> <p>(a) the range of topics that a Europe-wide set of LOs would need to cover in each general subject area;</p> <p>(b) the common core of most widely shared topics.</p> <p>Existing and potential content providers should receive this information, together with a regularly updated list of the topics already covered by existing CELEBRATE LOs</p>	2.7	P, M, R
<p>20. An alternative to a strategy that seeks to establish full curriculum coverage for countries is that the supply of LOs should focus on those topics, concepts, ideas or processes in each subject that cause students problems with learning and with which digital material could help.</p>	FW	P, D, R
<p>21. While the range of CELEBRATE LOs needs to be extended generally in future, there is a particular need for improving and extending the range of secondary LOs for older students.</p>	2, 5.2.1, 6	D
<p>22. Teachers must have access to LOs in their own language, and that match their curriculum needs. One way to meet both requirements is to organise a group of teachers to evaluate LOs in a second language and to translate the most suitable ones. To facilitate this, the pool of LOs in the commonest shared language (English) should be expanded.</p>	6.2.2	P, S
<p>23. Ways of designing LOs (and the portal) to make them accessible to students with particular kinds of sensory or motor disabilities should be explored.</p>	5.3	P, M, D
<p>24. Ways of designing LOs (and the portal) to make them useful and motivating for students with learning disabilities should be explored.</p>	5.3	P, M, D

E. Identifying and implementing ways of supporting advanced pedagogy⁹⁶	Source(s)	Key groups
25. LOs should be designed to support one or more of the following elements of learning: <ul style="list-style-type: none"> a. student agency, autonomy and reflection; b. collaboration among students; c. authenticity of content and activity; d. multiple perspectives. 	CS, 6.3.3, 7.5, 8.2.1	D, R, S
26. LOs should be designed to allow the students to interact with each other and the teacher to help develop student thinking and cognitive challenge and should try to avoid a focus on tasks rather than on the ideas and concepts that underlie these tasks.	6, 7.6	D, R
27. User advice should be provided with each LO covering the following elements: <ul style="list-style-type: none"> • Kinds of student autonomy that can be encouraged (i.e. that give the student some control or decision making about their learning). • How the LO can be used collaboratively, (i.e. that involve students in sharing and discussing ideas and concepts). • How the LO can act as a tool for student thinking, (i.e. to allow them to explore and manipulate ideas and data). • How the teacher can interact with students either face-to-face or electronically to engage with the ideas and the students' understanding of them (e.g. this might involve making them less independent of the teacher rather than more, unless this teacher-student interaction is replaced by student-student interaction). The development of this advice should centrally involve teachers.	CS	D

⁹⁶ This group of recommendations will effectively develop the ideas in Appendix 3.

<p>28. Where teachers already have core ICT skills there is a need for advice upon advanced pedagogy, to help them:</p> <ul style="list-style-type: none"> • Encourage student autonomy, collaboration, reflection and multiple representations of knowledge. • Review and improve their own interaction with students face-to-face or electronically so as to help students to interact with the ideas of the teaching and learning and to help students' understanding. • Be aware of the possible game-playing strategies that students may employ (e.g. with scoring systems of LOs) and to pre-plan strategies for dealing with this. <p>This advice should reflect the language and concerns of teachers.</p>	<p>CS, 8.8.2</p>	<p>D, S, R</p>
<p>29. To generate advanced pedagogy an exchange of views could be supported among teachers on their use of LOs. The relative advantages of doing this electronically and/or face to face should be explored, as should the relative advantages of doing this through a cross-Europe group, smaller two or three-country groups or within individual countries.</p>	<p>7, 8.8.2</p>	<p>P, R</p>

F. Building the capability to use LOs into professional development and training	Source(s)	Key groups
30. Teachers to be involved in working with new forms of LOs, to create LOs and to build up professional knowledge, where possible using the Portal of the ELOE.	8.2.2	P, M
31. , The implication of Recommendation 30 is that teachers will require time, and ministries will have to seek ways of making this available.	8.2.2	M
32. A minimum ICT skill ‘entry standard’ should be defined and disseminated to indicate what teachers need to be able to do to use LOs in the classroom. This would include basic ICT skills (with some technical elements) and pedagogic issues in relation to LO use. There should be some work done to identify the nature of both of these elements.	5.2.2, 7	P, S, R
33. In countries where LOs are to be systematically adopted, training in their use should be integrated into initial teacher training. This training should be mostly pedagogic, but also include any additional technical training that might be needed.	3, 5.2.2	M
34. Primary and secondary teachers need different kinds of training, with primary teachers in particular needing more pedagogic and technical support.	5.2.1	P, M
35. Information should be collected and disseminated on the various approaches used both by companies and national agencies to train teachers to develop or modify LOs and be made available to all current and future developers. This could be illustrated with concrete examples from the various programmes, and include contact details for those wishing to explore a particular approach further.	2.5 2.6	P, R
36. The facilitation of peer networks and teacher’s mutual sharing of best practices, LO evaluations and good ideas are all approaches that should be explored, including the possible use of the ELOE portal.	8.2.2	P, M

G. Identifying key questions for future research and evaluation	Source(s)	Key groups
37. There were a considerable number of teachers who were not convinced of the benefits of LOs, and a study of this group should be undertaken.	4.4.3	P, S, R
38. Some LOs remained unused, while others (e.g. the ‘Top 10’) were very popular. Why did teachers make the choices they did about these two groups of LOs, and what are the implications for the design of future LOs?	FW, 4.3	P, S, R
39. Many teachers will use other elearning and/or conventional resources and CELEBRATE LOs together - what can research on how this is done tell us about the relative educational advantages and limitations of each kind of material and the best ways to combine them?	FW	D, S, R
40. The specification of appropriate target age group for an LO proved problematic and alternative strategies need to be investigated.	6.3.1	R, S, D, M
41. Why is the distinction between LOs and LAs educationally important? What is the most productive way of conceptualizing the distinction and using it to improve the design, selection and use of both kinds of resource?	FW	D, S, R
42. The Portal allows teachers to rate and comment upon LOs. This offers users an alternative to metadata keyword searching as a way of selecting LOs. What are the relative strengths and weaknesses of this approach?	FW	P, S, R
43. In what circumstances is the <i>Lesson Bank</i> being used, for what purposes, and with what results, and how does this relate to more general communication functions among teachers through the Portal?	FW, 3.3.6	P, S, R
44. Does using the most frequently chosen LOs and those that receive the best teacher evaluations lead to higher levels of student achievement than the use of others? How could the findings on this help teachers to review their existing criteria for choosing LOs and guide future LO design?	6	D, S, R
45. The use of familiar non-CELEBRATE tools (e.g. <i>Flash</i>) to create LOs potentially saves on teacher development time. What are the key tools here, and how can any problems of interoperability be solved?	2.5 2.6 8.2.2	P, S, R

<p>46. One very large group of potential LO and LA providers are European museums, art galleries and libraries. How many of these are interested in this possibility, and why? What advantages and disadvantages would a major expansion in this direction have for all concerned?</p>	8.2.4	P
<p>47. What new problems would emerge if the development, modification and use of LOs were extended into more culturally challenging areas (e.g. history or religious education)? How could any such problems be solved?</p>	FW	P, D, EC
<p>48. What effects does long-term usage of LOs with advanced pedagogical practices have upon students and teachers, and why?</p>	FW	P, S, R

Appendix 2 Evaluation methodology

Overview

This section provides a brief introduction to the evaluation methodology used in the project, beginning with a description of the rationale for the design, and then setting out three overall objectives of the evaluation. The design of the instruments and process of data analysis are discussed. It also summarises the overall evaluation approach.

Rationale for the design

The project was both complex and closely specified in terms of what was required on the various members of the project team (*Annex 1- Description of Work – CELEBRATE – IST – 2001 – 35188*). The agreed scope of the role of the evaluation was not to look at how well the project team carried out their work, but at what emerged from the project itself. The theoretical approach chosen was based upon that advocated by Yin (2003) for cross-case evaluations. This involves using a case study methodology specifying a set of hypotheses initially and then designing instruments and methods of analysis that allows these to be tested.

The hypothesis was formulated by specifying what would work successfully at each stage of the process of LO development and LO use, if the aims of the project were to succeed.

The overall evaluation hypothesis was that:

- given suitable pre-conditions and working methods,
- learning objects can be created,
- translated,
- modified,
- distributed,
- and presented,
- within a 'market' that can be created to protect the rights of creators and provide necessary income where appropriate; and that
- learning objects can be selected and
- employed usefully and efficiently,
- in a range of subject areas and classroom contexts reflecting diverse education systems,
- by teachers of varying backgrounds and interests,
- using a variety of pedagogical models and working with students of selected ages, ethnicities, social backgrounds, levels of previous achievement, and diverse first languages and cultures.

The purpose of the evaluation was to:

- examine each of the areas of the hypothesis to determine if it had been achieved and, where there were problems or issues arising, to determine what the reasons were for this;



- identify whether there were significant differences in the judgments of usefulness and efficiency made by different categories of users and developers; and if so why;
- provisionally identify what changes in the pre-conditions and working methods would be needed to make the CELEBRATE system outcomes more effective and useful to all users and developers in the future.

Data sources used

The data sources for this report were of three kinds. The first was primary data collected directly by the evaluation team, the second was indirectly collected primary data, using staff from WP6 or their colleagues, and the third was secondary data in a number of deliverables and other kinds of documents produced within the CELEBRATE project.

Given that the evaluation was looking both for effects from the project and for understanding of how these had been produced, a mixture of quantitative and qualitative data was assembled. Ideally the quantitative data would provide patterns that the qualitative data could then be used to interpret. In practice the time constraints meant that both had to be carried out in parallel rather than in series.

A combination of semi-structured interviews, questionnaires and case studies were used. These instruments, the scale, and nature of the data provided by each, is summarised in the next section.

The instruments and data collection

Teacher registration questionnaire

Teacher registration questionnaire was integrated with the Demonstration Portal registration. It was launched in Nov 2003, and teachers were invited by e-mail to complete the questionnaire and register with the Demonstration Portal. The questionnaire was designed to capture data on teachers' background such as age, gender and teaching experience and their experience of using ICT, which was to help build up a profile of the teachers involved in the CELEBRATE project. These data are reported in the *Teacher registration questionnaire report*.

Teacher as user of LOs questionnaire

It was an online pre-determined response questionnaire, designed to collect teachers' views and their experiences of using CELEBRATE LOs. More specifically the questionnaire covered the following areas we aimed to explore:

- experience of using LOs in general;
- reactions to the quality of design and content of CELEBRATE LOs;
- use of LOs in teaching and learning;
- issues of language and culture.

Teachers were invited by email to complete the questionnaire when the Demonstration Portal record suggested that they had been registered with the Demonstration Portal for more than three weeks. Responses to the questionnaires



were coded and analysed through the use of SPSS V11.5 (Statistical Package for the Social Science). These data are reported in the *Teacher as user of LOs questionnaire report*.

Pop-up questionnaire

This was a very short structured online questionnaire. It aimed to collect teacher feedback on specific LOs teachers selected and/or saved in their basket on the Demonstration Portal. The six questions on the questionnaire repeat some of those used in the questionnaire related to teaching and learning. These data are reported in the *Pop-ups questionnaire report*.

Portal questionnaire

The aim of the questionnaire was to collect teachers' opinions and experiences of using CELEBRATE Demonstration Portal. It covered the following issues:

- experience of using Demonstration Portal in general;
- functionality of Demonstration Portal;
- professional usefulness and training.

The questionnaire was originally constructed in English, and piloted with some project teachers in two workshops. Then each pilot country project coordinator organised the translation of the revised version from English to their local language. Responses to the questionnaires were coded and analysed through the use of SPSS V11.5 (Statistical Package for the Social Science). These data are reported in the *Teacher as user of Demonstration Portal questionnaire report*.

Teacher interview schedule

Design of the interview studies was discussed at a Project meeting in September 2003 with the coordinators of six pilot countries, who would implement these studies⁹⁷. A semi-structured interview schedule and instructions for the conduct of the studies were discussed and agreed at this meeting. The interviews aimed to give us some insight into teachers' views and experience of using the CELBREATE LOs and Demonstration Portal, which questionnaire responses might not be able to provide. Also the intention was to explore school issues, rather than just those of individual teachers. However, in the event such issues were not apparent.

At end of May 2004 an analysis meeting was held in London with all WP6 coordinators and some of the WP7 team to work through samples of the data and agree on the analysis and write up of reports from each pilot country (Israel was done separately by telephone). The authors of the reports for each country were not all professional researchers, some were from engineering backgrounds and ministries of education, and researchers of the Open University therefore combined the data of the other countries and the UK to make this report.

⁹⁷ These six countries are: Finland, France, Hungary, Israel, Norway and the UK.



These data are reported in *Teacher's views on Learning Objects: A report with teachers in schools in Finland, France, Hungary, Israel, Norway and the United Kingdom (Interview Studies)*.

Experimental study

Aim of the experimental studies was to examine whether or not learning objects could enhance student learning outcomes in different pedagogical settings and with different types of LOs. In order to test the hypothesis, three independent experimental studies, with different kinds of structuring and pedagogical approaches were conducted. In all these studies the participants were from the same sample. In the first study students were learning aspects of Finnish language in two different learning environments; with 'Drill and practice' LOs and with traditional textbook assignments. In the second study the experimental design was the same, but students were learning mathematics, namely fractions and mixed numbers. In the third study, three groups were learning simple electrics. The first of these three groups was working with traditional hands-on laboratory activities; the second group used an electricity simulation LO, and the third group was using a combination of both of these methods (laboratory work and simulation LO). In each study, in order to compare learning outcomes between the conditions, pre-test and post-tests measuring subject knowledge were administered. Student answers were scored against model answer templates. Results were analysed both with statistical and qualitative analysis.

These data are reported in *Learning Objects – a lot of smoke but is there a fire? Academic impact of using Learning Objects in different pedagogical settings (Experimental studies)*.

Case studies

The data collected from the case studies including the following resources:

- Background information of the school and the setting. This data was gathered with a questionnaire for the schools as part of CELERATE evaluation.
- The participating teachers' "agendas" based on short interviews of the teacher before and after the observed lessons.
- Observation notes and video recording of the classroom activities.
- Possible informal discussions with the students during the classroom activities.
- Notes of discussions with the teacher.
- Written/discussed evaluation of the teaching and learning sequence by the teacher.
- Other informal data, e.g. e-mails from the teacher, notes of the informal, preparatory, meetings.

The analysis

Finland

The analysis of a case was conducted jointly with two researchers. The final structure of the analysis was derived from several preliminary analyses of the data. First, two researchers made a preliminary analysis of two cases, and then the findings were discussed and completed together. Some basic decisions of the analysis:

1. The teachers descriptions are based on the discussions with the teachers (who have many years of teaching, and experience in using computers in teaching). Based on the level of expertise, the teachers were classified as a national-level expert, municipal-level expert, advanced school-level teacher, or ordinary school-level teacher.
2. The analysis of the case (the nature of the activities, the nature of knowledge processing) was done based on the observation notes. The researcher of the case was responsible for introducing the preliminary explorative analysis of the case, based on a joint analysis schema, and the analysis was then discussed, compared to the other cases and modified. The research assistant participated in the analysis discussions.
3. The types of learning objects in cases are described according to the CELERATE Application profile.

France

The French team for the case studies were composed of:

- the two French pilot coordinators;
- a trainee for video recording;
- a trainee for observation and written notes.

All the persons above were not present in all the case studies. Three of the case studies have been video-recorded by the trainee. At least two others (two coordinators, or one coordinator plus one trainee) were present to write notes. After the observation, each person sent their notes to the coordinators who wrote the final case studies together using the video support and the Finnish pattern for the structure.

Hungary

The analysis of a case was done jointly with two researchers. The final structure of the analysis was done according to the Finnish pattern. First, two researchers made a preliminary collection of all the Hungarian data, and the findings were then discussed completed and analysed together with the project coordinator.

UK and Ireland

Two researchers collected data in the UK and Ireland. The classroom observation videos were transcribed and coded based on the OU team's preliminary discussions. The transcripts and video were viewed by the whole team (four people), with the preliminary coding and issues drawn out. Further data analysis was conducted and written up into two small reports by two researchers under the supervision of the project coordinator, using the Finnish structure.

These data are reported in *Learning Objects in classroom settings: A report of 13 case studies conducted in Finland, France, Hungary, Ireland and United Kingdom (Classroom Studies)*.

Content developer interview

Seven of the content developers were selected for interview. They came from different companies and agencies, including a mix of public and private sector developers and both large and small LO providers. A preliminary interview was held with one developer near the start of the project to test out the interview schedule



which was revised and then used for all the main interviews. These were conducted by telephone and lasted around an hour each.

Fifteen questions were covered, focusing upon the developer's methods of producing LOs and any problems encountered, their judgements on the project overall and their views on how the work should be developed after CELEBRATE finished. The interview tapes were transcribed and analysed using emergent coding, but starting from the main interview schedule topics.

Participants Profile

Quantitative – respondents to questionnaires

A total of 770 teachers registered with the Demonstration Portal and completed registration questionnaire by 12th of July, 2004. But only 190 teachers (25% of those registered) completed the teacher as user of LOs questionnaire. However, the data from the Portal records show that 370 teachers (48% of those registered) looked at or used LOs. Thus, from the point of view of the questionnaire this figure (370) is taken as 100%, and the response rate is thus over 50%.

The respondents to each questionnaire by country are summarised in the Table A1.

Table 1: participants for questionnaires

	Teacher registration Questionnaire	Teacher as user of LOs questionnaire	Pop-ups questionnaire	Portal questionnaire
Finland	323	103	83	85
France	92	13	10	13
Hungary	105	24	29	35
Israel	105	6	23	5
Norway	99	38	22	27
UK	31	2	1	1
Others	15	4	1	0
Total	770	190	169	166

Participants for qualitative studies

These studies, apart from the experimental studies, were carried out in all the pilot countries (Israel had, however, no classroom). Table 2A gives the numbers in each country by type of study.

Table 2: participants for qualitative studies

	Interview studies	Classroom studies	Experimental studies
Finland	9 schools & 10 teachers	4	1 school 3 groups students <ul style="list-style-type: none"> • Study 1: 37 students (11 years old) • Study 2: 35 students (10 years old) • Study 3: 66 students (10-11 years old)
France	10 schools & 14 teachers	4	x
Hungary	5 schools & 5 teachers	3	x
Israel	6 schools & 11 teachers	-	x
Norway	8 schools and 26 teachers	-	x
UK	2 schools & 2 teachers	1	x
Others	-	1	x

How the evaluation was organised

The project documents used were generated at various points within the project team and fed into the analysis as they became available; all of these were in English.

The primary data was collected by researchers from France, Hungary, Norway, Finland, Israel and the UK. Quantitative and qualitative data was therefore collected in several different languages, English being the only common language across the team. To improve consistency across all the questionnaires, each were written and agreed in English first, and then translated by the relevant team members into their own first language for use with their teachers etc. In addition, proformas were discussed and agreed for the qualitative instruments where data was collected from more than one location. The qualitative data obtained was also analysed in the first languages of the team members involved. As the costs of translation would have been too high, and the time for this too short, the analysis of the qualitative data was done by the local pilot country teams and then translated by them into English. Quantitative data was forwarded direct to the UK team they carried out nearly all the analysis for this. (The exceptions were the experimental study and the Portal questionnaire, which were both done in the University of Turku, Finland.)

Choice of method of data analysis

Responses to the various questionnaires were coded and analysed through the use of the SPSS V11.5 SPSS (Statistical Package for the Social Sciences: a comprehensive and integrated statistical program for data description and hypothesis testing in the



social sciences). Each participant in the study was given a unique identifying number, to retain his or her confidentiality. Statistical analyses were performed in order to compare the different groups.

Chi-square analysis was used to compare the response distribution for categorical variables, a p-value of <0.05 was considered significant. Contingency Coefficient was used for measurement of association between categorical variables (e.g. primary/secondary).

Kruskal Wallis was used to test differences the perception of LOs for teachers who were categorised according to their experience of teaching, ICT experience etc. Significance levels less than .05 indicate that the groups differ in their perception of LOs. A factor analysis was also carried out to determine the two ICT pedagogic skills.

For the secondary qualitative data (e.g. the interview study reports and case study reports) the general approach was to analyse the contents descriptively in relation to the various sections of the hypothesis, then sub-coding within this framework using categories generated by inspection of the data falling within each of the wider descriptive categories. In moving from descriptive analysis to interpretation and recommendation for the final report the UK team took into consideration three things:

- the perceived needs of the various stakeholders with an interest in the outcomes of the project and the evaluation;
- the recommendations made by teachers, respondents and other evaluation team members in the various reports that had fed into the final report;
- The UK teams' own interpretation of the data, seen against the background of their own wider knowledge of the field.

References

Yin, R. K. (2003) *Case study research : design and methods*. Thousand Oaks, California: Sage Publications.

Appendix 3 Learning object affordances

Section 7.5 discussed the ideas on affordances, taken from the *Classroom Studies* ‘Cross-country conclusions’, arguing that LOs can support, or detract from, ‘advanced pedagogy’ through the way they are designed. Nevertheless, it is the way the teachers build the use of the LO into their teaching that determines the pedagogic impact of an LO. WP2 produced a number of documents and papers that examined the relationship of pedagogy and LOs (e.g. from a more basic analysis of learning through metaphors of learning; Paavola *et al*, 2003) and, as part of Pedagogical Guidelines, which also examined how various features of advanced pedagogy related to the design of LOs (Ilomäki *et al*, 2003). In this appendix we build on these ideas and try to explore how the LO design and the supporting classroom activity can contribute to the features of advanced pedagogy we have discussed in the report, drawing on some of the data presented.⁹⁸ We outline these features and then consider for each what can be done *within* the LO and what *without*. The former in a sense acts as advice to those developers who are designing LOs and the latter advice to teachers who will be using them. Our focus in this appendix is on the design of LOs.

Features of advanced pedagogy

These features were discussed in Section 7.5, and include: authenticity, student responsibility for learning, different representations of knowledge, collaboration and student reflection. There are of course other factors and other ways of expressing these, some of which were considered in the *Classroom Studies* analysis of the cases, as the following quote indicates:

- Teaching and learning change from teacher-centered to learner-centered, supporting student's ownership and active involvement.
- Instead of concentrating on fact-based learning, more general skills and abilities are emphasized in relation to learners' understanding and activities. Students should become self-regulatory, reflective, and critical learners.
- Human beings construct ideas and things collaboratively and in social interaction; meanings and interpretations of things are negotiated socially. Also learning should be based on collaboration, dialogue, discourse to develop interaction and collaboration skills.
- School-learning should take authentic problems more into account and teach how to solve authentic, open-ended, and ill-defined problems within complex, real-life environments, and sustained working processes.

In the CELEBRATE project, for example, the following features were outlined to make concrete such advanced pedagogy related to the development of learning objects: activating prior knowledge; giving multiple representations; supporting conceptual change; visualisation of thinking; giving the possibility to deal with the complexity of the content; giving expert models and guidance; and supporting collaboration that is directed to thinking and explaining

(*Classroom Studies*, p. 4-4)

⁹⁸ This appendix has been written by the OU team and hence represents its interpretation of these ideas, which we acknowledge may not be shared by the authors of the other papers.

The *Classroom Studies* report goes on to discuss issues of multiple representations of knowledge and the support for different kinds of knowledge (procedural, silent, practical and theoretical), some of which are represented in the list in Section 7.5. It is not possible to explore all of these, and it is evident that a number of them might well be more to do with the teacher's general approach to pedagogy than to anything specific they might do with LOs.⁹⁹

The features we have chosen to focus on (drawing on those used in Section 7.5) are outlined below:

Authenticity. This has two senses, one which is authentic to the culture and the other to the person. The idea of *cultural authenticity* is critical in engaging in a community of practice. This means it is coherent, meaningful and purposeful within a social framework - the ordinary practices of the culture. Thus learning activities must allow students to engage in this authentic activity; if they are learning science they should be engaging in science as it is reflected in the world of science. Too often students have to engage in 'school science' that is no longer relevant to the world of modern science (much school science is nineteenth century science). However, there is a second sense in which authenticity needs to be considered, that of *personal authenticity*; i.e. that is where something is personally meaningful. Without this second element no construction of knowledge or participation, which will lead to learning, can take place. These two aspects of authenticity are inter-related but they can be thought of distinctly.

Student responsibility for learning. The usual term that is used for this in the learning literature is 'agency' (Bruner, 1996). Learning does not take place without the learner exercising some form of agency. Thus, a passive student exercises no agency and hence learning will be limited. The passive idea is the opposite of what happens in learning, namely learners constructing their knowledge. If they don't do this knowledge construction, they don't learn because knowledge is not *given* to them, so the basic argument in constructivism goes. In the quote above from the *Classroom Studies* 'student ownership and active involvement' are important. This implies not just *activity* but also ownership and involvement; LOs can be in danger of encouraging activity (e.g. clicking around pages), without ownership and much involvement in thinking.

Multiple representations. Students need to realise that knowledge is often contested, even in areas such as science. Schools therefore need to help learners to do this because, in the world outside, students have to make decisions daily about whose knowledge to trust and what seems a sensible conclusion etc., on the basis of the evidence they are presented with. Students daily see controversies over global learning, pollution risks, and health risks, argued about among scientists, yet they are subjected to a view of science in schools that sees it as cut and dried, with no controversies. For much of the science they deal with that might indeed be the case, but if they leave school thinking that there are no controversies in science or that people all think the same way about it, they will not be learning real science. In other

⁹⁹ It may well be that Work Package 2's final report (D2.3) will explore pedagogical advice to teachers in more detail, and also the *Advice* section of the Portal will be added to (we have already noted the use of the *Lesson Bank* in this regard).

areas of the curriculum there may be less of a problem introducing this idea. It has, for example, been common practice in history that students understand that there are different views of historical events (even at the time of the events), and different interpretations about the causes of historical developments.

Collaboration. Most people think about collaboration when they consider group work, but often such work is only co-operative, in the sense that people work together, but may have a limited amount of shared thinking. This idea of fully shared thinking is captured in the term of *intersubjectivity*, which arises between participants from the 'shared understanding based on a common focus of attention and some shared pre-suppositions that form the ground for communication' (Rogoff, 1990, p. 71). This term stems from views of learning, both as a *means* and as an *end* of learning. As a means, i.e. collaborating to learn, it stems from the views of learning that focus on social elements. The second view of collaboration, namely as an end in itself, focuses on the importance of students learning *how* to collaborate so that they will be able to identify and share common reference points and models of the situation. For collaboration to take place, students must engage in each other's thinking. But it also means that the tasks should enable this; tasks must give students opportunity to share. Students inevitably reformulate tasks, and alternative perceptions of purposes and salience emerge. Thus, tasks must give opportunities for talk, including the sharing of information, joint planning, presenting of ideas to the group, joint reasoning, evaluation and decision taking.

Student reflection. There are a number of inter-related ideas that are involved in reflection. It implies that students should be thinking, something that though obvious is not necessarily supported in work in classrooms. For example, it is common when teachers ask a question for them to wait for an answer for less than 1 second! If students are being asked to think, then they need time to do so. One way to provide this is to require students to discuss a question in pairs before answering. Similarly in any activity designed to engender thinking, there needs to be time and stimulus to reflect. It is also important to allow them to reflect on where they are going and how they are doing in an activity, rather than just be driven on, without thinking about their strategy or progress.

Affordances of LOs

Here we look at the design issues for LOs in relation to supporting the features of advanced pedagogy outlined above.

Authenticity

The content of an LO should relate to the realities of the subject or to that of the student (depending upon whether cultural or personal authenticity is being supported). Thus in the *Baking bread* LO (see Case 6 in *Classroom Studies*), the teachers used photographs and text drawn from a real bakery, and one local to the school. This would support both kinds of authenticity. In using the *Healthy meal* LO (Case 1, *Classroom Studies*), the LO gave examples of people who needed special diets (e.g. a 70-year old man takes little exercise and is slightly overweight). None of the examples would easily relate to a teenager, and hence the personal authenticity would be low. (In fact all the examples could be criticised in this regard and it might be easier to simply have ones of children of various ages as the examples that are give

for students to construct diets.) In the case study example, the teacher asked the students to enter their own diets and hence maximised the authenticity.

Another way that LOs can be more authentic is to simulate real situations. Thus, in the LO used in the *Experimental studies* report (*Electricity Exploration Tool*), a circuit is depicted as in Figure A3.1. The multimeter used to measure current and voltage on the circuits is depicted in a realistic way to make it look like a real instrument. The circuit itself is a standard science depiction of a circuit. But the students will have to relate this to real wires and batteries. Some special-purpose software for modelling electric circuits will give several views of a circuit, including a ‘real world’ version, which shows components and connections etc.¹⁰⁰ This helps the students to bridge the schematic world of science and the practical circuits that they are faced with in the laboratory. (This was important in the results of the experimental study that showed the combination of the laboratory work with wires and batteries, combined with the simulation of the circuits in the LO, led to better learning, at least in some respects. Again this is an example of the teacher adding activities.)

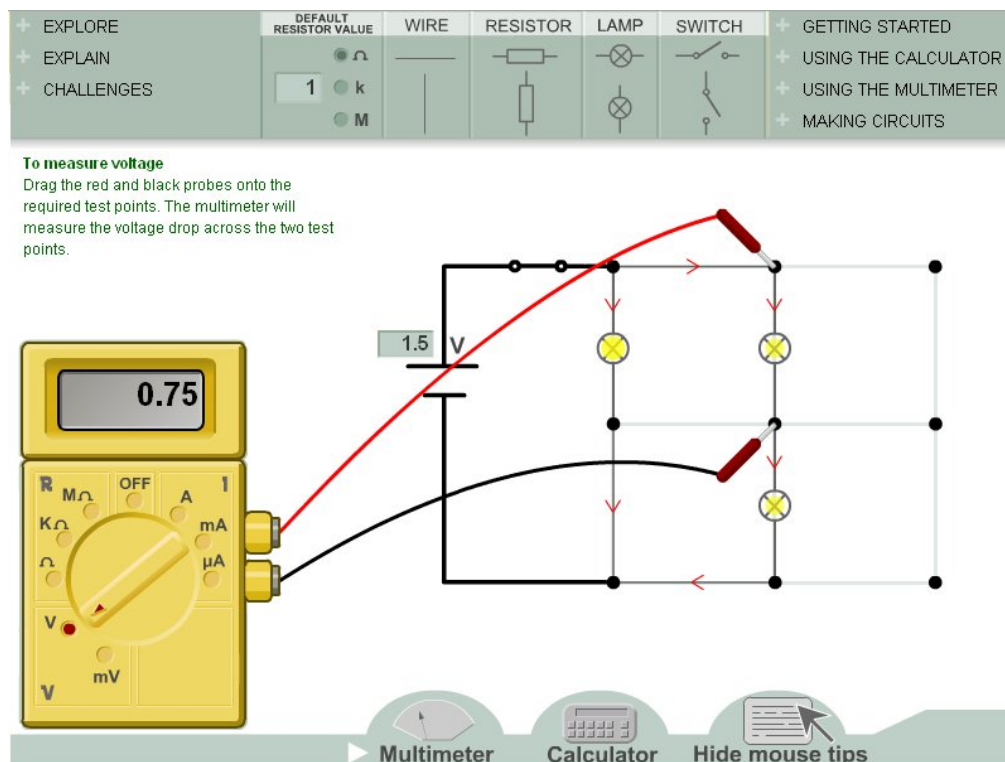


Figure 3A.1: the Electricity Exploration Tool LO

Agency

LOs usually control the learning in terms of the sequence, though they usually leave pace to the learner to control. There were examples in the classroom studies that timing encouraged students to rush (Case 11; see the discussion in Section 7.6.5), even though there was no timing control over students (i.e. requiring a response

¹⁰⁰ These might be electronic printed circuit boards and are more likely to be used for electronic circuits.

within a specified period). Allowing students to choose a route through that reflects the way they view the topic or problems, is one way they exercise agency. With a 'Drill and practice' LO, there is usually not much student control and they just have to answer the questions they are given in sequence. Using LOs that allow students to choose their route through might be a simple way of giving them more responsibility and sense of ownership.

A more sophisticated way to do it is to involve the student in defining the task to use an LO with. In the case studies, most LOs were set within tasks that the teacher created to make the LO meaningful and to give the student some form of control. For example, students learning about the senses and the brain (*Classroom Studies*, Case 3), were asked by the teacher to specify a research question that would frame their work with the LO and other materials. It may be that encouraging this kind of student control is better provided as an instruction to students (and teachers) rather than being built into the structure of the LO itself. But, if the LO is an information resource (as in the *Water Cycle* LO; see Case 5, *Classroom Studies*), then it would be possible to ask the student at the beginning to choose from a list of tasks, specify a task, or ask the teacher for a task. It is the task that gives a sense of meaning, which is an underlying aspect of agency.

Where the LO is supporting investigation there can be agency as the student might be constructing explanations. For example in the *Conservation of Energy* LO used in the Hungarian case study on energy (Case 9, *Classroom Studies*), there is a simulation that the student can take part in by loading coal into a furnace that creates steam in a boiler that then drives a steam engine and generates electricity, and electrical appliances can be plugged into the generation output (Figure A3.2). The student has to answer questions such as 'Why must you put coal into the boiler continuously?' Students can then experiment with 'dragging and dropping' the coal into the boiler, along with investigating the effect on say a light bulb plugged in. This could easily have been an explanation with a simulation run without student intervention. But the important thing in this LO is that the student must create explanations about the simulation and why certain effects are taking place. The nature of the questions asked is also important. The one on continuous adding of coal could be answered at the observation level, e.g. to keep the generator turning, to keep the flame burning, to keep the light glowing. The agency of the student might be increased by asking the student to explain how the light bulb is made to glow brighter and what is causing this. Now the simple answer is to say that the coal needs to be added faster, but the important underlying scientific idea is that the rate of input of energy determines the power output, and hence the brightness of the bulb. But, some class discussion is needed to get to this kind of point and the level of this material would be higher than it apparently is currently. The point is that explanations are complex and what counts as an answer is not straight forward. This LO, of course, did not have to deal with the difficulties of the answer, as the student presumably discusses this answer with someone else (peer or teacher).

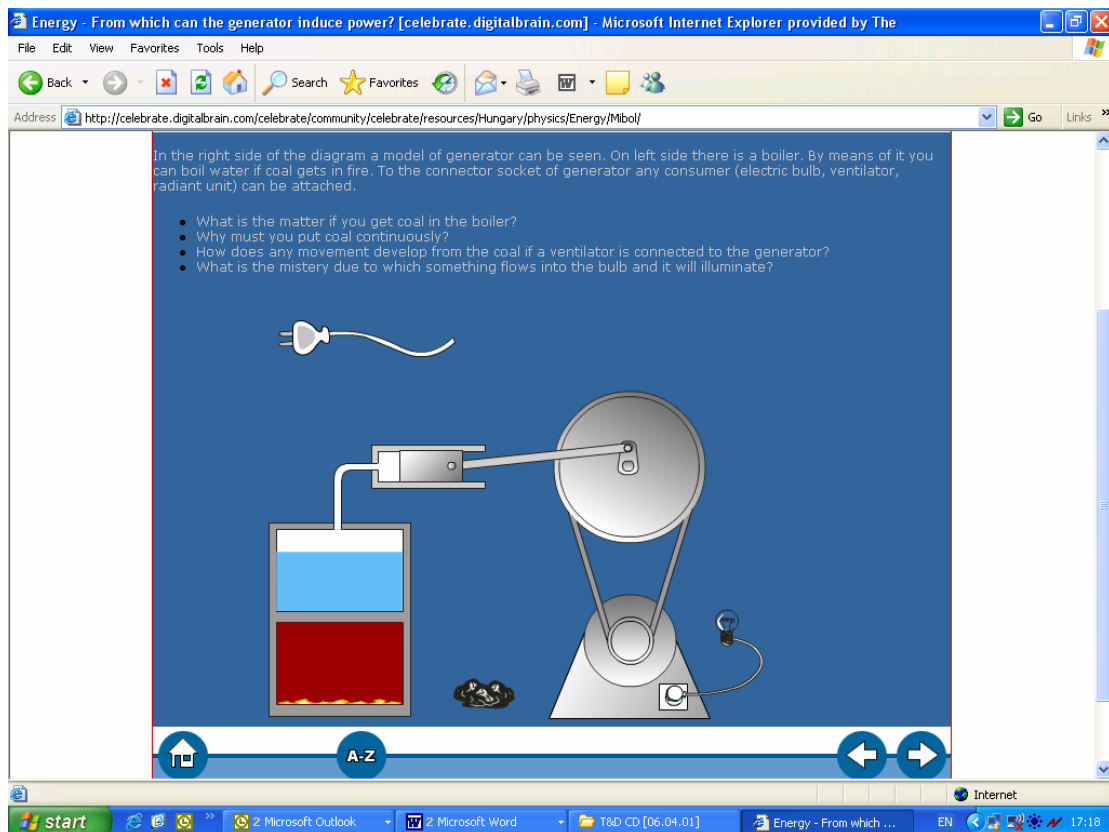


Figure A3.2: Conservation of Energy LO showing a simulation with some element of student control

Multiple perspectives

If an LO is to present multiple perspectives it has to present information in different ways and juxtapose explanations and arguments that are contentious. As noted earlier, this could be done in history by having different explanations or different reports of contemporaries' accounts, or interpretations of reports. We have not located any examples of these multiple perspectives in the LOs on CELEBRATE. It is likely that, as was the case in Case 13 on reproduction and Case 4 on multiple intelligence, the teacher would set up the different perspectives in her classroom, by bringing in experts to talk from different points of view, or showing a video that give the other side of material presented in the LO, for example.

Collaboration

This is a difficult area for individual LOs to deal with, as there is usually little explicitly in the design that contributes to collaborative work with the LO. In Case 9, *Energy*, the Hungarian researcher noted that the LOs were not designed for collaborative work and the 'National conclusions' indicated that the group dynamics did not work with them. However, in Case 10 on *Waves*, it is argued that both the individual and group work were combined in quite a sophisticated way:

Previous knowledge usually was stimulated by non-computer group activities. For example all groups (4-4 students) got an envelope with the same four sentences, cut up into single words and they had to recall them in a competition amongst groups. The students in a group often had individual tasks (for example searching for pieces of information) and the group gathered knowledge in discussions, using these small, individual parts.
(Case 10, *Classroom Studies*)

Figure 3A.3 shows an extract from a page of the LO, which requires students to observe wave movement and to understand how they create standing waves, for example. It utilises animation of the wave patterns and gives students some control over particular functions to observe the effects (though they cannot, for example, alter variables such as the length of a rope or tube).

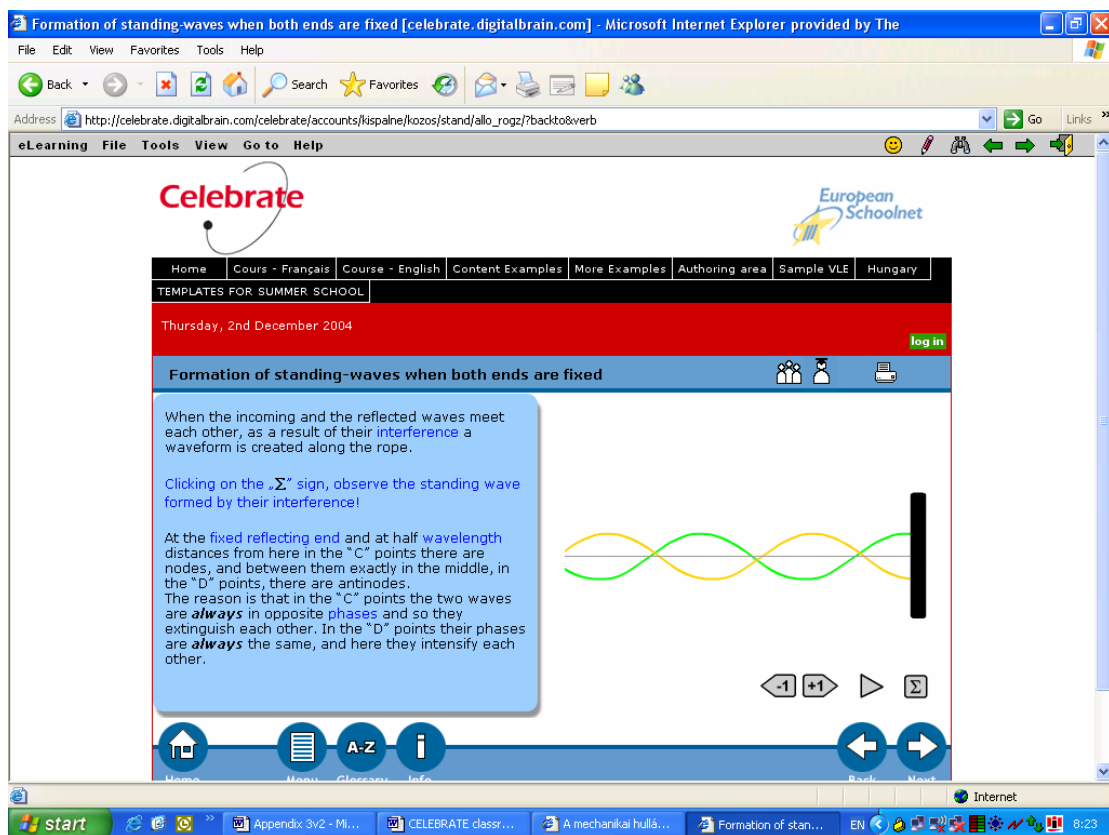


Figure 3A.3: a screen shot from the Standing Waves LO

As there were no direct collaborative elements that were associated with the design of the LO, it is interesting to turn to the ‘Teacher information’ given with the LO (there is an icon on each page which gives the same information), one element of which is on group work:

The program facilitates knowledge assimilation individually and in groups during the elaboration of the topic of waves.

In the case of group work, it is advisable to refresh the fundamentals of the topic of waves. It might be worth illustrating different phenomena in real life during the use of the program. Standing waves are easily observed on a oscillated rope. The change in the pitch of the pipe sound can be easily illustrated with pipes of different length.

This advice is unlikely to explain why it was that the teacher in this study was able to create good collaboration, whereas the one in Case 9 (*Energy*) was not (as the ‘National conclusions’ indicated). As Section 7 argues, the teacher’s role in this is central. But it also indicates that there is a role for the advice given to teachers with the LO to help them to create good collaborative activity. In this case that groups can:

- work with a single LO (though this will depend upon screen clarity for more than three gathered round a screen);
- have different tasks (so in fact one pupil could work with one part of an LO or a single LO, and then report to the group);
- have a joint task that requires some production of an account or presentation, based on the use of the LO.

Such advice is best based on actual activities that teachers have constructed around the LO and this links to our general discussions in Section 8 about the involvement of teachers in testing and developing LOs.

It is possible that when an LO asks students to answer questions that it could indicate that the answers should be discussed with a fellow student, before being entered or chosen. For example, in the French study on fractions (Case 8, *Relations*), examples are given of the dialogue of students that indicate they are interacting usefully in trying to balance the fractions on each side of the equation. This could be encouraged in instructions to students.

Of course the designers of this particular LO (Digitalbrain) could rightly object that it can be used in their virtual environment, which allows collaborative activity to be designed around the LO, much the same way as the teachers in Hungary built them within the actual classroom. Indeed this was the case in the one example of genuine collaborative activity we have in the case studies, namely in Case 4 (*Multiple Intelligence*). Below are a number of quotes from the *Classroom Studies* report of this case study:

the pupils wrote the first notes in the virtual discussion forum concerning the question “How could I develop my strong area?” ...
The pupils linked the learning objects to the virtual discussion forum and commented on them...
After the face-to-face period, the pupils continued the discussion for three weeks in the virtual forum...

Of course the ‘virtual discussion’ is in a different environment and no more ‘in’ the LO than the activities the Hungarian teachers organised in the classroom. But clearly they were able to link to the LOs, something more difficult to do with classroom activity combined with LOs. The students liked this and the researcher gives an explanation how their thinking will have been aided:

In the students’ feedback, the possibility for virtual discussion was highly appreciated. Several students thought that by discussion and argumentation they learned more, and became more motivated in the topic. There were probably several reasons for that: the discourse helped to clarify one’s own ideas; before writing the students had to think what they wrote and thus, e.g., read about the topic; virtual discussion promoted students’ activity; the longer processing time helped learning, and it was democratic: everyone could write to the common forum.

So, the conclusion on LO design is that supporting collaboration is likely to lie more with the advice to teachers or to structuring activities in a virtual environment that, both allows discussion, for example, and allows students to make links to the LOs.

Student reflection

We have already noted in the consideration of collaboration that discussion between students can help them to collaborate and, therefore, this will improve their thinking. But to make this reflective there is a need to try to introduce activities that will encourage this. In the fractions case study (Case 9, *Reflections*), students have to work out the rule that makes the fractions balance (Figure A3.4 shows what students are presented with). The teacher provided a sheet where they were to put down their results and from which they were to work out the rule. The students started by trial and error, and then the teacher tried to establish some rules from the work of some of them. The LO could have both provided a sheet to record these results and prompted students to note down their strategy *before* they started a sequence of trial and error. They could then be prompted to look again at this strategy and revise it in the light of their results. A simple notepad is all that is required, along with prompts after some number of attempts have been recorded. Of course the design could be made more complex if students could enter a rule and use it to predict a relationship (e.g. through a simple spreadsheet) and then to test it on the simulation.

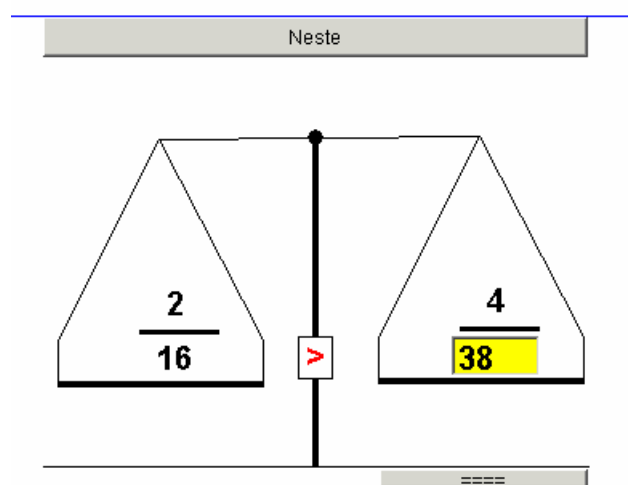


Figure A3.4: a screen shot from the LO used in the Reflections case study

It is more likely, however, that reflection will be encouraged by discussion among pupils, as indicated in relation to the support of collaboration. If questions asked are low-level then there will be little to discuss, and this gives clear guidance on the nature of questions. For 'Drill and practice' LOs this is a real problem assuming that the LO will have to evaluate the answer or at least present pre-determined answers from which the student chooses; it may be difficult to design the latter adequately, and

the former are necessarily restricted by the difficulty of having sophisticated models of student understanding.¹⁰¹

However, an information source LO could set up complex questions to be answered using the LO, with the discussion of the answers being handled by the teacher or between students, possibly reported to the class. Again, it might be possible to 'require' the students to record something about their strategy for answering the questions before they start and then, at appropriate points in say a series of questions, they can be asked to reflect on this strategy and to revise it if necessary. This puts the information on choice and use of information, which are higher-order thinking activities than just recording answers. Note the comments in the *Baking bread* LO (Case 6, *Classroom Studies*) about the fact that the structure of the LO narrowed the task:

Even though the pupils remained free to navigate through the LO how they liked, progress was in fact highly linear. Knowledge was presented in a very factual way and pupils mostly only had to transcribe information provided on the screen. The information was furthermore given in the same order as the questions asked; which facilitated the pupil's "pseudo-research" task even further.

Making the structure less linear and making the questions cross parts of the LO where information is given, are ways that will increase the student involvement and hence thinking within the LO (elements of 'agency'). The next step to encourage reflection is to ask them to reflect on the way they do it.

Guidelines to design

It is not easy to draw up straightforward guidelines that reflect the above examples and associated discussion, and it is likely that innovative and experienced teachers could both implement and develop these ideas in pedagogically creative ways. Nevertheless there are a few points worth making. First, in thinking about how to support features of 'advanced pedagogy' it is necessary to pay direct attention to the following elements of the LO and associated activities: the task students carry out; the nature of the content; the role the student has in using the LO; and the role of the teacher in supporting the student. Table 3A.1 indicates how some of the features of pedagogy relate to these elements.

¹⁰¹ McCormick (2003) discussed this problem in relation to the prospects of any LOs have really complex pedagogy built into their operation.

Table 3A.1: guide to design of LOs to support ‘advanced pedagogy’

Elements of pedagogy	Feature of advanced pedagogy	Example design implications
Definition of the task	Authenticity	Use a real problem, one taken from students’ lives or the subject area as found outside of school.
	Agency	Create investigations where students have to try to decide, for example, on a relationship between variables.
	Collaboration	Give instructions to students (or teacher) about discussing the task, both what it means and how to carry it out, and any ‘answers’ or products from it.
Nature of the content	Multiple perspectives	Involve multiple sources of evidence or ideas, including competing theories or explanations.
	Authenticity	Use expert information taken from outside of schools.
Role of the student	Agency	Students should not just be active, but have some control over the way they use the LO (e.g. route through). Students could define the task.
	Collaboration	Give specific instructions as to what students should do when they are working together on an LO (e.g. allocate roles).
	Reflection	Ask students to note down strategies for tackling the task that is the focus of the LO (provide prompts and tools to do this).
Role of the teacher ^a	Agency	Provide the teacher with probing questions they can ask as they go round a class working on the LO. Encourage the students to discuss ideas with the teacher.
	Reflection	Encourage teachers to require reporting back and a discussion of strategies of working or what is difficult to understand.

^a Note that here the role is in relation to the students’ use of the LO and ignores issues of their role in *planning* activities and other support associated with its use.

References

Bruner, J. (1996) *The Culture of Education*. Cambridge, MA: Harvard University Press.

[Classroom Studies] Ilomäki, L., & Lakkala, M., (eds.) (2004) *Learning objects in classroom settings: A report of 13 case studies conducted in Finland, France, Hungary, Ireland and United Kingdom*. CELEBRATE Work Package 7.

Ilomäki, L., Jaakkola, T., Lakkala, M., Nirhamo, L., Nurmi, S., Paavola, S., Rahikainen, M., & Lehtinen, E. (2003). *Principles, models and examples for designing learning objects (LOs). Pedagogical guidelines in CELEBRATE. A working paper for the European Commission, CELEBRATE Project, IST-2001-35188, delivered May 2003. Available online:*

<http://www.helsinki.fi/science/networkedlearning/texts/principlesforlos.pdf>

McCormick, R. (2003) *Keeping the pedagogy out of learning objects*. Paper presented in L. Ilomäki (Chair), *Designing virtual learning material*. Symposium conducted at the 10th Biennial Conference of European Association for Research on Learning and Instruction (EARLI) *Improving Learning, Fostering the will to Learn*, University of Padova, Italy, 26-30 August 2003.

Paavola, S., Ilomäki, L., Lakkala, M., & Hakkarainen, K. (2003,). *A framework for evaluating virtual learning materials through the three metaphors of learning*. Paper presented in L. Ilomäki (Chair), *Designing virtual learning material*. Symposium conducted at 10th Biennial Conference of the European Association for Research on Learning and Instruction (EARLI), University of Padova, Italy. 26-30 August 2003.

Rogoff, B. (1990) *Apprenticeship in Thinking: cognitive development in a social context*. New York: Oxford University Press.

Appendix 4 Brokerage System usability evaluation report

This report provides a summary of a selected group of CELEBRATE teachers' reactions to the Brokerage System in terms of its usability.

In the middle of November 2004, a short evaluation questionnaire was designed to explore whether there were any advantages or disadvantages when teachers search for resources using the CELEBRATE Brokerage System which currently links three LO/LA repositories. A selected group of teachers were invited to participate in the evaluation by each country coordinator. They were asked to search for LOs and LAs via the Demonstration Portal, which was connected to the Brokerage System and hence the repositories, and then complete a questionnaire. By 23 November, 2004, a total of 45 teachers from four pilot countries completed the questionnaire (Finland: 11; France: 7; Hungary: 21; Norway: 6). They covered a range of subjects including Art, Science, Language and Mathematics.

Summary of the results

In general, teachers were very positive about the Brokerage System and felt it was transparent in terms of its usability (see *Brokerage System Evaluation Data*). They were generally satisfied with the effectiveness of the federated searching using the Brokerage System. Some teachers made negative comments on the searching procedure but most of these related to the Demonstration Portal, rather than the Brokerage System *per se*. The comments they made were:

- Keyword searching is not effective,
In theory this system is similar to searching in any Internet search engine. You have to try to figure out what keywords to use in order to find what you want without getting a lot of irrelevant search results. I tried the word addition to get some math learning objects and got a lot of results that weren't math at all...
(Finnish teacher)
- Searching results from the Demonstration Portal is inconsistent with federated searching
A search with the keyword "Art" gives 542 objects from the DP and 239 from the federation. A search by subject choosing "Art" gives 42 objects from the DP and 16 from the federation!!!...
(French teacher)

There were also a set of comments that were the same as recorded in Section 3 on the Demonstration Portal, relating to the search process and the nature of the results.

The federated search will allow having access to more online resources but is it good? Not often regarding my experience, because there are risks of redundancy. Just talking about France, we can find in some academic websites, more or less the same LOs.
(French teacher)

It is difficult to find relevant results when searching. There are many fine small resources but it takes too long to find the good ones.
(Norwegian teacher)

It is too much time to check the list I have found when there is a long list.
Sometimes I know about the existence of an LO but it does not appear in the search results.

(Hungarian teacher)

- Expectations of more refined searching facilities such as 'Boolean search'

I need other complex search methods like AND / OR / NOT

(Hungarian teacher)

- Interface of searching windows on the Demonstration Portal needs improvement,

The additional search results window is too low. They should both open up to greater size to allow easier viewing.

(Finnish teacher)

The basket icon on the top is not very clear. A button on the bottom of the page (with eventually the basket icon) seems more logical.

(French teacher)

There are only one issue teachers commented negatively on the Brokerage System, namely concerning the delay in results. Unfortunately, there were no questions in the questionnaire asking teachers about the speed of the federated searching, but two teachers gave negative feedback in the additional comments.

I had problems finding your own resources in the BS search. It took too long to wait for the result in the BS search and no information when the search was finished.

(Norwegian teacher)

It is sometimes too slow...

(Hungarian teacher)

Overall judgement of the usability of the Brokerage System

Obviously, teachers were generally positive about the usability of Brokerage System and appreciated the advantage of federated searching. But the issue of speed of the search procedure may need to be resolved in the future. Nevertheless it is clear that the Brokerage system was successfully demonstrated to CELEBRATE teachers.

Teachers made some negative comments on the issues of interface, the search procedure producing inconsistent and too many results, but most of them were related to existing issues of the Demonstration Portal. These issues had already been identified in the CELEBRATE Evaluation Report and recommendations were made for improvements.

Brokerage System Evaluation Data

Responses from pilot teachers:

Finland	11
France	7
Hungary	21
Norway	6
TOTAL	45

Q1. What subject and age group were you searching for?

Subject	Age range	No. of teachers	Country
Art	10 years	1	FI
Art History	10-14	1	HU
Biology	16-18	1	NO
Biology, Geology	10-15	1	F
Biology	14-18	1	HU
Chemistry	14-18	2	HU
English	11-15	1	FI
English	10-14	2	HU
English	None specified	1	F
Environment	12-18	1	NO
Environmental studies	6-10	1	HU
Geography	10-14	1	HU
Geography	12-14	1	HU
Geography	14	1	HU
History	16-18	1	FI
History	10-12	1	F
History	10-14	1	HU
Hungarian lang (mother tongue)	6-10	1	HU
Informatics	10-12	1	HU
Literature, language	6-18	1	NO
Mathematics	None specified	1	F
Mathematics	6-10	1	HU

Subject	Age range	No. of teachers	Country
Mathematics	8-14	1	HU
Mathematics	10-12	2	HU
Mathematics	10-14	2	HU
Mathematics	14-18	1	HU
Mathematics	6-12	1	NO
Mathematics	1-9, 11-14, 12-16	3	FI
Maths, geography, sciences	8-12	1	F
Mathematics and science	8-12	1	NO
Mathematics and science	9-16	1	F
Natural Sciences (Biology, Chemistry, Physics)	13-18	1	HU
Physics	13-14	1	HU
Physics	16-19, 14->	2	FI
Physics	14-17	1	HU
Physics	14-18	1	HU
PHYSICS	16-17	1	HU
Science	9-16	1	FI
Social science, cross curriculum materials, English	13-15	1	NO
Special Education	8-12	1	FI
Visual Arts	8-12	1	FI

Q2. Which search options do you prefer to use? Please rank: 1 = most preferred, 3 = least preferred.

	Ranked 1	Ranked 2	Ranked 3
Browse by subjects	21	21	6
Basic text field search	4	1	27
Advanced search	20	15	8

Q3. Do you find the basic text search easy to use?

Yes	38
No	6
No response	1

Q4. Do you find the advanced search easy to use?

Yes	35
No	10

Q5. Was the interface, including the presentation of the results in two ‘windows’, suitable?

Yes	38
No	7

Q6. Does it provide relevant results?

Yes	35
No	11

1 Norwegian teacher ticked both Yes and No?

2 of the Finnish teachers who ticked yes, also said “sometimes”.

Q7. How easy is it to search for specific information?

Very easy	2
Easy	11
Neither easy nor difficult	25
Difficult	7
Very difficult	0

Q8. Did you get too many results too handle?

Yes	12
No	33

Q9. How satisfied are you with this new way of searching and displaying search results?

Very satisfied	4
Quite satisfied	29
No strong opinion	9
Dissatisfied	3
Very dissatisfied	0

Additional teacher comments:

Finland

- The additional search results window is too low. They should both open up to greater size to allow easier viewing.

- "In theory this system is similar to searching in any Internet search engine. You have to try to figure out what keywords to use in order to find what you want without getting a lot of irrelevant search results. I tried the word addition to get some math learning objects and got a lot of results that weren't math at all. I left out the subject when I tested this, if I chose mathematics it all worked well. The problem is that if I try to search in my native language there is only a limited amount of learning objects and if I add other languages (many learning objects work fine despite being in a foreign language) finding the right keywords is kind of a challenge. As a conclusion I like what I have got out of this demoportal and though taking up my spare time it has been a rewarding project."
- The biggest problem in searching LOs concerns the metadata. A single search gives too many results. Even a specific search can give hundreds of answers of which only a few are suitable. I think the biggest problems are about the definitions of ages and of subjects."

France

- Too many results to handle but it give the access to LOs which have given to me ideas
- I think that at least CELEBRATE is accessible to French teachers and even pupils
- I like very much this search in two steps even if the results in the second part take time to appear
- I like very much this new version
- The basket icon on the top is not very clear. A button on the bottom of the page (with eventually the basket icon) seems more logical
- This new search meets my expectations
- To the question "Was the interface, including the presentation of the results in two 'windows', suitable?", I could only reply by yes or no, so I have chosen yes but with those frames included one to another, we don't know which scrollbar to use
- The federated search will allow having access to more online resources but is it good? Not often regarding my experience. Because there are risks of redundancy. Just talking about France, we can find in some academic websites, more or less the same LOs.
- Question 8: I have no result if I use the simple search and too many if I use the browsing by subject
- A search with the keyword "Art" gives 542 objects from the DP and 239 from the federation. A search by subject choosing "Art" gives 42 objects from the DP and 16 from the federation!!! Both methods give correct results but also wrong ones (incomplete ones)
- It would better not to have to click on the button to display the result from the federation



Hungary

- It is too much time to check the list I have found when there is a long list. Sometimes I know about the existence of an LO but it does not appear in the search results.
- It is sometimes too slow. The fastest result comes when I ask for all the materials of a subject.
- I need other complex search methods like AND / OR / NOT
- Outside (Internet) search would be useful in a pop-up window when there is not enough material

Norway

- I had problems finding your own resources in the BS search. It took too long to wait for the result in the BS search and no information when the search was finished.
- It is difficult to find relevant results when searching. There are many fine small resources but it takes too long to find the good ones.