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Experiences with reusable E-learning objects From theory to practice

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Abstract

The idea of creating E-learning courses by combining reusable E-learning objects (ELOs), stored in a database, is gathering momentum. There is, however, no one definition of what constitutes an ELO or of what size such an object should be to maximise its reusability capability. The first part of this article explores these issues. The second part discusses the practical application of creating and reusing ELOs at the Centre for Economic Development and Applied Research (CEDAR) at Royal Roads University (RRU), Canada. First, some background on RRU and CEDAR is given. This is followed by an explanation of how reusable ELOs are defined, stored, and tagged in an online learner and content management tool. CEDAR's approach to ELOs and to sound instructional design is then discussed. Several examples are provided of how CEDAR implements reusable ELOs. Finally, the reader is given the opportunity to experiment with an online, template-based ELO. © 2002 Elsevier Science Inc. All rights reserved.

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1. Introduction

This article examines the philosophy, creation, and use of reusable E-learning objects (ELOs) from a practical application at the Centre for Economic Development and Applied Research (CEDAR) at Royal Roads University (RRU), Victoria, BC, Canada.

2. What is an ELO?

Currently, several different definitions of the term *ELO* exist and many other terms are used, seemingly interchangeably, in place of *ELO*. This often results in confusing or difficult communication (Wiley, 2001, p. 5). This is probably not surprising, given the newness of the field. The following examples illustrate just four approaches to defining *ELOs*.

Cisco (2001) defines a learning object as “a granular, reusable chunk of information that is media independent.” Other terms for *ELO* mentioned by Cisco include “educational objects, content objects, training components, nuggets, and chunks.”

South and Monson (2001) at Brigham Young University use the term “media object.” They define such an object as “digital media that is designed and/or used for instructional purposes. Such objects range from maps and charts to video demonstrations and interactive simulations.”

Wiley (2001) defines learning objects as “elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science.” They allow instructional designers to “build small (relative to the size of an entire course) instructional components that can be reused a number of times in different learning contexts. They are generally understood to be digital entities deliverable over the Internet, meaning that any number of people can access and use them simultaneously” (p. 3).

The *Internettime.com* (2001) site talks about “small chunks of learning (granules, objects)” that “are labeled (meta-tagged within IMS standards) so systems can automatically mix and match them to assemble and deliver individualized learning experiences.” They present a hierarchy of learning objects, that ranges from simulation through topical unit and reusable learning object (*RLO*) to information objects.

The issue of what exactly should be reusable is similarly confused. Is it a small granule that is reusable? Or is it a larger entity? For example, Cisco (2001) discusses an *RLO*, which is defined as a collection of reusable information objects (*RIOs*), overview, summary, and assessments that supports a specific learning objective. An *RIO* is defined as a collection of content, practice, and assessment items assembled around a single learning objective. *RIOs* are built on templates “depending on what is being communicated, whether content, fact, process, principle, or procedure.”

This article explores a practical application of creating and reusing both granular *ELOs* and those based on templates at CEDAR at RRU, Canada. First some background on RRU and CEDAR is given. This is followed by an explanation of how reusable *ELOs* are defined, stored, and tagged in a course editor tool. CEDAR’s approach to *ELOs* and sound instructional design is then discussed. Several examples are provided of how CEDAR

implements reusable ELOs and the reader is given the opportunity to experiment with designing an ELO using a template.

3. RRU

RRU was established by the BC Provincial Legislature in June 1995. Situated on the beautiful oceanfront heritage site of a former naval college, the existent infrastructure could accommodate only 300 students. As there was no possibility of new capital in the short term, new ways for leveraging the space into serving approximately 3000 students, the minimum number needed for self-sufficiency, had to be found.

The founders of RRU were influenced by a report written by Dolence and Norris (1995). They argued that, in the new economy, marketable skills and knowledge had a life expectancy of approximately 7 years. This meant that the existing workforce would find a need for ongoing “postsecondary” education throughout their working lives at intervals of approximately 5 to 7 years. As physical infrastructure and capability to support this demand could not possibly be forthcoming from traditional institutions, new methods of serving this market had to be found.

RRU investigated niche markets and proposed offering programs to mid-career learners. Programs would consist of a combination of short residency periods and Internet-based online courses to the tune of about 25 hours per week. This would allow RRU to service the huge, but underserved, market for secondary and postgraduate degrees. The Government of British Columbia gave RRU a special mandate to explore new methods of developing and delivering postsecondary education.

4. CEDAR

CEDAR at RRU was established in 1998. The aim of CEDAR was to develop new business enterprises including applied research ventures, special training programs, and partnerships with local industry. A small EDL team was formed in 1998 to explore the burgeoning field of E-learning. This team possessed a unique combination of interdisciplinary skills—entrepreneurship, computing, instructional design, and creative design. The members have one thing in common: they are all “out-of-the-box” thinkers. Although the members are well grounded in each of their various disciplines, a combination of intuition, experimentation, and plain good luck, rather than slavish adherence to tested theories, is the team’s approach to problem solving.

The first task was to examine how the capacity of computers to deal with infinite variables might allow courses to be more “learner-centred,” that is, tailored to an individual’s needs and style of learning. A philosophy of technology soon emerged. This included using commercially available software, storing content in small chunks in a database, and using templates to assemble and deliver courses. To test the ideas of learner-centredness and the underlying technology, a prototype course was designed and delivered (Muzio, 1999).

Since 1999, CEDAR has continued with these same underlying principles, improving courseware design in line with technology advances and with feedback from learners. CEDAR pioneered using databases to store content and was an early implementer of reusable ELOs. A course editor tool allows developers to create reusable ELOs and assemble courses from them. CEDAR's work has garnered international interest and awards.

5. Reusable ELOs at CEDAR

At CEDAR, an ELO is defined as a small piece of text, visual, audio, video, interactive component, etc. that is tagged, and stored in a database. Although most ELOs are content objects, they can also be other types of objects, for example, an FAQ or a glossary definition. A second term used at CEDAR is "interactive ELO." This term describes those ELOs where the learner has to do more than merely just look at the screen. For example, the learner might have to move the mouse around to see textual explanations, or assemble a diagram, or play a game.

Each ELO is tagged with user-defined key words. As no one definitive standard for how XML tags will be used has yet emerged, ELO developers apply their own tags. This approach allows the development of reusable ELOs and courses to be built from them. CEDAR fully supports the need for standards and recognises that later retrofitting to accommodate an appropriate standard will be necessary.

A major concern of potential ELO developers is that of intellectual property. CEDAR's approach to this problem is to have both personal and shared ELO libraries. The ELO creator decides whether or not the ELO can be freely shared with others. If it is deemed sharable then it resides on the database in both the shared ELO library and the creator's personal library. Other developers can then search the shared library for ELOs and transfer them to their own personal libraries. The copyright holder is the original developer of the ELO. Should the ELO be subsequently modified by someone other than the original creator, it is then stored as a new ELO with the new creator's name attached. This preserves the original ELO and associated copyright holder. The CEDAR team is currently exploring possible ways of paying for use of intellectual property when ELOs are reused outside the originating environment.

The issue of size of an ELO is another conundrum. South and Monson (2001) state that a course, a lesson, or a module can all be learning objects, whereas others, as noted in Section 2, regard an ELO as being as small as a granule. Unfortunately, even the definition of a granule is not clear. Wiley (2001), for example, asks how big a granule should be. He notes that there is a trade-off between the possible benefits of reuse and the expense of cataloguing ELOs (p. 12).

Regardless of this concern, at CEDAR ELOs are made as small as possible. For example, although a screen of text could consist of only one ELO, experience has shown that greater reusability occurs if such a screen incorporates two or more ELOs.

Making ELOs as small as possible allows them to be easily reused without change, or with minimal change, and to be combined in a variety of ways in other applications. This helps increase speed and efficiency of instructional design and provides ultimate flexibility.

Moreover, it mimics the known actions of instructors. If they are given access to instructional materials, they tend to break them down into their constituent parts and then to reassemble them in ways to support their individual instructional goals (Reigeluth & Nelson, 1997).

5.1. ELOs and the instructional design of E-learning courses

At CEDAR, the tagged ELOs are stored in an SQL database. The EDL team at CEDAR developed a course editor tool, based on the database for creating E-learning courses. A developer, or subject matter expert (SME), first begins to assemble a library of the ELOs needed for the course. Some ELOs are found by searching the shared ELO library and some are created directly by the SME. Other ELOs, especially interactive ones, are created by designers skilled in the use of multimedia products such as Flash, Generator, Director, Authorware, Quick Time, Real Audio, etc.

CEDAR's key underlying principle of creating courses from reusable ELOs is that sound instructional design practices must be followed. As Wiley (2001) points out, not much work has been done in this area. Instead work has centred on technology standards to support learning-object-based instruction and many people are excited by the possibilities of financial opportunities; however, the instructional design implications of learning objects has not received much attention (p. 9).

The developer, or SME, follows an instructional design methodology as the course is assembled using the course editor tool. After defining the course to the system, the developer specifies learning outcomes at both the course and unit levels. Learning outcomes provide (a) the means for designing appropriate instruction, (b) a framework for evaluating learning, and (c) a guide for the learner (Kemp, Morrison, & Ross, 1994, pp. 77–78). To each learning outcome, the developer adds a description and a reference to the appropriate level of Bloom's taxonomy for the cognitive domain (Bloom et al., 1956). This encourages developers to check that they are developing content that encompasses higher order thinking as well as merely knowing or understanding ideas and concepts.

Some instructional designers from outside CEDAR have questioned the use of Bloom's taxonomy. They have suggested, for example, that Gagne's (1965/1985) hierarchy for intellectual skills might be more appropriate. However, the reasons for using Bloom are simple:

- Bloom's terms are relatively easy to understand by a neophyte developer with little, if no, experience of instructional design. CEDAR's aim is that SMEs, where possible, develop their own ELOs and assemble the actual screen layouts for their courses.
- A number of synonyms can be given for each of Bloom's terms.
- It is easier to choose from six alternatives (Bloom) than from eight (Gagne).
- Bloom's taxonomy is widely used.

When the learning outcomes have been defined for a unit the developer can then specify the topics and subtopics that comprise the unit. At the subtopic level, the developer assembles

Meta Tag: census, United States

Copyright owner: US Census Bureau

Website Reference*: http://www.census.gov/index.html

Update Reset Cancel

(Right Click and choose Refresh if this content does not appear updated)

Fig. 1. Defining a web reference ELO.

the actual pages of content from the ELOs. Example 2 in Section 6.2 shows a screen layout within the course editor tool and the corresponding screen that the learner sees.

Most course developers, or SMEs, find it difficult, if not impossible, to create a course in a linear fashion. CEDAR's course editor tool allows for random development within a unit or from unit to unit, providing at least one course outcome and one unit outcome for a unit being worked on have been defined.

6. Examples of ELOs from CEDAR

In this section, various examples of ELOs are given. These ELOs form parts of a recently developed course, *ES 586: The Biosphere and Ecological Sustainability*, in the Master's Program in Environment and Management at RRU.

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ental Literacy

cological ty

U.S. Census Bureau reports

World population:
6,152,047,013
Tue Jun 05 09:59:16 PDT 2001

Web Resource: <http://www.census.gov/index.html>

Fig. 2. The web reference object as it appears to the learner.

6.1. Example 1: Basic ELO

Fig. 1 shows how a developer defines a simple ELO, in this case a web reference, to the database. The developer enters the website reference and suitable tags and then hits the update button. This adds the ELO to the developer’s personal ELO library.

The actual object that appears on the learner’s screen is shown in Fig. 2. This particular object is a real-time counter of the world’s current population. The count changes every second as the population increases.

6.2. Example 2: A content screen composed of a number of ELOs

The ELO shown in Example 1 is combined with other ELOs to create a screen of content (Fig. 3). This screen contains four ELOs. Two ELOs are text: (a) the web reference of

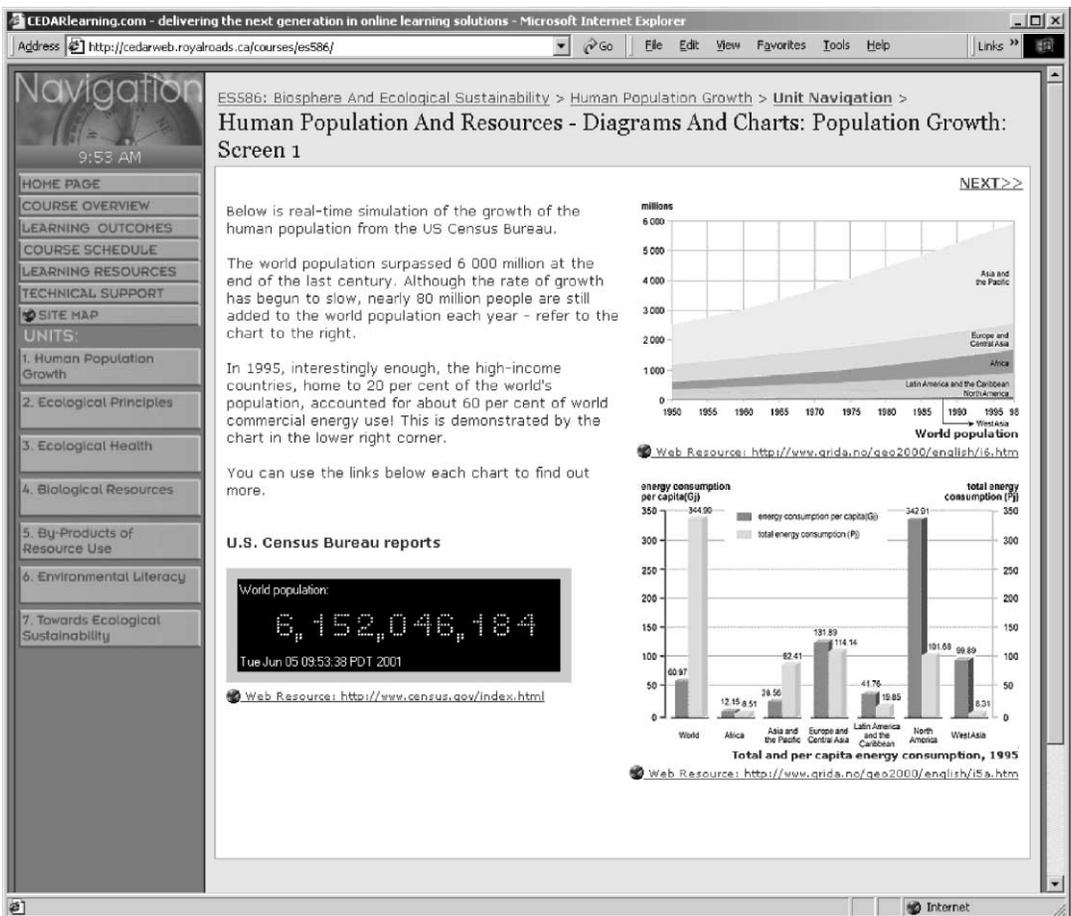


Fig. 3. Content screen consisting of four ELOs.

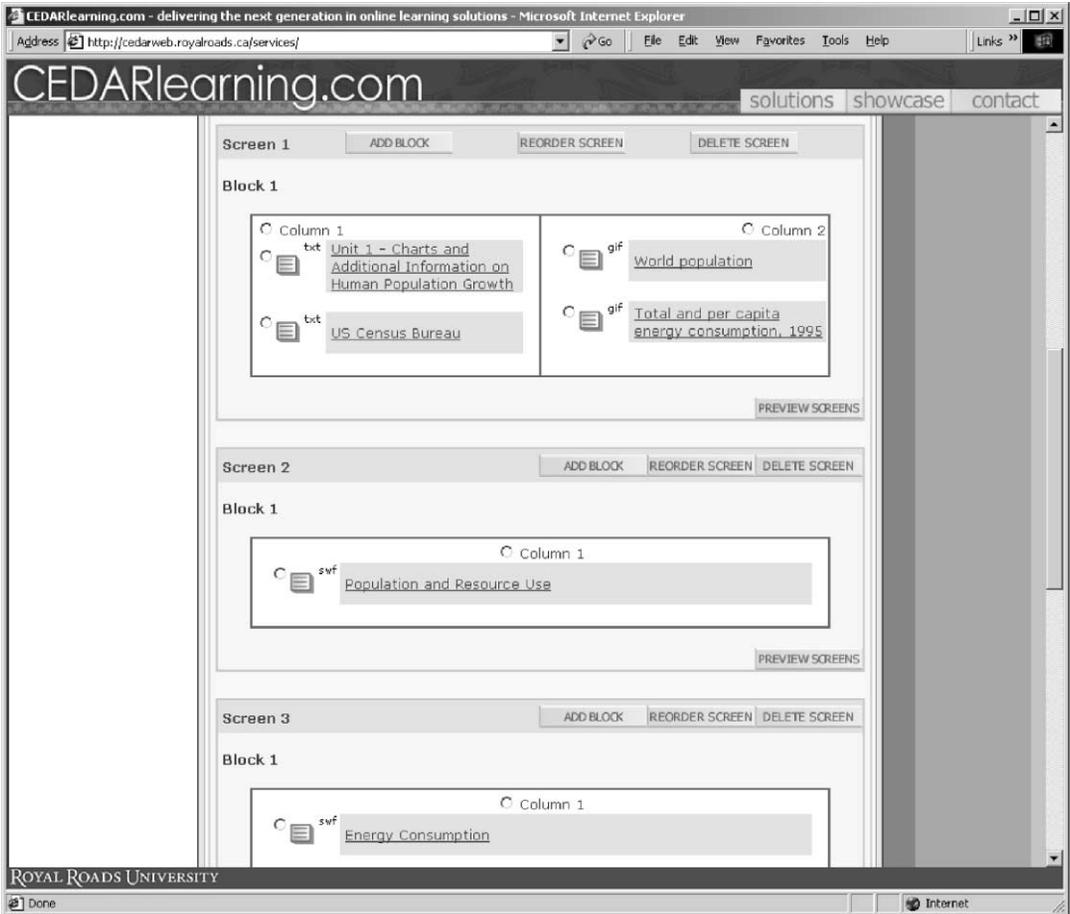


Fig. 4. Assembling a screen from several ELOs.

Example 1 and (b) developer-written text. The other two ELOs are graphs stored as .gif files.

The developer plans the actual layout of this screen in the course editor tool. Fig. 4 shows how the tool calls on the ELOs stored in the SME's personal ELO library.

The screen under consideration (screen 1 in Fig. 4) is laid out in two columns. The developer decided to place two ELOs—the developer-written text and the web reference—in the left-hand column. The right-hand column is defined with two ELOs, both of which are .gif files.

Fig. 5 shows how the ELOs that comprise this screen appear in the course content structure. The developer can add new screens from here and edit ELOs.



Fig. 5. Structure of the course content.

6.3. Example 3: Using templates to develop interactive ELOs

This example depicts the use of a reusable template to create a number of different ELOs. The particular template of Fig. 6 is created in Flash and is an illustration of the earth, sky, and ocean.

This template is then used in a number of different scenarios. Figs. 7 and 8 show two examples of interactive ELOs based on the template of Fig. 6.

South and Monson (2001) say that reusable ELOs must have “sufficient granularity to use in a variety of contexts but aggregated enough for exploring multiple facets of a single concept.” The same is true of reusable templates for ELOs. In this example, the concept (template) concerns ecological cycles; some of the multiple facets of these cycles are (a) the principal layers and compartments of the earth, (b) the carbon cycle, and (c) the nitrogen cycle. Figs. 7 and 8 show how relevant text, drawings, and audio are added as required to create different interactive ELOs.

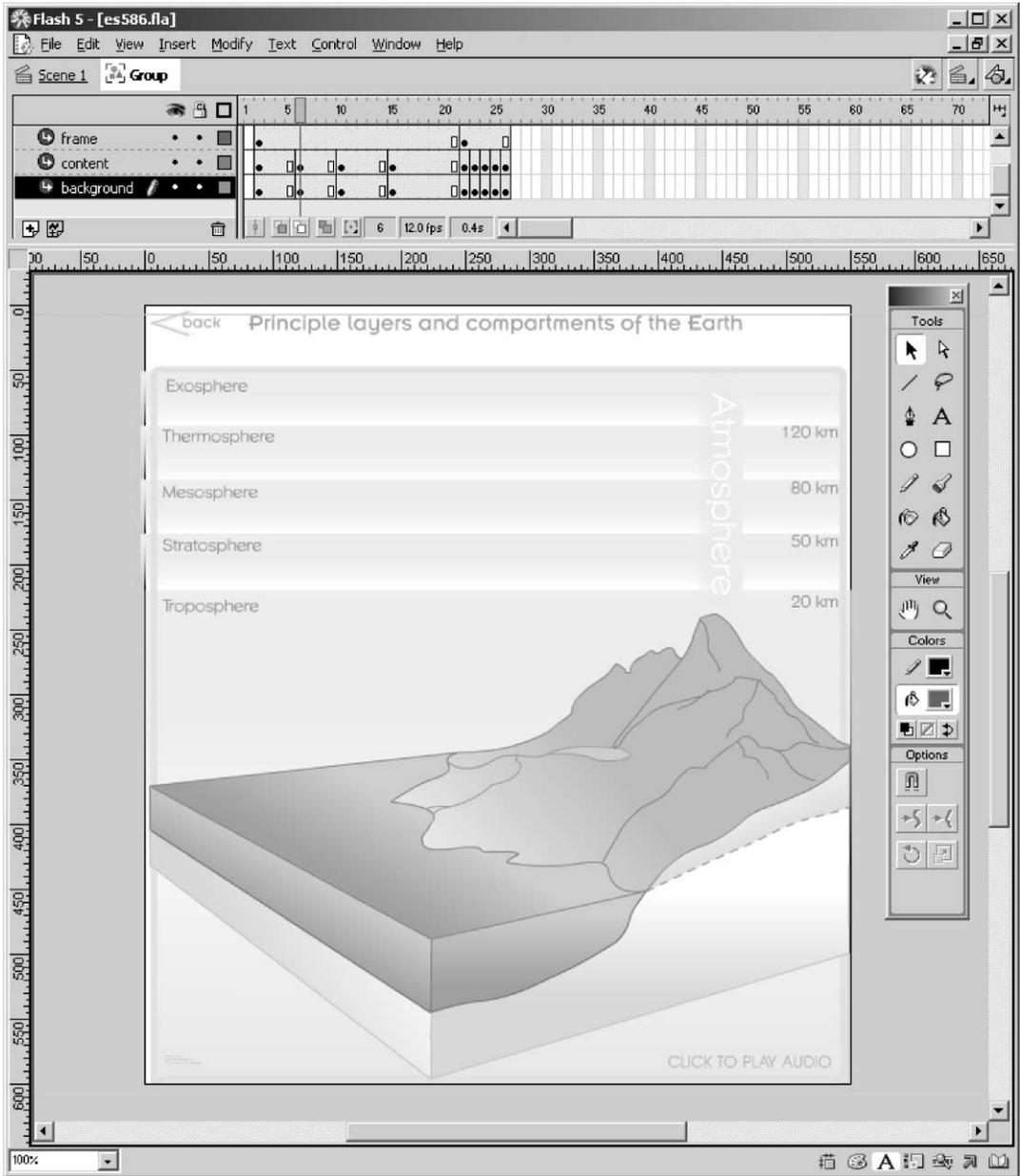


Fig. 6. Reusable template.

The interactive ELOs shown in Figs. 7 and 8 use graphics to gain the learner's attention—the first of Gagne's nine instructional events (as cited in Kearsley, 1994). Key points animate as the learner moves the cursor around the diagram. An optional voice-over

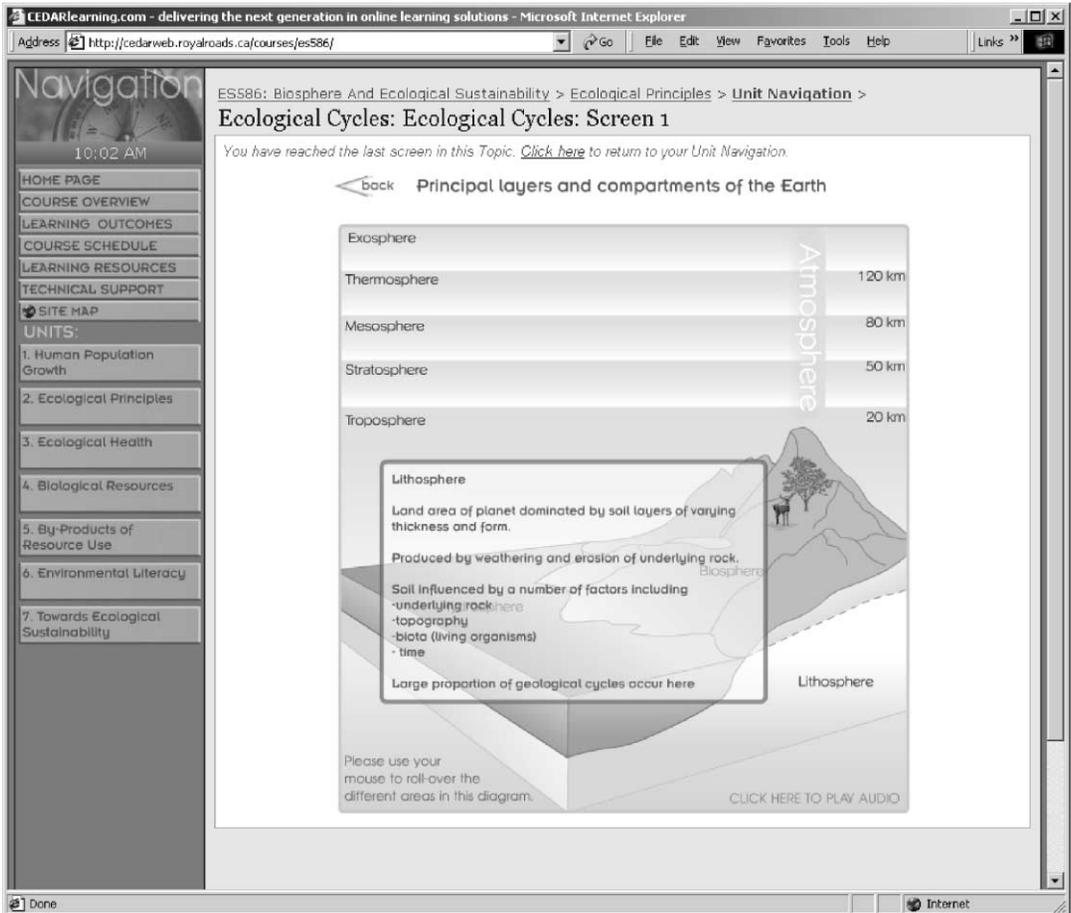


Fig. 7. Adding roll-over text and audio to template to create an interactive ELO.

“walks” learners through the diagrams and provides more explanations. (Note: the voice-overs are also available in print for learners with insufficient bandwidth or without sound playback capabilities).

Different learning styles (Gregorc, 1985) are accommodated in each of these ELOs. Sequential learners usually prefer to listen to the whole voice-over and move their cursor around according to what they hear. Random learners tend to skip around the diagram concentrating only on areas of interest and fast-forwarding through, or even ignoring, the sequential voice-over. These ELOs also allow for a high degree of self-direction (Grow, 1991) as the learner controls which areas to highlight to uncover the explanation. By becoming “participants in their own education,” they become involved learners with a fair degree of self-direction (p. 133).

A template-based ELO is stored differently from other ELOs. Both types record a reference of the filename or textual content in a field in the database. However, a template-based ELO

The screenshot shows a web browser window with the address bar containing <http://cedarweb.royalroads.ca/courses/es586/>. The page title is "ES586: Biosphere And Ecological Sustainability > Ecological Principles > Unit Navigation > Ecological Cycles: Ecological Cycles: Screen 1". A navigation menu on the left lists various site sections, including "UNIT 2: Ecological Principles". The main content area features a diagram titled "The Carbon Cycle" with a "back" button. The diagram illustrates the carbon cycle across three spheres: Atmosphere, Hydrosphere, and Lithosphere. Key processes shown include "plant photosynthesis", "plant respiration 50%", "animal respiration", "combustion E^o generation", and "consumerism (herbivore, predation)". A callout box indicates "CARBONDIOXIDE 0.03% in Atmosphere". A note at the bottom of the diagram says "Please use your mouse to roll-over the different areas in this diagram." and a link "CLICK HERE TO PLAY AUDIO" is provided. The browser's status bar at the bottom shows "Done" and "Internet".

Fig. 8. Adding roll-over text, images and audio to template to create an interactive ELO.

also communicates with the database to choose the content that will appear in the delivery of the ELO. The choice of specific content with which to populate the template is determined by the user's browser passing a variable to the template at run time.

6.4. Example 4: Reader's experimentation

As shown in Example 3, a template can be reused to create different ELOs. In this example, you can experiment with creating your own ELO using a template. At the site <http://www.cedarlearning.com/elo> you will find the template given in Example 3. Assume that you wish to use this template to create an ELO for your course. However, you wish to change the text for each of the component parts. You should be able to insert your own text in a straightforward manner.

7. Conclusions

This article has highlighted the practical experiences of CEDAR in creating, storing, using, and reusing ELOs. Of particular interest is the reusable template from which a multitude of different interactive ELOs can be made. Creating a sophisticated template can be costly in both time and money, especially if animation, video, and/or audio are involved. From the institution's perspective, such investment is worthwhile only if the template is reusable in a number of courses or if the template has resale potential. The template depicted in Example 3 in this article will be used in other RRU courses.

If there is sound economic justification for making a reusable template should they be made? A word of caution is necessary. If we want to make courses truly learner-centred, then the number of such attention-getting objects should be limited to prevent sensory overload. This takes us back to good instructional design, that is, use a particular medium only if it is the best way of presenting a particular message. We also need to ensure that good artistic design principles are also followed so that the learner is not bombarded with too many colours or fonts or too much detail.

CEDAR's philosophy of tying the use of ELOs to sound instructional design principles has also been discussed. It is all too easy to jump on the exciting bandwagons of the latest technologies and of how shareable ELOs can transform course creation and delivery. However, it behooves us to remember the truism that "good instructional design is more important than the specific technology" (Davie & Inskip, 1992, p. 32).

On a final note, the analogy that reusable ELOs are like LEGO blocks that can be combined in many thousands of ways (Hodgins, 2000) now appears to be outdated. Wiley (2001) suggests a new analogy that more closely mirrors CEDAR's experience—that of the atom. He states that "not every atom is combinable with every other atom, atoms can only be assembled in certain structures prescribed by their own internal structure, some training is required to assemble atoms" (p. 17). CEDAR's original intent was that SMEs would use the course editor tool to create their own courses. However, that has not happened. Although SMEs will happily edit ELOs, they do not wish to spend the time creating them, even the simple text-only ones.

Reusable ELOs is an exciting, emerging field. Indeed, maybe soon we will be able to search other's hard drives, rather than server repositories, to find shareable ELOs. And, in the context of sharing, we hope that you will share your experiences with us. We welcome dialogue on this article.

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