On the Sustainability of Open Educational Resource Initiatives in Higher Education

by

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Introduction

This paper describes ideas and issues around the sustainability of open educational resources in higher education. Specifically, the paper:

- Presents an overview of the notion of open educational resources and describes several open educational resources projects in higher education.
- Provides a working definition of sustainability.
- Reviews several models for running open educational resources initiatives and the costs associated with these.
- Examines the types of content produced by several open educational resources initiatives and the costs associated with these.
- Examines the types of reuse engaged in by users of open educational resources.
- Reviews several potential funding models for open educational resource projects.
- Summarises the issues described in the paper and provides a high-level list of things to consider in the context of open educational resource project sustainability.

1. The current state of open educational resource initiatives in higher education

A very large number of open educational resource initiatives are currently underway in around the globe. To understand this growing trend, we must first define what is meant by the term "open educational resources". We can then turn our attention to specific open educational resource initiatives both inside and outside higher education in order to understand the current state of world affairs as pertains to open educational resources.

1.1. Open educational resources

The term open educational resource is the results of a spring 2002 meeting held at UNESCO, and organised with support of WCET and the William and Flora Hewlett Foundation. The UNESCO report from the meeting states:

> *The sixteen principal participants from universities in developing and industrialised countries and representatives of six international and non-governmental organisations express in the declaration adopted by the Forum their wish to develop together a universal educational resource available for the whole of humanity, to be referred to henceforth as Open Educational Resources.*
>
> *Open Educational Resources are defined as "technology-enabled, open provision of educational resources for consultation, use and adaptation by a community of users for non-commercial purposes". They are typically made freely available over the Web or the Internet. Their principal use is by teachers and educational institutions support course development, but they can also be used directly by students. Open Educational Resources include learning objects such as lecture material, references and readings, simulations, experiments and demonstrations, as well as syllabi, curricula and teachers' guides (UNESCO, 2002).*

The term open educational resource is defined very broadly, including curriculum materials like lecture materials as well as educational software like computer-based simulations and experiments. While the UNESCO definition of the term states that teachers are the primary audience of open educational resources and that students are secondary users, in practice learners make up the great majority of users. MIT OCW, one of the most popular collections of open educational resources, reports that only 16% of its users are educators (Carson, 2006).

1.2. Open educational resource initiatives in higher education

The open educational resources movement is growing in the higher education environment. Around the world there are currently over 2 500 open access courses available (*opencoureswares*) from over 200 universities:

- In the United States 1 700 courses have been made available by seven university-based projects (http://ocw.mit.edu/, http://cnx.rice.edu/, http://ocw.jhsph.edu/, http://ocw.tufts.edu/, http://www.cmu.edu/oli/, http://ocw.nd.edu/, http://ocw.usu.edu/).
- In China 451 courses have been made available by 176 university members of the China Open Resources for Education (CORE) consortium. (http://www.core.org.cn/cn/jpkc/index_en.html).
- In Japan 350 courses have been made available by ten universities participating in the Japanese OCW Consortium (http://www.jocw.jp/)
- In France 178 courses have been made available by eleven member universities of the ParisTech OCW project (http://graduateschool.paristech.org/)

More open educational resource projects are emerging at educational institutions in Australia, Brazil, Canada, Cuba, Hungary, India, Iran, Ireland, the Netherlands, Portugal, Russia, South Africa, Spain, Thailand, the United Kingdom, the United States, and Vietnam.

There are also a number of projects underway to make these higher education-based materials available in multiple languages, including Universia's Spanish and Portuguese translations (http://mit.ocw.universia.net/ and http://www.universiabrasil.net/mit/index.jsp), CORE's simplified Chinese translations (http://www.core.org.cn/OcwWeb/Global/all-courses.htm), OOPS' traditional Chinese translations (http://www.cocw.net/), and Chulalongkorn University's Thai translations (http://mit-ocw-thai.eng.chula.ac.th/). With the exception of Taiwan's OOPS project, these translation projects work exclusively with MIT OCW content, which currently represents approximately 52% of all opencourseware-style courses.

1.3. Open educational resource initiatives outside higher education

The number of available non-course open educational resources – like articles, individual curriculum units, modules, and simulations – are also growing at a terrific rate. The English language Wikipedia (http://wikipedia.org/) contains over 1 300 000 articles. Math World (http://mathworld.wolfram.com/) contains 12 632 entries. Rice's Connexions project currently hosts 3 461 open learning objects (http://cnx.org/) available for mixing and matching into study units or full courses. And Textbook Revolution

(http://textbookrevolution.org/) contains links to 260 freely available, copyright-clean textbooks.

1.4. Funding of current open educational resource initiatives

Many of the open educational resource projects currently underway receive targeted external funding in support of their work. Specifically, the William and Flora Hewlett Foundation has put millions of dollars into university-based open educational resource projects around the world. Given the current budget climate for education, a concern naturally arises about the future of the university-based open educational resource projects. What will happen when the targeted external dollars dry up? Will the initiatives themselves also dry up? How are these initiatives to sustain themselves over time?

In order to answer these questions we must understand at a minimum (1) the different types of open educational resource initiatives underway in higher education and (2) the different costs associated with supporting these different types of projects. We will then be prepared to consider the long-term sustainability of these different projects.

2. What is sustainability?

It behaves any intellectual inquiry to begin with a definition of its major constructs. Having defined and given examples of *open educational resources*, we must now be explicit in what is meant by *sustainability*.

2.1. A working definition of sustainability

In the context of this paper, sustainability might be defined as the ability of a project to continue its operations. And certainly, the idea of *continuing* is a critical part of the meaning of sustainability. However, we cannot place value on the simple ongoing machinations of a project and staff who produce nothing of value. So the definition of sustainability should include the idea of *accomplishing goals* in addition to ideas related to longevity.

Hereafter, sustainability will be defined as an open educational resource project's ongoing ability to meet its goals.

2.2. The unique sustainability challenges of open educational resource projects

Open educational resource projects must find two unique types of sustainability. First, they must find a way to sustain the production and sharing of open educational resources. Second, and of equal importance, they must find a way to sustain the use and reuse of their open educational resources by end users (whether teachers or learners).

The first challenge must be considered in two parts: the sustainability of the production of open educational resources, and the sustainability of sharing the resources. For the first part, producing open educational resources requires human resources, workflow processes, and supporting technology. At a minimum, someone must capture content, digitise content, check content for intellectual property issues, resolve intellectual property issues, and provide quality assurance of the final product. All this must be done in the context of computers, access to the network, and one or more supporting software tools. There are real costs involved in people time, developing workflow policies,

purchasing computers, connecting to the network, and acquiring and administering software. Meeting these real costs is one part of the sustainability challenge. For the second part, copies of the finalised open educational resources must be distributed to end users. This can mean distribution of digital copies over the Internet, distribution of digital copies of the resources on physical media like hard drives, DVDs, and USB "thumb" drives, or printed paper copies of resources. Each of these distribution methods has real costs, including bandwidth for distributing digital copies online, and media inventory, duplication, and shipping costs for physical media and paper. Meeting these real costs is another part of the sustainability challenge for open educational resource projects.

The second challenge must be considered if an open educational resource project is to meet its goals – projects could easily spend years producing and sharing resources that teachers and learners are unable to use. Resources must be shared in a format that operates equally well across hardware and operating system platforms. Resources must be sourced in such a way that local adaptations can be made. Users may need technical tools for making effective reuse of resources; they may also need training or to see examples of how such localisations can be performed. Finally, in order to adhere to the "Share alike" license used with many open educational resources, users need either a place to put their derivative works or a place where they can tell others where their derivative works are located. Again, there are real costs associated with taking the trouble to source content in an easily editable, cross-platform manner, in providing novel tools for resource localisation, in providing training about the localisation process, and in providing mechanisms for users to meet their "Share alike" obligations. Meeting these real costs is another part of the sustainability challenge for open educational resource projects.

These very real costs that must somehow be resourced in order for projects to continue meeting their goals are not necessarily unique to open educational resource projects. However, the firm determination to give away the results of all these efforts for free, with no "cost recovery" mechanism, is rather unique to open educational resource projects. Without a way of bringing in dollars, how is a project to provide the resources necessary to keep pace with its real costs from year to year?

2.3. Sustainability is about incentives generally, not financial resources specifically

Discussions of sustainability almost immediately turn to discussions of money – "how will we bring in enough money this year to keep the project running?" And below I will present and comment on Downes and Dholakai's discussions of funding models for open educational resource projects. However, it is *critical* to point out early in the discussion that real costs can be met with resources other than money.

The closest point of comparison for open educational resource projects is open source software projects. The largest cost for open source software projects, as for open educational resource projects, is the cost of people involved in the project. However, literally hundreds of open source software projects continue to meet their goals over extended periods without paying the individuals involved. This is partly because, in place of money, people find other incentives sufficient to merit their involvement in projects. *People will often volunteer to do things you could never pay them enough money to do*. In as much as anything in economics is simple, this is a simple matter of value versus cost. When people find more value in participating in an activity than the cost of participating in the activity, they are likely to participate. By paying attention to this cost/benefit analysis, and increasing the value inherent in participating in open educational resource

projects for staff, teachers, and learners, we may be able to decrease the amount of extrinsic incentives (such as money) that are necessary to sustain open educational resource projects.

In short, money is not the only incentive sufficient to engage users in open educational resource projects.

2.4. Sustainability and replicability

Much of the conversation about the sustainability of open educational resource projects has centered on the search for a business model that can sustain these projects over the long-term. The unspoken hope is that if one project can strike upon a model that will sustain their work, several other projects will benefit from using the model or an adaptation of the model. It must be remembered, however, that sustainability and replicability are two very different things. The discovery of a sustainable manner of carrying out an open educational resources project will not necessarily be replicable by projects.

2.5. Summary of remarks about sustainability

Sustainability, even as captured in the simple definition "an open educational resource project's ongoing ability to meet its goals", is a rich and complex topic. More than a search for revenue models in which core staff are able to stay employed indefinitely, sustainability implies an understanding of project goals, the specific activities that must be carried out to meet those goals, and an ability to create incentives that will provide people with sufficient motivation to engage in those activities.

3. Different open educational resource initiative models in higher education

In this section I will describe three models for open educational resource projects in higher education: the MIT model, the USU model, and the Rice model. These three models exhibit an instructive diversity in their size, organisation, and provision of IP-clearance, content creation, and other services. The MIT model is highly centralised and tightly coordinated in terms of organisation and the provision of services, relying almost exclusively on paid employees. The USU model is a hybrid of centralisation and decentralisation of both organisation and services, and work is distributed across some employed staff and a number of volunteers. The Rice model is almost fully decentralised and volunteers provide almost all services.

3.1. The MIT model

The goal of MIT OCW is to publish each and every course in the entire 1 800-course university catalogue in a fixed period of time, and to continually republish new versions of courses and archive older versions. The undertaking is massive, and so is the organisation that supports it. MIT OCW employs at least 29 people in service of the opencourseware project. This includes eight core staff, five publication managers, four production team members, two intellectual property researchers, and ten department liaisons. The two intellectual property researchers manage rights issues for 6 000 pieces of third-party owned content each year (*e.g.*, requesting the right to use the materials on

the MIT OCW website). Department liaisons identify faculty to work with and manage those relationships on behalf of MIT OCW.

MIT OCW also contracts with a number of vendors to gain access to additional services. For example, "Sapient Corporation has been MIT OCW's primary partner in the design, implementation, and support of the MIT OCW Web site's underlying content management and publishing infrastructure. Sapient also provides programme management and content authoring services" (http://ocw.mit.edu/OcwWeb/Global/AboutOCW/partners.htm). Sapient employees in India also do much of the content editing and programming necessary to support MIT OCW. Other vendor partners in MIT OCW include Microsoft, Maxtor, Hewlett-Packard, Akamai, and NetRaker, each of which provides additional services or products to the initiative.

Annual budgets for MIT OCW projected from 2007 through 2011 average just over USD 4 300 000 per year, with the most resources allocated to staff (USD 2 095 000 per year), technology (USD 1 046 000 per year), and contracted services (USD 562 000 per year). An average spend of USD 4 300 000 per year on an average of 540 courses produced per year makes for an average cost of just under USD 10 000 per course.

MIT OCW has done a singular job of acquiring foundation and private donor support (dozens of millions of US dollars over the life of the project) and engaging vendors in partnerships. While MIT has made an institutional commitment to sustain the project over the long term, there is very little chance that any other institution will be able to replicate the MIT model.

3.2. The USU model

The goal of USU OCW is to publish as many of the courses in the USU course catalogue as possible. Project staff include one full-time project director and five part-time student assistants who are integrated into the university's Faculty Assistance Center for Teaching. A number of student volunteers also work on USU OCW in the context of digital media or instructional design studio classes, Practicum experiences, or Creative Projects. Faculty volunteer to coordinate this work as part of their teaching or advising responsibilities by making USU OCW-related work eligible for credit in their courses. The Center for Open and Sustainable Learning manages USU OCW technology as part of its day-to-day responsibilities (the USU OCW development and production environments run entirely on free and open source software). USU OCW identifies and immediately removes all third-party owned content from courses, replacing some of this content with equivalent materials owned by USU. (Over a two-year period developing 50 courses, rights have been acquired for only one piece of third party owned content.) Faculty recruiting is done largely by word-of-mouth, with the exception of the USU OCW emphasis areas: agriculture, irrigation engineering, and instructional technology, where stronger relationships exist between USU OCW staff and college or department leadership.

The annual projected budget for USU OCW in 2007 is just over USD 127 000, including one full-time Director, two half-time graduate students, and three half-time undergraduates. An average spend of USD 127 000 per year on an average of 25 courses produced per year makes for an average cost of just over USD 5 000 per course.

USU OCW has also done an excellent job of acquiring foundation support (more than USD 250 000 over the life of the project). While USU OCW operates at a miniscule scale compared to MIT OCW in terms of courses developed per year (25 per year as opposed

to 450 per year), the model does appear to be sustainable for USU and, importantly, may be replicable by other universities.

3.3. The Rice model

The goal of Rice Connexions is to enable the collaborative development of educational modules and courses by authors from around the world. Unlike MIT OCW, but like USU OCW, there is no target number of courses to be developed. And unlike either MIT or USU, the courses and modules built in Rice Connexions are not all from courses taught at the host university – authors from around the world contribute material to the site.

The site, then, is totally self-organising. No one coordinates what courses or modules are being built. No one provides technical or pedagogical support to individuals who author content on the site, or helps authors identify and remove third-party owned content. But there is extensive documentation provided on the site in these areas.

Of the 179 courses and 3 525 modules currently available from Connexions, only a handful of the materials have had any financial backing (one example is Brandt's Introductory Music Appreciation course which receives funding from the US National Endowment for the Arts). The average cost per course under the Connexions model is, then, extraordinarily low.

Using a very different model, Connexions has done an excellent job of facilitating the gathering and collaborative authoring of individuals from around the globe. Digital Signal Processing has become a particularly popular area in part due to the efforts of founder Dr. Richard Baraniuk, who has authored 215 modules and five courses, and maintains another 93 modules and six courses. Obviously, his passion plays a large part in the success of the project.

3.4. A note regarding technology and the USU and Rice models

It is worth pointing out that in addition to running the content-related portions of their open educational resource projects, both Utah State University and Rice University engage in parallel projects in which they develop open source software used to run their projects. These projects are funded separately and this software is available to other institutions to use at no cost. In addition to the no-cost availability of the server source code, both USU and Rice provide hosting for other organisations' content (*e.g.*, the Notre Dame OCW is hosted at USU and running on USU's eduCommons software). For these reasons, the resources used in developing these supporting technologies have been omitted from the previous discussions.

3.5. Summary of the different models

The MIT, USU, and Rice models show much of the diversity possible in open educational resource initiatives in higher education. Initiatives may set goals to make all of their university's courses available (MIT), many of their university's courses available (USU), or to make many courses available regardless of origin (Rice). Organisational configurations can range from large and highly structured (MIT) to medium-sized and less formally structured (USU) to almost fully decentralised (Rice). Cost per course produced follows organisational size, ranging from USD 10 000/course (MIT) to USD 5 000/course (USU) to USD 0/course (Rice). The degree of control over the courses

produced ranges from a high degree (MIT and their department and faculty liaisons) to a small degree (USU and its opportunistic approach) to practically no control whatsoever (Rice and their open-to-all-authors approach). Table 1 summarises this information (Data for this table is taken from personal communication with project representatives).

Table 1. Diversity of models employed by higher education open educational resource initiatives

	MIT	USU	Rice
Course production goals	All courses offered by MIT	Many courses offered by USU	Many courses offered anywhere
Control over courses produced	High degree of control	Small degree of control	Practically no control
Cost per course produced	USD 10 000	USD 5 000	USD 0
Organisation size	Large	Medium	Small

Of course, not all organisations fit this "left-to-right" categorisation scheme. For example, Carnegie Mellon University's Open Learning Initiative has a goal of only producing a few courses from CMU, but the cost per course is quite high because so many interactive materials are developed for the courses.

Some of the first sustainability questions an open educational resources initiative needs to ask are: What are our publication goals? How will we be structured, if at all? How much money do we intend to spend in producing each course?

4. Different types of resources developed and the media in which they are shared

Open educational resource initiatives can choose to develop and share several kinds of content. These fall into two broad categories: those to be used in teaching and those to be used in studying. These materials can be shared in a variety of media, including textual content in a variety of formats, audio content, video content, and simulation content, and other interactive content.

4.1. Resources to be used in teaching

Resources to be used in teaching are designed on the assumption of existing knowledge of a content area. For example, a set of presentation slides with a few bullets of text per slide are meaningful to experts who can mentally "fill in the blanks", while the same set of slides will be worth little to the novice who has no frame for understanding them. The same is true for skeletal lecture notes and assignments or problem sets without solutions. Experts who will be teaching a course are looking for resources that indicate structure of the domain, sequencing of topics within the domain, and names of textbooks. MIT OCW states that its primary audience is teachers, and their content is structured accordingly.

4.2. Resources to be used in studying

Resources to be used in learning must be significantly richer, filling in all the gaps found in content that might assume pre-existing knowledge in a domain. Rather than a high-level, structural view of the domain, these resources must provide significant detail about the topics in the domain. A collection of videos from an actual course, in which the

teacher provides the most significant content and answers content-related questions, is one example of this type of resource. Resources that provide opportunities for practice with feedback also belong in this category. An interactive quiz that provides an explanation when a user provides an incorrect answer is one example. Carnegie Mellon's Open Learning Initiative state that its primary audience is learners, and their content is structured accordingly.

4.3. Different formats in which content can be shared

Textual content is by far the most frequently shared type of content in current open educational resource collections. This content takes on a variety of forms, including HTML, XML, and PDF. Collections with large amounts of scientific or mathematical content tend to favor PDF because it is currently so much easier to publish directly from Word, OpenOffice, or LaTeX to PDF than to reproduce equations and other content in the equivalent HTML + MathML.

Audio content in open educational resource collections is comprised largely of files using the MP3 format, though some audio content is available in Windows Media and Real formats.

Video content in open educational resource collections is available in a wide variety of formats with no clear leader across projects. Windows Media, Real, Quicktime, and MP4 formats can all be found in collections around the Internet.

Simulation content is still quite rare in open educational resource collections. The simulations that can be found are generally developed in the Java or Flash formats.

Other interactive content in open educational resource collections (such as drills, or formative assessments that offer immediate feedback) are currently largely authored in Flash, though some Java may be found, as well as some content utilising AJAX techniques to accomplish their interaction.

4.4. The cost of authoring different types of content and different formats

Resources developed for teachers are clearly less expensive to produce than resources for learners. Providing high-level information about the structure of a domain and appropriate sequences of the topics in a domain obviously requires less time and resource than providing all that information plus all the detail necessary to make the resources meaningful to a novice.

On the other hand, very few general remarks can be made regarding the cost of authoring content in different formats. While one might assume that textual content is easier and less expensive to produce than audio or video, this may not be the case. If a teacher has his or her lecture notes already typed out and in digital form, converting these into an open educational resource may be rather inexpensive. On the other hand, if someone must record and transcribe these notes, and then the teacher must review the transcription for quality, producing textual content can be quite expensive. In many instances, recording video or audio of a teacher as they go about teaching a class and carrying out necessary post-production activities can be much less expensive than transcribing the same lectures into textual content.

The one remark regarding the cost of developing different types of content that is generally true is that simulation and other interactive content cost significantly more to

produce than do text, audio, and video. This is why text, audio, and video are so prevalent in open educational resource collections, and simulations and interactive content are so rare.

4.5. The instructional effectiveness of different content formats

When an open educational resource initiative has as one of its goals to promote learning, questions regarding the instructional effectiveness of these resources frequently arise. Is one type of content more effective that another? Does video teach better than text? Does interactive content support deeper learning than static content? Do simulations promote farther transfer than audio content?

Such questions are meaningless. As chronicled in over 350 research reports on the No Significant Difference website (http://www.nosignificantdifference.org/) and as taught in every introductory instructional design course, the medium of delivery does not factor into the effectiveness of educational materials. Just as there are extremely effective textual, audio, video, simulation, and interactive materials, there are extremely poor textual, audio, video, simulation, and interactive materials. Educational effectiveness is a function of the design of the materials and not the channel by which they are conveyed.

4.6. The instructional effectiveness of open educational resources generally

As with educational materials developed in a diversity of content types like audio and video, educational materials do not become more effective simply because they have a Creative Commons or other open source license applied to them. Research questions of the form "are open educational resources as effective as traditional resources?" are meaningless. The application of a Creative Commons license to a textbook does not make it more instructionally effective. Open licensing makes educational resource infinitely more available, but does not improve their effectiveness.

4.9. Summary of remarks about different kinds of content

One of the first sustainability-related questions an open educational resource project needs to ask is "what kind of content will we produce?" and "in what format will we share our resources?" Projects should realise that there is no pedagogical implication of choosing one format over another; however, there are many downstream implications of choosing one format over another, as described in the next section.

5. Different types of reuse engaged in by end users

Users of educational resources do a variety of things with them. In providing open educational resources to users, we must at a minimum enable all these historic reuses to which users have grown accustomed. Each of these types of historic reuse must be considered by open educational resource initiatives in order to insure that project goals can be met (particularly in the context of sustainability).

5.1. As-is reuse

As-is reuse, or making use of an educational resource without any modification or alternation, is the primary method of reuse among instructional designers and teachers using copyright-encumbered materials (since they do not have the rights to make any

modifications to the materials, and generally do not have editable source materials). Consequently, many individuals will default to this behavior. This is the type of reuse most frequently referred to in the literature on learning objects for the same reason – people generally have neither the rights nor the source code to edit educational materials.

In order to be reused as-is, an educational resource must adhere to some common practices or comply with de facto standards. For example, if an online resource cannot be viewed in a web browser, or requires an obscure browser plug-in in order to be viewed, it will be considered for reuse only very rarely – because very few people are willing to download and install a browser plug-in just to view one of 100 search results.

5.2. Technical adaptations for reuse

Occasionally an educational resource that does not meet de facto standards will be selected for reuse. Or perhaps something about a given resource makes it incompatible with the local teaching and learning environment. In these and other cases, technical adaptations must be made to a resource before it can be reused.

For example, the CSS stylesheet in a web page may be changed to point to the default stylesheet of the website where it is being reused, so that the resource will have the same visual look as the rest of the site. As another example, perhaps several photographs with appropriate images are available from a collection, but only in TIFF or RAW formats. These images would have to be converted into a web browser-compatible format like PNG or JPG before they could be reused online. A final example of technical adaptations would be the format and structure changes necessary to prepare a series of webpages for printing to support offline use in lower-bandwidth regions.

5.3. Linguistic adaptations for reuse

Linguistic changes must often be made to materials before teachers of learners can engage them. For example, textual content produced for English speakers may need to be translated into Chinese, or content designed for graduate students may need to be adapted to the linguistic level of high school students.

5.4. Cultural adaptations for reuse

Culture-related adaptations are not necessary linked to linguistic adaptations. For example, in some cultures learning by doing and making mistakes is a normal part of the learning process. In other cultures, any errors committed during the learning process are frowned upon. As another example, in some cultures, teamwork and group work are the norm, while in other cultures these are interpreted as academic dishonesty. Note that culture here applies in the broadest sense of the terms, including both culture in the everyday sense of the term (like the French culture) as well as other cultural groups like academic disciplines, which generally have distinct and highly developed cultures of their own.

5.5. Pedagogical adaptations for reuse

When a teacher is going to use an educational resource, he or she will frequently prefer to make a few changes to the resource to make it better fit his or her "teaching style". For example, they might involve removing certain drill-oriented types of practice

and replacing these with problem-based work. For another example, an instructor might break up lengthy lectures and provide the smaller pieces of content as just-in-time support for group activities rather than as one large dump of information.

5.6. Annotation as adaptation for reuse

When individuals use physical educational materials like books and photocopies, they frequently mark these up with colored highlighters, writing notes in the margins, folding down the corners of pages, and making a variety of alterations to the materials so that they will be more useful at some future time (like the night before an exam).

5.7. Access to source code, facilitating reuse, and sustainability

According to the GNU General Public License version 2.0, the term "source code" means "the preferred form of the work for making modifications to it" (http://www.gnu.org/copyleft/gpl.html). Different types of reuse interact with different publication formats in different ways, and therefore affect the sustainability of open educational resource projects in different ways.

In the case of most adaptations of open educational resources, access to the source code is absolutely necessary to make the required changes. For example, to edit an HTML page you need to be able to access the HTML file itself. While this may seem like a trivial thing, some commercial learning management systems such as WebCT purposefully obfuscate the code within these files so that adaptations are much more difficult to make.

Users' desires to reuse content quickly and easily can run at odds with projects' desires to publish content quickly and easily. For example, for scientific materials originally authored in LaTeX, it is quickest for the open educational resource project to convert the file to PDF for online distribution. However, from the reuser's perspective, that same material published as HTML+MathML is significantly easier to reuse in every sense of the term – particularly since HTML+MathML can be converted to PDF (but the conversion does not work the other direction). As another example, in a context where no digitised text already exists, a project may choose to produce video and audio almost exclusively due to the lower cost of capturing and digitising this content when compared to transcribing and the other costs associated with producing textual content. However, from a reuser's perspective, textual content is much more amenable to adaptation than either audio or video.

Also, because most users will not be highly technical, a critical part of helping users reuse materials is connecting them with tools that make it easy to translate materials and make other content-related adaptations. For example, an inline WYSIWYG editor will allow many more people to edit content than a large text field sprawling with XML.

Because many open educational resource projects will have both "publish open educational resources as efficiently as possible" and "support end-user reuse of our open educational resources" as goals, careful thought must be taken in choosing a middle position between these two contradictory goals. As per the definition of sustainability posited at the beginning of this paper, an open educational resource project that runs for 20 years producing hundreds of thousands of open educational resources will not have been sustainable if the critical goal of enabling meaningful reuse of materials was never reached.

6. Potential funding models

During the winter of 2005-2006 the OECD requested short papers on the topic of open educational resource project sustainability from Dholakai and Downes. Both these papers presented a number of potential funding models for open educational resource projects. In this section I represent their proposed models and provide some commentary.

6.1. Funding models from Downes

Endowment model – on this model, the project obtains base funding. A fund administrator manages this base funding and the project is sustained from interest earned on that fund. At the Stanford Encyclopedia of Philosophy, for example, where organisers reasoned that a subscription-based model would cost more than it would earn (because volunteers would have to be paid), funds (USD 3 to 4 million) were raised from a variety of charitable foundations, generating in interest the service's USD 190 000 operating budget (Zalta, 2005).

Membership model – on this model, a coalition of interested organisations is invited to contribute a certain sum, either as seed only or as an annual contribution or subscription; this fund generates operating revenues for the OEM service. The Sakai Educational Partners Programme, for example, is a for-fee community that is open to educational. Members contribute USD 10 000 and in turn are granted a set of privileges, including early access to roadmap decisions, code releases and documentation. (Sakai, 2005). Beshears (2005) describes how this model could replace user-pay models of textbook distribution.

Donations model – on this model, a project deemed worthy of support by the wider community requests, and receives donations. Donations are in turn managed by a non-profit foundation, which may apply them to operating expenses or, if amounts are sufficient, seek to establish an endowment. Numerous open source and open content projects are funded in this manner, including Wikipedia (Foote, 2005) and the Apache Foundation (Apache, 2005). It is worth noting that such donations are often supplemented with purchases of branded products; the Spread Firefox initiative is a good example of this (Mozilla Foundation, 2005). Variations of this model exist. For example, contributions to the Apache project are owned by the contributor and licensed to the project. However, in another model (sometimes called the conservancy model), property is assigned to the organisation, which then acts as a steward (Everitt, 2004).

Conversion model – as summarised by Sterne and Herring (2005) "In the Conversion model, you give something away for free and then convert the consumer of the freebie to a paying customer." This approach, they argue, is needed because "there is a natural limit to the amount of resources the Donation model can bring to an open source project, probably about USD 5 million per year". Linux distributors, such as SuSe, RedHat and Ubuntu, where the software is available for free under an open source license, have adopted this model. Subscribers receive services (such as installation and support) or advanced features. In the educational community, the conversion model has proven popular, having been adopted by Elgg and LAMS.

Contributor-pay model – adopted by the Public Library of Science, the "PLoS Open Access Model: One Time Author-Side Payments" (Doyle, 2005) consists of a mechanism whereby contributors pay for the cost of maintaining the contribution, and where the provider thereafter makes the contribution available for free. Interestingly, this is a model

that has earned some support from publishers, particularly in view of foundations, such as the Wellcome Trust, that have begun to require that materials funded be freely available. Thus, in the "open choice option" offered by publishers, "research articles and supporting documentation will be made freely available online to view immediately upon publication. The charges for this process will be met by funding bodies, such as the Wellcome Trust – who calculate it will represent approximately 1% of their annual spend". (Wellcome Trust, 2006)

Sponsorship model – this model underlies a form of open access that is available in most homes: free radio and television. The sponsorship model can range from intrusive commercial messages, such as are found on commercial television networks, to more subtle "sponsorship" message, as are found in public broadcasting. In online educational initiatives, various companies have supported OER projects on a more or less explicit sponsorship basis, often in partnership with educational institutions. Examples include the MIT iCampus Outreach Initiative (Microsoft) (CORE, 2005) and the recently announced Stanford on iTunes project (Apple) (Stanford, 2005). It is worth noting that GNU EPrints adopted this model as a direct result of a move by Research Councils UK to mandate open access for all funded research (Yeates, 2005).

Institutional model – a variation, perhaps, on the sponsorship model is the case in which an institution will assume the responsibility itself for an OER initiative. Probably the most well known of these is MIT's OpenCourseWare project, where funding for the project represents a part of the universities regular programme, justified as constituting a part of its organisational mission. "It is an ideal that flows from the MIT Faculty's passionate belief in the MIT mission, based on the conviction that the open dissemination of knowledge and information can open new doors to the powerful benefits of education for humanity around the world." (MIT, 2005)

Governmental model – similar to the institutional model, the governmental model represents direct funding for OER projects by government agencies, including the United Nations. Numerous projects sustained in this manner exist, for example, Canada's SchoolNet project.

6.2. Funding models from Dholakai

Replacement model. The educational content stored, disseminated, and re-used through the OEP [open education programme] often replaces the use of other technology software and infrastructure such as course management systems, virtual learning environments (*e.g.*, Blackboard), and proprietary data repositories and web-sites (Wright, Yoshimi and Gavilan, 2005). Since educational institutions spend significant amounts for these replaced knowledge management systems, the cost savings resulting from their discontinued use can be employed to fund the OEP.

Foundation model. If the OEP grows to a significant size in a particular subject area, in total number of users, in serving users of a particular country or geographic region, etc., it could seek on-going funding from foundations, philanthropic institutions, professional societies, trade or industry groups, individual firms, governmental and/or non-governmental agencies that are focused on this particular niche. The key to implementing this model is to identify an underserved user segment, and then focus the programme's efforts and initiatives in serving this segment, thereby creating a differentiated brand image. A variation of the foundation model is a consortium model,

where the OEP charges a fee from affiliated universities and institutions for joint development and ownership of the project.

Segmentation model. This model relies on the idea that while providing open access to all the educational content on the site to users, the OEP can simultaneously provide "value-added" services to specific user segments and charge them for the services. Examples of such specific services that could be offered are: sales of paper copies of culled content organised around a particular topic, training and user support to institutional users for annual fees, housing and dissemination of copyrighted content within the same site on a subscription basis, "ask-an-expert" services for a fee, and consulting services to provide custom education to corporate clients.

Voluntary support model. A revenue model based on voluntary support emulates fund-raising methods used by National Public Radio, National Public Television, and other media outlets in the United States. From time to time, these media organisations run fund-raising campaigns to raise money from conscientious users to financially support their operation. Recent revenue models, employed successfully by blogs such as tip-jars, the solicitation of "micro-patrons" (*e.g.*, www.kottke.org) who contribute micropayments (*e.g.*, Micali and Rivest, 2002; Yang and Garcia-Molina, 2003) could be used in conjunction.

6.3. Other support models for open educational resource projects

The most intriguing support possibility for open educational resource projects based in higher education that is not mentioned above is to reduce the cost of the open educational resource projects so drastically that there is little or nothing left to fund. This is the approach taken in joint work by the Sakai Project, an open source course management system, and eduCommons, an open source opencourseware management system. The two projects are working together to leverage all the effort that already goes into building and publishing online courses. Many universities, including the Michigan and Utah State Universities, already have funding, processes, and personnel in place to build online courses within their chosen course management tool. If a "one button" feature could be added to these systems that exports an open version of the official course into a university's opencourseware collection, this would remove many of the major costs associated with running open educational resource projects.

6.4. Summary of funding models

Obviously, there are dozens of funding models that an open educational resource initiative might adopt. Because every initiative will have different goals and exist in a different institutional context, no single model will fit every project. However, there is still much that individuals and institutions can learn by watching the beginning attempts at sustainability that are just emerging in many previously-grant-funded open educational resource initiatives.

7. Policy issues for institutions and nations

There are a variety of policies that can enable or hinder the work of open educational resource projects. For the sake of the open educational resource movement, the adoption of policies that enable or encourage the development of open educational resource work should be encouraged where applicable. Additionally, we should encourage the removal

or alteration of policies that prohibit or make difficult our open educational resource efforts.

7.1. Policy issues for institutions

While institutions can coordinate open educational resource projects, faculty who voluntarily share their creative works are the primary force behind the success of these projects. The most salient policy question a higher education institution can ask in regard to open educational resources is, therefore, "what can we do to provide incentives for faculty to participate in an open educational resource initiative?"

One answer to this question is as follows. It is frequently, though not exclusively, the case that younger faculty in institutions of higher education are more comfortable using advanced computer-related technologies and more familiar with the notion of openness expressed in the open educational resource movement. Unfortunately, many of these younger professionals are under very real restrictions on how they spend their time due to tenure-related concerns. However, the current higher education climate is moving toward greater transparency and accountability in teaching – the increasing popularity of teaching portfolios as a required part of tenure documentation is one example of this trend – and there appears to be an excellent opportunity here to insert open educational resources into the tenure process. Where institutions have teaching portfolio or similar requirements as part of their tenure process, we may promote the idea that at least one course should be converted into an open educational resource format as part of the teaching portfolio or similar tenure requirement to document excellence in teaching. Even though the increase in available open educational resources resulting from this policy would be slow, it would be very steady, and provide ongoing sustainability to higher education initiatives.

The next most salient institutional policy question for champions of open educational resources in higher education is "what current institutional policies create obstacles for faculty who wish to open access to one or more of their courses?" Examples of such policies may include those that discourage faculty from engaging in online teaching activities before tenure and policies by which institutions claim to control intellectual property developed by their faculty.

7.2. Policy issues for nations

Traditionally, regional or national policies are targeted toward higher education institutions as a whole and not individual faculty. The policy work of regions and nations must therefore always be one degree of separation from the heart of open educational resource projects, and can only deal with providing incentives that may encourage institutions to provide the coordinating support necessary for faculty to engage in open educational resource projects.

While increases in funding for institutions of higher education to work on open educational resource projects are unlikely, policies providing institutions with explicit permissions to use previously allocated monies for this purpose may encourage engagement. National or regional conversations regarding institutional policies that can promote faculty engagement, or at least lower barriers to faculty engagement, may be useful.

8. Summing up the issues related to sustaining open educational resource projects

Sustaining work whose efforts are given away freely is difficult. There is no way around this conclusion. However, difficult and impossible are two very different things, and careful consideration of several factors should increase an open educational resource project's chances of surviving long-term in order to continue to meet its goals over many years.

First, open educational resource projects must be explicit in stating their goals and tenacious in focusing on them. If sustainability is a project's ongoing ability to meet its goals, then without a clear understanding of its goals no open educational resource project can be sustainable.

The next several decisions must be made conjointly.

In the context of project goals, an open educational resource project must make decisions about its organisation – whether it will be an MIT, a USU, a Rice, or assume some other combination of values for its size, structure, and degree of centralisation of the organisation. Smaller organisations or more decentralised organisations are less expensive to sustain, but may be less capable of creating large numbers of resources in a short period of time. They may be less capable of moving in a specific, predetermined direction.

In the context of project goals, an open educational resource project must make decisions about the types of resources it will offer and the media formats in which these resources will be shared. There are many instances in which the easiest format for the project to capture resources in will be the most difficult format for users to reuse.

In the context of project goals, an open educational resource project must make decisions about the types of end user reuse that are most likely to help the project meet its goals. Decisions must be made about how much explicit support will be provided to users in support of their reuse of the content. Will the website link to these tools offsite? Will they be integrated into the website itself? If it is centralised, explicit support is always available but becomes expensive. If it is decentralised across a network of volunteers, explicit support is inexpensive but somewhat unreliable.

In the context of project goals, an open educational resource project must make decisions about finding and utilising non-monetary incentives to engage as many participants as possible. Utilising student volunteers in production, decentralising support responsibilities across the group of users, and leveraging organisational rewards for participation are all ways of reducing costs, though they come with some tradeoffs.

In the context of project goals, an open educational resource project must make decisions about ways it can reduce costs while still meeting project goals. Smaller teams, establishing a policy of replacing or rejecting all third-party licensed content instead of attempting to license it, and integrating open publishing directly into existing online course development processes are all ways to reduce costs, although they come with some tradeoffs.

Finally, in the context of project goals, an open educational resource project must make decisions about which of the many available funding models is most likely to result in levels of funding sufficient to allow the project to continue meeting its goals in an ongoing manner.

9. Conclusion

In the end, it may be that neither funding models nor national policy are unnecessary to promote higher education's engagement in open educational resource projects. After all, there are no national policies encouraging or requiring higher education institutions to maintain publicly accessible websites with information about their admissions policies, available programmes, courses, and faculty, and yet almost 100% of higher education institutions spend a significant amount of human and capital resource providing these web-based services. After a few early adopters showed the benefits of providing this kind of information via the Internet, other universities had to follow suit in order to stay competitive.

Ideally, open educational resource projects will become another service that the public simply expects of every institution of higher education, and each institution will find the will and the resource within itself to engage in these projects. In the intervening years until that time comes, pilot open educational resource projects must navigate the highly contextual waters of sustainability.

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