

Open Educational Resources (OER) and Connexions

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For those of us who are interested in education and also in the opportunities for technology to improve education, we are seeing indications that something remarkable is happening just now. There are non-trivial experiments being conducted and changes being tried in a wide variety of aspects of education. These range from advances in brain science to copyright systems to semantic mark-up languages to new business models with combinations of open and closed content. The high cost of books together with the difficulty in keeping the content fresh and up to date is part of what is driving these new experiments but the ever more obvious need for dynamic, interactive on-line learning environments is an even more compelling driver for innovations in the use of technology in education. This paper tries to find the common threads in all of these experiments and new systems and build models that we can use to pull all of it together.

Part of the results of this investigation is the creation of the Connexions project which is our response to a very wide variety of changes across all disciplines, all levels, and all learning styles. Indeed much of the vision comes from the experiences of those in the open source software movement.

Models for the Impact of New Technology

The impact of a truly new and disruptive technology can be **modeled** as occurring in two phases. In the *first phase*, the new technology does what the old technology did only better. In the *second phase*, this new technology redefines the problem and the questions that first phase dealt with and comes up with truly new results. Indeed, it is in the second phase that the visionaries see and try to realize. And by its very nature, it is the second phase where real innovation occurs.

The project by Google to scan books and make them available on the web is a phase one effort. It is doing what traditional books do, only better. It is making content written for traditional media available to a wider audience and essentially free. Making videos of course lectures and putting them on the web is likewise phase one. E-books like the Amazon Kindle and the Sony Reader are currently phase one but may become phase two.

Most of our visionary images of the future are phase two where the very nature of the activity is changed. In phase one, the impact of the new technology is fairly predictable because it is solving the same problem. However, it is in phase two that “unintended consequences” can occur because the situation is different than it ever has been before. Hopefully, most of the surprises are positive but some can be negative.

A **second model** of change is made by grouping those who adopt the new technology. This comes from Everett Rogers, Geoffrey Moore, and others. The groups who adopt it first are called the “early adopters” and they will tolerate difficulties in order to benefit from the advantage. If the early adopters demonstrate the potential of the new technology, a second group can be defined who will put up with minor inconveniences but wants demonstrated significant improvement. The third group will go along with the new “standard” but want guaranteed results and easy use. Finally, the laggards will not change even for reliable demonstrated advantage. The earliest of the early adopters are the innovators who literally invent or create the new technology. Imagine the early days of the automobile where punctured tires, engine failures, and no mechanics scared off all but the truly adventurous “early adopters”.

A **third model** looks at technology as a sequence of “problem solving” phases where you first solve the immediate presenting problem, then you go on to solve the next phase of the problem, given the solution of the first phase. Unless some idea of the second (and perhaps third and fourth) phase is taken into account in solving the first phase, decisions will be made that make the solution of later phases inefficient or impossible. Choosing the wrong format for your educational content can make later re-use and/or maintenance difficult or impossible (a bit mapped scan, for example). The same is true in choosing a copyright license. Choosing a non-commercial license could make sustainability very difficult.

A **fourth model** looks specifically at the development of information technology that has produced the printed book. An important transition occurred around 2000 BCE when writing was invented. This was the transition from an oral process where knowledge was passed from generation to generation and from group to group orally to a written process with hand written manuscripts read by the literate few. The second transition occurred around 500 years ago when the movable type printing press was invented and we moved from a written tradition to a print tradition. This transition is an excellent place to use the “two phase” model to see the early printed books as simply being a better version of the hand written ones. But the literate world was revolutionized by the large number of cheap, accurate books. The third transition is the one we are in now going from the print world to the electronic or digital world. The first two transitions had fundamental effects on education. The impact of the third transition is what this paper is about.

Open Educational Resources (OER)

A large number of educators, writers, and scholars feel that educational content and resources should be freely available to all teachers, learners and potential learners, regardless of circumstances. This comes partially from philosophical positions and partially from the success of three open access systems: MIT’s OpenCourseWare (OCW), Rice’s Connexions (Cnx), and Wikipedia.

Another source of inspiration for the OER activities is the remarkable success of the open source software movement. The original idea of open source simply said

the source code for computer software should be made available to the users of the code so they could better understand and apply it. It rather quickly evolved a philosophy, Free Software (free as freedom not no cost), that said the code should not only be visible, it should be free, modifiable, and community supported and maintained. This movement has produced Linux, Firefox, Apache, Open Office, and many other successful products and companies. However, it should be noted that computer code and educational resources are not the same so a direct translation is not appropriate but an inspiration is.

Connexions

Connexions (Cnx) is an Internet repository of XML encoded educational content, organized in modules (<http://cnx.org/>). It has tools for writing, maintaining, organizing, and using the content. It has tools for assembling collections of modules such as essays, books, courses, even entire curricula. And it is a community of authors, teachers, and learners that create and use the repository and tools. The Cnx content can be used on-line or to produce a printed book or to produce an eBook. It can be used to support a traditional course, distance education, or self education in synchronous or asynchronous applications. It can be use for pre-K through graduate education in all disciplines. All of the content in Cnx is copyrighted under the Creative Commons attribution license which allows completely open use and reuse provided the author is attributed. It has a facility for quality assurance through peer review or other endorsements.

Printed Books and eBooks from OER

The phase one of OER is the easy production, maintenance, and use of printed books. XML allows a flexibility of use and re-use that simply cannot be achieved with any non-semantic system. Even with all the advantages of OER books and eBooks, they are phase one. It is the dynamic, interactive on-line use where phase two becomes real.

Several courses at Rice and other universities use text books that are in Connexions. They are free for on line use and low-cost for a professionally printed version. A book that might cost \$130 from a traditional publisher costs \$30 through Connexions. A very exciting project in Connexions has just produced a text book for Statistics. This is being used in the California community college system and is spreading to other systems. Nationally, the cost of text books is a major limitation to education in community colleges.

A very exciting project has begun in South Africa where the Schuttleworth Foundation has funded the Siyavula Project to place the entire K-12 curriculum content into Connexions. This will make high quality educational content available free on the web and at a very low cost in print form to everyone. Although this is targeted for the South Africa school system, it will be available to everyone in the world.

On-Line Use of OER

XML allows the implementation of virtual laboratories, it allows the dynamic simulation of complex systems under the control of the learner, it allows the use of graphics, audio, video, etc that is semantically tagged in a way that has never existed before. Mathematics can be done not just described. Likewise with chemistry and other sciences. Music can be played, transposed, etc. Virtual laboratories can be “run”, not just statically illustrated on a page. Assessment can be made in real-time to give feedback to a student. This is truly phase two and we can only vaguely predict its future but it is extremely exciting.

Extendable Markup Language (XML)

While the formal definition of XML is “Extendable Markup Language”, after considering mathML, chemistryML, and musicML, another definition might define X as the unknown that you substitute your discipline into. It allows the encoding of the foundation of a discipline into the electronic document. In a book or in conventional HTML, you have a picture of the mathematical formula. In XML, you have the actual rules of the math coded into the formula, or the valences of the atoms encoded into the molecule, or the frequency of a note in a music score.

With the maturing of XML and as teachers and authors learn how to use XML in new forms of pedagogy and as better authoring tools are developed, a completely new learning environment can evolve and emerge.

Open Copyright Licenses

Even with the technical power of XML and the modular architecture of the Connexions organization, a new copyright license that is consistent with and supportive of the open philosophy must be used. The Creative Commons organization founded by Larry Lessig and others has created a set of licenses that do exactly that (<http://creativecommons.org/>). In order for the “viral” or exponential growth of educational content to happen, the copyright license must not only be “open”, but allow derivative works to be generated and allow commercialization to sustain the various projects using the OERs and to allow the partnering of OER with commercial companies. Connexions uses the Creative Commons attribution copyright (cc-by).

Quality Assurance and Post-Publication Peer-Review

In order to assure the quality of content of any Open Educational Resource, some assessment procedure must exist. In Connexions, a portal or filter that we call a “lens” can be created so that modules and collections that have been evaluated and endorsed can be tagged by the “owners” of the lens. Then, looking at the Connexions repository through the lens will present only the endorsed content.

For example, a society or agency or organization can create a lens and use a traditional peer-review system to decide which modules will be endorsed and, therefore, seen through the lens.

Connexions and the Signal Processing Society of the IEEE (Institute of Electrical and Electronic Engineers) have a pilot project where researchers and teachers will publish their manuscript in Connexions, then request that the SPS review it. If the review is favorable, the paper will be tagged so that the SPS lens will show it. This allows a much more flexible publication system and allows open access to the work while it is being review. The lenses are controlled by their creator, not by Connexions, and not editable by anyone other than the owner. This is a post-publication review rather than a pre-publication review system. It scales much better with the gate keeping review not being the bottle-neck that it has been traditionally.

Community Building

The organization of Connexions allows three locations for the OER modules to exist. First, there are work groups created by authors, potential authors, and maintainers of the content. The modules in a work group are visible and available only to the members of the work group. These people form a collaborative community developing high quality educational content as a team. The work group might consist of only one author. It might consist of a faculty member and a student. It might consist of several faculty members at one institution or many institutions. It might consist of a whole department, or laboratory, or school. While in the work group, the modules are visible to and modifiable by all members of the group but no one else. After the group agrees the module is ready for the public, it is “published” which places it in the open Connexions repository. This publishing is non-reversible. Once published, the module is public and in the second location for ever. It may be revised, modified, re-written, but all versions are public and accessible by anyone with Internet access and a browser.

It is when a module is published that the group decides who the authors are, who the maintainers are, and who holds the copyright. The module is then a full fledged member of the OER world and it can be used, reused, modified, or anything else, but the author(s) name cannot be removed according to the CC copyright rules. The authors of the modules or anyone else can author a “collection” or a book by stringing a set of modules together to form an essay, article, book, course, or curriculum. That collection can then be “published” just as the module was in the repository. The modules and collections in the repository are open and free in the same sense that software in the open source, free software movement are.

Placing modules in the Connexions repository is open to anyone who signs up for an account. However, the third location is controlled by a lens and that is not open to anyone other than the lens creator and owner. It is the lens that allows a strict quality assurance, just as journals control the quality of the content they publish. The lenses may be owned by an individual, or by a society, or by a

commercial enterprise, or by anybody. The owner controls what modules and/or collections are in a lens and they may remove content from the lens (but not from the repository) if the opinion of quality changes.

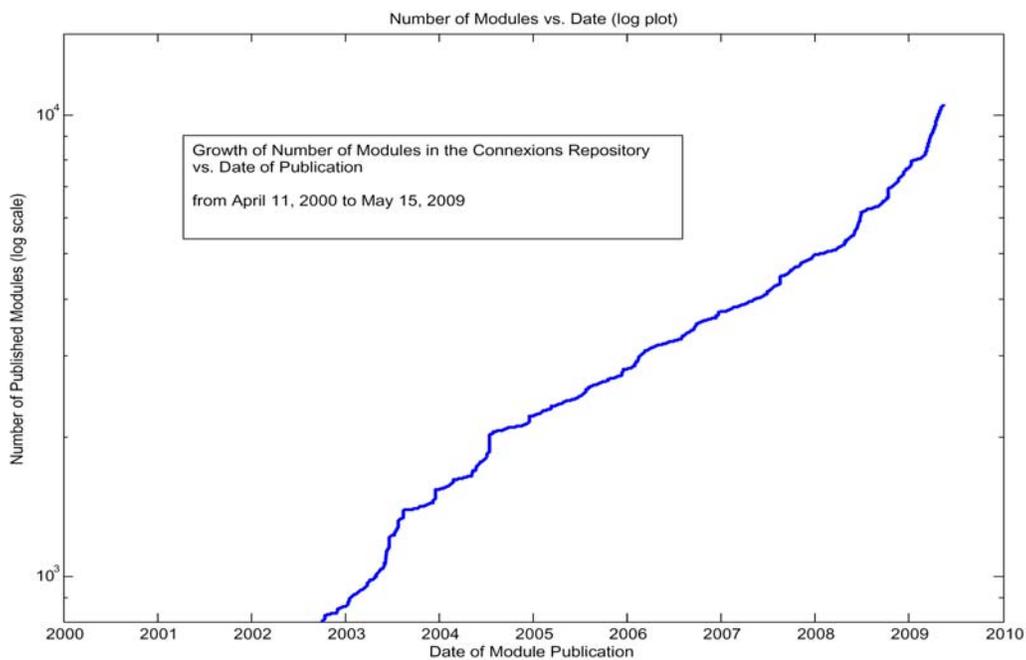
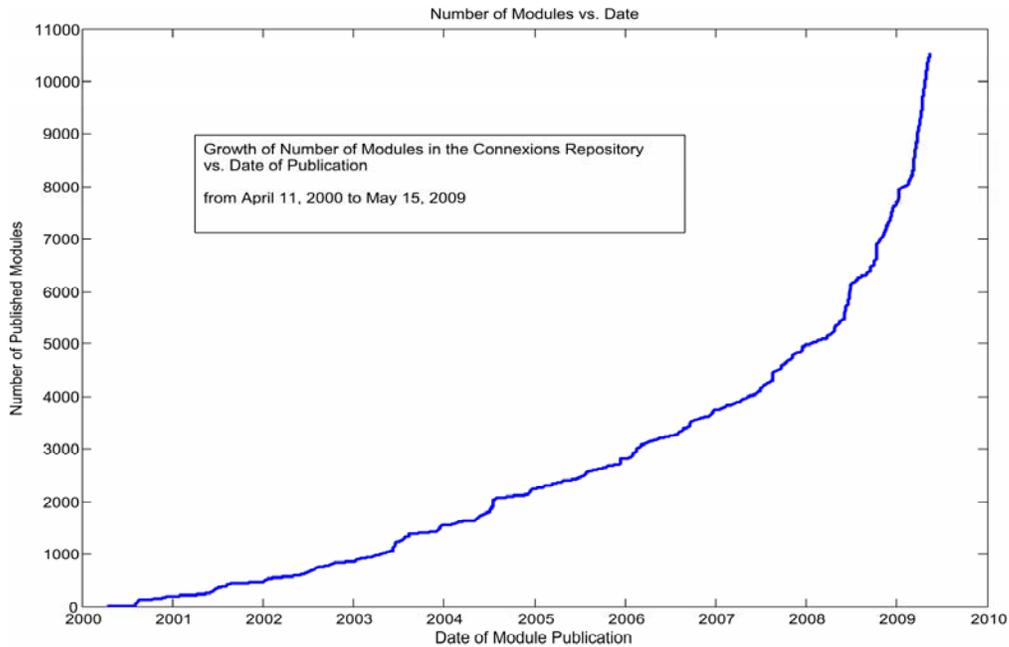
The existence of these three locations allows an extraordinary variety of OER usage. It allows completely individual authorship or completely communal writing or, more likely, some combination. It allows a completely open authoring, teaching, and learning environment. But, it also allows strict evaluation and quality control with the criteria determined by the lens creators.

Growth of Connexions

Connexions was founded by Prof. Richard Baraniuk in 1999 at Rice University. On December 11, 2009 the repository had around 15,500 modules and 940 collections or books. The level of the content ranges from K-12 through graduate research and continuing education. The variety of content ranges from art to anthropology, from music to mathematics, and from engineering to history. University Presses are using Connexions (with lenses) as the production and distribution “engine”.

If the number of modules and collections in Connexions only came from the efforts of the staff, board, and a fixed size group of followers, the growth would be linear. If people involved with Connections in some way cause other people to become involved and they, in turn, cause still other people to become involved, the growth is exponential and the spread is called "viral".

A graph of the logarithm of the number of modules would be linear if the growth itself is exponential. Super exponential (faster than exponential) growth can come from the system itself becoming better (either linearly or exponentially or ??) while the spread itself is viral. This kind of growth sets Connexions apart from others in the open educational repository world. This is analyzed and discussed in the 2007 article by Ochoa <http://ariadne.cti.espol.edu.ec/xavier/papers/Ochoa-TLT2009b.pdf>



Note, the number of modules has been growing exponentially since mid-2004 and since mid-2007 is growing super-exponentially. During that recent period, the Cnx staff has been working particularly on improving the environment for authors. It is also the same period that the efforts of the NSF grant 0538934 have had an effect. We are also beginning to see the effects of the Shuttleworth Siyavula project in South Africa.

The usage is in over 150 countries and, although most of the content is in English, there is a wide variety of other languages, even using non-Latin alphabets.

Although the Connexions content is not universally available, it will be in the near future as the Internet invades all the nooks and crannies of our globe. It indeed looks like OER in general and perhaps Connexions in particular will be the next phase in the evolution of the textbook. Our challenge is how to use its power to significantly improve education.

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