What Makes an Open Education Program Sustainable? The Case of *Connexions*

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Introduction

The past five years have witnessed the emergence of a growing movement of concerned educators and scientists who aim to open up access to the world's knowledge resources. Inspired by parallel developments in the open source software world such as the Linux operating system and the Apache web server (e.g., Hamm 2005; Lakhani and von Hippel 2003; Raymond, 2001), this Open Education movement seeks to provide free access to quality teaching materials that can be customized and personalized to match local contexts (language, level, users' educational goals, etc.). Furthermore, the Open Education movement seeks to empower and link local educators within a global knowledge community that can benefit and efficiently propagate educational content.

As this movement has spread, over the last three years or so especially, Open Education Programs (OEPs) sponsored and supported by individual institutions have exploded in popularity (e.g., Wiley 2006). Such programs can take many different forms. Some universities are implementing OEPs that provide open access to educational content such as courses developed *solely* by their faculty, scholars, and instructors. *MIT's OpenCourseWare* is perhaps the prototypical example of this type of OEP. Others like the *Sakai Project* are concerned with providing an open software platform to facilitate collaborative and learning environments for higher education. Still others such as the *SEP* (*Stanford Encyclopedia of Philosophy*) provide open access to content that is contributed by faculty from many universities but within a single discipline. Some programs like the *Open Learning Initiative* at Carnegie Mellon University emphasize innovative online instructional tools such as cognitive tutors, virtual laboratories, group experiments, and simulations. Finally OEPs such as *Connexions* (*cnx.org*), which we focus on in this paper, provide broad-based content commons of free, interconnected educational materials in a modular format along

with an open software platform so that the materials can be used, reused, and re-contextualized by anyone globally.

Despite the diversity of orientations and affordances across the programs, one common and critical issue that all OEPs face at the present time is the challenge of planning for and ensuring their respective ***sustainability***, which is defined here as the long-term viability and stability of the open education program (see also Downes 2006, for a detailed discussion of sustainability issues). The sustainability challenge arises for at least two reasons. First, traditional revenue models that are employed as a matter of course in other educational settings, to earn revenue from knowledge creation and dissemination such as enrolment fees, tuition, book sales, subscriptions, etc. do not directly apply to OEPs. In most cases, the OEP's intellectual properties such as the content and/or the software platform are "open" in the sense that they are available to users without a charge. Users can download, consume (and in some cases, with appropriate attributions, use and re-use) the content freely.

Second and perhaps less explicitly acknowledged is the fact that in this early "explosive growth" phase of the OEP life cycle, there are simply too many OEPs being seeded that will compete for the scarce financial resources available from philanthropic institutions, universities, governmental and non-governmental agencies in the long run. Consequently, the founders and managers of every OEP *must* consider how their project will become sustainable once it is, voluntarily or involuntarily, freed from the apron-strings of the start-up funding institution. It is noteworthy that despite this challenge, a majority of OEPs tend to emphasize their technical and educational content prowess, goals and accomplishments, without paying adequate attention to the question of their future sustainability.

Our objective in this paper is to focus on this overlooked yet crucial question in the OEP arena and explore issues of OEP sustainability in depth. In particular, we have two goals. First, in a broad sense, we propose a process by which OEPs can think about sustainability. We call this the "sustainability model" for OEPs. Second, in more specific terms and in the spirit of the openness that is the core of all OEPs, we

share our experiences and approaches to working toward sustainability using this model for our particular OEP, Connexions.

The rest of the paper is organized as follows. First, we provide an overview of Connexions to readers. We do this because we employ Connexions as a case study to frame the issues of OEP sustainability throughout the paper, as well as to provide specific examples of how particular revenue models may be employed by OEPs. Next, through principles derived from marketing theory, social psychology and sociology, relying upon accumulating evidence, and using the case of Connexions as well as other successful business case studies, we present a framework for thinking about OEP sustainability, that we term the "sustainability model". This model seeks to address the two challenges described above. We then provide more specific discussion of revenue models available to OEPs stemming from the sustainability model and conclude the paper.

Connexions

Connexions (cnx.org) is an open-access repository of scholarly materials *and* an open-source software toolkit to help authors publish and collaborate, instructors rapidly build and share customer courses, and learners explore the links among concepts, courses, and disciplines (Baraniuk et al., 2002; 2004; Henry, Baraniuk, and Kelty, 2003). The design of Connexions is based on a set of intuitions that are shared by a remarkably wide range of academics, which are as follows:

(1) knowledge should be free and open for use and re-use;
(2) collaboration should be easier, not harder;
(3) people should get credit and kudos for contributing to research and education;
(4) concepts and ideas are linked in unusual and surprising ways and not the simple linear forms that textbooks present.

In one sense, Connexions is an on-going, large-scale experiment into what might be necessary to effectively create the conditions for the widespread *re-use* of educational or scholarly materials by communities of educators and learners. Within

Connexions, authors can create "modules" of information – smallish documents intended to communicate one particular concept, one procedure, one set of questions about something. A bunch of modules can be strung together by an author or an instructor to create a course or weave a curriculum entirely of his or her choosing. Students can freely access the high-quality modular, interactive content, and are then able to interactively explore the links among concepts, courses, and disciplines, learning in an effective manner.

Connexions directly challenges the current notion of a "textbook" by exploding it and asking different people to create its parts in a semi-structured but re-configurable manner, rather than having a single Maestro do it all and take the credit (see Figure 1). Connexions is currently being used in traditional college and K-12 settings, in distance learning, and by lifelong learners around the world.

In colloquial terms, borrowing from an Apple slogan and a book by Lawrence Lessig, Connexions can be described as allowing users to "Create, Rip, Mix, and Burn". In particular, in Connexions, users are free to:

- **Create:** to create educational materials and contribute them to the repository;
- **Rip:** to copy the materials and customize them;
- **Mix:** to mix the materials together into new books and courses;
- **Burn:** to create finished products like e-learning web courses, CDroms, and even printed books.

As discussed later in this paper, such a combination of affordances opens up many opportunities to earn revenues while staying true to our core principles, in order to make the Connexions project sustainable.

Connexions is also an open-source software toolset that currently includes:

- *Collaborative workspaces* that support collaboration and community building throughout the authoring, course-building, and learning processes;
- *Semantic content markup* in XML that provides a common framework for sharing and re-using materials;

- *Creative Commons licenses* that provide a common legal framework for using, modifying, and disseminating the content.

Connexions' open-source software system is called *Rhaptos* (rhaptos.org), a Plone-based educational content management system, developed in-house. Connexions' content architecture is embodied in CNXML, a variant of XML. The architectural philosophy maximizes the use of meta-data and semantic content, facilitating the search and construction of semantic webs. Furthermore, Connexions encourages the use of domain specific markup languages, such as MathML, which embed semantic content.

By design and as a point of differentiation when compared to many other OEPs, Connexions is an inter-institutional endeavour. Rather than the traditional content development model of one author to one textbook, Connexions invites and links worldwide communities of authors to collaboratively create, expand, revise, and maintain the Content Commons. The result is a dynamic, up-to-date content base that makes the latest knowledge globally available.

In Connexions, authors retain the copyright on their materials but make them freely available under a Creative Commons open-content license (Kelty, 2001; Lessig, 2001, 2005). This license shares the spirit of open-source software licenses like the General Public License (GPL) and the Berkeley Software Distribution (BSD) license but is expressly designed for content. The license allows anyone to copy, modify, and redistribute Connexions modules and courses as long as they attribute the original author(s). To take the guesswork out of what users can and cannot do with the content, the license information is embedded directly into the XML source of each and every module and course.

Modularity and open-content development substantially lowers the barrier to entry into the author community. Consider this quote from an electrical engineering faculty member at the University of Illinois: "For years I have wanted to write a textbook, because I love to write about FFTs. However, any complete text in my field also has to cover z-transforms, on which I have no interest in writing." Connexions

allows this faculty member to contribute his excellent FFT material and then weave a custom text for this course using contributions from other authors passionate about z-transforms. Since authors can contribute a high-quality, high-impact module in a number of hours or days in Connexions instead of the years it usually takes to write a traditional text-book, many more college faculty, industry professionals, K-12 teachers, and even talented students can write about what excites them and contribute modules to the commons.

Connexions is being used in traditional college and K-12 settings, in distance learning, and by lifelong learners around the globe. Demand is surging; in January 2006 alone, the Connexions servers handled over 16 million hits and 1.1 million page views representing over 500,000 unique visitors from 157 countries. It is growing at the rate of approximately 12% per month. As of January 2006, there were over 3,200 modules and over 150 courses in Connexions. Volunteers are translating modules and courses into a wide variety of different languages, including Spanish, Japanese, Italian, Chinese, Portuguese, and Thai. To summarize, Connexions is an internationally focused, interdisciplinary, and grassroots organized OEP.

The Sustainability Model for Open Education Programs and its Application to Connexions

When the question of long-term stability and viability of OEPs is considered, at the first blush, the crucial question appears to be: "How do we acquire an ongoing adequate stream of financial resources in the future to keep our project running?" This leads to a consideration of the various tactical programs that can be implemented to generate revenue. Indeed, most discussions of OEP sustainability frame the discussion in this manner. From a business-model perspective too, the revenue model (i.e., how the project will earn revenue to maintain its ongoing activities) is viewed as central to the business planning process (Magretta, 2002). Unfortunately, oftentimes programs implemented in this fashion fail to yield the desired outcomes.

However, our thesis in this paper is that such an approach may be myopic, because it focuses too much attention on the "product" – the features of the OEP and the technology underlying it, and not enough attention on understanding what its users want, and working deliberately to grow the OEP's value for various user groups. Our proposal is that prior to considering different revenue models for a particular OEP and choosing one or a combination of them, ***it behooves the OEP's organizers to consider and focus on the issue of increasing the aggregate value of the site to its constituents to the greatest extent possible***. In other words, unless the OEP site is able to *first* gain and maintain a critical mass of active, engaged users, and provide substantial and differentiated value to them in its start-up and growth phases, then none of the available and/or chosen revenue models will be likely to work for the OEP in the long run. The important first step for an OEP is to gain a deep understanding of who its site's users are (and should be), and what constitutes value for them. We suggest that answering these questions in-depth naturally leads to opportunities to generate revenue for the OEP. We use the example of the Connexions to discuss the application of our sustainability model to an OEP.

Understanding Connexions' users

As noted earlier, Connexions has *three* distinct user groups: (1) ***authors***, who create original educational content and make it available in the Content Commons, (2) ***instructors***, who can select the available content and compile or otherwise manipulate it, to create customized instructional materials such as a course or a curriculum for use in their classes and teaching activities, and (3) ***students***, who consume the educational materials, and **learn**. The starting point for making Connexions sustainable was to better understand these three user groups and grow Connexions' value to them. We explicitly recognized that Connexions can only be sustainable in the long run if enough authors, instructors, and students find it useful enough and employ it on a regular basis to achieve their educational goals.

Over the last three or so years, we have learnt a great deal about these three user groups through formal marketing research (e.g., Dholakia, Roll and McKeever 2005), by attending to feedback received from our users, as well as through informal observation and interactions with them. For example, we know that the primary motive for a majority of academic text-book authors that contribute their original content to Connexions is *not* to earn royalties; rather, it is to have the greatest possible impact on scholars, practitioners, and students within their disciplines through the widespread dissemination and use of their educational and scholarly materials. It is noteworthy that a typical traditional engineering text-book that costs $120 at retail earns a royalty of less than $5 for the author. Furthermore, a vast majority of the traditional text-books are "small-run", selling from a few dozen to a few thousand copies. As a result, while authors may agree to not receive revenues from putting their authored contributions within Connexions, it is important that they receive full credit for their contributions; not surprisingly, this is often a prerequisite for them to participate.

Furthermore, we also know that our authors are a diverse group. While many are professors at major universities, others are "shut outs" like Kitty Jones, a private music teacher from Champaign, IL, who is writing on music theory. Interestingly, Kitty's materials are among the most popular in Connexions at present. She had over 600,000 page views of her materials in January 2006 alone.

We also know that many of the instructors that use Connexions teach in community colleges in the United States and have intensive teaching schedules during the work week. So they appreciate being able to have a repository of educational materials organized in a modular format to make their course preparation more efficient. Other instructors are corporate trainers in companies like National Instruments and Texas Instruments.

Many of our students first visit the Connexions site through a search engine like Google when they type in a search term such as "Fourier transforms." Or they first visit because their instructor requires them to use the content available in

Connexions (Dholakia et al. 2005). The Connexions student user group is just as diverse as the author group. Students using Connexions range from those in elementary school through advanced graduate school students, as well corporate trainees, and lifelong learners.

Growing the value of Connexions for these three user groups

How can we grow the value of Connexions for these three user groups? We have identified four key components that provide significant value to our users. Considering each of these components, in turn, leads to specific revenue generating opportunities to make Connexions sustainable.

Value Component 1: Increase the Equity of the Connexions brand (by staying true to our values).

While conventionally a brand refers to "a name, term, sign, or symbol, intended to identify a seller," brand equity is the added (usually intangible) value endowed to products or services by the brand which results in tangible positive outcomes. As an example, because of its brand equity, Coca Cola has a world-wide base of loyal drinkers, is able to charge higher prices for its products than an unbranded or 'private label' manufacturer, is able to launch new product – called brand extensions – effectively, and is buffered during economic environments by steady demand. A study conducted last year estimated the value of the Coca Cola brand to be approximately $67.5 billion (BusinessWeek 2005). OEPs can benefit in comparable ways from creating a strong brand.

In the current crowded (and ever-expanding) domain of OEPs, creating and increasing the OEP's brand equity gains added importance because it will determine whether a particular OEP will be recognized by users, stand out, and be viewed as unique and worth using by its current and potential users. Perhaps even more importantly, as in the Coca Cola example, brand equity impacts key measures by

which OEPs' performance is measured such as number of loyal users, growth rate, and activity of users.

To increase the OEP brand's equity, there are two key challenges: (1) *to increase awareness* among the OEP's potential user base, and (2) to create a differentiated, consistent, and meaningful brand image, where users associate the site with key elements or attributes that are important to them (e.g., Keller, 1993). At the same time, it is crucial that this brand image be aligned with the core values, principles, and purposes underlying the OEP. Awareness regarding the OEP among potential users is a pre-requisite for the brand to have any meaning for these individuals, whether they are authors, instructors, or students.

From a marketing perspective, brand elements are psychological associations that users think of when they see the brand, and which contribute positively (or negatively) to its value in the user's mind. Brand elements include everything from a memorable and meaningful brand name and logo, to the specific attributes in the product or service – functional and/or symbolic – that create value for users (see Kotler and Keller 2006, for a detailed discussion of these issues). The Connexions brand name and logo have undergone several changes over the course of the years, and its current version is designed so as to be memorable, meaningful, transferable, and protectible.

Creating a differentiated, consistent, and meaningful brand image in the case of Connexions means that the Connexions brand should stand for the values that its founder, managers, project members, and users believe in, and all the actions and projects undertaken by Connexions communicate these values clearly. The following examples are illustrative.

An important component of Connexions' mission is to make knowledge free and open; therefore, education in the developing world is a matter of great interest to Connexions and its supporters. In pursuit of this goal, Connexions is working with *Teachers without Borders* (TWB) on a number of projects in the developing world. TWB, which is involved in teacher training and teacher certification, has community

teaching and learning centers in 12 countries and their teacher training materials are in use in 84 countries. TWB has committed to making their entire repository of teacher certification materials available in Connexions and using the system as a common platform. These materials will then be "localized" and translated to make them suitable for use in each of the countries that TWB functions in, and distributed through Connexions.

One of the most significant challenges in delivering content to the developing world is the availability of computer and network resources. Connexions is developing a relationship with the AMD *50x15* Consortium to address these limitations. The goal of the 50x15 Consortium is to provide 50% of the world's population with access to computers and the internet by 2015. To this end, AMD is developing an array of very low cost devices that will be deployed in developing countries. It is our intention to make Connexions the common educational platform on these devices. Projects like these provide an opportunity to create substantial value to large groups of new users in developing country, and in the process, contribute positively to the Connexions brand by reinforcing the values and benefits that the project stands for.

The *University of California at Merced* in the United States is developing their Introduction to Biology and College Algebra courses in Connexions. UC Merced is committed to utilizing the Connexions platform across its curriculum; recently it hired a full-time Connexions facilitator to aid the faculty in creating and importing content. Their mission is clear and harmonizes with ours: "UC Merced will increase educational access and opportunities for Valley students." Connexions provides an open access platform to support their close collaboration with community colleges and secondary schools. Indeed, local schools and colleges can use UC Merced-generated content in their classrooms. This ability to "re-contextualize" content is one of Connexions' greatest strengths, and our partnership with progressive institutions like UC-Merced enables us to portray our brand consistently.

Another value that Connexions stands for is dynamism; in the sense of constant innovation and improvement in the way educational content is created, stored, displayed, manipulated, and contextualized. Consistent with this value, Connexions is exploring new authoring methods with the College of Oceanographic and Atmospheric Sciences (COAS) at Oregon State University. COAS is internationally recognized for its faculty, research and facilities, including state-of-the-art computing infrastructure to support real-time ocean/atmosphere observation and prediction. COAS processes over 17 terabytes of data per day; its models of the Earth change daily. This dynamic science requires a dynamic medium. We are developing ways to automate the Connexions authoring process so that modules and courses can always have the most current data, analyses, graphics, and imagery.

Furthermore, we have identified three things that are that are extremely important to our users, and which have the potential to serve as strong drivers of the Connexions brand equity: the quality and quantity of the content in the Connexions Content Commons, an active and engaged user community, and the site's user-friendliness. Each of these value components also offer opportunities to develop and pursue various revenue models. Each of them is discussed in greater detail next.

Value Component 2. High Quality, Ample, Modular, Continually Updated, Personalized on Assembly, Published on Demand Content.

As mentioned earlier, most users, in particular students, first find Connexions through a search engine like Google. They are looking for specific information regarding a particular topic. Research on virtual communities suggests that the initial motivations of most participants for joining a community are specific and purposive, i.e., they join to solve a particular problem or to obtain a particular missing piece of information (Dholakia, Bagozzi, and Klein Pearo 2004). It is therefore important for the OEP to be able to provide high-quality content across a wide spectrum of disciplines (or if the OEP is focused, to provide exhaustive content within the OEP's discipline of interest) to attract new users. Once a student has discovered the site, it is

still important to be able to provide all the high-quality content that s/he is looking for on an ongoing basis. This is the route to getting repeated use and loyalty to the site from users.

At Connexions, the most active content development areas at present include music, engineering, physics, chemistry, bioinformatics, nanotechnology, and history. For example, a group of electrical engineering faculty from Stanford, UC Berkeley, University of Illinois, Michigan, Wisconsin, Ohio State, Georgia Tech, Rice, Cambridge, and TU Norway is developing a customizable digital signal processing (DSP) curriculum in Connexions. This content will take the form of a "super text-book" which can then be customized by a particular faculty member or a particular university to suit their respective curricula.

When compared to traditional text-books, the content available within Connexions is characterized by modularity, so that students can interact with the knowledge and draw connections across different concepts, courses, and disciplines, thereby learning in an effective manner. Unlike books, the content can be updated frequently, even on a real-time basis (as evident in the COAS example above), and customized to the needs of the instructor or student. Perhaps even more importantly, the content within Connexions can be "published on demand". On-demand books printed with Connexions content can be modularly organized, authored by a community, personalized for a particular class, and completely up-to-date, since printing and shipping them takes no more than a day or two.

Content can also be generated through partnerships with other for-profit and not-for-profit institutions. An example is the collaboration between the Customer Education Group of National Instruments (NI), a leading software firm based in Austin Texas and Connexions. NI has placed the entire contents of its LabVIEW[1]

[1] LabVIEW is National Instruments' flagship and industry-standard software development environment. Since its introduction in 1986, LabVIEW has become the leading graphical development tool for science and engineering with built-in functionality for simulation, data acquisition, analysis, presentation, Digital Signal Processing, image processing, communications, and control. LabVIEW provides the flexibility of a powerful programming language without the complexity of traditional text-based development environments.

Basics I course manuals into the Connexions Commons. NI customers pay almost $1,495 to spend three days taking an instructor-led version of this course or can purchase the exact same manual by itself for $495. Now, this material is available completely free for anyone wishing to learn LabVIEW and educators looking to incorporate LabVIEW into their curriculum. This course has become one of the most popular courses in Connexions.

With NI, Connexions is also collaborating to build a new LabVIEW player, specifically for use in Connexions. The goal is to enrich engineering content, promote active learning, exploration, and experimentation by our users, significantly enhancing value for them. The new LabVIEW player will have the ability toe embed a live LabVIEW VI directly into a web browser. This will allow an educator to provide a visual simulation of a theoretical topic, which can include everything from interactive graphs to 3D animations, allowing a student to run and interact with the simulation virtually anytime and anywhere. In keeping with the Connexions spirit of open-access content and open-source software, NI will adopt a model similar to that used by Adobe with its Acrobat pdf viewer, where any end user (a student or instructor, for example) will be able to make free use of the technology without purchasing the software necessary to run the simulations. The only requirement will be to download and install a simple plug-in to activate the technology on their computers. It is worth noting that this project, funded partly by NI and supported by a grant from the National Science Foundation, not only enhances the quality of content available in Connexions, but contributes to its brand equity.

Value Component 3. An Engaged and Involved User Community

One of the main objectives of the Connexions project is to *foster collaboration* between users. This follows from a vast literature in education research showing that collaboration and social interaction enhance students' learning experience, as well as the quality and the degree of learning (e.g., Bowen, 1996; Tinto, 1998). OEP organizers also recognize the importance of communities (e.g.,

Hanley, 2005; Stephenson, 2005). Research on virtual communities shows that with repeated participation, users form relationships with others and this increases their engagement with the site (Dholakia et al., 2004). So it is important to have a vibrant and active OEP user community.

Our initial market research with Connexions users (Dholakia et al. 2005) has revealed that communities form and grow through a three-stage process:

Stage 1: The OEP community as a resource. This is the early stage of a community, where it consists mostly of self-interested individuals, who really do not think of themselves as a group or community, but rather seek to achieve their individual aspirations. Taking the example of Connexions, at this stage of the community's evolution, authors might participate to put their content online and to gain exposure to the marketplace; instructors might participate to gain access to free and high-quality content; and students because they have to, or because they find the materials useful.

Stage 2: The OEP community as a user network. In this intermediate stage of the community's evolution, participants feel some affinity to the community and are willing to help other members, but only if it is not too inconvenient or effortful. For example, in Connexions, instructors may answer some questions of students, authors may be willing to get feedback from instructors or students, but none of the participants will be willing to spend too much time and effort interacting with other community members.

Stage 3: The OEP community as an engaged, vibrant community. In this ultimate stage of the community's development, participants have a genuine interest in the well-being of other members, and are willing to invest significant amounts of time and effort to help others. Participants have shared goals and values and a sense of belonging to the community (see Bagozzi and Dholakia 2006 for an example of such communities in the case of Open Source Software user groups).

From a technological standpoint, features of the Open Education site can be engineered to help the evolution of communities. In Connexions, each module has a

Discussion Forum (provided by Utah State University's Open Learning Support (OLS)) in which users can post messages, view messages posted by other readers, and reply to previously posted messages. All of these messages are visible to any person who views the module. The goal is to provide an online forum where individuals can connect to discuss topics, share information, debate, and learn. To break the ice, authors can create "Member Profile" web pages to tell Connexions visitors about themselves.

As part of the collaboration with National Instruments discussed earlier, we are working systematically and deliberately to build a community of authors, instructors, students, and practicing engineers to develop a critical mass of inter-connected Digital Signal Processing (DSP) materials. The DSP community will be supported by a "DSP community page" that will be built on the Connexions web site, which will contain information about the community, a discussion forum, a "to do" list of modules and courses that are needed, and a statistics section detailing how much traffic the community is generating. The goal is to think beyond open-access publishing toward truly "collaborative publishing", where not only is the access free but also collaboration and innovation of the materials is encouraged.

Value Component 4. Site usability.

A key determinant of site adoption by authors and instructors is how easy it is to use the site (e.g., Spool, et al., 1998; Wei et al., 2005). Authors and instructors will only be interested in using the OEP site if they can upload their content and modify it effortlessly, in the format and layout of their choice. Consequently, user-friendliness is a critical driver of value for OEP users.

A particular aspect of ease of use for the user is being able to find the "right" material that suits one's needs. This is especially important as a large number of modules and courses develop around any given topic. How will Connexions evaluate and direct users to modules deemed of high quality? Unfortunately, standard pre-

publication peer review is too unwieldy to keep up with the fast pace of Connexions module and course development, where materials may change daily or even hourly.

We are currently working to design and build a system for search and discovery and *distributed, post-publication peer review* in Connexions. This will enable users to preferentially locate and view modules and courses rated high quality by choosing from a range of different lenses, each with a different focus. Lenses will be controlled by third parties, who will establish their own review process. For example, the National Council of Professors of Educational Administration (NCPEA, ncpea.net) is setting up an editorial board to evaluate and credential DSP content. Lenses based on measures of use (e.g., most-linked-to, most-read, collaborative filtering – such as google.com or amazon.com) will also be designed.

Revenue models for OEP sustainability

As the organizers and managers of the OEP discover the drivers of value for the OEP site's users, the process leads to the uncovering of many revenue-generating opportunities. In fact, it can be argued that there are more revenue-generating opportunities available than can reasonably be pursued, and a significant challenge is to choose the ones to pursue. To formalize and build on our earlier discussion, we discuss three of the revenue-generating opportunities that we have pursued for the Connexions project based on our analysis of users' value. Downes (2006) provides a more extensive list of funding models for Open Education Programs.

Substitution model

The educational content stored, disseminated, and re-used through the OEP 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, & Gavilan, 2005), and even text-books. Since educational institutions and/or students spend significant

amounts for these replaced knowledge management systems, the cost savings resulting from their discontinued use can be employed to fund the OEP.

Take the example of the National Council of Professors of Educational Administration (NCPEA), which is developing a Connexions knowledge base in school leadership and administration. This knowledge base will supersede the print materials that they currently produce. NCPEA is also developing a community-based peer review process to identify and direct readers to high-quality materials they endorse as an organization. Such an initiative can easily be funded through the savings generated from the dissemination of content online instead of through print. The project with the University of California at Merced described earlier is another example of the substitution funding model.

Partnership model

As 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., and forms partnerships with various organizations and institutions, 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 partnership model is to identify an underserved user segment and/or a suitable institution that would directly benefit from a partnership with the OEP, and then focus the program's efforts and initiatives in on serving this segment and/or institution, thereby creating a differentiated brand image. A variation of the partnership model is a consortium model, where the OEP charges a fee from affiliated universities and institutions for joint development and ownership of the project.

As an example of an application of this model with respect to Connexions, the Government of Vietnam is deploying Connexions throughout the country to support science and engineering education across the country. They will use the material in English, at the same time, creating and linking to abridged versions of key modules

translated into Vietnamese. Students can learn in English yet have access to key materials in their native language to facilitate the learning process.

The examples of the Connexions project's collaborations with Teachers Without Borders, National Instruments, and AMD 50x15 are other examples of the partnership funding model where the partnering institution, through its use of the OEP platform and/or resources, funds the additional content and/or technological innovations created through the collaboration.

Another type of partnership that an OEP might form might be with an industry as a whole. For example, a new publishing initiative that Connexions is pursuing is with Tom Robbins, previously DSP editor for Prentice-Hall, plans to utilize Connexions as a content repository for upcoming works. The vision is to begin publishing works in Connexions as soon they reach draft phase, allowing the community to review and improve upon the work. Final products would have all multimedia and supplementary content on Connexions and would provide educators around the world with a low-cost alternative to textbooks without the need to introduce separate international editions. Such a model also provides a quicker time to market for translations and derivative works.

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. In marketing terms, this is called as "versioning" (Shapiro and Varian 1998), where a basic version of a product is offered for free, and value-added versions targeted at specific consumer groups are offered at higher price. Examples of such specific services that could be offered are: sales of paper copies of culled content organized 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.

In the case of Connexions, take the example of on-demand text books discussed earlier. The use of the Creative Commons attribution license allows its authors’ content to “live” beyond the web. Connexions is working with several print-on-demand presses, including QOOP Inc., in Mill Valley, California. These presses allow the delivery of customized textbooks, and printed versions of courses at dramatically lower costs. For example, a new 300 page, hard-bound engineering textbook sells for $15-$20, as opposed to $100-150 from a traditional academic publisher. The $15-20 final price to the student not only includes costs and profit for the on-demand press but also a small “sustainability revenue stream” that goes to fund the Connexions project as well as a revenue stream that goes into a fund that will enable students in the developing world to get the printed on demand version of the book for free. Such a method naturally segments users at the individual level; they pay for a customized and value-added version of the content available freely within Connexions, yet end up paying a fraction of what they would pay if they purchased an equivalent traditional text-book.

It is worth noting here that the on-demand publishing approach that we have discussed here is quite compatible with current models of commercial publishing. Indeed, high-quality but very low-cost Connexions books have been printed and bound by FedexKinko’s each semester for several courses at Rice University for the last two years. In a joint venture with Cambridge University Press, Professor Alfred Hero’s new book on statistical signal processing will be simultaneously published as a traditional book and made available freely in the Connexions Content Commons. The expectation of such a publication strategy is that a vibrant community-of-use will emerge around this material, and help it evolve and grow with time. As we pointed out earlier, a vast majority of faculty members write textbooks not to make money but to make an impact, and systems like Connexions make their work more accessible to more people, thus increasing their potential impact (e.g., Hajjem, Harnad and Gingras

2005). To summarize, Connexions is specifically targeting the "long tail" of the publishing industry, i.e., the textbooks that typically sell a few hundreds or thousands of copies.

Concluding Thoughts

Our goals in this paper have been to point out the importance of systematically and deliberately considering the sustainability of Open Education Programs, and formulating this question by employing a "user-centric" approach. Rather than trying to create tactical programs to generate revenue, we propose that it may be more important to first understand the motivations, characteristics, and profiles of the user groups that participate on the OEP site. Even more importantly, it is crucial to learn what value users derive from the OEP, and then consider how to maximize value to them. Answering these questions carefully and thoughtfully will naturally lead to opportunities to generate revenue for the OEP. In concluding, we wish to note that like the content in Connexions, this paper is "active" content. It will be updated periodically to reflect our evolving thinking regarding the sustainability of Connexions more specifically, and sustainability issues surrounding Open Education programs more generally.

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