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ABSTRACT

We argue that information systems educators—and others in similarly dynamic professional disciplines—could benefit from an alternative infrastructure for learning. We present an "open classroom" model of education which expands upon Ferris' (2002) collaborative partnership model of education by integrating "open" technologies such as Wiki and Open Source Software to create enduring "knowledge products" that more completely engage the students and provide value to society. We further view this concept through the lens of a social-technical system to demonstrate how such a system represents significant, third order change to traditional classroom environments. We illustrate our model with two successful cases from our personal teaching experiences.

Keywords: Collaborative Partnership Model, Social-Technical System, Open Source Software, Wiki, Knowledge Creation

1. INTRODUCTION

Tell me, and I will forget.
Show me, and I may remember.
Involve me, and I will understand.
- Confucius, 450 B.C.

Sometimes there is a confluence of technology and ideas that provides an opportunity for a significant positive transformation of an industry. Recent thinking on management education (Ferris, 2002) and collaborative technologies, such as wiki (Leuf and Cunningham, 2001), suggests such a concurrence, and a corresponding chance for change within the higher education environment. As information systems educators, we have observed settings that are quite often characterized by:

- Faculty who are struggling to maintain their knowledge in the face of a technology onslaught;
- Passive students who watch a stream of video projected slides;
- Throwaway assignments that are discarded at the end of the semester, if not sooner;
- Assignments that do not motivate students to engage fully their intellect and energy;
- Failure to exploit the talent of students to create knowledge or learning material.

We contend that collaborative partnerships supported by enabling technologies can address these shortcomings in information systems education. In the remainder of this article, we elaborate on some of the problems we see in the current learning model, apply the socio-technical systems perspective as a device for viewing educational change, review the collaborative partnership model, and discuss how open technologies can support the implementation of this model and expand its benefits beyond the classroom. We draw on some examples from our current teaching practices to illustrate how we are applying these ideas. Finally, we present some future opportunities for invigorating higher education.

2. DEFINING THE PROBLEM

There are several distinct challenges facing information systems (IS) instructors which we believe contribute to—or are exacerbated by—the negative classroom situations listed in the introduction above. One such challenge is the speed at which change occurs in the information technologies being taught in the classroom. This presents two significant

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difficulties. First, it often takes quite some time to become familiar with any new technology to be an effective "traditional" instructor (i.e., an instructor in a lecture-based classroom environment). Second, the availability of classroom materials including books, exercises, and presentations often lags behind technological changes. Instructors must invest significant time to research the numerous scattered, written and online technical resources—which are usually not directly appropriate for classroom consumption—and develop customized classroom materials, often for each new class, each and every semester.

Further, our students' need to continue learning at a fast pace will not stop at graduation. Students must continuously adapt their skills to meet the ever-changing market demands. Many organizations do not allocate the resources to provide continuous, instructor-led training opportunities for employees. Rather, employees must have both the ability and the motivation to self-manage their continued learning throughout their careers.

In addition, we are also challenged to instill a high degree of creativity into our students. Our graduates must almost immediately be able to interact well with clients, understand their requirements, abstract these into technical designs, and deliver workable solutions. Even the basic skills required for this creative process necessitate much more development and practice than most typical classroom experiences can provide. Thus, it is very appropriate that information systems educators mirror in the classroom the creativity and innovation that is expected of our graduates.

We believe that the majority of the challenges presented in the preceding paragraphs exist in the classrooms of many disciplines—specifically, those disciplines that must prepare students to face a professional world in which the key ideas, tools, and technologies required to perform their roles are constantly evolving. Although information systems is an obvious candidate to this challenge, most applied disciplines also rely on a diversity of tools and technologies to remain at the cutting edge of their field. The speed of technological advance is particularly challenging for those who teach in the technology sphere, but there are few disciplines that are not touched by technology these days, and thus the problem is general in scope even though its severity varies. We hope and expect that the ideas proposed in this article can be adapted to aid the many disciplines characterized by rapidly advancing knowledge and technology.

3. SOLVING THE PROBLEM

One potential solution to these challenges resides not merely in providing up-to-date classroom materials and knowledgeable instructors, but in changing the classroom experience from a one-way to a two-way transfer of knowledge. In this collaborative partnership model (Ferris, 2002), students are encouraged to not only learn the material provided to them by way of the instructor, but also to learn additional material and relay their knowledge back to the instructor and to the rest of the class. Thus, students are actively engaged in the teaching and learning process, not just passively learning.

We assert that the collaborative partnership model can be improved further by preserving the knowledge gained by the students for use beyond the boundaries of a single classroom environment. So much of the knowledge that is currently created inside of the classroom is lost to the filing cabinets of the instructors, the notebooks of the students, or the waste paper basket. Class projects are filed away, to be discarded some semesters later, and the students' unique contributions are lost to society. By leveraging technology, encouraging students to participate in knowledge creation and enhancement activities, and sharing the findings through the public Internet, we believe that the learning process can create not only the next generation of professionals, but also create knowledge itself.

3.1 The Socio-Technical Perspective

Analyzing the classroom from a socio-technical perspective helps us to identify the possible roles of technology within this setting. The socio-technical system (STS), based on the fundamental concepts of general systems theory, represents the organization as the interaction of four highly interrelated variables: task, people, structure (or roles), and technology (Bostrom and Heinen, 1977). An organization is portrayed as a collection of interrelated parts working together to achieve a common goal. The STS model can be adapted to the classroom context by remapping tasks, people, structures, and technology within this setting.

There are two primary interdependent elements within the organization: the social system and the technical system. The social system includes people and the roles they assume. Thus, the attributes of the professor and students (attitudes, skills, and values), and the communications, authority, and workflow systems within the classroom are within the province of the social system. The technical system includes the technology and the tasks performed to achieve classroom goals. While the same type of technology may be present in many classrooms (e.g., computer access, projector, whiteboards), the technical system will be different within each classroom. This is because the technical system is the result of how the professors—and perhaps the students—apply the technology, and the implementation choices are manifold. Thus, some professors might rely heavily on class discussion and whiteboard synthesis, whereas others might use a computer for a presentation.

The STS model is a useful foundation for understanding the types of change that can occur within an organization (O'Hara et al., 1999), and by extension, a classroom (see Figure 1). The model recognizes three orders of change.

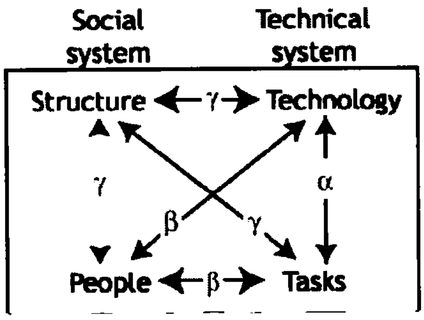

Figure 1. The Social-Technical System (O'Hara et al., 1999)

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First order change involves only task accomplishment supported by technology. It occurs, for example, when a task is automated in some fashion (e.g., using electronic mail to distribute assignments to students). First order change, resulting from a change in an interaction between technology and task, is also called alpha change (α), and is the lowest order of change that may result from technology implementations. This type of change portrays technology as a content-transmission tool that can alter the traditional lecturing process and roles of printed material and instructors (Benbunan-Fich, 2002). Alpha change fits the objectivist model of learning, where the goal is to transfer knowledge from the faculty member to the student, and is typically facilitated by technology that can automate the knowledge transmission process (Benbunan-Fich, 2002; Leidner and Jarvenpaa, 1995). A typical example of classroom alpha change is the replacement of acetate slides and overhead projectors by PowerPoint and a video projector. The professor shows the same slides, hopefully updated frequently, and teaches in the same manner. Only the technology has changed. Products such as BlackBoard and WebCT are often used to support first order change.

Second order change occurs when the tasks and the people who perform them are affected. This change represents second order or beta change (β). It is shown in Figure 1 by two interaction arrows: (1) people and tasks, and (2) people and technology. Technology is viewed as a communication support tool; it impacts faculty members by extending their availability beyond class times and office hours, and it enables students to interact electronically with classmates. Technology as a communication support tool may also be used to support administrative activities such as the distribution of class materials, announcements, and grade notifications (Benbunan-Fich, 2002). In terms of the constructivist model of learning, beta change facilitates knowledge creation. Knowledge is constructed through peer interactions. Technologies typically leveraged to support this model of learning are known to "informate down," that is, to provide information to students to allow them to critically analyze information or discuss issues among their peers (Leidner and Jarvenpaa, 1995). An example of beta change is when students use Web site creation software to develop learning material for sharing with other class members. This way, students take on some of the responsibility for educating the class. Another instance is when students have the opportunity to use a class-related blog to supplement their learning. Following the successful introduction of blogs in two MBA courses at Queensland University of Technology, the majority of students claimed an increased level of meaningful intellectual exchanges among their peers (Williams and Jacobs, 2004).

Type of change		Definition	Example
Order	*Type*		
1st	Alpha	Using technology to change how a task is performed	Replacing acetate slides with PowerPoint presentations
2nd	Beta	Using technology to change people's roles	Students creating Web sites for the class to use as part of its learning
3rd	Gamma	Using technology to change the structure of a system	Students creating the class textbook and teaching each other

Table 1. Types of Change

Third order change affects task, people, and organizational structure. This change, also known as gamma change (γ), is highlighted in Figure 1 by three interaction arrows: (1) people and structure, (2) structure and task, and (3) structure and technology. Under gamma change, the learning environment would be completely restructured and the notion of a traditional classroom, for example, might disappear. Gamma changes are more likely to occur under a collaborative model of learning, if it is leveraged by a technology that can transform the entire learning process (Leidner and Jarvenpaa, 1995). Later in this article, we will discuss how we required a class to leverage new technology to write collectively a textbook for the class and to teach each other. This is an instance of third order change because the structure of the class was altered with students taking on the major responsibility both for the class textbook and for the teaching and learning process itself.

While there has been tremendous attention paid to the role of the Internet and related technology (e.g., e-learning, computer-supported collaborative learning, etc.), our observations suggest that much of what has happened is first order change. Leading products have focused on automating tasks (e.g., distributing the syllabus, learning material, and grades electronically) and traditional classroom functions have been electronically replicated (e.g., electronic presentations, real-time chat, etc.). Perhaps the lack of second and third order change is due to a lack of new models for classroom interaction because the Internet in itself is not a strategy (Porter, 2001). Automating tasks typically improves efficiency, but the ultimate goal of increasing the quality of learning is scarcely altered unless roles and structures are resolved. We believe that the major payoff will be realized when technology is used to implement or augment a new model for education, which leads us to a discussion of the collaborative partnership model. Our goal is to enhance and extend the tenets of collaborative learning through application of technology that fosters gamma changes.

3.2 The Collaborative Partnership Model

The collaborative approach is not new (e.g., Alavi, 1994; Alavi and Dufner, 2005; Oliver et al., 1998), and it exists in many variations such as cooperative learning (Slavin, 1991), co-discovery learning (Lim et al., 1997), student-centered learning (Felder and Brent, 1996), and the collaborative partnership model (Ferris, 2002). The collaborative approach has been suggested to be superior to other learning approaches (Johnson et al., 1991; King, 1989; Lim et al., 1997).

A collaborative partnership model (Ferris, 2002) is an example of an alternative teaching approach that may alleviate some of the shortcomings we perceive to be present in higher education. This model has been applied with

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success in various business disciplines (e.g., Ferris, 2002), such as management, accounting, and finance. It focuses on learning as a partnership where both students and faculty are looking for personal growth and development. It emphasizes the need to help students learn how to learn—anticipating the time when they will be on their own and will have to learn independently.

The collaborative partnership model is based on the analogy of a junior partner (e.g., student) and senior partner (e.g., faculty) evolving in a close relationship within a firm (e.g., the university). This relationship is balanced in the sense that no partner can operate without the complete cooperation of the other. The collaborative partnership model, because it departs significantly from the traditional teaching approach, is argued to be more likely to produce higher order changes (β and γ changes). Indeed, this model fundamentally redefines the structure (roles) most traditionally assumed in an educational social system, along with its interaction with people, tasks, and technology. After briefly describing the changes associated with the first three variables (structure, people, and tasks), we then discuss the fourth variable (technology) in the next section, providing examples of how higher order changes may be achievable.

Changes in Structure: In traditional learning models, such as the "student-as-customer" model (McCullough and Gremler, 1999), or its variant, the "student-as-client" model (Armstrong, 2003), students are perceived as having underlying needs and wants, which are mainly fulfilled through the formal teaching imparted by the "experts," i.e., the faculty. In contrast, the collaborative partnership model promotes students as knowledge consumers and knowledge producers. Both junior and senior partners must be committed to the same major goal of personal growth, which is mostly (but not exclusively) focused around the stated goals of the course. This goal is achieved only if roles are transformed such that faculty and students are creators, distributors, and recipients of knowledge. In so doing, students learn to interact and the flow of learning can be two-way.

The partnership model changes the semantics of the classroom. In its simplest form, labeling theory (e.g., Ashforth and Humphrey, 1997) argues that the labels affixed to people greatly influence their behavior. The labels, "student" and "teacher" have been ingrained since kindergarten: the student passively awaits the pouring forth of knowledge from the teacher and the teacher expects to learn little from the class. Conversely, "partner" connotes a shared enterprise. While skills and knowledge might differ, partners are collectively responsible for achieving an outcome. Changing roles also requires that we change labels if we expect to convert the flaccid student to an energetic partner, and these new expectations to be established and managed.

Changes in People: The partnership model is only appropriate when the involved partners have specific characteristics. Among these, personal growth and development in the field along with motivation level are especially important contingencies. On the one hand, the closer the junior partners are to the senior partners in existing levels of personal growth and development in the field, the easier it will be to carry on the partnership relationship. On the other hand, if the junior and senior partners are at very different levels of personal growth and development in the field, the partnership relationship can also be rewarding if (and only if) the junior partner's growth needs are high. Motivated upper-division students are thus likely to prosper more in a collaborative partnership than younger students without the necessary level of knowledge or experience. Changing the relationship in the teaching and learning relationship is beneficial for transmitting the necessary learning processes to students and facilitating the open flow of communication between students and faculty.

Changes in Tasks: A collaborative partnership model necessitates senior partners becoming classroom facilitators rather than oracles. They must also polish their mentoring capabilities, so as to provide adequate advice, counsel, and expertise to the junior partners. Moreover, senior partners need to assure that the proper conditions are present for the junior partners to achieve their fullest potential growth. This typically means that the senior partners must leave place for the junior partners to contribute to the stated goals of the class, such as letting them take the lead. In fact, senior partners should make it an objective to "prepare for the unexpected," that is, to be flexible enough and let serendipity shape part of their classes. As to the junior partners, their main task is redefined to the extent that they must cooperate fully in the learning process by demonstrating an active involvement in the joint venture. These task changes will be constructive for training students to learn and enabling them to practice interaction with others. Done properly, the students' output can be retained for use beyond the borders of the classroom itself.

In sum, the partnership model has the potential to resolve many of the problems we perceive as infecting higher education. First, students are discouraged from being passive learners because, as junior partners, their involvement is essential to the success of their educational experience. Second, faculty can share the learning of new concepts and technologies with their students, lessening the burden of having to be on the cutting edge of technology. Third, students are likely to exhibit greater motivation in their learning because their role within the partnership is considered neither inferior to nor less important than the role of the instructor. Rather, the roles are complementary. Finally, because students are expected to share their inputs with other students and the instructor, the talent and intellect of students are leveraged.

Both a model of learning (or pedagogical structure) and the characteristics of the technology must be taken into consideration when assessing learning outcomes (Alavi and Dufner, 2005; Alavi and Leidner, 2001; Arbaugh, 2005). The collaborative approach, supplemented by the use of technologies and structures in a creative fashion, has the potential to enable beta change (e.g., Brower, 2003). We contend that the collaborative partnership model, specifically, combined with a change in the interaction between structure and technology, can lead to gamma change. The technology factor is addressed in the next section.

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3.3 Opening the Classroom

We believe that certain information technologies may be leveraged to increase the effectiveness of the collaborative partnership model discussed previously and perhaps affect a gamma change within the higher education classroom environment. Attention in this discussion is confined to two *open technologies*: open content documents and open source software. We assert that an *open* philosophy for the creation of technologies is ideal for the enablement of gamma change. Open technologies not only allow technology to be brought to bear to enable changes in structures and tasks, but also to allow the people organized around new structures and performing new tasks to affect change in the technologies themselves. These changes can endure beyond the semester boundaries and can also be leveraged by other students and by society beyond university borders. Open technologies further encourage open communication and open learning. In the case of software, students can inspect the underlying code and add to it, learning from and building upon the work of prior programmers. Similarly with open content documents, students can build on the work of other students—without geographic or temporal constraints—to add to and improve upon the work of prior students. Thus, open technologies further enable students to *model* the work of those with prior experience and knowledge, an important and widespread form of learning (Bandura, 1977).

We implemented this open classroom concept through the creation of two projects using two separate open technologies. The details of these technologies as well as some analysis of the results of our informal experimentation now follow.

3.4 Open Content Documents - Wiki Technology

Wiki technology is web based collaborative software that allows a group of people to create, edit, and store shared web documents, called wiki pages. The wiki pages can be linked together and the resulting collection of linked hypertext documents is called a wiki. The content is maintained in a completely open manner. Anyone who wants to change the content of a wiki page or add a link to a new wiki page can do so by using a simple markup language and a standard web browser. All these features are aimed to make the authoring process convenient. An author should be able to concentrate on the content without significant knowledge of the underlying technology. A wiki page has no defined structure. The structure, like the content, continuously changes and evolves with the collaborative work of many users.

A wiki has many advantages. Once it is centrally set up on a web server, it is accessible to every student in the class. Because little syntax knowledge is required, content is easy to create and edit. Every student can contribute, thus establishing a democratic process. The work can be stored for further use and development in future classes or released in the public domain and made open for every Internet user. Because wiki pages can be revised and edited remotely, collaborative works with students from other universities or institutions is possible. Also, because wiki keeps prior versions of any entries, thus enabling rollback and comparison functions, it has a unique capability over other web-based collaborative tools. For further discussion about the differences between Wiki and other collaborative technologies, see Wagner (2004) and Mindel & Verma (2006).

Problem in traditional classroom	How wiki technology can help
Outdated textbooks	Textbooks can quickly become out of date. In contrast, wiki pages are in a constant process of changing and a final version is not achieved nor desired.
Engaging students	A wiki supports collaborative and creative work. Students can work together to create something of value to others.
Two-way flow of knowledge	In a traditional classroom setting, there is a one-way flow of knowledge from the teacher to the students. Students have little chance to share their knowledge with the class. A wiki makes learning a democratic process, resulting in a two-way flow of knowledge.
Avoiding waste in education	Typically, students' assignments are discarded at the completion of the term. With a wiki, the students' work can be further developed by future classes or released into the public domain. The recognition and appreciation of a student's work may also be a source of motivation for her to further engage in the collaborative partnership model.
Knowledge creation and learning	Students are knowledge consumers and knowledge producers. A wiki gives the student the opportunity to be actively involved in the development of content. The students and their teacher are creators and recipients of knowledge.

Table 2. Traditional Classroom Problems Addressed by Wiki Technology

Examples of the use of a wiki in educational settings are collaborative writing of documentation and essays, brainstorming, bulletin boards that can be edited by teachers and students, project status updates, or persistent discussion boards that can be used in lieu of e-mail. Classes from San Francisco State University used it to conduct business analysis (Mindel and Verma, 2006). Some of the benefits of using a wiki in the classroom are summarized in Table 2.

As discussed briefly above, we experimented with the usage of wiki technology in our teaching by establishing a project in which students were involved in the writing of an XML textbook. In January 2004, a graduate class in advanced data management commenced work on an open content XML textbook (*wikibooks.org/wiki/XML*) using wiki software. We chose a graduate class as it is a better fit for the type of students required in the partnership model and because previous literature suggests that collaboration in a virtual learning space, such as in a wiki context, may be more effective for mature, motivated learners (Leidner & Jarvenpaa, 1995). The class completed 18 chapters, with each student and the instructor writing one chapter and teaching the class that chapter. Students were also the editor of the chapter preceding the one they wrote. That is, they

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Strengths are that the course stimulates learning and thinking. Weaknesses might be that some lectures were not very explanatory (since the students were giving the lectures).
Weaknesses can be since students are teaching and presenting and researching chapters they make it as comprehensive or simple as they want. Other students then rely on their research and validity of info presented.
Working on our own textbook really helped learning the material thoroughly, although it was a risk that chapters prepared by the students left out important details. However, I felt like being taught in an excellent way.
Strengths allow the course to create the class and have self-learning.
This was a great class and I learned a ton!
It's experimental–which is good and bad. One problem is that I don't know my standing in the course. Organization was a bit of a problem. The exercises were sometimes too difficult since there were no experts.
It really made us think about what were working on.
Giving students the opportunity to research a topic promoted better understanding of the material.

Table 3. Students' Comments on the Class

worked with the author to improve the quality of the material prior to publication of the chapter.

In the following months, the book was then used with two classes in Germany, who were each required to improve the book by correcting errors, improving the consistency across chapters, adding boxed inserts on XML applications, or adding exercises. Currently, the book is being used and further improved by other classes where students are learning XML and adding value to the textbook. Since its beginning, the textbook has been greatly improved and extended by three chapters. Parts have been translated into Chinese and Italian.

Based on both formal and informal feedback, the students almost uniformly reacted positively to the course. The comments of those who included a statement in their formal class evaluation are reported in Table 3. The general tenor of the statements indicates the students found the course stimulating and supportive of learning. The quality of their work and the book's continued use and evolution are themselves evidence of the motivating influence of the model.

Evaluation of student learning relied on several mechanisms. There were weekly XML skill development exercises, which were graded, and the best weekly solution was added to the text as the sample answer and received bonus points. Each class member rated all chapters on a 100-point scale. A chapter's score contributed to the author's and the chapter editor's grades. Thus, evaluation was a combination of professor and peer judgment, with a strong focus on the quality of a student's output and an emphasis on higher level competencies (Bloom, 1956).

Students who use the XML text clearly don't have the opportunity to contribute to the same degree as those who created the original edition. However, many respond well to the request "to leave the book in better shape." Several have opted to add new chapters when the set assignment is quite modest (e.g., add a new exercise or exemplary vignette). The appeal of an assignment of enduring value, no matter how small, captures students' imaginations and interest. It stands in contrast to many other assignments, even in the same class, which have a fleeting life. The challenge is to find ways to apply the tenets to all, or nearly all, assignments.

3.5 Open Source Software

The advent and popularity of open source software present an opportunity for software application developers to participate in software projects around the world. One of the principles of open source is that anyone, including students, can access and modify the existing source code, allowing for the collaborative development of applications across most boundaries.

Open source is typified by the development of software by a geographically dispersed community of administrators, developers, and users who share a common interest in the application. New software code is developed by anyone to fit modularly within the existing framework and is subject to review by the other members of the community. Acceptable code is included in future releases of the application or made available as a patch for installation by interested parties. Unacceptable code is rejected by the community, at which time the author is free to revise the code and resubmit. Existing code that is found to have bugs is "repaired" by members of the community.

Sourceforge (www.sourceforge.net) claims to be the "world's largest Open Source software development website," with over 166,000 projects and 1.75 million users (as of December 2007). Each of these projects has access to a suite of tools and applications designed to make open source development easier, including mailing lists, message forums, bug and feature tracking, website hosting, and source code management systems. In an academic course setting, these tools can allow students to be involved in a project that more closely resembles commercial software development environments than the typical class assignments. Open source development principles, methodologies, and tools can be used to enhance educational goals in a variety of ways (see Table 4).

The resultant applications can be released for further development and usage by both future students or by the global open source community. There are several examples of open source applications that follow this model, including *PHPWebSite* (phpwebsite.appstate.edu), which is a very popular open source web content management system originally developed and maintained by the Web Technology Group at Appalachian State University (which is comprised of upper level and graduate students in Computer Science). As it has become more popular, external developers have also contributed to the project.

We decided to experiment directly with the use of an open source project in an academic setting by involving students in the development and maintenance of a project in an early stage of development. In the first half of 2003, the Open Tourism Consortium (OTC—www.opentourism.org) was created with the aim of establishing an organization to participate in the open development of publicly available standards and software to support tourism (Watson et al., 2004). The OTC's goals are to support information services

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Educational goals	Open Source classroom application
Allow students to gain experience working with existing code bases and application frameworks	Devise class projects around the development of specific modifications and extensions to a given application developed by both previous classes and outside developers
Expose students to the peer-review process for their software	Invite administrators (perhaps including the instructor) to review students' work for quality and completeness and encourage testing of both existing code and submissions from the current term
Convince students to look beyond the end of the term	Foster within students the importance of documentation, modularity, and other professional software development practices for future developers' benefit as well as that of user base
Improve students' communication and collaborative skills	Encourage participation in discussion forums, bug trackers, and so forth
Provide experience working in teams	Assign projects on a team basis instead of an individual basis
Provide experience interfacing with users	Release projects for public usage and comment to allow (hopefully) students to experience the joys of satisfying both new and existing users

Table 4: Educational Goals and Application

for the three phases of tourism: pre-tour (planning), touring, and post-tour (reminiscing). OTC's components include:

- *TourDM*—a standard data model for tourism objects and events;
- *TourML*—an XML based data exchange language for objects and events of interest to tourists;
- *TourML* parser—an open source program to parse TourML files and insert the data into a relational database based on the standard data model;
- *TourStyle*—a set of XML stylesheets for transforming output to a device's characteristics;
- *TourCMS*—a content management system for tourism authorities;
- *TourImplement*—guidelines and tools to assist implementation;
- *TourCommunity*—engaging the local community to extend the information available.

In spring 2003, we engaged a class in advanced data management in the development of TourDM and TourML. Then in 2004, a master's student at a German University completed the work for his thesis and released version 1.0 of TourDM and TourML. Still in 2004, we directed five local graduate students to develop the first version of TourCMS as part of their major project. Each member of this team had a particular role (e.g., project leader, technical specialist) and a local tourist authority was the client. The team took TourDM and wrote code to support database maintenance and access. In 2005 and 2006, we continued our informal experiment by directing two local teams of students to build on the work of prior classes by creating the next version of TourCMS, this time extending an existing open source software system to better meet the overall needs of the OTC project.

Nearly every system can be improved in some way, and there are always extensions and new features to add, so there is no difficulty in keeping the OTC project alive. Each team extends and enhances the work of the prior team by using the documentation and code left behind by their predecessors, which parallels professional practice very closely as software systems are updated and team members come and go. The output of one semester becomes the input for another. Of course, students quickly learn that their predecessors did not always document clearly what they did or had bugs in their code, but that is the reality of the software business in many situations.

From our experience, students involved in a joint and living project environment such as the OTC not only gained valuable knowledge in application development, but also learned to collaborate with a wide range of stakeholders, including instructors, team members, other classmates, developers of previous versions of the application, external developers, and user communities. Through such involvement, several of the problems typical of traditional classroom settings might be addressed (see Table 5). Students are encouraged to participate in a project that will live on beyond the end of the current term. Turning over parts of the project directly to students makes them more involved in the educational process as they apply themselves to the attainment of the projects' goals. It also provides faculty an opportunity to develop additional skills and knowledge via the contributions and experiences of the students.

Problem in traditional classroom	How open source principles can help
Avoiding waste in education	Projects live on in perpetuity, maintained by future sections of the class and/or external developers.
Faculty struggling to maintain their knowledge	By assuming meta-responsibility for projects across terms and course sections, faculty can deepen their knowledge of subject areas through repeated experiences.
Assignments that don't motivate students toward full engagement	Projects lead students to become actively engaged in the ongoing and expanding development of successive versions of a project.
Failure to exploit the talent of students	Students learn to apply their very best in order to satisfy the needs of a wide range of stakeholders.

Table 5: Traditional Classroom Problems Addressed by Open Source Principles

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3.6 Other Open Projects

The open movement is stimulating thinking in variety of areas about creatiing knowledge and opening the economy (e.g., Benkler, 2002). Thus, it is not surprising that similar projects are emerging. One interesting case is the Berkman Center's Openlaw experiment in crafting legal arguments (*cyber.law.harvard.edu/openlaw*). Lay people and lawyers are invited to participate in the development of briefs. Openlaw is investigating collaborative tools to support cooperative brief development.

In biology, researchers use an open community to sequence bacteria and yeast (Goetz, 2003). In engineering, a distributed team (*www.thinkcycle.com*) is reported to have designed an easy to use intravenous saline drip that costs about $1.25 to manufacture, instead of the alternative cost of about $2,000 (Goetz, 2003). In investment, a new type of *open source* investing was developed to educate investors pooling their stock market information (Schmerken, 2000). Finally, NASA seeks volunteers to help it identify Martian craters (Goetz, 2003), and there is a proponent (Gerlach, 2005) for opening the space program. These projects offer educators models for participation and reinvention, but first the openness mode needs to be set for receiving these signals, and that is one of the goals of this article.

4. DISCUSSION AND FUTURE DIRECTIONS

Nearly every technology that has appeared in recent times has been announced as a herald for a revolution in education. The web has also been presented as education's latest savior. Unfortunately, new technologies are often relegated to the least influential task (i.e., improving the distribution of educational material) and achieve only alpha change. The broadcasting of content is obviously important, but it is often no more engaging than a professor's monotone soliloquy. The power of technology is released when it enables new and more productive roles and transforms organizational structures. In order to harness this potential, we need scholarly activity to develop theory and practice to take advantage of this possibility.

The choice of one given technology and how it will be deployed will greatly influence the extent of high quality outcomes (Hedberg, 2003). However, how such outcomes can be measured is questionable. Boud and Prosser's (2002) framework distinguishes four types of influences on high quality learning. Each of these, and the extent to which they are likely to be achieved through the learning approach we suggested in this article, are now described.

1. *Engagement of students (i.e., students must have reasons to wish to become involved in a task given their previous interests, understandings, experience, etc.)*: Students involved in the XML book and OTC project were genuinely engaged in their assignment, primarily because there were real enduring outcomes rather than fictitious ephemeral assignments.
2. *Acknowledgement of the learning context (i.e., students must understand the larger context within which their work fits and is transferable)*: Because the XML book and OTC project are both real-life endeavors, students can appreciate the immediacy of their contributions to the real world.
3. *Challenging the students (i.e., students must be active in their participation, using the support of other students, taking a critical approach to the materials, and going beyond what is immediately provided)*: In this case, students had no choice but to be active participants in their respective assignments, as this was a necessary pre-condition to their involvement in both projects.
4. *Providing practice (i.e., students must be able to demonstrate learning, gain feedback, and reflect and learn from the task)*: Through hands-on activities and immediate feedback from peers and outside collaborators, students had many opportunities in the projects to reflect upon and learn from their work.

The two projects we describe in this article satisfy the four criteria. While we conceive of the shift to a technology enabled partnership model as a gamma change in learning, Boud and Prosser see it is as a fourfold shift in the learning process. As the Chinese proverb notes, there are many roads to the top of the mountain, and we scholars typically foresee different paths to the top. What is important is that we see that climbing the mountain improves the quality of education, and in our case also creates enduring value.

Our initial observations suggest that the gamma change achieved using the open classroom model may improve educational outcomes for students and faculty. However, much work remains to be done to validate and explore fully the potential of this concept. The remainder of this section presents three avenues of progress for the open classroom concept that will help formalize the model, expand it beyond its current boundaries, and demonstrate the potential for adapting the model to solve issues outside of the classroom.

4.1 Formalize: Refine the Theoretical Basis and Conduct more Rigorous Studies

We have described what we believe to be an improvement to collaborative partnership model of education and have argued the relative merits of our model by examining it using a socio-technical perspective. We now need to enhance our theoretical foundation to examine more thoroughly *how* technologies leveraged in this fashion might improve learning outcomes and to better understand the contingencies involved. This will most likely require an amalgamation and reconstitution of existing scholarship on learning and research on computer-mediated communication (e.g., Te'eni, 2001).

A more systematic approach also needs to be taken to determining the costs and effectiveness of an open classroom approach. We have piloted the approach, however much redesign and adjustment occurs under such a model thus making precise measurement of outcomes infeasible. As the method of learning stabilizes, it will be possible to gain more accurate data on overall effectiveness.

Though our preliminary experimentation seems to show positive results, these projects did not represent rigorous scientific studies. Armed with a more refined theoretical basis, formal and scientifically rigorous studies that build upon the initial concepts presented herein must be conducted to test and refine the model.

4.2 Expand: Knowledge Creation Pedagogy

The potential for the open classroom concept is even larger than advancing the productivity of the learning environment.

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We see students as a vast, neglected and latent reservoir of wealth in the knowledge economy. There is a global talent pool of 132 million university students (UNESCO Institute for Statistics, 2006) whose intellectual efforts are too frequently discarded because we have not developed an infrastructure to engage them in enduring, value creating projects.

As our brief experiences appear to support (e.g., Table 3), students are more motivated when they are engaged in productive and enduring activities (Felder and Brent, 1996) and when their work is to be considered by a larger audience than just a faculty member (Ferris, 2002). They learn the material with greater enthusiasm, and leave behind something of value for those who follow. If we can create structures and procedures that lead to greater student involvement in knowledge creation and develop renewable projects, we all gain.

The collaborative partnership model is a description for improving learning through redefining the role of the two key stakeholders, students and professors. It does not address creating long-lived knowledge by distributed groups of students as part of their learning process. We need to learn more about the creation and sustenance of renewable projects that endure well beyond one semester, one instructor, and one university. We need to develop a pedagogy that tackles this goal. In our work, we have adapted existing technology, such as wiki software, but a more substantial pedagogical-based and task-fitting technology will indubitably lead to greater learning and more productive knowledge creation.

4.3 Adapt: Global Text Project

After reflecting upon the XML textbook project, we realized that the core principles of the open classroom concept, with some modifications, could be applied to a major global problem. Mass education is for many a path out of poverty. It is common for professors in most academic subjects to design their courses around a textbook, but what happens when students can't afford texts? While textbooks are considered expensive in Europe and the U.S., they are beyond the reach of many in developing countries. For example, a $108 Biology textbook sells for $51 in Africa (CALPIRG Education Fund, 2004). The U.S. GNI per capita is $43,740, and in Uganda it is $280 (World Bank, 2006). Obviously, the developed world's textbook business model does not meet the needs of those in the developing world. A different publishing model is greatly needed.

The purpose of the Global Text Project (*www.globaltext.org*)—building on what has been learned from the open source, open access, and open content movements, in general, and the XML textbook, specifically—is to show that academic communities can be engaged in creating textbooks for altruistic reasons, that editorial oversight can be established, and that open source wiki software can be modified so that it is a suitable platform for creating high quality, authoritative, textbooks. The plan is to balance community involvement (i.e. faculty, students, and practitioners) with the need for content currency and accuracy. Thus, the Global Text Project plans to manage texts as if they were lightly peer-reviewed journals, with an editor-in-chief for each book as well as chapter editors.

The project is in its initial stages, and several books are in the production stage. While each chapter is under the control of a suitably qualified expert (typically a professor) and the wiki model has been modified to ensure quality control, there are still many opportunities for students to partner in the creation of a book. Furthermore, the Global Text Project moves the open classroom beyond the realms of information systems to potentially all disciplines. For example, some chapter editors are using their class to help outline and write a chapter. Students can be engaged in translating chapters, as the goal is provide the books in four major languages: Arabic, Chinese, English, and Spanish. Students are expected to be an important source of examples and exercises as these are contribution chunks well within the scope of most students. Following the precepts of labeling theory (e.g., Ashforth and Humphrey, 1997), readers will be referred to as contributors to encourage them to rethink their relationship with their texts.

Experimentation and reflection are active elements of innovation. Opening the classroom, as we have learned, starts a journey of discovery for faculty members and students. We can continue to innovate within the new frames we initially create or stand back and see these frames as elements of a much larger structure. In our case, we have seen a greater opportunity that offers the prospect of improving education in manifold ways for needy multitudes.

5. CONCLUSION

Open source software development and open content knowledge creation are driven by an idealistic belief that intellectual property should be created for the benefit of many. The desire to benefit the greater society is also a conviction that fuels mass education. Thus it is not surprising that those with an idealistic bent should see parallels between these two mass movements, and it is our belief and our classroom experience that this synergy should ignite a reappraisal of the role of technology in education.

In this article, we have asserted that a better learning environment may be realized by leveraging appropriate technologies to support the realignment of roles in the classroom. Our notion of the open classroom is derived from Ferris' (2002) collaborative partnership model in which the roles of the students are expanded to a level on near-par with that of the instructor. However, unique to our model is the prescribed use of "open" technologies to facilitate not only the effective day-to-day operation of the collaborative partnership model but also the creation of a lasting "knowledge product," which provides both an immediate sense of purpose to the classroom participants as well as enduring value for society.

Viewing the classroom as a social-technical system provides us with insight into why most attempts to integrate technology have done little to improve classroom environments regardless of the nature of the technology or the level of its appropriation. Such attempts rarely have extended beyond first order, or *alpha*, change—they have simply provided "higher-tech" analogues to existing technologies within the social-technical system. Improvements in efficiency can be realized with alpha change, but second order (*beta*) or third order (*gamma*)

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change is often required to affect changes to an ailing system.

If gamma change is desired, one must simultaneously enact changes not only to technology and how it is used within the system but also to the social structure of the system itself. The two cases that we have presented provide concrete examples of gamma change within their respective classroom environments and in both cases the results of these changes were very well received by the students and faculty. Furthermore, these changes resulted in the creation of knowledge products that are today still being leveraged and improved upon well beyond the boundaries of the original classroom.

The immediate attraction of any new technology is its potential to automate existing tasks, and too often the search for improvement through the use of technology stops here. We believe that we must look beyond the immediately obvious to examine how we can use information technology to change the roles, relationships, and structures of education. Furthermore, if we reformulate higher-level education as a knowledge creation activity then we improve learning and create value for others to consume and enhance. If Confucius were a 21st century philosopher, he might proclaim

Give me alpha change, and I receive lessons faster
Give me beta change, and I am motivated to learn
Give me gamma change, and the world will benefit.

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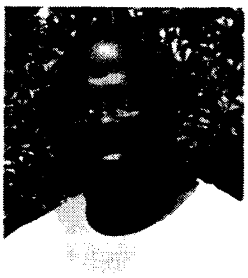

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