

OPEN EDUCATIONAL RESOURCES FOR BLENDED LEARNING IN HIGH SCHOOLS: OVERCOMING IMPEDIMENTS IN DEVELOPING COUNTRIES

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ABSTRACT

With today's computer and telecommunications technologies, every young person can have a quality education regardless of his or her place of birth. This is the dream that Open Educational Resources (OERs), when viewed as a right rather than a privilege, are directed to realize. For developing countries, we propose a type of OER initiative that leverages not only technology but also the skills of the in-class teacher, that utilizes not only the Internet but also lower-tech delivery platforms, and that is created not only by developed countries of the West but also by educators in many countries worldwide. We outline the design of a cross-border, collaborative learning and teaching system called the Blended Learning Open Source Science or Math Studies Initiative (BLOSSOMS), with an associated partnership network established for its implementation in developing countries. BLOSSOMS is to develop a large, free repository of blended-learning video modules for high school math and science classes, created by gifted volunteer educators from around the world and designed to offer potentially transformative learning exercises that will enhance critical thinking skills and retain students' interest in math and science. The initiative has been designed and developed within a multinational network of partner organizations in the developing world, a characteristic that distinguishes it from many other OER projects.

KEYWORDS

Open Educational Resources (OERs), Blended Learning, Online Repository, International Collaboration, High School Education, Mathematics and Science, Critical Thinking

In mid-October 2004, we had the privilege of visiting schools in the isolated and economically depressed villages of the Yanzhou District in Ningxia Province, China. These schools were so poor that despite the frigid autumn temperatures, officials were unable to heat the buildings until late November. Teachers and students sat at their desks wrapped in heavy coats, hats and boots. All of the faces we met were red with cold, and it was difficult to see how any valuable teaching or learning could be accomplished in such an environment. Yet one scene left a lasting impression. As we entered yet another cold and crowded classroom, this time at the Touying Middle School, we observed each red face locked attentively upon a television screen at the front of the room. A lesson on the Human Body was being presented asynchronously via DVD by a professor from Tsinghua University in Beijing, and the students, despite their bleak surroundings, enthusiastically digested the information. Every once in while, the classroom teacher would pause the DVD while adding her own content. This lesson was provided by the Tsinghua University Education-Aiding-the-Poor Project (EAPP) which aims to provide people in underdeveloped areas with the opportunity to access high-quality educational

resources by means of modern information technology. The project's goal is to eliminate poverty by spreading knowledge.

I. INTRODUCTION

This scene in Touying was to have a significant impact in shaping the direction of a young project we were just undertaking at MIT at the time of our China visit. Earlier in 2004, the Second Conference of MIT's Learning International Networks Consortium (LINC) had spawned an exciting initiative created by nine participants from the Middle East and Pakistan, including Palestine and Israel. These consortium members proposed a LINC Middle Eastern Initiative focused on the use of cross border, collaborative distance learning to educate high school math and science teachers in the Region. The encounter in China had taught us three important lessons that we brought to our work with partners in designing the Middle Eastern Initiative: 1) If education is to be a right rather than a privilege then this initiative must involve creation of Open Educational Resources (OER) that are accessible to poor, isolated schools throughout the Middle East region and beyond; 2) This initiative should entail a Blended Learning model of education, integrating technology-enabled lessons with face-to-face teaching, since such a model is more familiar than a straight online approach and thus more comfortable and accessible to teachers and students alike; and 3) To reach poor, isolated schools, this initiative cannot rely solely on the Internet, but must be accessible in lower tech forms as well, including CD, DVD, or VHS.

This paper presents the LINC Middle Eastern Initiative—now called the Blended Learning Open Source Science or Math Studies Initiative (BLOSSOMS)—and the partnership network established for its implementation in developing countries. At the start, we introduce the initiative itself as originally conceived by a group of educators from the U.S. and the Middle East Region. Then as background to the discussion, we first provide an overview of the Open Educational Resources (OER) Movement, with particular focus on barriers to OER access/implementation in developing countries. Next, we examine the concept of Blended Learning as a bridge between traditional teaching and online education. Finally, we introduce MIT LINC, a unique international consortium that has given rise to the birth and ongoing development of this young initiative. After these background discussions, we present an in-depth examination of the ambitious High School BLOSSOMS project, which is now in its final pre-implementation phase. We review our efforts to design an OER initiative that surmounts traditional barriers to access in developing countries by encouraging mutual collaboration *across* borders and *among* module producers and users. And we present feedback from BLOSSOMS partners in over fifteen countries, whose ideas and guidance have been invaluable as we systematically designed our approach.

Starting out, we offer two framing perspectives. Over much of the world, classroom education remains a labor-intensive craft profession, essentially unchanged since the 19th Century. A craft industry can be defined as a “Site of small scale industrial production often involving hand work and craft skills” [1]. As an example of a craft industry, consider New England shoe making in the 1830's:

“Shoes were usually completed in small shops, where each worker sat at a bench with his hammer, last, awls, pegs, string, wax, and bristles close at hand.”

In thinking of a teacher preparing for a class, consider this as a representative description:

“Class lectures and exercises are usually completed at home in a den or small room, where each teacher sits at his desk with his pencil, pen, ruler, calculator, reference texts, laptop computer, and pads of paper close at hand.”

This describes a craft profession in the tradition of the 1800's but operating in the 21st Century. With

exponentially increasing youthful populations in many developing countries, the growing demand for teaching cannot be matched by the craft model. We need to highly leverage the teaching talents of our in-class teachers, limited in number, with scaling technologies and pedagogy of the 21st Century. We need to bring content and pedagogy experts into the classroom, using asynchronous delivery, not to replace the in-class teacher but significantly to enhance and multiply her teaching impact. Recently, in the U.S. the National Research Council (NRC) reported, “*the basic teaching style in too many mathematics and science classes today remains essentially what it was two generations ago*” [2]. While optimistically seeing only two generations of sameness, it is comforting to note that the NRC also sees the urgent need to change fundamentally the style of teaching and learning of mathematics and science. The blended learning modules we discuss represent some feasible steps in that direction.

In our second framing, we confront the fact that in much of the world math and science teaching is ‘teaching to the test,’ featuring rote learning to be regurgitated at exam time. Independent critical thinking is not valued in such environments. Many in the Middle East, the United States and elsewhere recognize this educational flaw. Donald Kennedy, former President of Stanford University and currently editor-in-chief of the prestigious magazine, *Science* (of the American Association for the Advancement of Science), said in a public lecture on April 6, 2007,

“Education: what is it for? In the sciences, is it to produce a thin layer of outstandingly brilliant innovators who will become leaders in establishing new frontiers of investigation?” And, shouldn’t it be “... a way to produce a level of scientific literacy in the general population that can help our society apply better judgments to policy issues in which science and technology play crucial roles” [3]?

Kennedy’s point is that in our increasingly complex technological world, knowledge and understanding of science, and the critical thinking that goes along with such understanding, cannot be left solely to a small scientific elite. Basic scientific knowledge and the ability to be critical thinkers need to be spread throughout the population. Not only in the U.S., but studies and reports from Egypt, Jordan and elsewhere in the Middle East have emphasized the need to advance critical thinking skills in students.

II. THE HIGH SCHOOL BLOSSOMS INITIATIVE

The vision of this project is to develop a large, free repository of video modules created by gifted volunteer teachers from around the world, seeded initially by MIT faculty members and by other founding faculty members from the Middle East and elsewhere. Each module would be designed pedagogically to run in harmony with the regular in-class teacher, the subject matter covering a specific area of mathematics or of a physical science. Each module would build on prerequisite material studied but would present a math or science concept in a mind-expanding and exciting form. The goal would be to develop deeper and richer skills in the students and to enhance their critical-thinking skills. Simultaneously, we want to excite them in pursuing a science, math or engineering career.

The BLOSSOMS initiative is guided by eight major considerations:

- 1) Technology is changing education, allowing a much richer menu of learning opportunities than was available before. Some believe that historians—in the future—will cite *education* as one of the top three transformative effects of the Internet.
- 2) The Open Source movement is creating learning materials free of copyright restrictions.
- 3) The World is co-inventing major environments on the web (e.g., Wikipedia).
- 4) Many high school students, both young women and young men, are turned off to studying math and science, seeing it as hard work with little relevance in their lives.

- 5) Teachers in high schools need appropriate technology-enabled means to leverage their skills in order to further engage and excite the students.
- 6) For many teachers, a blended or hybrid model that combines traditional face-to-face with technology-enhanced teaching will be a less threatening way to leverage their effectiveness through technology.
- 7) Much teaching of mathematics in high schools is done formally, often in theorem and proof mode, and the style of student learning is too often rote memorization for an exam, and then forgetting.
- 8) New ways need to be developed to help students engage in creative critical thinking, often assembling in unusual ways concepts and facts learned in more traditional modes.
- 9) Students need to be shown that mathematics and science can apply in exciting and useful ways in their lives, both professional and personal, thereby increasing the numbers who will select engineering, science and mathematics as career goals.

The BLOSSOMS video modules are not intended to replace an existing curriculum but rather to enhance the teaching of certain lessons, encouraging critical thinking and creating interest to pursue further math and science studies. Students in the classroom setting would watch a segment of a BLOSSOMS video, none lasting longer than about 5 minutes. Then after each segment, the in-class teacher would guide the students with an active learning exercise building from the video segment. After the learning objective is accomplished, the video is turned on again for another short segment. This iterative process continues until the exercise is over, usually lasting a full class session.

With MIT providing peer review and quality assurance, uploads onto the streaming video web site would occur as easily as those to the widely popular YouTube. A transcript of the module to facilitate translation of it into other languages would accompany each blended learning video. Also, metadata tags for ease of searching would accompany each. Finally, each BLOSSOMS video would be submitted with a teacher's guide, for the in-class teacher to review before offering the module for the first time, so that the important "blended learning" role of the in-class teacher is seen and understood. For the vast majority of high school classrooms worldwide that do not have access to broadband Internet connections supporting steaming video, the content of the web site would also be available to teachers in other formats: CD, DVD and videotape. Content in these formats could be mailed to teachers upon request. As the repository grows, it is expected that many of the modules will be translated (again by volunteers, as with Wikipedia) into other languages. Ideally this would be done in voice-over form, but could also occur as translated subtitles shown on the video in the classroom's native-language. Finally, the proposed Open Source repository of blended learning modules would have—for each module—space for a threaded discussion group, with the discussion focusing on in-class experiences using that module, and a rating system by users, not unlike Internet ratings for movies, books and restaurants. In that way, those modules providing the best learning experiences, as reported by users, would become known more quickly.

Note that we are extending our definition of OER beyond Internet access, to CD's, DVD's and videotape. Most high school classrooms worldwide do not have access to broadband Internet connections, so necessary for viewing streaming video, but almost all can support at least videotape presentations of the materials. And videotape, iteratively started and stopped, is all that is required for our proposed implementation of blended learning in these classrooms. Even if the materials are experienced via one of the non-Internet alternatives, students and teachers can still learn about all the options on the BLOSSOMS web site and offer their own online evaluations of the modules they have used.

The end goal of the initiative is to attract a larger fraction of students, young men and women, to math

and sciences, leading to excellent careers in the increasingly dominating ‘knowledge economy’ of the world. Via an appropriate technology for each high school, these blended learning modules would bring into the classroom a world-class expert in pedagogy and the area of math or science knowledge being studied by the students. The modules for this project would be created by expert teachers in the Middle East, at MIT and eventually at other universities around the world. In our view, “The World” would create voluntarily the contents of the blended learning high school math and science repository. Market forces would then determine which modules are frequently used and which ones will languish. MIT would provide, at least initially, quality assurance.

We imagine that the types of modules created would be as varied as are the disciplines and applications of mathematics and sciences as experienced in high school education. In our view, the contents of the typical module would not be a segment of government-mandated required curriculum coverage, such as introduction to the Pythagorean theorem or solution to a quadratic equation. Such material should be left to the in-class teacher. But, a module could build in one of several directions from mandated content, hopefully often in exciting mind-expanding ways. One example could develop from the contents of a remarkable book, *The Pythagorean Proposition*, a compendium of 256 proofs of that famous theorem. The manuscript was prepared in 1907 and published in 1927, and recently re-published by the National Council of Teachers of Mathematics [4]. Many of these alternative, relatively unknown proofs of the theorem are now available on public web sites. One could imagine a blended learning class that explores some of these web sites and then asks the students to report on a proof from the book not yet covered on any web site. Such a module would expand a student’s mathematical abilities and understanding of a core concept. Another example in this category that could be developed into a module relates to seven circular coins of equal denomination, such as seven American dimes. The question is this: “Why is it that six of the coins fit tightly, exactly around the circumference of the seventh, where the seventh sits in the middle of the other six?”

Another type of module could explore the real-world application of a new concept. An example using the Pythagorean theorem would be an application in surveying or in navigation or estimating the height of a tall tree or building. Yet another type of module may present a project building from one or more recent concepts taught in class, and then ask the students to work in teams over the next week or so and present to the class the results of their project. Perhaps there would be a follow-up blended learning module to accompany the presentations.

Thanks to the generosity of the Virtual University of Pakistan (Lahore), we have created an illustrative prototype for tenth grade geometry students. The problem is as follows:

A yardstick is broken at two ‘random points.’ What is the probability that a triangle can be created from the three pieces of yard stick so obtained?

This problem brings applied probability into a strictly deterministic class on geometry. And the problem addresses triangles, a key focus of Euclidean geometry. It can be viewed as a problem in mind-expanding critical thinking, as it represents a situation the students have not yet seen and requires thinking at a fundamental “roll-up-your-sleeves” level. The ‘solution’ is shown in the blended learning module we have created (available on request) and also on the web in animated form at http://web.mit.edu/urban_or_book/www/animated-eg/stick/f1.0.html. The CD-based prototype is used as a video that the students watch in segments, none longer than 5 minutes. Then after each segment the in-class teacher guides the students with an active learning exercise building from the video segment. After the learning objective is accomplished, then the video is turned on again for another short segment. This iterative process continues until the exercise is over, usually lasting a full class session. This type of module expands the classroom experience in two significant ways; it enables a student to see how high school

geometry can have broad applications in the real world and it extends the reach of a teacher to more creative classroom presentations and critical discussions. While the broken stick experiment does not have immediate applicability to real world applications, it has been found to be a pedagogically compelling challenge problem to do in high school geometry classes. That is, we have pre-tested this problem many times, but only using live teachers. And, on the ‘drawing boards,’ we have other problem situations drawn from various real-life areas such as urban living (e.g., car traffic, shopping, mail delivery, energy consumption), problems that can be framed and formulated and solved with the knowledge that the students are acquiring in their high school classes.

III. THE OPEN EDUCATIONAL RESOURCES MOVEMENT: OPPORTUNITIES AND OBSTACLES

The high school BLOSSOMS Initiative has been designed as an Open Educational Resource (OER). OERs are positioned to play a transformative role in a world where access to quality education is viewed as a right rather than a privilege. The OER movement is built around the premise that all educational content should be open and free, representing as it does a significant part of the global human heritage. While this premise is admirable and ambitious, there continue to be substantial impediments to fulfilling the potential of Open Educational Resources, particularly in the developing world where such resources are needed most. Overcoming these impediments has been a central goal of the international team of educators behind BLOSSOMS.

A. UNESCO’s International Institute for Educational Planning (IIEP)

The term “Open Educational Resources” (OER) is quite new to the global lexicon having been coined in 2002 by UNESCO’s International Institute for Educational Planning. According to Susan d’Antoni, Program Specialist at IIEP, OER refers to “web-based materials offered freely and openly for re-use in teaching, learning and research”[5]. Specifically, OER refers to:

- Content— materials for learning or reference;
- Tools—software for development or delivery of resources;
- Standards—shared conventions for digital publishing of open resources.

To carry out its mission of “fostering a culture of peace,” UNESCO works to improve education worldwide through technical advice, standard setting, innovative projects and networking. In a move to facilitate this work, IIEP was established in 1967 to “to help strengthen the capacity of countries to plan and manage their education systems”[5]. Ms D’Antoni, a central leader in the young OER movement, states that UNESCO is interested in OER, particularly open content, because “it has the potential to facilitate the expansion of the offer of education worldwide” [5]. In a 2002 meeting in Paris convened to discuss *The Impact of Open Courseware for Higher Education in Developing Countries*, participants expressed a wish:

“...to develop together a universal educational resource available for the whole of humanity, to be referred to henceforth as Open Educational Resources. Following the example of the World Heritage of Humanity, preserved by UNESCO, they hope that this open resource for the future mobilizes the whole of the worldwide community of educators” [5].

With support from the William and Flora Hewlett Foundation, in 2004 IIEP started a two-year initiative designed to increase awareness of the concept of OER and to support capacity-building and informed decision-making on the part of current and potential providers and users. This initiative had three specific aims:

- To foster an international dialogue and exchange of information;
- To link people who might not otherwise meet, either in person or virtually, particularly those who constitute the main constituency of UNESCO—developing countries—to come together and participate in a debate; and
- To create an international Community of Practice on OER.

This IIEP initiative conducted several online international discussion forums, and much of the knowledge we have today about the OER movement in the developing world is the result of these forums.

B. Critical Challenges Facing the OER Movement

While there is little doubt that the OER Movement represents a powerful step in the journey to make “education a right rather than a privilege,” this movement also faces significant challenges. In 2005, the Organization for Economic Co-operation and Development (OECD), through its Center for Educational Research and Innovation (CERI), identified the following four critical issues facing the providers and users of OER:

1. There is a need to clarify Intellectual Property Rights issues linked to OER initiatives.
2. There is a need to improve access and usefulness for users of OER, including issues of quality assurance, adaptability to local contexts, technology requirements and barriers.
3. There is a need to examine the incentives and barriers for universities and faculties and staff to deliver their material to OER initiatives.
4. There is a need to develop sustainable cost/benefit models for OER initiatives. Most current initiatives rely on donor financing and are not sustainable in the long term. [6]

In this paper, we will examine only the critical issues listed above that affect the BLOSSOMS Initiative and its goal of reaching high schools in the developing world. The first issue, Intellectual Property Rights, will not affect BLOSSOMS since professors creating the modules will have granted open legal access. However, it should be noted that in general, great care must be taken when licensing open educational content for widespread distribution in a world with many varied legal systems.

C. Barriers to OER Access for Users in Developing Countries

Open Educational Resources need to be accessible to those who need or want them. An inadequate ICT infrastructure is a major obstacle to the dissemination and use of all OER. According to Paul Albright of the Western Interstate Commission for Higher Education in his final report of the *2005 IIED Internet Forum on Open Educational Resources*, the greatest challenge for OER initiatives in the developing world is to work with educators to build collaboratively effective OER delivery in areas where bandwidth and technology are limited. He writes that some IIED forum participants believed that “a low technological threshold [namely low tech delivery models] not only allowed more access but also encouraged production of materials from all cultures, leading to new OER that is richer and more diverse” [7]. In its goal to reach as many high schools worldwide as possible, the BLOSSOMS Initiative has pursued this suggested strategy of technological minimalism by creating video rather than digital modules. Not only will the repository modules be available via low-tech means as well as by streaming Internet video, but the BLOSSOMS strategy will make it easier for partnering professors in developing countries to participate in the project by creating videotaped modules for the initiative, rather than requiring them to produce digital course materials.

Next to ICT infrastructure limitations, the greatest barriers to OER usage in developing countries involve language and culture. According to Albright, “not only does the English language dominate OER provision, but English-language content tends to be based on Western learning theory; this limits the relevance and accessibility of OER materials in non-English, non-Western settings” [7]. These two issues, translation and pedagogical relevance, as well as cultural sensitivity, have been constant concerns in the development of the BLOSSOMS Initiative. It is hoped that by nurturing partner module developers among university professors in developing countries, a collaborative network of BLOSSOMS users and producers will develop. Such a network would not only provide a pool of translators versed in local culture and pedagogy, but would, over time, alert Western module producers to potential pedagogical or cultural differences for users in developing countries.

Two other major challenges for OER users include, first, the ability to locate the resources and second, assurance about their quality. To quote Susan D’Antoni, “Open Resources are not much use if they cannot be found and trusted” [5]. Because using a general search engine results in too many references, it has been found that branded repositories are one way of effectively identifying, tagging and organizing OER content. Gathering these resources in a trusted repository also provides the capacity to assess their quality, ease of use and effectiveness for teaching and learning. The High School BLOSSOMS Initiative will be a screened repository of video modules managed at MIT, with module quality assessed not only through peer review but also through online user evaluation feedback.

D. Incentives and Barriers for OER Producers in Developing Countries

Many of the impediments to OER development by faculty in the developing world are the same as those in the developed world, including lack of time, lack of incentives, lack of capacity (both technical and financial) and fear of loss of control. In addition, there is a lack of knowledge about licensing and copyright issues, as well as a lack of institutional support on the part of universities. However, when it comes to potential OER producers in the developing world, each of these impediments looms larger and more intractable than in the West. In his final report of the 2005 IIED Forum, Paul Albright writes:

“For open educational content to reach its full potential, it must be available and relevant to the developing countries of the world. That cannot be a one-way street with developed countries producing OER and less developed countries confined to consumption. In short, global balance is required” [7].

Developers of the BLOSSOMS Initiative have worked to lessen these impediments by establishing relationships with the administration of partner universities and also by developing ties, where possible, with Ministries of Education in the countries of these universities. The project will also provide technical assistance to professors at universities who volunteer to create a math or science video module.

E. The Need for Sustainable Cost Effective Models for OER Initiatives

Many fledgling OER projects make the mistake of focusing on their technical and educational goals without paying adequate attention to issues of financial sustainability. This can prove to be a serious lack of foresight given the fact that “current explosive OER growth will result in stiff competition for available funds over the long run” [8]. Stephen Downes of the National Research Council Canada lists a variety of models used for funding recent OER projects:

- **Endowment Model** — here the project obtains base funding.
- **Membership Model** — here a coalition of interested organizations is invited to contribute a certain sum, either as seed only or as an annual contribution or subscription.

- **Donations Model** — here a project deemed worthy of support by the wider community requests, and receives, donations.
- **Sponsorship Model** — here sponsorship can range from intrusive commercial messages to more subtle messages, as found in public broadcasting. In online educational initiatives, various companies have supported OER projects on a more or less explicit sponsorship basis, often in partnership with educational institutions.
- **Institutional Model** — here an institution will assume the responsibility itself for an OER initiative (i.e. MIT and OpenCourseWare—OCW).
- **Governmental Model** — here governmental agencies, including the United Nations, provide direct funding for OER projects [9].

Developers of the BLOSSOMS Initiative are carefully watching the beginning attempts at sustainability that are just emerging in many previously grant-funded OER projects. One model being considered is a consortium model in which BLOSSOMS would charge a fee from affiliated universities and educational ministries for joint development and ownership of the initiative.

IV. BLENDED LEARNING: A BRIDGE BETWEEN TRADITIONAL TEACHING AND TECHNOLOGY-ENABLED EDUCATION

As described earlier, it was the observation of Blended Learning in an isolated and impoverished village of Western China that convinced BLOSSOMS developers to follow a blended learning model. Yet the term Blended Learning has many definitions. According to Larry Ragan of Rice University's Connexions, a project for the collaborative development and free sharing of educational content on the Web, Blended Learning is "the planned integration of online and face-to-face instructional approaches in a way that maximizes the positive features of each respective delivery mode." The goal is to build from each approach "to create an innovative and effective learning experience for students" [10]. Such courses, also known as "hybrid", "mixed-mode", and "flexible learning", appear to be gaining in popularity [11]. In this approach, a teacher employs online multimedia teaching objects to improve her teaching effectiveness and efficiency. She prepares the students ahead of time using traditional teaching objects that constitute the backbone of class activities, then "plays" the technology-enabled teaching objects and assesses students' understanding via a range of online and in-class activities or exercises. The theory is that Blended Learning has the potential of offering courses or training that, through the wise choice of the blend, can have results that are better than the sum of the parts. In addition, Blended Learning deals with a very real constraint; we are not going to suddenly replace millions of in-class teachers with clones of Albert Einstein. Blended Learning leverages the strengths of current in-class teachers and extends the total learning experiences of the students to new heights.

Blended courses demonstrate great variety in how the face-to-face ratio to online time is distributed. For example, some instructors might choose to replace one class per week with online assignments. Others might meet with their students in class for several weeks and then suspended class meetings for several weeks as the students work independently or in teams on online assignments. The reduction of time spent in a face-to-face classroom setting by online instruction is known as the "replacement" model of Blended Learning. A classroom situation in which the face-to-face instruction is not reduced but rather supplemented by online or other technology-enabled instruction is known as the "enhanced" model [10].

Research has suggested that the "enhanced" model, although representing a more surface blend of traditional and technology-enabled education, does indicate "a willingness among both instructors and administrators to step outside of the traditional instructional boundaries and experiment with blended

learning” [12]. That is, traditional teachers are more willing to use the enhanced model. It is hoped that this model represents a “stepping stone” on the path for teachers to transform their classrooms and pedagogies more completely by integrating technology with their teaching.

The BLOSSOMS Initiative will use an “enhanced” model of Blended Learning, employing streaming video via the Internet (or via low-tech delivery of CD, DVD or videotape), augmented by a threaded discussion group for module users and producers. One underlying tenet of this initiative has been that the most effective way to make it accessible and valuable for high school teachers and students in developing countries is to keep it as simple as possible. This is particularly true from a technological perspective as discussed above, but also valid from a pedagogical perspective. Most teacher and student users of these video modules will have been educated in a didactic manner and will not necessarily understand the new role of instructor as “facilitator” in e-learning education, rather than as a “teacher” in the traditional sense. Therefore, while delivering a mind-expanding yet traditional video lecture segment to the classroom, it is hoped that these modules will also serve to introduce teachers in developing countries—in a non-threatening way—to the vast “enhancing” potential of open educational content now available online. A parallel and equally important hope here is that going online will help both teachers and students to overcome fears about computers and develop a range of new skills.

All available literature on Blended Learning emphasizes the importance of integrating the online material with the teaching goals of a classroom subject. As relates to math and science topics covered in the BLOSSOMS videos, module producers will need to have a clear understanding of how and where their lectures fit pedagogically into a particular course, say geometry or physics. In this regard, the teacher’s guide accompanying each module will outline what classroom content should be covered ahead of time, in order for the module to be most effective as a teaching tool. Similarly, teachers will need guidance from these “subject experts” around strategies for presenting the online lectures in a less passive and more active format—for example, by pausing the video and conducting a related highly-interactive in-class exercise.

V. MIT’S LEARNING INTERNATIONAL NETWORKS CONSORTIUM AND THE BIRTH AND ONGOING DEVELOPMENT OF THE INITIATIVE

The High School BLOSSOMS Initiative is the creation of a unique consortium of international educators: MIT’s Learning International Networks Consortium (LINC). LINC was founded in 2002 at MIT by the first author as a vehicle through which MIT could reach out to educators in developing countries around issues related to technology-enabled education. It is an MIT-affiliated initiative established to enhance the delivery of high quality Distance Education and E-Learning to students in the emerging world. LINC’s premise is simple and compelling:

With today’s computer and telecommunications technologies, every young person can have a quality education regardless of his or her place of birth.

The Internet and satellite communications have opened virtually all parts of the world to information, news, education and more. For education in developing countries, this has provided a unique opportunity. Many of these countries have burgeoning young populations, often with 50% of the citizens less than 25 years of age. Capacity constraints at brick and mortar universities restrict the fraction of young people who can attend college or university to 2 to 4 percent of the population. This is in contrast to 40 to 60 percent in the developed western world. The Internet and communication satellites provide a way to

dramatically increase educational capacity—via “distance learning”—without building more brick and mortar facilities and without having to train thousands of new teachers.

As a result of these technological advances, distance learning initiatives have begun in scores of countries, a virtual A-to-Z from Algeria, to Brazil, to China ...to Zambia. Many perceived distance learning as a panacea, as a quick win where the only issue was acquisition and implementation of the technology. But soon it became apparent that the design and implementation of distance learning ‘systems’ was a much more complicated process than had been envisaged. More important than the technology was the environment in which the systems were being implemented, an environment defined by economics, culture and tradition, pedagogy, work rules and more. Many countries tried to ‘go it alone,’ and learn only from their own mistakes. Meanwhile these same countries often proved to be naïve customers of marketeers brandishing the latest ICT’s.

LINC is an international community of individuals and organizations that focuses on secondary and tertiary education in emerging countries and the role that technology can play in expanding educational reach. It is a hybrid, a professional society whose participants include scholars, practitioners, students, corporate executives, government officials and foundation professionals. Participating educators from around the world collaborate to share best practices and to learn from each other’s mistakes, in order to move forward with successful distance learning projects in their home countries. Their goal in collaborating through LINC is to help build on-the-ground expertise and virtual distance learning communities in each of the respective countries seeking such assistance. Their focus is not on the narrow aspects of technology but on pedagogical issues, educational content, financial planning, political constraints and organizational issues. Technology fits into this in a natural way—as defining what can and cannot be done in various regions. A hybrid part of LINC arises because LINC also supports various programmatic initiatives. In that sense, LINC is a ‘professional society with an entrepreneurial attitude,’ one that applies new and modestly priced distance-learning initiatives in various countries and regions around the globe. BLOSSOMS is an example of these programmatic initiatives.

To help disseminate state-of-the-art learning and best practices, LINC regularly holds international conferences. The first three were held at MIT in 2003, 2004 and 2005, and the fourth was held at the Dead Sea in Jordan in October 2007. At these conferences, innovative educators from around the world come together to learn from leaders in the field, to share lessons learned and to meet partners for future collaborations. The 2007 conference, with the theme, “Technology-Enabled Education: A Catalyst for Positive Change”, had more than 500 delegates from 40 countries and over 50 papers presented in parallel sessions.

It was at the second LINC conference in 2004 that seeds for the High School BLOSSOMS initiative were dramatically planted. Present among delegates at that conference were seven plenary speakers from seven different Arab countries and three participants from Israel. As a result of relationships made and discussions undertaken at the meeting, before leaving Cambridge these ten educators drew up and finalized a joint plan for further action: the MIT LINC Middle Eastern Initiative would focus on the use of cross border, collaborative distance learning to educate high school math and science teachers in the Region. The project as devised that March morning in 2004 had two main objectives: 1) to improve high school math and science education in the countries of the Middle East; and 2) to provide a constructive vehicle for collaboration among committed Arab and Israeli educators.

Over the past four years, many of these original partners have continued their discussions via emails, in occasional face-to-face meetings and at two subsequent LINC conferences. Their ideas have evolved as

they worked hard to hammer out details of a systematic, sustainable and above all achievable program, one that would be truly accessible to all high schools in the Region. It was at this stage in the planning process that we brought in the lessons learned in Touying, including the need for content that was: freely available, adaptable to a blended learning approach, and open to delivery via both Internet and non-Internet technologies. The end result of these deliberations was the conception of a program to be initiated in the Middle East region but not limited to that region—the High School BLOSSOMS Initiative. What follows is an in-depth presentation of this initiative, as it exists today, having benefited greatly from the input and participation of LINC partners not only in the Middle East but also in Africa, Asia and Mexico.

VI. DEVELOPING A COLLABORATIVE NETWORK OF BLOSSOMS PARTNERS

Potential stakeholders of any major initiative such as BLOSSOMS need to become advocates and co-inventors. How an OER initiative is organized and implemented will liberate or stifle its potential for achieving open and collaborative education. BLOSSOMS has been designed and developed within a multinational network of partner organizations in the developing world, a characteristic that distinguishes it from many other OER projects. A Hollywood film about baseball (*Field of Dreams*) popularized the phrase, “Build it and they will come.” This may have worked in the film, but it will not work automatically in bringing OER content to educators in emerging nations. More appropriately, the phrase may be, “Build it and they will not come unless you design a system to promote and encourage access.” Devon Duhaney in his article, “Blended Learning: Rethinking Educational Delivery for Development,” writes:

“...the changing ‘landscape’ of the educational environment requires institutions to establish more partnerships or consortial arrangements ...between and among institutions from developing and developed countries to allow a larger number of students and teachers to benefit from the maximization of the use of available resources” [13].

From its beginning at the LINC Conference in 2004, the BLOSSOMS initiative has been a collaboration of partners committed to enhancing high school math and science education in the Middle East and committed to working together to achieve that end. The founding partners still involved in designing and implementing this program include educators from Jordan, Syria, Lebanon, United Arab Emirates, Israel, Gaza and Pakistan. More recently, these supporters have been joined by partners from Egypt, Turkey and Iraq. In addition, as the scope of this initiative expanded beyond the Middle Eastern region, the BLOSSOMS network has grown to include educators from China, Nigeria, Tanzania, Kenya, Rwanda and Botswana. All of these partners will play a critical role in establishing in their respective countries an implementation system that includes three layers of support: support at the university level; support at the governmental level; and support among high school math and science teachers and their students.

A. Support in Partnering Universities, the Backbone of BLOSSOMS

The majority of partners in BLOSSOMS are university professors, although we do have a few who are high school teachers. Without a doubt, these professors will play the most critical role in the BLOSSOMS implementation system. Not only do they nurture support for the program at their universities, but they are also charged with initiating support among governmental officials and teacher associations. At the university support level, a professor has three tasks: 1) to persuade university officials on the value of the initiative; 2) to encourage other professors at the university to create math or science blended-learning video modules for high school students; and 3) to organize a volunteer network at the university to localize BLOSSOMS modules.

In both developed and developing nations alike, very few universities value the use and production of OER by faculty members. The reasons for this lack of support have been described above. Yet there are a number of reasons why partnering universities would choose to support the production of these resources by their professors, including: “a wish to promote an international perspective within the university, to share resources with other countries, to be part of the institution’s contribution to society, to establish a service to local, national and international communities, and to enhance the institution’s visibility...” [14]. And let us not forget: If the effort is successful, a larger number of highly qualified and motivated applicants from high schools will apply to that college or university! It is the job of BLOSSOMS partnering professors to educate their university officials about the value of OER in general and about the BLOSSOMS project in particular. The goal is to make the university a partner in the initiative, encouraging faculty to become OER producers by developing incentives for them to do so. Discussants at the 2005 IIED Internet Discussion Forum suggested that adding OER to portfolios presented for academic promotion and tenure would be a major first step in this direction [7].

The second job of these partnering professors is to encourage fellow faculty members at their own or other universities to produce a mind-expanding math or science blended-learning video module to share as OER. BLOSSOMS organizers have been cognizant from the start that a major challenge of the initiative will be to encourage educators in developing countries to create the video modules. Yet in pursuit of this goal, organizers have been inspired by the words of consortium member, Nabil Sabry, professor at the French University of Egypt:

“The ultimate goal of Open Educational Resources will be to train educators all over the world to incorporate available quality content and up-to-date knowledge from around the world into their own courses, in a way that preserves their cultural identity while at the same time providing them with a space where they can add their own creative production” [15].

For many of these faculty members, the concept of OER, and perhaps even Blended Learning, will be new. BLOSSOMS partnering professors will serve as a bridge between initiative organizers and these faculty members, explaining the program and providing information on module video production. Any teacher interested in participating in module creation will be put in touch with partnering professors and project organizers, receiving guidance and support around pedagogical and video production issues involved in module development.

The third role of these BLOSSOMS professors is to organize a university-based network of faculty or student volunteers for localization of blended-learning video modules. This aspect of the BLOSSOMS initiative, establishment of a network of volunteer translators in developing countries, will make or break the project’s goal of achieving truly open access. Participants at the 2005 IIED Internet Discussion Forum were in agreement on the following:

“There was recognition of the importance—and difficulties—of the translator’s job. Localizing OER material is not only a question of language but also one of culture. It is important to be aware of cultural and pedagogical differences between the original context of use and the intended new use of the material” [7].

Translators in the BLOSSOMS volunteer network will be assigned not only to translate the module audio into their native language for voice-over or video subtitles, but they will also need to adapt, if necessary, that audio to local cultural and educational norms. If BLOSSOMS is to fulfill its objective of “encouraging mutual collaboration *across* borders and *among* module producers and users”, the capability of providing language, cultural and educational “translation” is critical.

B. Support at the Governmental Level

BLOSSOMS organizers will work to develop governmental support in all developing countries where there are partnering universities. This support could be at the ministerial level in some countries, and at the state or local level in others. Such support is critical for several reasons. First and foremost, to succeed in a developing country, it is important that an OER initiative be congruent with that nation's educational goals and philosophy. Speaking at the LINC 2007 Conference, Babatunde Ipaye of the Open University of Nigeria stated:

“The needs of the individual, the society and the nation where e-learning is provided should be the priority of the online education providers. The education a nation gives its citizens must be congruent with the nation's philosophy, goals and aspirations, and in these days of global development, a nation's educational system must support the achievement of the Millennium Development Goals (MDG) alongside the national goals”. [16]

By insuring that such congruence exists with a partner developing country, BLOSSOMS will gain the backing of officials who can assist in the successful implementation of the initiative. Government officials at all levels will be valuable in publicizing the initiative and encouraging, perhaps by developing incentives, high school math and science teachers to participate. Similarly, these officials could be instrumental in providing resources and other incentives to encourage module producers in local universities or institutes. Finally, in those countries where educational officials are not familiar with the potential of OER and Blended Learning for development, the BLOSSOMS initiative can serve as an introduction and invitation to this new world of technology-enabled education.

C. Support Among Math and Science High School Teachers

In order to insure access to and usage of the video modules, BLOSSOMS will need to reach out to high school math and science departments in countries where there are partnering universities. This will be accomplished with the help of partnering professors and supportive government officials, and will entail publicizing the initiative via national and local teacher associations, at teacher workshops and also through web sites used by teachers and students. In each of these participating countries, questionnaires on the initiative will be distributed to a sample of high school math and science teachers in order to assess needs, request feedback and encourage participation.

In publicizing BLOSSOMS, efforts will be made to emphasize the technical simplicity of these OER modules in an effort to overcome hesitation by teachers uncomfortable with complex technology and/or the concept of Blended Learning. Teachers themselves will be encouraged to create and submit their own blended learning modules. Perhaps there could be annual awards, on a regional basis, given to those teachers who best integrate blended learning into their classrooms and for those who produce the best blended-learning modules.

In one partnering Middle Eastern country, BLOSSOMS will work with an ongoing educational technology program for teachers. Similarly, BLOSSOMS will partner with an ongoing initiative in Africa that is training math and science teachers in 10 African countries. It has also been suggested that private school chains throughout the Middle East region would be an effective vehicle for testing and publicizing the modules. As BLOSSOMS nurtures relationships with partnering universities in additional developing countries, it is hoped that collaborations with synergistic teacher initiatives like the ones cited above can be identified and established.

VII. FEEDBACK FROM BLOSSOMS' STAKEHOLDERS

In the fall of 2007, BLOSSOMS organizers sent an overview description of the initiative along with an accompanying questionnaire to forty LINC consortium members who had expressed interest in the new project. The survey instrument had sixteen questions covering the following three topics: 1) questions relating to the overall initiative; 2) questions relating to module development; and 3) questions relating to module repository access and usage. Respondents included university professors from the following countries: Botswana, China, Iraq, Israel, Jordan, Kenya, Nigeria, Pakistan, Rwanda, Tanzania, Turkey, Saudi Arabia and the United States. Input from these professors has proven to be invaluable as BLOSSOMS moves from the early stages of design and planning to that of implementation—hopefully in 2008. What follows is an overview of feedback received in these questionnaires.

A. BLOSSOMS' Strengths and Weaknesses

A large majority of respondents cited “the collaborative nature of the initiative” as its greatest strength. Their feedback highlighted a wide variety of potential collaborations including: those between module users and producers; those between “North and South, East and West”; those between universities and local high schools; those among module users; and those among module producers. “Design as a blended learning tool” was selected as a strength on approximately half of the questionnaires, although it is interesting to note that quite a few respondents indicated that Blended Learning was a foreign concept to educators in their countries. There seemed to be agreement that the introduction of a blended learning model to their education systems would be a valuable contribution.

“Lack of a long-term model for sustainability” was cited above all to be the initiative’s greatest weakness. Many respondents referred to ambitious education initiatives in their countries that had failed due to this same weakness. However, no suggestions were offered on how this sustainability might be achieved. “Lack of onsite training capability for teachers” was also targeted as a critical weakness of BLOSSOMS, with most respondents concluding that a Teacher’s Manual would not be adequate for the task.

B. Individual Requirements of Partner Developing Countries

Responses to the questionnaire revealed one indisputable fact: there is little uniformity among partner developing countries when it comes to requirements for participating in the BLOSSOMS Initiative. For example, while “technical simplicity” was selected as a strength by only 25% of respondents, it was the choice of all five professors from Africa. Here the respondent from Rwanda acknowledged that even CD’s, DVD’s and VHS would be technically too advanced for many teachers in his nation. Similarly, while most of the professors listed lack of incentives or lack of time as the reasons why colleagues would not produce video modules, several African respondents cited a lack of technical background as the reason. Also, as mentioned above, Blended Learning was described as a “foreign concept” in several questionnaires, including those from Iraq, Tanzania and Rwanda. And in answer to the question “Would there be resistance within the educational system in your country to usage of these blended learning video modules,” while 80% of respondents answered “no”, several African professors answered “yes”, citing the natural resistance to change and a lack of understanding about technology-enabled education.

C. The Need for Training

Undoubtedly, the single most frequent suggestion made for the BLOSSOMS Initiative related to the need for training—training not only for teachers in the use of the blended learning modules but also for producers of those modules. Most respondents did not believe that a Teacher’s Manual would provide sufficient training and encouraged initiative organizers to arrange onsite training or, at a minimum, online

video teaching instruction. However, there was widespread agreement that teachers would be assisted by referral to online forum archives or blogs where other teachers have discussed usage of a particular module. Also, many respondents advocated development of a communication mechanism between high school teachers/students and module producers, enabling teachers to communicate with producers regarding science and math suggestions for module topics.

Questionnaire responses reinforced the contention of BLOSSOMS' organizers that a major challenge will be to locate and nurture video module producers in developing countries. In addition to a lack of time and incentives for module creation by university professors, a lack of training in the design and production of these videos was widely cited. As with the teachers, onsite training was preferable but an effective online training was also suggested. One African educator, active in the field of e-Learning throughout Africa, recommended the establishment of "a structure to coordinate a process to design and produce the video modules and to bring them to implementation." This educator volunteered the services of his department to train potential video module producers in African universities. One respondent recommended the establishment of an online communication network of video module producers to share expertise and experience, while another suggested that BLOSSOMS create a network of participants with technical expertise in video module production. Almost all respondents advocated regular workshops and conferences to be attended by both module users and producers.

D. Learning Centers of Excellence in Developing Countries

Several respondents recommended the establishment of Learning Centers of Excellence at partner universities in developing countries. Such centers would become local, national and regional leaders in the areas of Open Educational Resources, Blended Learning, and the production of educational video modules.

For example, in relation to OERs, these centers could develop expertise in areas such as Intellectual Property Rights or contents "localization." Centers could develop expertise around issues of Blended Learning, introducing that approach to their educational systems. And through involvement in BLOSSOMS, these centers could become expert in video production and even in interactive multimedia materials production. There was widespread agreement that all participating countries would hugely benefit from the learning experience of being involved in the world-wide instructional design exercise that is embodied in this initiative.

VIII. CONCLUSIONS

BLOSSOMS proposes to be an OER online and off-line repository of video-based blended learning modules for high school math and science students—worldwide. We are aware that many, perhaps most, attempts to innovate substantially in educational systems have ultimately failed. So, our focus here, in addition to characterizing the intent and preliminary design of BLOSSOMS, has been directed at ingredients necessary for success. Especially in developing countries, with different languages, cultures, sensitivities, accepted traditional behaviors in classrooms, etc., one must be cognizant of the many potential pitfalls.

To overcome the pitfalls, we intend to design and operate BLOSSOMS as follows:

- (1) Develop an extended international network of advocates, first users and co-inventors;

- (2) In moving away from the labor-intensive craft model of teaching, utilize the concept of massive technology-leveraging, where one superlative blended learning module may be experienced by one million or more teachers and students;
- (3) Place the blended learning video modules on a facilitator-moderated public web site, searchable by topic and level of difficulty, and allowing comments and scoring of contents by users;
- (4) Provide each module in four different realizations: streaming video from the Internet; DVD, CD and videotape (in local standard format);
- (5) Provide delivery service (e.g., mail) for the three lower technology realizations of the content;
- (6) Utilize a form of blended learning that is inexpensive to produce and is least disruptive to the usual classroom setting, thereby smoothing the adoption by teachers;
- (7) Welcome current high school math and science teachers into the program, leveraging their own unique skills and interests and recognizing that their use of the modules is purely voluntary;
- (8) Provide incentives for both university faculty members and high school teachers to participate in the program as co-inventors, i.e., as contributors to the module repository, and as evaluators of its contents;
- (9) Provide the written transcript of each module, facilitating “localization” and language translation, either with subtitles or voice-over;
- (10) Continually monitor the program to find areas needing improvement;
- (11) Advocate for significant recognition of contributions to BLOSSOMS in the personnel files and annual performance reviews of professors and high school teachers;
- (12) Provide both virtual and on-site (local) means to alert and train high school teachers in the blended learning pedagogy;
- (13) Provide both virtual and on-site (local) means to alert and train university faculty and high school teachers in the area of blended learning video module production;
- (14) Provide for teachers online forums for sharing experiences in creating and using the contents of BLOSSOMS;
- (15) Urgently explore sustaining financial models, both locally at the school and university level for those who wish to become content creators, and globally to support the overall BLOSSOMS effort.

If the High School BLOSSOMS Initiative is successful, it will create an open repository of educational content from around the world, making a huge variety of “mind-expanding” modules available to teaching and learning communities everywhere. With that goal in mind, we close this paper with words—spoken at the Third International LINC Conference—that have served as inspiration to BLOSSOMS organizers:

“Will the third world countries be only spectators, or at most consumers, of material, cultural and educational wealth developed elsewhere? Will they get access to quality education in order to participate in this “global” planet-wide development? Will they be able to produce cultural and educational materials that will enrich human heritage with valuable creative resources? Preserving cultural diversity is fundamental at this level, in order to enable every nation to embrace other nations’ achievements, to assimilate them, and to enrich the world with their own creative contributions.” - Nabil Sabry

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