International Journal of Education and Development using Information and Communication Technology

Volume 10, Issue 2 June 2014

Special Issue of Comparative & International Education Society (CIES) ICT4D Special Interest Group

Chief Editors:

Stewart Marshall and Wal Taylor
The University of the West Indies, Barbados, West Indies

Guest Editors:

Jayson W. Richardson
University of Kentucky, USA

Jeffrey Lee
Azusa Pacific University, USA

IJEDICT Sponsoring Organizations:

The University of the West Indies Open Campus, West Indies

Published online by:

The University of the West Indies Open Campus, West Indies

IJEDICT url: http://ijedict.dec.uwi.edu

ISSN: 1814-0556

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Publication Frequency
There will be five issues of IJEDICT per year, in a continuous publication cycle. Articles will be published immediately in the current issue of IJEDICT on completion of the review/editing process.

Publication Classification Details
Key title: International journal of education and development using information and communication technology
Abbreviated key title: Int. j. educ. dev. using inf. commun. technol.

ISSN: 1814-0556

About the journal

The International Journal of Education and Development using Information and Communication Technology (IJEDICT) is an e-journal that provides free and open access to all of its content. It aims to strengthen links between research and practice in ICT in education and development in hitherto less developed parts of the world, e.g., developing countries (especially small states), and rural and remote regions of developed countries. The emphasis is on providing a space for researchers, practitioners and theoreticians to jointly explore ideas using an eclectic mix of research methods and disciplines. It brings together research, action research and case studies in order to assist in the transfer of best practice, the development of policy and the creation of theory. Thus, IJEDICT is of interest to a wide-ranging audience of researchers, policy-makers, practitioners, government officers and other professionals involved in education for development in communities throughout the world.

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IJEDICT has a major emphasis on the use of ICT in education and development in hitherto less developed parts of the world. The journal includes descriptive case studies about education projects in developing countries and in rural and remote regions of developed countries, as well research articles evaluating such projects, developing policy or creating theory. Topics covered include, but are not limited to, the following areas: Distance learning, e-learning, flexible learning and delivery, blended learning, open learning, e-literacy, e-portfolios, MOOCS.

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This section contains short comments or notes that are useful for practitioners working in the field of ICT in education and/or development.

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- Please use Arial 12-point font for the Title, which should be in bold "title" (upper and lower) case.
- Use Arial 10-point font for the remainder of your article.
- First level headings should be in bold uppercase.
- Second level headings should be in bold "title" (upper and lower) case.
- No footnotes please - instead use endnotes.
- Photographs, maps, diagrams and other audio-visual aids are encouraged. Please include these in the text where and as they should appear. Please provide images in gif or jpeg formats.
- Note that all submissions are checked for originality using Turnitin before being sent out for review.

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Submitted manuscripts must be written in the Harvard editorial style:

- References should relate only to material cited within the manuscript and be listed in alphabetical order, including the author's name, complete title of the cited work, title of the source, volume, issue, year of publication, and pages cited. See the following examples:

    Marshall, S. (1991), "A genre-based approach to the teaching of report-writing". English for Specific Purposes, vol. 10, no.1, pp. 3-13.

    Taylor, W. & Marshall, S. (2002), "Collaboration: the Key to Establishing Community Networks in Regional Australia", Informing Science, vol. 5, pp. 155-162.

    Marshall, S., Taylor, W., & Yu, X. (eds.) (2003), Closing the Digital Divide: Transforming Regional Economies and Communities with Information Technology, Greenwood Publishing, Westport CT.

- Citations in the text should include the author's name and year of publication where you use the source in the text, as in the following examples:

    In this way, information technology can be seen to effect and influence changes in organisational structure (Orlikowski & Robey 1991).

    Edwards (1995, p.250) views the globalising of distance education as "invested with the uniform cultural messages of modernity".

Globalisation, especially in relation to open and distance education, will reduce the tolerance of difference and so "how can local issues and contexts be addressed?" (Evans 1995, p.314).

- Further information about the Harvard editorial style can be found at: http://www.lmu.ac.uk/lskills/open/sfl/content/harvard/index.html

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Principal Contact and Mailing Address

Professor Stewart Marshall
Managing Editor, IJEDICT
The University of the West Indies Open Campus
Cavehill, Bridgetown, BARBADOS, West Indies
Email: stewart.marshall@open.uwi.edu

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Editorial: Special Issue of Comparative & International Education Society ICT4D Special Interest Group

Stewart Marshall
The University of the West Indies, Barbados, West Indies

Wal Taylor
The Information Society Institute (TISI), South Africa

Welcome to Volume 10 Issue 2 of the *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*.

This Special Issue has been edited by guest editors Jayson W. Richardson and Jeffrey Lee and we thank them for suggesting the issue and for their hard work in putting it together. As always, the emphasis in IJEDICT is on providing a space for researchers, practitioners and theoreticians to jointly explore ideas using an eclectic mix of research methods and disciplines. This particular issue links with another such interdisciplinary space - the Information and Communication Technology for Development (ICT4D) Special Interest Group (SIG) of the Comparative & International Education Society (CIES) – and highlights the work of the members.

The journal now has several sister publications (all free to read and subscribe):

- *ICT For Education and Development Blog* - http://stewart-marshall.com/ict4ed/
- *IJEDICT Weekly News* – an online newspaper published every Thursday http://paper.li/f-1325685118
- *ICT for Education and Development* - a daily, magazine style curation http://www.scoop.it/t/ict-for-education-and-development
- *CEDICT: Communication, Education and Development using ICT* – a blog http://cedict.blogspot.com/

Stewart Marshall and Wal Taylor
Chief Editors, IJEDICT

International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 3-5

Guest Editorial: Special Issue of Comparative & International Education Society (CIES) ICT4D Special Interest Group

Jayson W. Richardson
University of Kentucky, USA

Jeffrey Lee
Azusa Pacific University, USA

Welcome to Volume 10 Issue 2 of the *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*. This issue highlights the work from members of the Information and Communication Technology for Development (ICT4D) Special Interest Group (SIG) of the Comparative & International Education Society (CIES).

Kang lays the groundwork for this SIG by researching the prevalence of ICT4D at CIES conferences. In “Revisioning Information and Communication Technology for Development (ICT4D) at the Comparative & International Education Society (CIES): A Five-Year Account (2009 - 2013)”, Kang provides an account of how ICT has evolved as a key topic and research area at the CIES conference. The past five years’ CIES conference papers with an ICT component are reviewed for common development trends, opportunities, and challenges. The findings include: 1) ICT has a strong presence at CIES; 2) Countries from Asia, Africa, and Northern America regions have been the major contributors to CIES; 3) Educational institutions, private and professional organizations, and companies have been the key ICT4D players at CIES; 4) The interaction between ICT and other areas has been established; and 5) ICT4D SIG is suggested to further claim its role of connecting, building, and strengthening ICT4D community of practice at CIES.

In the article “ICT oriented toward nyaya: Community computing in India’s slums”, Byker presents a case study of a grassroots effort, called the community computing model, in Bangalore, India. Using Amartya Sen’s work on nyaya and Paulo Freire’s work on conscientization, the author explains how this model of community computing infused and developed a social justice oriented and deeper “critical consciousness” of the slum community where this computer center was situated.

In Byker’ second article, “Sociotechnical narratives in rural, high-poverty elementary schools: Comparative findings from East Texas and South India,” he compares case studies of computer technology use at two rural elementary schools across two international settings. Byker’s study uses the Social Construction of Technology (SCOT) theory to guide a comparative investigation of how elementary school teachers and students in East Texas and South India construct meaning for computer technology. Byker found that even though the two settings are far apart geographically and culturally, a similar sociotechnical narrative emerged. The sociotechnical narrative includes: (1) A shared hope in the opportunity and possibilities with computer technology, (2) the development of literacy skills, and (3) similarity in knowledge tasks for the future.

Lee and Sparks take an ethnographic approach to exploring telecenters in Nepal. In “Sustaining a Nepali telecenter: An ethnographic study using activity theory”, the authors explore tensions youth face when using a telecenter located in Sankhu, Nepal, a Newari village 20 kilometers southeast of Kathmandu. Tensions are categorized in order of frequency as they appeared in the data. Major tensions included gender norms, generational distrust, lack of awareness, and funding. Moderate tensions included lack of training and time. Minor tensions were location, power, and connectivity.

In the article "Unsystematic technology adoption in Cambodia: Students' perceptions of computer and Internet use", Richardson, Nash, and Flora set out to understand how upper secondary school students in Cambodia perceive the use of computers and the Internet. Using questionnaires, data were collected from students in three urban upper secondary schools (n=1,137) in Cambodia. The data indicate that the more exposure a Cambodian student had to computers and the Internet the more favorable their attitudes were toward these technologies. Additionally, students with limited exposure to these technologies were more likely to have increased anxiety about using such technologies. The findings are discussed using Rogers' conceptualization of the Diffusion of Innovations theory. This study is the first of its kind aimed at understanding the perceptions and use of digital technology by Cambodian upper secondary students.

In their article, "ICT and instructional innovation: The case of Crescent Girls' School in Singapore", Shear, Patel, Trinidad, Tan, Hoh, and Png describe a global professional development program called 21st Century Learning Design (21CLD). This program helps teachers design academic lessons that integrate opportunities for students to develop 21st Century competencies in a variety of dimensions such as collaboration, knowledge construction, and the powerful use of ICT for learning. The paper highlights the example of Crescent Girls' School in Singapore, which is implementing this program school-wide as a next step on its longstanding journey to leverage ICT for instructional innovation. The paper describes the results for teaching and learning through a communicative arts lesson that leverages place-based ICT tools for student knowledge construction.

In the article, "The effect of using XO computers on students' mathematics and reading abilities: Evidences from learning achievement tests conducted in primary education schools in Mongolia", Yamaguchi, Sukhbaatar, Takada, and Dayan-Ochir discuss the One Laptop per Child (OLPC) project in Mongolia. This paper presents the findings of a study conducted in 2012 to evaluate the impact of the OLPC initiatives on students' literacy and math skills. This study covered 14 primary schools, of which 7 received laptops and 7 did not received laptops. Over 2,000 fifth grade students in these 14 schools were tested on math and reading skill using items from the 2008 National Primary Education Assessment. In addition to these tests, students were asked to respond to a questionnaire, which consisted of demographic and ICT-related questions and computer attitude measure for young student instrument. The findings of the study indicate that the use of XO computer may have enhanced students reading skills controlling for gender, math scores, hours spent for watching TV, doing homework, and earning money.

Light and Pierson wrote "Increasing student engagement in math: The use of Khan Academy in Chilean classroom." In August of 2013, the researchers traveled to Santiago, Chile to conduct research in five schools where teachers were using Khan Academy. Light and Pierson found that the way Khan Academy functions as a digital learning environment changes the ways and the degree to which students engage with and are engaged by the math content; it also changes the way teachers and students interact with each other. The authors conclude that the Khan Academy's straightforward approach of providing an endless bank of practice exercises makes it an inviting and universally adaptable tool across different types of teachers, classrooms, and countries.

Pouezevara, Mekhael, and Darcy wrote "Planning and evaluating ICT in education programs using the four dimensions of sustainability: A program evaluation from Egypt." In this article, the authors present the findings from a program evaluation of an ICT in education project within the USAID-funded Girls Improved Learning Outcomes (GILO) program. The evaluation used a framework of four dimensions of ICT sustainability to examine the appropriateness of the design and implementation of the project, which provided simple, relevant technology to 166 schools in Upper Egypt. The findings suggest that ICT in education projects must favor neither the hardware nor the pedagogical aspects of the technology. Instead they layer the pedagogical use of technology on top of a deliberate technology infrastructure. The technical and pedagogical aspects of the program should be treated as two distinct efforts with separate but complementary goals. Paying attention to social, political, economic, and technological dimensions during the process can make a difference in sustainability and, ultimately, success of the initiative.

Finally, Porcaro and Carrier developed "Ten guiding principles for designing online modules that involve international collaborations." The authors detail how there are many opportunities for instructional designers to collaboratively design online modules with international teams. These collaborations can take many shapes, as have various levels of localization. Porcaro and Carrier thus present ten guiding principles that are shaping the work of an online module development project for training in-service teachers in Jordan.

We hope the readers enjoy this special issue of IJEDICT. To find out more about the ICT4D SIG, the Comparative & International Education Society, or the annual conference, please visit us online (www.cies.us).

Jayson W. Richardson and Jeffrey Lee
Guest Editors, IJEDICT

Original article at: http://ijedict.dec.uwi.edu/viewarticle.php?id=1833

International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 6-18

Revisioning Information and Communication Technology for Development (ICT4D) at the Comparative & International Education Society (CIES): A Five-Year Account (2009 - 2013)

Haijun Kang
Kansas State University, USA

ABSTRACT

The purpose of this paper is to provide an account of how Information and Communication Technology (ICT) has evolved as a key topic and research area at the Comparative and International Education Society (CIES) conference. The past five years' CIES conference papers with an ICT component are reviewed for common development trends, opportunities, and challenges. The findings include: 1) ICT has a strong presence at CIES; 2) Countries from Asia, Africa and Northern America regions have been the major contributors to CIES; 3) Educational institutions, private and professional organizations and companies have been the key ICT4D players at CIES; 4) The interaction between ICT and other areas has been established; 5) ICT4D SIG is suggested to further claim its role of connecting, building, and strengthening ICT4D community of practice at CIES. Recommendations are also made for the development of a broad research agenda for the field to grow and mature in this connected global ICT context.

Keywords: *ICT; ICT4D SIG; Development Trend; CIES; Educational Technology; Comparative Education; International*

INTRODUCTION

After its inaugural meeting at the Teachers College, Columbia University in New York City in 2008, the Information and Communication Technology for Development (ICT4D) Special Interest Group (SIG) has grown rapidly in number and strength. In 2013, the ICT4D SIG celebrated its fifth anniversary. Thus is it a good time to take a closer look at how the subject matter has evolved, how the context has changed, and what CIES members have been doing in the ICT4D area in this past five years.

Reviewing this evolution not only helps us celebrate what we have accomplished in the past five years as a community of practice (Lave & Wenger, 1991), but also gives us an opportunity to gain better understanding of current ICT4D related issues and to recognize the direction of theory, research, policy, and practice in the ICT4D area in this global context. As the interplay of technology with education is very complex (ITU, 2011; Fu, 2013), effort of such is by all means a central factor in defining our field and defining those of us who work in this field. It is also a necessary step for us to envision what ICT4D community of practice in general and ICT4D SIG at CIES in particular can do in the next five to ten years to contribute to "the future of the EFA movement in a global context" envisioned by 2014 CIES conference committee (CIES, 2014, para. 2).

Therefore, the purpose of this paper is to provide an account of how ICT4D has evolved as a key topic and research area at CIES annual conferences in the past five years. The assumption underpinning this research is that each year's CIES conference papers included in all general sessions with the ICT4D component not only reflect the rapid changing emphasis and orientation of the ICT4D research area, but also provide strong evidence on the growing diversity and maturity of the field itself. This research involved a comparative analysis on 2009-2013 CIES conference papers that had an ICT4D component. In doing so, this study looked for common developmental trends, opportunities, and challenges by asking the following questions:

1. How is the presence of the ICT4D community of practice at CIES?
2. Which countries and regions' ICT4D initiatives are represented at CIES? And which countries and regions' ICT4D initiatives are not represented?
3. Who are the key ICT4D players at CIES?
4. How does ICT4D interplay with other research areas at CIES?

METHODOLOGY

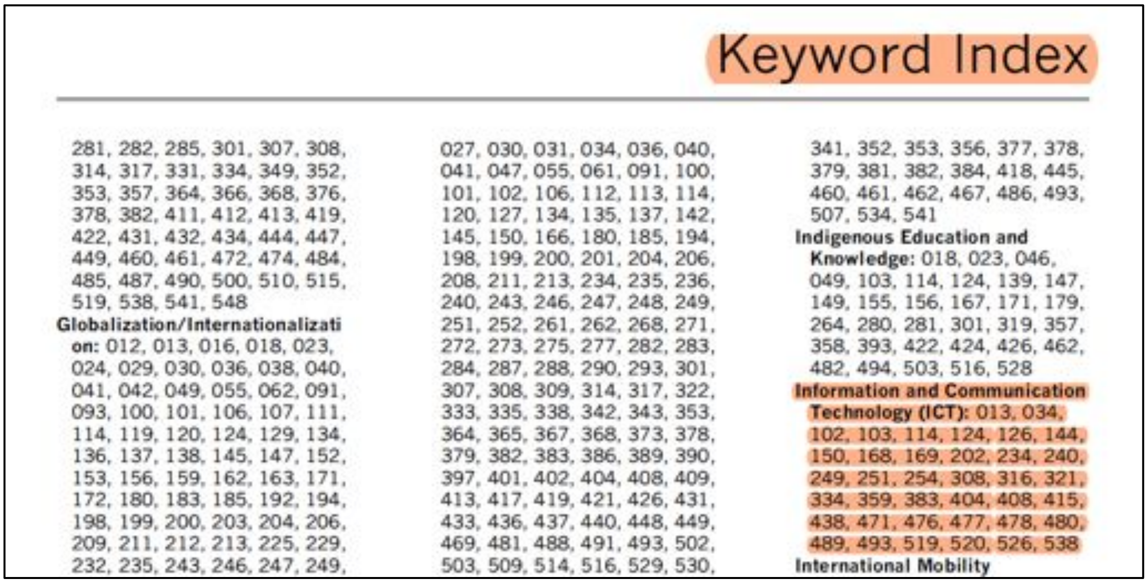
This study is a content analysis of CIES conference papers with an ICT4D component from 2009 through 2013. All conference papers with ICT4D components were retrieved from http://www.allacademic.com/ where recent years' CIES conference papers were archived and indexed. The only exception is the 2011 CIES conference at Montreal, Canada, but the conference's main website (http://cies2011.mcgill.ca/) provides access to the full conference program in pdf format.

The indexes built into CIES's online database and print programs were used to develop the following five categories: SIG, Submission Session, Research Area, Country, and Presenter's Affiliation. The purpose of adopting these existing categories built into the conference management system was two fold. First, I wanted to locate all conference papers with ICT4D components. Second, I wanted to keep the search keys mutually exclusive and inclusive to minimize the chance of missing the "global" development themes/structures (Hand, 2007, p. 621) while still having the ability to organize our conference paper data into different categories for analysis.

Data Collection Procedure

The first step was to locate CIES conference papers with ICT4D components in the past five years from 2009 through 2013. To do so, the phrase "Technology in the classroom and ICTs" was used to conduct key search on "Research Area" with CIES annual conferences held in 2009 and 2010. The rationale behind this search strategy is that this phrase was predetermined by CIES and all conference papers tagged with this phrase self-identified themselves as having an ICT4D component. For conferences held in 2011, 2012 and 2013, CIES changed the phrase to "Information and Communication Technology." The researchers believe that this change was a timely response to the field's rapid development and its broader impact. As researchers and practitioners, we should not constrain our focus merely on ICT4D's impact in classroom settings because education interacts with the socio-cultural context that it is situated in and learning is "communal and in community, rather than an isolated activity" (Merriam, Caffarella, & Baumgartner, 2007, p. 240). Balanced focus is needed on the interaction between ICT4D and education's local and global contexts.

Since CIES conference papers in 2011 were not available from CIES conference e-portal at the time of this study, the search for ICT4D conference papers for that year was done manually using the Keyword Index enclosed at the end of the conference program (See Figure 1).



Keyword Index

281, 282, 285, 301, 307, 308, 314, 317, 331, 334, 349, 352, 353, 357, 364, 366, 368, 376, 378, 382, 411, 412, 413, 419, 422, 431, 432, 434, 444, 447, 449, 460, 461, 472, 474, 484, 485, 487, 490, 500, 510, 515, 519, 538, 541, 548

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Information and Communication Technology (ICT): 013, 034, 102, 103, 114, 124, 126, 144, 150, 168, 169, 202, 234, 240, 249, 251, 254, 308, 316, 321, 334, 359, 383, 404, 408, 415, 438, 471, 476, 477, 478, 480, 489, 493, 519, 520, 526, 538

International Mobility

Figure 1: *CIES 2011 Montreal Conference Program Keyword Index*

The second step was to remove the conference papers that were tagged as having an ICT component by error. All the titles located through the "Research Area" search ("Keyword Index" search was used with 2011 CIES conference program) were reviewed. When a title did not show a clear tie to ICT4D, the abstract was reviewed. When an ICT component was not identified through the review, the conference paper was removed from the dataset. For example, a panel discussion session entitled "Deliberating in a Democracy: A Collaborative International Professional Development Initiative" in the 2010 CIES conference program was included in our search results when we did the search using the key phrase "Technology in the classroom and ICTs". We reviewed this panel's abstract (See Figure 2) and did not see a clear connection to ICT4D so it was removed from the data pool.

The panel objectives are to:

- Share promising results and lessons from DID for substantive learning and procedural civic skill building.
- Demonstrate how teachers and non-governmental organizations in different democracies can cooperate to promote democratic principles and effective methodology
- Discuss how DID enables teachers to learn and appreciate among themselves the power of deliberation in their classrooms
- Share how DID provides students with opportunities to discuss substantive content on controversial issues in their democracies and learn from other democratic societies

Figure 2: *Panel Objectives of CANDE SIG Highlighted Session*

After narrowing down the dataset to conference papers having a clear ICT4D component, the search results formed the official data pool and were then sorted by SIG, Submission Session, Country, and Presenter's Affiliation for further data mapping and cluster analysis to find out development themes and structures. Each category was examined for commonalities and connections; mapping and cluster analysis were conducted as well because most conference papers were found cross-listed in more than one category. For content stratification purposes, the conference papers with an ICT4D component were put into a main category based on the perceived focus of each analysis.

To make this review more inclusive to represent ICT's presence at the various venues of CIES annual conferences, all sessions were included in our search and analysis. See Figure 3 for included session types.

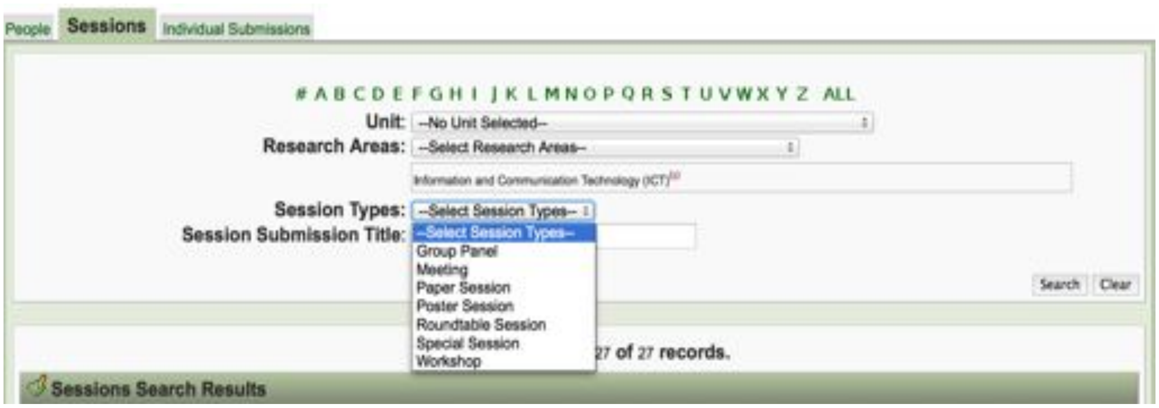

Figure 3: *CIES Conference Program Session Types*

FINDINGS AND DISCUSSION

ICT4D Has a Strong Presence at CIES

After a search in "Research Area" and a systematic title review of 2009 through 2013 CIES conference papers, our search yielded 230 titles that had an ICT4D component and all these conference papers were spread out into 112 sessions. Table 1 shows a breakout of the number of conference papers on ICT and the number of sessions that included more than one presentation on ICT4D at each year's CIES conference. On average, 46 conference presentations were made on ICT4D in 22 sessions at each year's conference.

Table 1: *Summary of 2009~2013 CIES Annual Conference Papers on ICT4D*

Year	Search Key Phrases	Number of Sessions / Presentations
2013	"Information and Communication Technology"	27/52
2012	"Information and Communication Technology"	18/39
2011	"Information and Communication Technology"	33/53
2010	"Technology in the classroom and ICTs"	15/40
2009	"Technology in the classroom and ICTs"	19 /46
Total		112/230

If ICT4D conference papers were all arranged to present on the same day, the conference's entire half-day agenda would be easily filled. Therefore, ICT4D has maintained strong presence at each year's CIES annual conference and shows a strong legacy in the history of CIES.

Countries and Regions Represented at CIES

The United Nations (2012) maintains a full list of countries in the world and these countries are organized into six broad regions including Africa, Asia, Europe, Latin America and the Caribbean, Northern America, and Oceania. The aforementioned 230 conference papers on ICT4D were sorted by countries and regions and mapped against the United Nation's member state list to find the country and region representations at each year's CIES conference.

As shown in Figure 4, all six regions were represented at CIES annual conferences in the past five years with Asia, Africa, and Northern America being the major contributors to each year's conference. These five years also witnessed the region of Africa's rapid growth from about six conference papers on ICT4D at 2009 conference to about 24 conference papers at 2013 conference. A possible explanation could be the worldwide efforts and projects initiated and led by organizations such as UNESCO to help African countries to develop information and communication technology.

The region that has not been well represented is the region of Oceania with only five conference papers on ICT4D in total in the past five years. Knowing the fact that countries such as Australia and New Zealand who have done a lot of wonderful research and practical projects on ICT4D are both located in the Oceania region, it is a little bit disappointing not seeing many conference papers on ICT4D from this region presented at CIES annual conferences. Would their contribution be critical to ICT4D development at CIES? Do they publish and present using different venues? If so, what are they? Do we care to know? These are the questions that may need to be addressed when thinking about growing our community of practice at CIES in the next five to ten years.

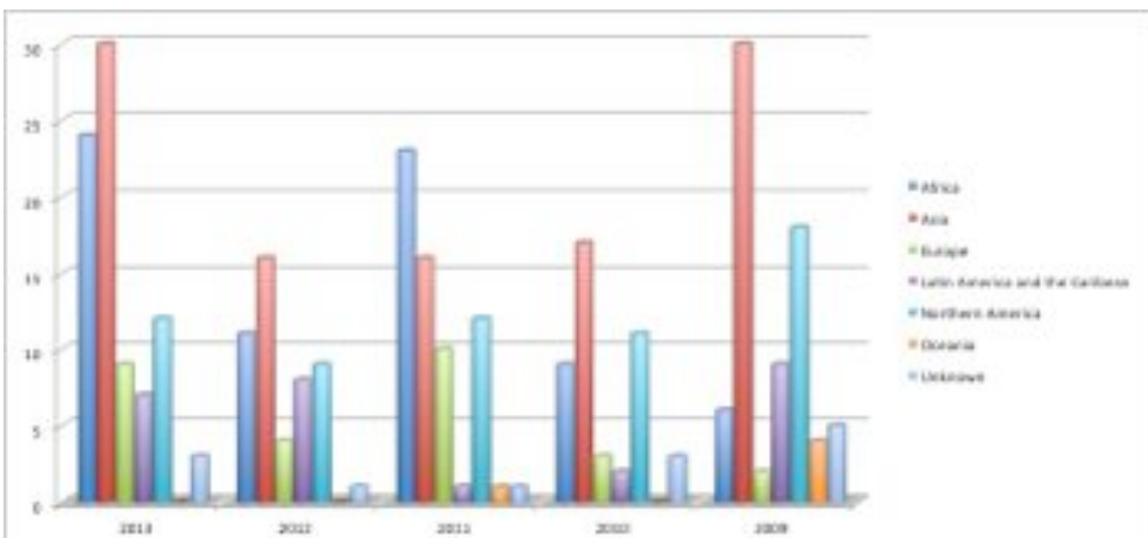

Figure 4: *Regions Represented at CIES's Annual Conference from 2009 through 2013*

To understand country representations by ICT4D conference papers, cluster analysis was conducted at the country level (See Table 2). After combining the five-year country data and removing duplicated countries (each country was counted only once during this five year period regardless of how many presentations were made each year), I located 89 countries that were represented in the aforementioned 230 ICT4D presentations.

Table 2: *Countries Most Represented at CIES's Annual Conferences from 2009 through 2013*

Year	Number of Countries	Instances of Presentations		
		No. 1 Represented	No. 2 Represented	No. 3 Represented
2013	>46	US (11)	India (6), South Africa (6)	N/A
2012	>32	US (8)	Mexico (5)	United Republic of Tanzania (3), Mongolia (3)
2011	>37	US (11)	South Africa (4), Spain (4)	N/A
2010	> 27	US (10)	Turkey (3), Yemen (3)	N/A
2009	>32	US (15)	China (6)	India (5), Korea (5)

The 2013 CIES annual conference had the greatest diversity representing more than 46 countries followed by the 2011 CIES conference that represented more than 37 countries. The reason a ">" sign was put before the number of countries in the second column is that each year had several presentations for which the presenter(s) did not specify their studies' country contexts and the authors were unable to tell their studies' country contexts by reading their conference papers. I did not want to under-calculate the number of countries represented at each year's conference nor overestimate. Therefore, the ">" sign was added to indicate that most likely there were a few more countries represented than what were identified in this study.

The numbers in brackets next to each country in columns 2 - 6 of Table 2 shows the number of ICT4D presentations presented at that year's conference. As shown in Table 2, ICT4D presentations from the United States (Northern America region) dominated each year's conference followed by China (Asia region) in 2009, by Turkey (Asia region) and Yemen (Asia region) in 2010, by South Africa (Africa region) and Spain (Europe region) in 2011, by Mexico (Latin America and the Caribbean region) in 2012, and by India (Asia region) and South Africa (Africa region) in 2013. This result is in line with the above finding that the past five years' CIES conferences highlighted countries from Asia, Africa, and Northern America regions. Where the conference is held (See Table 3) could be a possible reason to explain why the United States had the highest number of each year's ICT4D presentations, but it is not clear why we see more ICT4D presentations from Asia and Africa regions than from other regions.

***Table 3**: CIES Conference Locations from 2009 through 2013*

Year	Location
2013	New Orleans, Louisiana, US
2012	San Juan, Puerto Rico
2011	Montreal, Quebec, Canada
2010	Chicago, Illinois, US
2009	Charleston, South Carolina, US

ICT4D Players Presented at CIES

It seems that we are all living a technology-mediated life and working in a technology-facilitated environment, but who are the key ICT4D players represented at CIES? “Though individuals are the units of adaptation, they are not the units of actual evolution. The units of evolution are necessarily social groups, structures, and systems at all levels of size and complexity” (Sanderson, as cited in Kang, 2009, p. 160). A cluster analysis was done using the presenter’s affiliation to understand what types of organizations and institutions were the key ICT4D players at CIES in the past five years. According to the nature of each entity, the data was organized into four categories including: (1) Governmental agencies (i.e. Department of Education of the Philippines, Ministry of Education Sports and Culture of Samoa, etc.), (2) private or professional organizations, and companies (i.e., NGOs, consulting companies, etc.), (3) educational institutions, and (4) others (i.e., independent consultant, etc.).

After combining the five-year presenter affiliation data and removing duplicated data entry (each entity was counted only once during this five year period regardless of how many presenters from this entity presented at each year’s CIES conference), 141 organizations and institutions were identified. The commonalities shared by these entities include: they came to CIES from different parts of the world, most of them have been active players in the field of ICT4D for years, and all were represented by the aforementioned 230 ICT4D presentations. Sixty-five percent of them were educational institutions (i.e., Stanford University, USA; Belgorod State University, Russian Federation; etc.) and 28% were private or professional organizations and companies (i.e., RTI International, Intel Corporation, etc.). Therefore, they were the key ICT4D players at CIES in the past five years and need to be commended for being the main driving force for making ICT4D a core topic and research area at each year’s CIES conference.

With duplicated data entries removed (one conference paper was treated as one data entry regardless of how many presenters were listed), Table 4 lists the number of entities that presented ICT4D research and projects at CIES annual conferences in the past five years. The first three entities that sent the largest delegation of presenters to present on ICT4D at each year’s CIES conference are also listed in Table 4. This finding reaffirms that educational institutions and private or professional organizations and companies were the two major forces driving ICT4D at CIES in the past five years.

As we know, in many countries, governments play the key role in their ICT development. It would be great if governments of developing and third world countries were encouraged to present their ICT4D research and practical projects at future CIES annual conferences. Hearing voices from all parties and learning from each country’s experience would make it easier for the field to form synergy to study global factors affecting ICT4D integration into our daily life, to identify best research and practices that can be borrowed and adapted from one socio-cultural context to another, and to develop partnership to share ICT4D resources and social capital to maximize the benefits for each country.

***Table 4**: Key ICT4D Players Represented at CIES Annual Conferences from 2009 through 2013*

Year	Number of Entities Represented	Number 1 Represented	Number 2 Represented	Number 3 Represented
2013	47	Education Development Center, Inc. (7)	Penn State University (USA) (6)	Hazara University (Pakistan) (5)
2012	46	Universidad Autónoma de Tamaulipas (Mexico) (6)	University of Kentucky (4), Tokyo Institute of Technology (4) Penn State University (4), Anadolu University (Turkey) (4)	N/A
2011	46	Universitat Oberta de Catalunya, Spain (10)	RTI International (5), Concordia University, Canada (5),	N/A
2010	38	Michigan State University (6)	University of Minnesota (4), SRI International (4), Penn State University (4),	N/A
2009	38	University of Toronto(6)	Teachers College, Columbia University (4)	SRI International (3), American Institutes for Research (3), Academy for Educational Development (3)

ICT4D Infusion at CIES

After the ICT4D SIG's inaugural meeting five years ago, each year's CIES conference assigned one to two sessions to highlight ICT4D conference papers, which, as indicated in the above analysis, would never be enough to accommodate the need. Many conference papers having an ICT4D component were put into other sessions based on other key research areas self-tagged by the presenters. Hence, word cloud analysis was conducted on "Research Area" self-identified by ICT4D presenters to shed light on the interplay between ICT4D and other research areas presented at each year's CIES conference. The more frequently a phrase is used to describe a proposal's research area, the larger it appears in Figure 5. This analysis technique is referred to as word or tag cloud analysis. It is useful for visualizing the most prominent terms to determine its relative prominence (Souto, 2009).

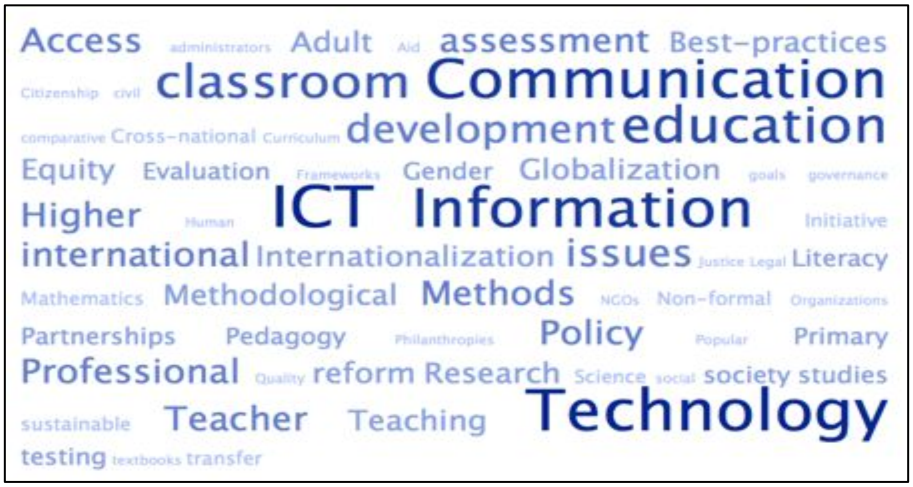

Figure 5: *Connections Between Research Areas at CIES's Annual Conferences from 2009 through 2013*

The above analysis indicates that ICT4D is deeply infused into each year's CIES conference and shows clear interaction between ICT4D and the various social issues pursued by CIES members. Some example social issues that ICT4D have been used to address include: access, adults, assessment, best practices, development, education, equity, gender, globalization, literacy, policy, teacher, among others. Some popular topics that many ICT4D conference papers presented on in the past five years include the search for best practices on ICT4D integration, ICT4D use in teacher education and training, assessment of ICT4D's effectiveness (quality), ICT4D vs. education access and equity (gender), ICT4D policies, ICT4D in developing countries (globalization and internationalization), ICT4D and social reforms, among others. Examples of research areas that overlaps with ICT4D in the past five years include: Adult Education, Equity and Access, Literacy, Assessment, Teacher Education and Professional Development, Primary/Secondary Education, and Gender Issues, among others.

A further analysis of the ICT4D conference papers tagged with research areas other than ICT4D indicates strong interplay between ICT4D and other SIGs and standing committees. Figure 6, for example, shows that ICT4D conference papers were highlighted in eight SIGs and two standing committees in the past five years. If we trace ICT4D development trend in this global context, it is logical to envision that the tie between ICT4D SIG and all the other SIGs and standing committees will be stronger and the interplay between them will be more energetic. The next five to ten years will witness more and more cross-SIG collaboration and cooperation.

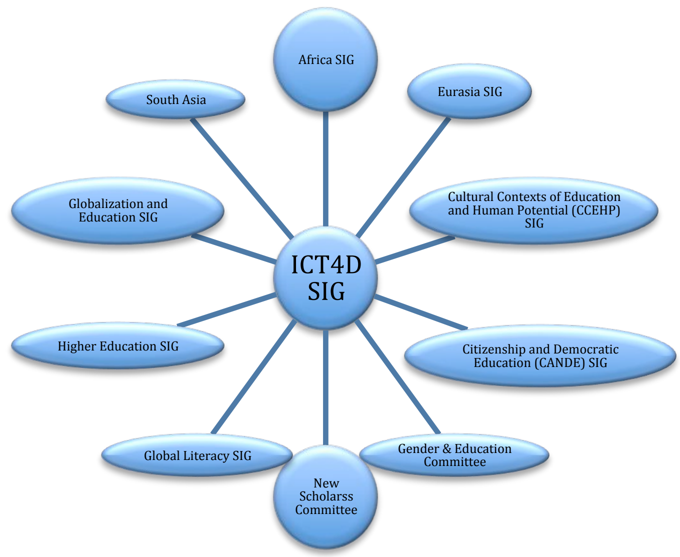

Figure 6: *Interplay Between CT4D SIG and Other CIES SIGs/Standing Committees*

CONCLUSIONS AND RECOMMMENDATIONS

The ICT4D SIG has grown rapidly in number and strength in the past five years at CIES. The data analysis demonstrated strong ICT4D presence at CIES. In particular, the study showed: (1) on average, conference papers with an ICT4D component were presented at each year's conference; (2) five of the six regions defined by UN and more than 27 countries were consistently represented at each year's conference; (3) educational institutions and private or professional organizations and companies comprised the major active ICT4D players at CIES; and, (4) strong connections between ICT4D and those topics and research areas pursued by other CIES SIGs and groups were established. It is clear that CIES members have recognized the indispensible role ICT4D plays in "the future of the EFA movement in a global context" envisioned by 2014 CIES conference committee (CIES, 2014, para. 2).

The results of this study are in line with previous studies on the trends and issues of ICT4D that digital divide remains an enduring concern in many countries (ITU, 2011; Manalo & Fliert, 2011; Marais, 2011). Capturing the fifth wave of development informatics research (Heeks, 2014), the findings of this study also highlight the contribution of applied research to the field of ICT4D (Chepken *et al*., 2012) and emphasize the importance of not underestimating the role non-technology factors play in the integration of ICT4D into education (Fu, 2013; Hamel, 2010; ITU, 2011; Wagner, et al, 2005).

Further, this study identified several research gaps that need to be filled. For example, in the past five years, not many presentations addressed how individuals involved in ICT4D, such as administrators, teachers, and learners, develop the skills and dispositions associated with learning equity and learning access; not many cross-country/culture ICT4D presentations were conducted; and, there was a paucity of presentations on the philosophical underpinning of the field. Even though, the conference index term was changed from "Technology in the classroom and ICTs" to "Information and Communication Technology (ICT)", no significant shift in the foci of the ICT4D field was identified. Therefore, future research studies are suggested to address the following areas:

1. Identify the characteristics of the global population that benefits from the use of ICT and the global population that suffers because of ICT integration in different countries and regions;
2. Explore the various research sub-areas under the big ICT4D umbrella;
3. Study ICT4D use in sub-regions listed on UN's member state list;
4. Make special efforts to bring more countries from underrepresented regions (i.e., Oceania) to CIES annual conferences to share their ICT4D achievements and lessons;
5. Test the various international comparative research methods in the context of ICT4D;
6. Develop and validate research topic appropriate instruments;
7. Develop indicators for sustainability in ICT4D that have strong research and practice base and application;
8. Conduct more cross-country/culture comparative ICT4D studies;

Effective exploration of these areas under the big ICT4D umbrella requires the active participation of scholars and practitioners who recognize the complex and overlapping contextual differences and who take opportunities to make sense of, and do something about, equity of learning outcomes and bridging ever-widening inequality of access to higher levels of learning worldwide. It is time for ICT4D SIG at CIES to claim its coordinator role to connect and build ICT4D Community of Practice. The ICT4D SIG must:

- Strengthen connections with the key ICT4D players at CIES and pursuing collaborations and partnerships with other SIGs and standing committees;
- Provide resources to encourage countries from less represented regions to participate in future ICT4D events at CIES;
- Network with ICT4D groups in different countries and regions to form synergy to address ICT4D issues and challenges from a more holistic approach;
- Form small research groups to help define the field, identify research sub-areas, create research-based indicators for quality ICT4D projects, develop and validate research methods and instruments for conducting cross-cultural ICT4D research studies.

In conclusion, ICT4D holds significant promise to address learning equity and access but more synergistic approaches, such as human scale development (Marais, 2011) and sustainable human development (Hamel, 2010), are needed to maximize ICT4D's potential benefits for human development. Even though this study only scratched the surface of the direction and evolution of ICT4D from reviewing the related conference papers presented at CIES from 2009 through 2013, the seed is planted for the development of an international comparative research agenda that could grow in many directions in the broad context of ICT4D.

ACKNOWLEDGMENT

Thanks to Dr. Brad Burenheide, Associate Professor at Kansas State University, for providing feedback to improve this article.

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Original article at: http://ijedict.dec.uwi.edu/viewarticle.php?id=1775

International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 19-28

ICT Oriented Toward Nyaya: Community Computing in India's Slums

Erik J. Byker
Stephen F. Austin State University, USA

ABSTRACT

In many schools across India, access to information and communication technology (ICT) is still a rare privilege. While the Annual Status of Education Report in India (2013) showed a marginal uptick in the amount of computers, the opportunities for children to use those computers have remained stagnant. The lack of access to ICT is especially common in India's urban slum areas, which is privy to the "Matthew Effect" (Merton, 1968) where the poor become poorer based in part on the scarcity of high-tech resources. This article's purpose is to describe and report on ICT program interventions that target young people living in India's slums. Specifically, the article examines a case study of a grassroots effort, called the *community computing model*, in Bangalore, India. Using Amartya Sen's work on nyaya and Paulo Freire's work on conscientization, the article explains how this model of community computing infused and developed a social justice oriented and deeper "critical consciousness" of the slum community where this computer center was situated.

Keywords: *Bangalore; Community Computing; Conscientization; Educational Technology; Freire; India; Nyaya; Sen; Social Construction of Technology Theory (SCOT)*

INTRODUCTION

I do not think I will ever forget the frustration that a 10-year old child expressed when I asked her about computer technology at her government-run, public school in Bangalore, India. I inquired, "How often do you use computers at the school you attend?" The child responded, "Sir, never, sir. My teacher does not allow us to use the computer, Sir. She thinks we will break it. Sir, I am not allowed to touch the computer at my school, but I come here and am so proud to use it. I will continue to use the computer to help make my community better." The place that the student was referring to is called the Ramji Center. It is an example of a community computing center in one of Bangalore's largest slums.

Community computing is a grassroots model that seeks to empower people in marginalized (and, often, neglected) communities with basic computer skills. Community computing emerged as a model of information and communication technology (ICT) for development in Bangalore, India. The model provides children living in slum communities a place to use computer technology and develop digital skills. The purpose of this paper is to describe and report on case study research of the Ramji Center by examining how the children at the center used and assigned meaning to the center's computer technology. Specifically, the paper investigates how the uses for the computer technology led students to develop a critical consciousness of themselves and their community.

I organize the paper into four sections. In the first section, I introduce the study's social context and describe the theoretical frameworks that ground this study. In particular, I discuss the Social Construction of Technology (SCOT) theory (Bijker, 1995), Paulo Freire's (1970) work related to conscientization, and Amartya Sen's (2001) work on social justice or *nyaya*. In the second section, I describe the research methodology. In the third section, I report on the findings from this case study on the Ramji Center. In the final section, called Discussion, I discuss the study's findings in relationship to the theoretical frameworks. I also further explain how the Ramji Center utilizes their ICT based curriculum towards social justice and the development of critical consciousness.

BACKGROUND

Bangalore is mirror of the great contrasts that is represented throughout India. While India is increasingly known for its highly skilled ICT industry, one third of the world's poor live in India. In his profound and sweeping book, *India after Gandhi*, Guha (2007) describes the contrasts in this way, "prosperity co-exists with human misery, technological sophistication with human degradation" (p. 711). Indeed, some parts of India are quite developed, but most of India is still developing (Guha, 2007; Kumar, 2010). An "emerging nation" is one label that policymakers often use to characterize India. But, as Guha (2007) perceptively notes it is difficult to identify or define India with one descriptor or label; India "is *sui generis* . . . it stands on its own" (p. 771). In many ways, Bangalore also reflects India's uniqueness.

Bangalore is framed by various meanings. Bangalore shares the dual, and somewhat binary, nicknames of India's Silicon Valley and India's Garden City. In early Indian history, Bangalore was known for being a lush retreat for South Indian royals. Today, Bangalore is a place that echoes with the hum of computer technology and the din of globalization. Bangalore as the nexus of globalization was popularized by the writings of Thomas Friedman, *New York Times* columnist and author of *The World is Flat.* Friedman (2005) associates Bangalore with the opportunities represented in a globalized world. He explains this association with the following rush of words, "Bangalore represents the possibility to collaborate and compete in real time with other people on more different kinds of work from more different corners of the planet on a more equal footing than at any previous time in history" (Friedman, 2005, p. 8). Bangalore represents the *possibilities* of Indian society. For example, uses for computer technology have helped to generate India's steady economic growth and reputation as a technological leader in today's global economy. And much of the discussion of India's reputation in this regard starts with the word Bangalore.

Yet, the uses for computer technology in India's schools are also problematic because of the realities of Indian society. Since developed nations' industries rely on the Indian workforce, India's reach as technological leader touches most developed nations. But this technological leadership barely even grazes many of India's urban slums and rural villages. Indeed, it is quite rare for India's government-run public schools in rural areas to have even a single working computer (ASER, 2013; Azim Premji Foundation, 2004). In urban areas, many children share the frustration of the 10-year old girl, who is introduced in the paper's first paragraph, because of the lack of access to computer technology. In India, as in other countries, it is the poor who continue to get neglected and marginalized when it comes to issues of equity and access to ICT. Raven (2013) explains this marginalization as reflection of the "digital divide, which is widely used to refer to differences in access to information and communication technologies, basically the gap between the 'haves' and the 'have not's'" (p. 174).

The Ramji Center seeks to bridge the digital divide that exists in Bangalore's urban slum neighborhoods. The origin of the Ramji Center helps to explain why the Ramji Center is so committed to its vision. The genesis of the community computing model starts with children from the slum, a community activist, and computer software engineers. The children were upset that they were not allowed to use computer technology at the government-run, public schools that they attended. They wanted to learn how to use computer technology and asked a local community activist, Ms. Lakshmi (a pseudonym), if someone could help set up a computer center in a small space that was not being used by the community.

Ms. Lakshmi liked the idea and had the children make a promise to not give up in their pursuit of computer education. She explained that they were the ones who were going to bridge the digital divide. Then, Ms. Lakshmi discussed the children's suggestions with some software engineers who worked in one of high-rise, office buildings next to the slum. The software engineers agreed to volunteer their time to help set up the center. Ms. Lakshmi found some people to donate a couple used laptops and desktop computers, and the Ramji Community Computing Center commenced. As mentioned earlier, the Ramji Center utilizes a unique model called community computing. The community computing model is a moniker that originated from the software engineers who helped to organize the Ramji Center in 2008. The volunteers explained that "community computing" is an empowerment initiative owned by the local community to address the widening digital divide through the use of free software.

Specifically, the community computing model seeks to empower local community through ownership of computers and computer education. The Ramji Center has a three prong mission for community computing: (1) Create self-sustained and employable young people who have excellent computer skills, (2) Enable upward social mobility to slum children by providing computer skills and educational support, and (3) Create agents of change in the local community who can be catalysts for social transformation. This mission is enacted in two unique ways. First, the mission is implemented through a cycle of "pass it on" education. Pass it on education simply means that the volunteers from the local software companies first worked with the teenagers in the Ramji Center to teach them basic computer literacy skills. Once these teenagers, who are all from the same slum, learned some basics they became the teachers for the younger children. Second, the Ramji Center mission is implemented using free, "open source" GNU/LINUX software. The course instruction includes hands on computer skill training that revolves around the free software movement. The Free Software Foundation website explains that free software is synonymous with liberation in that it lets people develop and improve software. The use of free software reflects the Ramji Center's larger commitment to the mission of social transformation. Free software allows the students to have equitable access as well as investigate how software is developed and changed. Later in the paper's findings section, I explain how the children at the Ramji Center used various free software programs to support their development of digital skills.

THEORETICAL FRAMEWORK

There are three theories that ground this research. First, the paper's conceptual frame, which also informs the methodology, is situated in the Social Construction of Technology (SCOT) theory. SCOT's core premise is that people give meaning and purpose to technology (Bijker, 2010). SCOT theory originated from Pinch and Bijker's (1984) case study investigation of the historical development of technologies like the bicycle and light bulbs. SCOT maintains that social groups, like students and teachers, construct the meanings and purposes for technology based on their social context and interactions. In a school setting like the Ramji Center, the social shaping of technology happens in a context of use and negotiation among students and teachers.

SCOT also offers a methodological approach for examining how people negotiate meaning for technology. SCOT's four step approach includes: (1) identifying the relevant social groups who share space in a technology's meaning construction; (2) examining each group's interpretative flexibility, which is their interpretations for using computer technology; (3) investigating how the social groups negotiate their interpretative differences; and (4) examining each social group's demographics or "technological frame" in relationship to their interpretations for computer technology (Bijker, 1995). This methodological approach is helpful in uncovering how and why people assign meaning to computer technology based on their social context and interactions. I discuss more about how I use SCOT's methodological approach in the methodology section of this paper.

In order to examine how the coupling of computer technology with social justice at the Ramji Center, I use two additional theories. The paper is informed by the works of Sen (2001, 2009), and Paulo Freire (1970, 1994, 2004). So what do I mean by social justice? Conceptions of social justice have been influenced by John Rawls (1999) assertion that justice is fairness. Justice gets exercised through the upholding of rights and liberties, which are situated in equality and the common good. Sen (2001, 2009) situates social justice in the everyday lives of people, not just the larger institutions that network people. Sen's (2009) conception of justice starts with an examination of the world's "manifest injustices" (p. 259). He explains that social justice ought to be more concerned with removing injustices, rather than defining a just, utopian society. Sen employs the Sanskrit word, *nyaya,* to anchor his conception of social justice. Nyaya, which Sen (2009) defines as realized justice, is connected to how justice "actually emerges" and not just the law and order that societies happen to have not just the in comprehensive to have (p. 20). This paper's working definition for social justice, that I will explain momentarily, is rooted in the concept of nyaya, which I describe as realized justice as it actually happens.

While nyaya serves as a foundation for my working definition of social justice, the definition is further informed by the writings of Paulo Freire. For Freire, education's true purpose was for the development of a critical consciousness of the world. Freire (1970) termed such critical consciousness as conscientization, or *conscientizao*, which he describes as knowledge "that emerges only through invention and re-invention, through restless, impatient, continuing, hopeful inquiry that human beings pursue in the world, with the world, and with each other" (p. 58). Freire equates conscientization to an education that liberates; an education that helps learners to transform who they are and how to change their reality. I imagine that if Freire were still alive, he would embrace Sen's understanding of social justice being synonymous with nyaya, or realized justice. Freire might also emphasize the importance of literacy as it relates to nyaya. For Freire, literacy involved more than just the ability to read and write; rather, literacy meant "reading the world" and "re-writing the world." Reading the world is the critical examination of the social realities, including the "manifest injustices" (Sen, 2009, p. 259) that exist for many people. Re-writing the world speaks to how those injustices can be transformed through knowledge and action. Such transformation is where nyaya is actually realized in the lived experiences of people in their communities.

Thus, social justice is cognizant action to reveal and root out injustices; it is the consciousness of societal inequalities and injustices that dehumanize people. Yet, social justice also includes action. Through the acknowledgement that society does not have to be this way; social justice transforms inequalities. This work of actual societal transformation is what makes social justice, or nyaya, so robust and gritty. Nyaya happens in communities, among people, in relationship to the wide context. In the paper's findings section, I share how the Ramji Center is making inroads toward nyaya through their uses and meanings for computer technology.

METHODOLOGY

Grounded in the SCOT framework, the study's research questions are the following: (a) What are the meanings and uses for computer technology in the Ramji Center?; (b) What characterizes the social shaping of computer technology at the Ramji Center? I divide these primary questions into the following research sub-questions that are based on SCOT's heuristics.

1. Who are the relevant social groups and what is the social context like at the Ramji Center?
2. What meanings do the study's relevant social groups (students and teachers) assign to computer technology?

3. How do the relevant social groups at the Ramji Center negotiate the meaning for computer technology use? To what degree is there stabilization?
4. How does the Ramji Center's social context help explain the meaning they assign and negotiate for computer technology?

I organize the findings section by addressing each question one by one. I utilize a case study research design in the ethnographic tradition (Geertz, 1973). According to Yin (2008), case study is a research design for empirical inquiry that allows for the investigation of complex phenomena within in an authentic context. The study employed qualitative and quantitative methods to compile a case study of the Ramji Center. The study's data were collected between November 2010 and April 2011. The study's sample was drawn from the Ramji Center (a pseudonym), which is a community center in Bangalore. The study's child participant sample is 13 elementary-aged kids, who are at the fifth grade age range (10 and 11 years old). The study's educator participant sample is five educators, who all live in the same community as the students, and range in age from 16 years old to 22 years old.

There were four qualitative data sources: field notes from on-site observations, a student focus group interview, educator interviews, and collected artifacts like curriculum documents and digital images. The study's observation protocol provided focus for field observations. The student focus group interviews and tutor interviews were structured to identify perceptions for using computer technology. Collected artifacts included curriculum documents and digital images as visual data of the Ramji Center's computer hardware and software. Two sources of quantitative data included: a student questionnaire and an educator questionnaire. The questionnaires generated demographic data and identified the participants' perceptions about using computer technology.

I analyzed the qualitative data using a three-step interpretive approach and the constant-comparative method (Miles & Huberman, 1994). Pattern-matching logic (Yin, 2008) was also utilized to identify patterns in the data that either do or do not match with Freire's conscientization. I analyzed the quantitative analysis at a descriptive level. These descriptive statistics were intended to provide "snapshots" of participant perceptions of computer technology. The quantitative results were helpful to triangulate findings about the participants' perceptions of computer use. However, the quantitative data only provided basic descriptive statistics and not intended to claim causality.

FINDINGS

As mentioned earlier, I report the findings for this research by addressing each SCOT question. The first question is: *Who are the relevant social groups and what is the social context like at the Ramji Center?* I will first address the context. The Ramji Center is an after-school community center located at the end of what some might call a narrow, "back alley" of a slum. Three story tenements tower above the alley. The tenements are densely populated with families. The alley serves as a kitchen, latrine, washroom, and the communal laundry area. The center is located in a one-story building that serves as both a computer center and a communal area for the slum. The building is one large room about 8 meters in length by 3 meters wide. The walls are a two-toned color with canary yellow on top and baby blue on the bottom. The cement floor is painted an auburn color and is dusty. The room has four large windows that open up to a view of the alley way. A metal locker, a wooden table, four chairs, and a bookshelf make up the room's furniture. A framed portrait of Dr. B.R. Ambedkar hangs on the main wall. Inscribed below his portrait are these words, "Father of India's Constitution." One of the rules of the center is to remove shoes before entering; yet, many students arrive barefoot and explain they prefer to walk around the slum neighborhood that way.

The Ramji Center holds classes for elementary-aged slum children on weekend evenings for two hours at a time. The center has a desktop computer and three laptop computers, which students take turns using. The Ramji Center educators post a rotation schedule so that all the children who attend get about 15 minutes on the computer. Students primarily play computer games or go to a computer art program called Tux Paint. Students who are waiting for their turn on the computer receive tutoring for their school homework. The last 15 minutes of each weekend lesson is dedicated for singing and dancing. The songs that the students sing are social-justice oriented and in the Tamilian language.

Children and the center's educators are the relevant social groups related to this study. About 20 children regularly attend on the weekends, of which 80% are girls (the students are between 8 years old and 12 years old). I interviewed 13 students who were 10-11 years old. As previously mentioned, the educator participant sample is five educators, who all live in the same community as the students, and range in age from 16 years old to 22 years old. All the participants' parents are either day laborers or house servants. Many of the parents are Tamilians, who migrated to Bangalore from Tamil-Nadu, the Indian state that neighbors the State of Karnataka where Bangalore is the capital. The families move to Bangalore looking for jobs and economic opportunity, but find that the housing market is unaffordable. Thus, many cannot afford to live in an apartment on their meager wages from daily work, so they end up renting in the slums. Most of the children in this study reported that they live in a one room flat with, at least, four or five other people and sometimes with another whole family. Firewood and garbage are the common sources of fuel used to cook food in the slum's alleyway. None of the children's families owned a car. Instead, most the children reported that their family had a bicycle that was used for transportation. Additionally, all the study's children reported that their families owned a television and a cell phone. The study's participants reported that the average amount of books in the place they lived was seven. Finally, more than 75% of the study's children shared that they wanted to become software engineers in the future.

The second question is: *What meanings do the study's relevant social groups (students and teachers) assign to computer technology?* This question seeks to identify the different interpretations that relevant social groups have related to computer technology. At the Ramji Center, the students and educators had different interpretations for the computer's purpose. The educator's interpretations aligned closely with the Ramji Center mission statement whereas the students' interpretations were focused more on the activities, which they enjoy the most while at the Ramji Center: Playing games.

In Table 1, I organize the interpretations by percentage of how often that interpretation. I also include example participant quotes that illustrate each interpretation. Table 1 shows that while the Ramji Center's participants assigned different meanings and interpretations for computer technology, confidence and self-esteem were common themes among the two groups. The students talked about the computer games they get to play as part of developing confidence on the computer. Confidence development also connects with the Ramji Center's mission statement related to children seeing themselves as part of the catalyst for social transformation. See Table 1 for more details.

***Table 1**: Relevant Social Groups' Interpretations for Computer Technology at the Ramji Center*

Teachers' Interpretations	Students' Interpretations
1) Self-esteem - 60% "*the computer makes me proud of who I am*"	1) Games a pathway to confidence – 62% *"I am so proud to use computers"*
2) Upward mobility – 20% "*knowing the computer is the children's way out of the slum*"	2) Computers are fun - 23% *"I like the computer, it does not make me tired"*
3) Social transformation – 20% "*my computer skills can make the community better*"	3) Computers as special knowledge - 15% *"computer is important for my future"*

The third question is: *How do the relevant social groups at the Ramji Center negotiate the meaning for computer technology use? To what degree is there stabilization?* The fact that the Ramji Center students and teachers agree on a similar interpretation for computer technology (i.e., the development of confidence) shows a level of consensus related to the stabilization of meaning. So how did this consensus of meaning happen? I asked this question to the educators, and they explained how when they first started, the educators tried to teach using GNU-Linux (free, open source software) to even the younger, elementary-aged students who attended. The educators noticed that the younger students were either bored or unruly and many dropped out of the program. So the educators changed the curriculum for younger students. Game playing has become the focus in order to keep the younger students attending and to help spark their interest in learning about computers. As one of the educators explained, "The children are motivated to play games and make things with the computer and these things help build their confidence with the computer's keyboard." Another Ramji Center educator posited that such motivation would most likely increase the chances that the children will continue to consistently attend Ramji Center. The educators also explained that the Ramji Center children grow older; more advanced computer skills would be introduced. Yet, the educators were especially attuned to the importance of keeping children motivated to return each weekend to the Ramji Center. The key, though, is to have students consistently attend and buy into the Ramji Center mission.

One form of buy in is to also have students learn how to create artifacts and documents on the computer. In my field observations at Ramji Center, I observed the children playing games on the laptops. The favorite games were chess, a racing car game, and a free software Cricket type game. The children also enjoyed using the OpenOffice Impress program to create projects that reflected the Ramji Center's mission of having the children become future change agents in their community. For example, one such project was a poster design. For this project, the children created a poster that explained a social problem with both images and words (in English and in the Tamilian script, which is the mother tongue language of many children living in the slum). The children created posters that included topics like: child labor, air and noise pollution, the danger of firecrackers, and women's rights. The poster's purpose was to raise awareness of community and social issues. Such a project fits with the center's goal of promoting social justice through computer use.

The last question is: *How does the Ramji Center's social context help explain the meaning the students and educators assign for computer technology?* Prior to visiting the Ramji Center, I had the opportunity to interview and chat with one of the software engineers who volunteered to help get the Ramji Center started. During our interview, the software engineer focused his conversation on understanding the context where the Ramji Center is situated. He explained how most of the students and educators were the daughters and sons of day laborers and house servants. For many of them, they had never even touched a computer before coming to the Ramji Center. The Ramji Center played an important part in the slum community by providing access to computer technology hardware and software.

The software engineer also discussed and was quite familiar with many education theorists, including John Dewey and Paulo Freire. When I asked the volunteer about the impetus for volunteering and helping to start the Ramji Center in the slum, the volunteer stated, “I think of what Paulo Freire said about education without social action is no education at all. So we are guiding students in learning computer skills that will empower them to make their community better.”

Indeed, throughout the interviews and data collection with the study’s participants, words like empowerment, empower, community, and improvement were oft repeated. For example, when I asked one of the Ramji Center educators why computer education was important for the center’s children, here was the response, “The computer is a better way to learn more without a teacher. I want the children to know that the computer is useful in the field of life, they can use the computer to improve their life.” I followed up on this question by asking, “How so, how does the computer help to improve a child’s life?” The educator responded by exclaiming, “The world tells the children that this [the slums] is where they belong, but knowing the computer is their way out. By knowing how to type in English, make presentations, and work a computer, the children make the community better, too.”

The Ramji Center student participants also agreed with this sentiment. When I asked the children in the student focus group interview if they thought that computer technology would prepare them for the future, all the children enthusiastically agreed that it would. I asked a couple of the children to explain how and why. Here are the responses that they gave: 1) “Sir, yes, sir. Sir, knowing how to use the computer is important for my future. I want to be software engineer, so the computer is something I will use every day.” Thus, the Ramji Center’s wider social context shapes the emancipatory meanings that students and educators assign to the technology.

DISCUSSION

Ramji Center is an example of educational settings that is committed to computing towards nyaya through, in part, the development of a critical consciousness. Earlier in the paper, I referenced Sen’s (2009) use of the term, nyaya. I adopted Sen’s notion of nyaya to define social justice as cognizant action to reveal and root out injustices. Throughout this section, I discuss the ways that the Ramji Center use for computer technology was social constructed for nyaya or social justice.

The first way that I focus is on is access, which is a big part of the Ramji Center’s mission statement. Indeed, the Ramji Center’s vision is oriented toward providing computer technology access and skills to underprivileged children, who are often ensnared by the inequalities and injustices that characterize life in India’s slums (Dalrymple, 2009; Deb, 2011; Guha, 2007). Lack of access to resources is an injustice that continues to persist in these communities. For example, in India’s government-run, elementary schools, computer technology is quite scarce. And like the Ramji Center children reported, even if there are computers in the school, children are often not allowed to even touch the computers until they are in the seventh or eighth standard. The Ramji Center addresses this issue of access by providing computer technology for the students to use. Furthermore, the students were encouraged to use the technology. It is no surprise that the students and educators perceived that such access is liberating and a key part helping to develop confidence.

Another way that the Ramji Center were computing towards nyaya was in giving their students a voice. Srinivasan (2006) provides an instructive analysis regarding social justice oriented computer education. Srinivasan (2006) explains that the power of computing towards nyaya is that it "directly engage the voices, categorical notions and discourses directly from the community themselves" (p. 357). The inception of the Ramji Center is an example of Srinivasan's quote. For example, when the Ramji Center's children voiced their request for computer technology, their voices were heard and acted on. In India and in many other countries around the world, including the United States, the voices of children are often suppressed and silenced. Indeed, it is rare in the literature to find instances where children, especially underprivileged children, have political power or influence; where their collective voice is truly heard. However, in the case of the Ramji Center, it was the children who helped to get the center started.

A third way is through media authorship. One of the affordances of computer technology is that it is a malleable tool that gets used for many purposes. Indeed, an important benefit of computer technology is that it allows for the creation of content and media (Srinivasan, 2006). Computer technology is powerful because it can be shaped, changed, and re-purposed. The Ramji Center help guided their students to create and present content with computer technology. This shows the possibilities of using computer technology to develop a critical consciousness by rewriting or, more fittingly perhaps, to reprogramming the world. The uses for computer technology can have an emancipatory quality; it can be used to disrupt, intervene, and question the existing powers structures. For example, when the Ramji Center educators had the children create their poster projects about social issues, there was also the expectation that the children would hang their posters in the community in order to raise awareness. Such acts are oriented toward nyaya as students develop a deeper and "critical understanding of technology that is infused with the growing capacity for intervention in the world" (Freire, 2004, p. 85).

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Original article at: http://ijedict.dec.uwi.edu/viewarticle.php?id=1777

International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 29-40

Sociotechnical Narratives in Rural, High-Poverty Elementary Schools: Comparative Findings from East Texas and South India

Erik J. Byker
Stephen F. Austin State University, USA

ABSTRACT

The article's purpose is to compare case studies of computer technology use at two rural elementary schools across two international settings. This study uses the Social Construction of Technology (SCOT) theory to guide this comparative investigation of how elementary school teachers and students in East Texas and South India construct meaning for computer technology. Building off of SCOT theory, the article also introduces the term, "sociotechnical narratives" as part of the analysis of the meaningful descriptions of ways that social groups use tools in relationship to their wider social context. The article found that even though the two settings, East Texas and Rural Karnataka, are about as far apart geographically as they are culturally, similar sociotechnical narrative emerged. The sociotechnical narrative includes: (1) A shared hope in the opportunity and possibilities with computer technology, (2) the development of literacy skills, and (3) similarity in knowledge tasks for the future. The study's comparative research design provides greater depth in analyzing the meaning and uses for computer technology among students and teachers in rural, high-poverty areas across international contexts.

Keywords: *Elementary Schooling; ICT; India; Poverty; Rural Schools; Sociotechnical Narratives; Social Construction of Technology Theory (SCOT)*

INTRODUCTION

In his deeply perceptive book*, The Social Character of Learning*, Krishna Kumar (1989) asserts that, "schools equip individuals with knowledge and skills that are appropriate to the tasks generated by the economy and supported by politics and the local culture" (p. 69). In the current Global Information Technology Age, which is characterized by technological advances but also growing inequities, what knowledge and skills do elementary schools begin to equip individuals with? Does the knowledge and skills emphasized in schools reflect the tasks generated by a highly interconnected globalized economy? And, does the knowledge and skills address or just reproduce the inequities? This article takes up these questions by examining the meanings for computer technology in rural, high-poverty elementary schools. Specifically, the article compares perceptions of computer technology use among students and teachers in rural elementary schools in South India and in East Texas.

The article's purpose is to describe and report on case studies of computer technology use at two rural elementary schools in the international locales. The article reports on similarities and differences in the sociotechnical narratives (Byker, 2012) that emerged from the two schools. Sociotechnical narratives are the meaningful descriptions of ways that social groups use tools in relationship to their wider social context. This definition for sociotechnical narratives combines Bijker's (1995) notion of the sociotechnical with Mattingly's (1991) notion of narratives. The sociotechnical, then, is made up of the many different spheres of social context (e.g., economic sphere, political sphere) and the technological, which is the way people use tools (Bijker, 1995). According to Mattingly (1991), a narrative is how people make sense of complex experiences and phenomenon in descriptive and meaningful ways. This article utilizes sociotechnical narratives to explore how the meanings that the study's participants assigned to computer technology reflect the rural contexts in which both schools are situated.

The paper is divided in to five parts. The first part provides background information with a review of the literature. The paper's second part describes the study's theoretical framework, which is a social constructivist theory, called the Social Construction of Technology (SCOT) theory. The SCOT theoretical frame further informs the study's research questions. The study's methodology is explained in the paper's third part. Part four describes and discusses the comparative findings from the two schools. In the paper's conclusion, the final part, recommendations of further studies are highlighted. Additionally, the study's findings are discussed in order to shed light on examples of the complex sociotechnical narratives that emerge from rural elementary schools in East Texas and South India.

BACKGROUND

Government leaders and educators often link computer technology use with promising educational benefits in delivering innovative ways to educate elementary schoolchildren. However, little is known about how school level contextual issues shape the meanings for computer use (Light, 2010; Pal, 2009; Walsham, 2010). Likewise, there is very little research on how elementary school teachers and students construct and negotiate their meanings or purposes for the use of classroom computer technology. Nor is there much comparative and international research on the similarities and differences in the uses for computer technology across school contexts. So while there is considerable interest in utilizing technology to raise student achievement, educators are unclear about the best ways to do this. The extensive research efforts of international organizations, like the Organization for Economic Co-operation and Development (OECD), have resulted in a deep knowledge base about the possibilities and effectiveness of using technology in school. Yet, there is this strong knowledge base among policymakers, the way technology enhances teaching and student learning is not well understood by educators. Despite all the grant money, goals, and promises related to educational technology, there is limited knowledge among educators about the way technology also gets contextualized in the classroom (Buckingham, 2007; Cuban, 2001; Ertmer,Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; IlBe, Maeng, & Binns, 2013; Howley, Wood, & Hough, 2011; Kim, et al., 2013; Selwyn, 2002). Thus, the research surrounding elementary school technology integration research is scarce and inconclusive.

The literature reveals that more empirical research is needed into constructivist practices around computer technology as well as how meanings for technology are socially constructed. Researchers including Buckingham (2007), Selwyn (2010), and Staples, Pugach, and Himes (2005) emphasized how elementary school context shapes the way in which technology get utilized. For example, Staples, Pugach, and Himes (2005) argue that successful integration of technology is more than just access to technology or an investment in laptops. Their case studies of three elementary schools reported findings to help scaffold successful elementary school technology integration. They posited that three factors are necessary to meet the challenges and barriers of technology integration. First, technology must be aligned with curriculum and the elementary school's mission. Related to this first point, the importance of including everyday stakeholders in the elementary school community especially the teachers and students, is discussed. Second, there must be teacher and principal acceptance and "buy in" for using the technology. Buy in is evident in the everyday, consistent commitment that teachers show in their use of the technology. Third, public recognition must be given for students and teachers to continue to be engaged with instructional technology. This current study picks up on similar themes, but with a deeper investigation as to how computer technology is socially constructed through a context of use in rural schools.

THEORETICAL FRAMEWORK

This study uses the Social Construction of Technology (SCOT) theory to guide the comparative investigation of how elementary school teachers and students in East Texas and South India construct meaning for computer technology. SCOT theory maintains that the meanings and purposes for technology come from people (Bijker, 2010). SCOT posits that a technology's meaning making happens through negotiation among groups of people, like students and teacher. And this negotiation happens through a discourse about the technology. Discourse, is the process by which people communicate, both verbally and nonverbally, their interpretations about objects and ideas. SCOT holds that a technology's discourse happens in the context of use.

SCOT theory offers four steps for investigating how people negotiate meaning for technology. The first SCOT step is identifying relevant social groups. According to Bijker (1995), relevant social groups are the actors who share space in a technology's meaning construction. The study's relevant social groups were fifth grade students and teachers at an elementary school in East Texas and at an elementary school in rural Bangalore. More details about the two schools are provided in the methodology sections. The second SCOT step is to distinguish the relevant social groups' interpretations of technology. Bijker calls this interpretative flexibility. Bijker asserts that interpretative flexibility is detected via a social group's rhetoric about a technology's goals, outcomes, and purposes. The third SCOT step examines how the social groups negotiate their interpretative differences. Bijker describes this negotiation process as a technology's stabilization. Different degrees of stabilization include: (1) relevant social groups come to a *consensus* about the meaning of a technology; (2) one social group *dominates* the "meaning making" process of technology; or (3) two or more social groups *compete* in the "meaning making" process and the meaning gets negotiated through this competition (emphasis added, Bijker, 1995). The fourth SCOT step requires a further examination of demographic data in order to identify each social group's technological frame. The technological frame is each group's cultural and socio-economic characteristics (Bijker, 2010). Bijker (2010) explains that as social groups interrelate, they negotiate and construct a common interpretation of a technology using their technological frame characteristics.

SCOT theory is useful for identifying how social groups construct different meanings for their understanding of "core meaning of a technology" (Bijker, 1995, p. 281). These core stories are what the article recognizes as "sociotechnical narratives." As mentioned earlier, the notion of sociotechnical narrative emerged, in a grounded theory way (Glaser & Strauss, 1967), from the work of Byker (2012). Sociotechnical narratives also build on the contours of SCOT theory, particularly within the explanation of technological frames. To review, sociotechnical narratives are the meaningful descriptions of ways that social groups use tools in relationship to their wider social context. In the context of schooling, these narratives help illustrate the complexity related to the purposes that teachers and students construct about a technology's core. Thus, the uses for a school's computer technology is constructed into something considerably more meaningful than just computer hardware, software, or knowing how to tap on a computer's keyboard.

In order to identify and compare the study's sociotechnical narratives, two primary research questions situate the study: 1) How and why is computer technology socially constructed in elementary schools in East Texas and South India?; and 2) How is the social construction of technology similar and different between the two locations?

The power of SCOT theory is that it is not only a theoretical framework, but it is also a methodological approach. SCOT provides a set of questions, which are aligned to its four steps, for investigating the uses for technology in a certain setting. These questions are the following:

1. Who are the relevant social groups and what is their social context like?
2. What meanings do the study's relevant social groups assign to computer technology?
3. How do the relevant social groups negotiate the meaning for computer technology use? To what degree is there stabilization?
4. How does the social context help explain the meaning the relevant social groups assign and negotiate for computer technology?

METHODOLOGY

To investigate these questions, the study employs a comparative case study research design (Yin, 2008) that is situated in the ethnographic tradition. Geertz (1992) said, "The aim of ethnography is to clarify what on earth is going on among various people at various times and draw some conclusions about the constraints, causes, hopes, and possibilities—the practicalities of life" (p. 133). The study's method is aimed at understanding and drawing comparisons between the meanings constructed for computer technology in elementary schools.

Yin (2008) asserts that case study is a research design for empirical inquiry that allows for the investigation of complex phenomena of authentic contexts. The strength of case study research design is that it allows the researcher to examine *how* and *why* questions. A *how* question is useful for identifying the processes that a people under study use in order to accomplish objectives; whereas, the *why* question is important for understanding the reasoning and purposes behind the processes (Yin, 2008). To examine these how and why questions, case study design insists on the multiple data sources, including both qualitative and quantitative data. Yin explains that the use of multiple data sources helps to triangulate the research findings. Additionally, the multiple data sources are valuable for testing and developing theory (Yin, 2008).

The study employed qualitative and quantitative methods to compile a case study of each school. There were four qualitative data sources: field notes from on-site observations, student focus group interviews, teacher interviews, and collected artifacts like curriculum documents and digital images. The student focus group interviews and teacher interviews were structured to identify interpretations for using computer technology. Collected artifacts included curriculum documents and digital images as visual data of each of each school's computer hardware and software.

Two sources of quantitative data included: a student questionnaire and a teacher questionnaire. The questionnaires generated demographic data and identified perceptions about using computer technology. The student questionnaire was given to all the study's student participants. At both schools in this study, the student response rate on the questionnaire was 100%. The questionnaire was intended to generate additional data in order to identify the students' interpretative flexibility and technological frame. The teacher questionnaire was adapted from one developed by Law, Pelgrum, and Plomp (2008) and was given to all the study's teacher participants. The teacher questionnaire response rate was 100%, as well. The questionnaire was intended to generate additional data about the teachers' interpretations of computer technology use.

Data Analysis

The study's qualitative data were analyzed examined using Miles and Huberman's (1994) three-step interpretive approach. Their approach includes: (1) data reduction; (2) data display; and (3) conclusion drawing through triangulation verification. Additionally, the study used the constant-comparative method (Glaser & Strauss, 1967) to compare findings. As part of case study research design, Yin (2008) asserts that pattern-matching logic is a useful form of analysis in order to identify patterns in the data that either do or do not match with study's theoretical framework. The quantitative analysis is at a descriptive level. These descriptive statistics are intended to provide "snapshots" of the participant perceptions of computer technology. This analysis also reports on the demographics of the participants. The quantitative results provide a way to triangulate findings about each relevant social group's interpretative flexibility and their larger technological frames. Yet, it is important to assert that the quantitative data only provide basic descriptive statistics and do not mean to infer causality or to imply that the findings are somehow universal. Rather, the descriptive statistics are meant to develop each case study's thick description (Geertz, 1973) through the report of demographics and the participants' perceptions of computer technology.

Sample

The study's sample was drawn two case study schools. The first school is elementary school, which is referred to as *Jinka Public* (a pseudonym), located in rural Bangalore, India. The second case study was about *Cedar Elementary School* (also a pseudonym), which is located in rural East Texas, United States. The target population at each school was Grade 5 students and their teachers. The study selected the Grade 5 age range (10 – 11 years of age) because research shows that is when children begin to acquire intermediate experimental design skills that lead to more advanced computer skills (Zimmerman, 2007). In order to investigate the study's research questions, it was important that the students could verbalize their interpretations for the computer's purposes. The study narrowed in on Grade 5 students because they were more likely to have a greater amount of experiences with computers than the students in the lower elementary grade levels.

Across the two schools, the total participant sample was 65 Grade 5 students and six educators. Educators mean the school professionals, like teachers and administrators, who had a direct impact on the curriculum and instruction of the study's students. Table 1 provides a brief description of each school by its demographic description and sample size.

Table 1: *The School Samples*

School	Type/Location	Sample
Jinka Public School	Government-run public, Rural Bangalore	Students: 11 Teachers: 3
Cedar Elementary School	Public school, East Texas	Students: 54 Teachers: 3

Settings

The description of the sample addresses the first part of the SCOT question: Who are the relevant social groups and what is their social context like? In order to address the social context, the article moves to a description of each school's setting.

Jinka Public School. Jinka Public is a government-run public school that is located about 25 kilometers from Bangalore's city center. Jinka Public serves about 60 students living in the Jinka village. The student population at Jinka Public is of low socio-economic status. The majority of students live in small, brick and mud dwellings called *kutchas*. These hut-like dwellings have either a thatched roof or a roof fashioned from pieces of metal. Most kutchas in Jinka village have only one or two rooms and are void of indoor plumbing and running water. Food is cooked on a wood fire. While the students live in small kutchas, it is interesting to note that 72% of the Jinka Public students indicated that their families owned a television. All the Jinka Public students indicated that their families owned a cell phone.

While Jinka Public is part of rural Bangalore, the school is situated in a village that, culturally, seems quite removed from the hustle and bustle of Bangalore. Kannada, which is the official state language of State of Karnataka where Bangalore is the capital, is the language of instruction. Jinka Public is a “one laptop” school, which means they have single laptop that the whole school community shares. The laptop was provided through a Public-Private Partnership program with a Bangalore based non-governmental organization (NGO). The one laptop per school scheme supports the effort to maintain consistent attendance among the school’s upper elementary students. The primary use of the laptop is to help teach English language skills through the typing (copying) of Word document. Jinka Public’s teachers explained that the laptop kept the students motivated to attend school, because they wanted to use the laptop to practice writing and communicating in English. Additionally, it was also an incentive for the parents, most of whom were day laborers or seasonal field workers, to keep sending their children to the school.

Cedar Elementary Public School. Cedar Elementary is a public elementary school located in a small city (estimated population 33,000) surrounded by rural areas in East Texas. The Cedar Elementary sample is drawn from a school district that has over 23% of its families living in extreme poverty (Southern Education Foundation, 2010). The Southern Education Foundation (2010) defines extreme poverty as, “Where the income is less than half the threshold of poverty for a household of four, which is about $15.09 per day for each persons, whereas for extreme poverty it is below $7.54 per day for each person” (p. 5). The racial and ethnic breakdown of this public school district is almost 53% Black or African American, over 30% Hispanic or Latino, and 13% White or Caucasian.

The Cedar Elementary campus grade span is preschool to Grade 5. There are about 520 students in the school. Of that student population, about 95% are economically disadvantaged and 24% are English Language Learners. Although the school has iPads for all of its students and teachers, the school has not met standards on student achievement, closing performance gaps, and was rated “academically unacceptable” in reading, math, and science based on the school’s performance on the state’s standardized test. While the student participants at Cedar Elementary use their iPads in all the subject areas. The most common use for the iPad was literacy based applications where the students were able to practice their reading and writing.

Limitations

From the school descriptions, it is evident that there are many differences between the two case studies. For example, there is quite a variance between each school’s student sample sizes. Also, the social and cultural context that situates each school is very unique to the region where the school is located. And while both regions are classified as “rural environs,” there is a lot difference in what a rural area in South India is like compared to a rural area in the United States. For comparative purposes, these differences represent limitations to this research. So, in light of the limitations, the study focuses in on the one variable that both schools’ have in common: poverty. Both schools are high-poverty. Of course, definitions of poverty are also quite relative to the political and economic context where a person is situated. Indeed, what it means to be “poor” in India is very different than what it means to be “poor” in the United States. But, given the fact that both schools serve students who are disadvantaged, what are the similarities and differences in the ways the students use and construct meaning for computer technology? That is the question this research attempts to address.

With any research project, especially one that is driven by interpretation of data, the researcher is situated in the research design's strengths and weaknesses. The researcher holds "interpretive omnipotence" (Van Maanen, 1988, p. 53) over the entire research project. As Van Maanen (1998) reminds field researchers, such omnipotence is rife with limitations. In reporting the findings, the study strives to follow the ethnographic ethic (Altheide & Johnson, 1998), which means that explanations are provided for what the study is claiming to know about the study's schools using the collected data.

FINDINGS

While the two settings, East Texas and Rural Karnataka are about as far apart geographically as they are culturally, there are comparative findings between the two elementary schools. The paper organizes these findings by themes. The first theme is that while the schools had very different types of computer hardware, their students had the same hope for the possibilities of using computer technology. The second theme found that there was emphasis in both schools on developing literacy skills with the computer technology. Third, similarities in knowledge tasks that the students indicated computer technology would help prepare them to do in the future. Yet, these knowledge tasks were somewhat paradoxical as the participants chose tasks that revolved around service jobs, like teaching.

Finding 1: Same Hope, Different Hardware

Earlier, the paper described the type of technology at each school. Jinka Public has a one laptop-per-school program. There is only one laptop for the entire school body to share. Yet, the NGO that provides the laptop to the school has designated the school's students as the owners of the laptop. Their ownership is significant, because it increases responsibility and is a great source of motivation for the student learning. On the student survey, all the Jinka Public students indicated that they agreed or strongly agreed with the statement: I enjoy using a computer in school. During the student focus group interview, I asked the students why they enjoyed the laptop so much. The students began quickly chattering in Kannada to explain why they believed that way. My translator for this interview asked the students to speak one at a time. The first student to speak said this in Kannada, "*Laptop neevu nam deshage haege bandira, haage naavu nim daeshage barthare.*" Translated into English this means "the laptop is how you [they were speaking to me] were able to come to our country, so in the same way, we learn the laptop to be able to go to your country [the United States]." Another student shared that she enjoyed the laptop because the laptop provided "a way to a better life." What the student meant by that is through knowing how to use a laptop would provide greater opportunities in life.

Cedar Elementary has an iPad program where all the students have access to an iPad. When the students get to use the iPads, it is also a great source of motivation. On their student surveys, 81% of the Cedar Elementary students either agreed or strongly agreed with the statement: I enjoy using a computer in school. About 15% were undecided and 4% disagreed. The students communicated that their iPads made it easier to search and find information. They all either agreed or strongly agreed with the statement: I will have more opportunities in the future because of my computer knowledge and skills. The Cedar Elementary teachers communicated a similar interpretation for computer technology. In response to the question, "What is the most important thing you would like your students to know about using a computer?" Two of the three teaches answered, "That the use of computers can help them to be successful in the 21st century." The Cedar Elementary students shared this hope about the opportunity for a "better life" through the use of computer technology. Indeed, it was a hope shared by all the study's students.

Finding 2: An Emphasis on Literacy

Literacy was also a common theme. In the context of Jinka Public school, the literacy emphasis was related to the development of English vocabulary. At Cedar Elementary, the focus was about digital literacy and practice in English Language Arts (ELA). In the student focus interview with the Jinka Public students, participants were asked, “What words or phrases do you think of when you hear the word computer?” The students responded, mixing English with Kannada, by sharing the following associations, “typing [repeated three times],” “English [repeated twice],” “games,” “typing my name,” “typing my parents’ names,” “ “ball game,” “Writer program.” The students mentioned the words “typing” and “English” the most. That question was followed up by inquiring about their perceptions of the relationship between English and typing.

I asked, “Do you think that typing on the laptop helps you to learn English?” Again, students echoed, “Yes, sir.” I replied, “How so? How do you think that typing on the laptop helps you learn English?” A fifth grade boy student started in, “Everything we type on the laptop is in English, so when we use the laptop we learn English.” Another boy student added, “The laptop’s keyboard is in English that helps us learn English.” Like their teachers communicated during my interview with them, the Jinka Public students also identified typing on the laptop as the way to learn English. The students’ questionnaire responses align with their interpretations of English and the laptop. All the Jinka Public students either agreed or strongly agreed with the statement: I do better in reading, social, and second language (English) when using the computer.

At Cedar Elementary, there was more of a mixed response to the same statement (i.e., I do better in reading and language arts when using the computer). But 74% of the students either agreed or strongly agreed with statement. Many of these same students wrote in the survey that they enjoyed reading from their iPads. Much of the activities they did with the iPads involved developing digital literacy, which included searching for information and evaluating the resources. All of the Cedar Elementary teachers indicated that reading and literacy development were the subject matter areas that their students learn best when using the iPad.

Finding 3: Prepared for the Future

Third, the students at both schools believed that their uses for computer technology would help prepare them for a future job or career. The students were asked to indicate what kind of job or career they would like to in the future. Table 2 shows the most cited job preferences by school.

Table 2: *Top Three Most Cited Job Preferences by School*

		Most Cited Job Preferences	
School	First Job (% Cited)	Second Job (% Cited)	Third Job (% Cited)
Jinka Public	Teacher (55%)*	Software engineer (27%)	Police (18%)
Cedar Elementary	Teacher (28%)	Police/ FBI (19%)	Military (13%)

Note. The asterisk sign (*) signifies that the response was cited exclusively by one gender. At Jinka Public, only female students wrote in “teacher.”

As Table 2 shows, teacher was the most cited job preferences among the Jinka Public and Cedar Elementary students. It was not surprising to see the high percentage response for "teacher" (or that it was only female students who wrote in this response) from Jinka Public, since it is well established in the literature that Indian parents of underprivileged female children often desire that their daughters go into teaching, because teaching is considered a secure government job that has some degree of flexibility for family planning (Pal, 2009). To some degree, a similar perception exists with a military or police office job for sons in underprivileged families. The male children are encouraged to join the military for the security that job offers. Yet, comparatively this finding is interesting in that the students, although thousands of miles apart, they share similar career goals in relationship to the uses of technology. This finding is also somewhat paradoxical in that most of these careers are service-oriented and, perhaps, are perceived to not require as much technological sophistication or technological know-how.

DISCUSSION

The paper began with a quote and a question. The quote was from Krishna Kumar (1989), who stated that, "schools equip individuals with knowledge and skills that are appropriate to the tasks generated by the economy and supported by politics and the local culture" (p. 69). And the question was: In this Global Information Technology Age, which is characterized by technological advances but also growing inequities, what knowledge and skills do elementary schools begin to equip individuals with? This paper aimed to address that question by describing and comparing computer use in two elementary schools; one school that was located in South India, the other school in East Texas. While these two places have very distinct contexts, both schools were situated in rural areas that were characterized by high-poverty and scarcity of economic opportunities. In light of rural, high-poverty contextualization, the study centered on two research questions: 1) How and why is computer technology socially constructed in the two elementary schools? and 2) How is the social construction of technology similar and different between the two locations? The paper now examines the findings related to these questions by discussing the findings as sociotechnical narratives that shed light on ways that elementary schools use technological tools in relationship to their wider social context.

ICT 4 Literacy Development

In both schools, one of the primary purposes for computer use was the development of literacy skills. Ale and Chib (2011) posit that such use of computer technology to develop literacy skills reflects the one of the basic functions of elementary schools: "to facilitate the acquisition of basic skills like literacy and numeracy" (p. 54). It is interesting that in both schools the literacy development was monolingual and centered on English language learning. When it comes to using information and communication technology (ICT) for development, especially in rural areas, why is there such a focus on English? Advani (2009) argues that the English language is the medium of the global economy. It is required for landing a decent job in both India and the United States. There is an economic advantage attached to learning English. Yet, what is role of computer technology in helping to facilitate ways that children can learn English?

At Jinka Public the primary way to learn English vocabulary was through the repetitive typing of English vocabulary words. Whereas, at Cedar Elementary, their literacy focus related more to digital literacy and using the technology to support the reading of students. While literacy and English language development is one of the common "sociotechnical narratives" between the two schools, the primacy of English language when it comes to accessing a computer needs to be critiqued. Rozan, et al. (2006) question whether English as an entryway to technology is equitable? Rozan, et al. (2006) argue that one of the growing needs of computer technology is to have readily accessible software that is easily translated, with the touch of a mouse, into several languages. Such translation allows for greater access and understanding of computer technology. Future research and development is needed to examine what an easily translatable interface would entail. Also, more research is needed about questions related to how effective is it to learn English with a computer? and What are the educational benefits and costs within the entanglement between computer technology and the English language?

A Future Hope

In the study's two rural, high-poverty elementary schools, another dominant sociotechnical narrative between the schools centered on hope for more opportunities because of technological know-how. Hope was a strong, connective narrative among all the participants. In one sense, hope was the acknowledgement of the reality that society is highly interconnected globalized economy; yet, it is the recognition that uses for computers are pathway toward a better life. Hope was a constant even access to resources were scarce. One such example of the lack of access was the Internet connectivity. At Jinka Public, that access was non-existent as there was not a consistent power source for a wifi network in the Jinka Village. At Cedar Elementary, the participants had access to the Internet and used the Internet regularly.

To conclude this paper I return to some lingering inquiries. Is digital literacy a skill that reflects the type of knowledge needed for the tasks generated by a highly interconnected globalized economy? Does digital literacy insure a continual growth of these types of knowledge and skills address or just reproduce the inequities? These are questions that continue to deserve further exploration. In high-poverty rural schools, like Cedar Elementary in East Texas and Jinka Public in Rural Bangalore, the sociotechnical narratives are complex. The narratives include an emphasis on literacy and English language, a hope for the opportunities that might be possible in the future, and a willingness to serve in a public way through a future career.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 41-62

Sustaining a Nepali Telecenter: An Ethnographic Study Using Activity Theory

Jeffrey Lee
Azusa Pacific University, USA

Paul Sparks
Pepperdine University, USA

ABSTRACT

While advances have made it possible for the average Nepali to access mobile phones, computers, and digital cameras, barriers continue to impede access. Like other governments, Nepal responded in 2004 by creating about 80 telecenters to push sustainable technology to its people. Five years later, most telecenters struggle with sustainability. This ethnographic study explores tensions youth face when using a telecenter located in Sankhu, Nepal, a Newari village 20 kilometers southeast of Kathmandu. To understand the complex tensions, an ethnographic approach was adopted as the method for data collection. Given the nature of the problem, Activity Theory was used as a framework for analyzing and understanding the tensions. Tensions are categorized in order of frequency as they appeared in the data. Major tensions included gender norms, generational distrust, lack of awareness, and funding. Moderate tensions included lack of training and time. Minor tensions were location, power, and connectivity.

Keywords: *Telecenter; Nepal; ICT; Ethnography; Activity Theory; Tensions*

INTRODUCTION

Nepal and Technology

Developing countries such as Nepal struggle to keep up with 21^{st} Century technology. While advances have made it possible for the average Nepali to access mobile phones, computers, and digital cameras, barriers continue to impede access. Like other governments (Huerta & Sandoval-Almazan, 2007) (Mokhtarian & Ravikumar, 2002), Nepal responded in 2004 with telecenters to push sustainable technology to its people. Five years later most telecenters struggle to accomplish their purpose (Lee, 2009a).

Technology in Nepal is evolving rapidly (Lee, 2004). In many rural communities, homes do not have landlines, yet cell phone usage is abundant, cheap, and reliable. Cell towers have been built throughout Nepal so that all 75 districts have coverage. In terms of Internet connectivity, communities in mountainous regions are significantly more limited. In such cases, communities can use either SIM cards from cell phones to connect to the Internet or USB connection devices called CDMI to connect computers and laptops to the Internet (Lee, 2009b).

Telecenters in Nepal

In 2004, the government of Nepal responded to local technological needs by creating a series of telecenters in rural villages. These centers provide basic computer needs such as Internet access, email, printing and photocopying to the communities. Over time, these centers evolved to further meet community needs.

On the surface, it may appear that telecenters are successfully serving the needs of the community. However, based on nearly ten years of ongoing interaction with over a dozen telecenters in Nepal, it was apparent that most struggle with sustainability. A deeper investigation into Nepali telecenters revealed that most are youth driven and operated. Youth face the reality of a new post-civil war government and economic instability and are eager to take control of their future and embrace technology as a means of creating change. This parallels similar countries around the world where youth are looking to technology as a vehicle to mobilize support for change (United Nations, 2007). As a result, youth tend to be the biggest consumers of technology and participate the most in telecenter activities.

Like other developing countries, in Nepal, technology often symbolizes wealth. Nepali's living conditions are poor, and government instability creates a climate of uncertainty. Ownership of technology is representative of power and authority. On many occasions, donors discovered telecenter equipment to be locked up and inaccessible for the youth, who are the intended users. Male elders, who are the main decision makers for Nepalese communities, play a significant role in this struggle for control. Several telecenters reported that elders do not understand how to use technology, yet lock the technology up as a means of control (Lee, 2005).

PROBLEM STATEMENT

Anecdotal findings suggested a need for a deeper understanding of tensions within Nepali telecenters. This study focused on one Nepali telecenter by seeking to answer the research question: What tensions exist within the Sankhu telecenter? To understand the issues, an ethnographic approach was adopted as the method for data collection. Given the nature of the problem, Activity Theory (as described by Engestrom, Lompscher, & Ruckriem, 2005) was used as a framework for analyzing and understanding the tensions Sankhu youth face. As a descriptive theory, it fits properly with an ethnographic study (Spradley, 1979). The analysis of tensions will provide valuable information for improving current and future telecenter programs.

Significance of Study

The findings of this study are significant in the following ways. The findings can: inform local stakeholders in future telecenter and ICT decisions in Nepal; inform stakeholders working with ICT in other developing countries; and shed light on current cultural norms and decision making protocols in Nepali villages related to technology. Furthermore, the methodology for the study offers an interesting approach to analyzing qualitative data by looking at ethnographic data through the lens of Activity Theory.

REVIEW OF LITERATURE

This review of literature is unique due to the narrow scope of this study. Peer reviewed articles that target the specific topic of tensions within Nepali telecenters revealed very little data. As a result, this review of literature covers a wide range of topics in an attempt to illuminate the landscape of researched work on slightly broader, yet related, topics.

A background of Nepal will be shared. Then, a survey of technology in developing countries will be examined, followed by discussion on the need for technology in Nepal. Next, the review will explore Nepal's response to local needs by creating telecenters. Finally, a slightly broader exploration on how other developing countries are using telecenters as an approach to infuse technology in rural locations will shed light on the appropriateness creating telecenters in Nepal.

Background of Nepal

Nepal, with eight of the world's ten highest peaks, is a landlocked country tucked in the Kathmandu Valley of the rugged Himalayan mountains. Eighty-six percent of Nepal's terrain is identified as rural, with an agriculturally dependent economy. This dramatic landscape creates significant obstacles to education, health care, and dissemination of information. Compared to major cities, literacy rates are significantly lower in rural areas of Nepal (49% overall, 63% male, 35% female). Those living in remote mountain villages are often a day's walk from education and health services. Formal schooling is constrained by economic and cultural factors such as a need for children to work at home or in the fields and a bias against educating girls. Furthermore, Nepal is ranked amongst the poorest countries in the world with a per capita income of $322USD. According to Nepali standards, 31% of the country lives below the poverty line (US Department of State, 2000).

Becoming a unified state over 200 years ago, Nepal is influenced strongly by China in the north and India in the south and has a 2000-year history of urban civilization. Buddhism and Hinduism peacefully coexist in the Nepalese culture. Lumbini is the birthplace of Gautama Buddha and is considered the Mecca of Buddhism and is one of four holy places of the Buddhist religion (Whelpton, 2005).

In recent years, three major events helped shape the Nepal of today. The convergence of the People's Movement for Democracy (1990), the massacre of the king and the royal family (2001), and the intensified insurgency of Maoists (since early 1990's). The later led to the resignation of King Gyanendra Bir Bikram Shah and the formation of the first democratic government of Nepal. In the summer of 2008, Nepal elected its first president, Ram Baran Yadav (Whelpton, 2005).

Nepal's multiple barriers - both economic and cultural - allow only a small percentage of its citizens to obtain education. Only 2% of the total population receive higher education. Half of that 2% drop out largely due to financial constraints (US Department of State, 2000). Remote access to learn via the Internet offers a way to reduce this barrier given that technological advances are penetrating Nepal's geographically isolated environment. As technology becomes a reality in everyday lives, access to information is accelerating the interaction between Nepalese people and other communities and individuals around the world. Compared to previous generations, Nepalese women and those in lower castes are becoming more empowered through technology (Rennie, 2007).

The Need For Technology in Developing Countries

Information and communication technology (ICT) is a key tool in narrowing the digital divide, especially for developing countries. The Internet can help the disadvantaged gain access to resources that otherwise would be inaccessible due to economic and geographic constraints. For communities with households that cannot afford technology, telecenters and community phone shops are providing access to these resources (Hafkin & Taggart, 2007).

It is said that two billion children in developing countries around the world are either inadequately educated or not educated at all. One in three does not finish fifth grade (Massachusetts Institute of Technology, 2007). The need for educational resources has been recognized by organizations like The One Laptop per Child (OLPC) team, who suggested that any country's most precious natural resource is its children (Massachusetts Institute of Technology, 2007). Developing countries must leverage this resource by tapping into the child's innate capacity to learn, share, and create. One tool to achieve this is through the use of a personal computer.

The OLPC project targeted two key concepts in developing countries. First, it addressed the issue of access. OLPC has aimed to mass-produce and distribute $100USD laptops in an effort to provide access to technology for children in developing countries. Second, OLPC took a constructionist approach to technology integration where all children in schools will have their own laptops and a connected community will emerge (OLPC, 2007). According to Floridi (2001), only 7% of the world's population currently has access to ICT.

Castells (2004) recognized that ICT is the most significant factor separating developed and developing countries. Developing countries are encouraged to join the information age because, if used properly, ICT can promote industry and increase productivity in administration and communication. According to Pradhan and Metcalfe (2002), countries that are unsuccessful in keeping up with ICT often collapse and are unable to achieve social-economic growth.

Technology in Nepal

In Nepal, the High Level Commission for Information Technology (HLICT) created the National Information Technology Center (NITC) initiative in 2002 and thus created the first telecenters. These telecenters targeted rural areas, with a focus on those with the most marginalized access to resources. The telecenters served as public facilities for communities to access information on the Internet, print and reproduce material through the use of computers, and learn how to use technology. The HLCIT identified telecenters as a vital initiative to bridge the digital divide (High Level Commission for Information Technology, 2007).

Nepal's Telecenters

Around 2004, when Nepal was nearing the end of its decade long civil war, HLCIT created approximately 80 telecenters throughout Nepal. These telecenters were funded for two years by the Nepali government and became a valuable bridge between rural indigenous villages and the rest of the modern 21st Century world. Although the attempt to infuse technology was noble, the two-year stoppage to funding was harsh. As a result, most telecenters failed (Bhattarai, 2009b).

In 2004, the principal investigator of this study began working with 10 telecenters on approaches to long-term sustainability. Based on this experience, it was obvious that telecenters are youth driven and barriers to sustainability are much more complicated than just funding. Cultural norms, division of labor obstacles, and community opinions prohibited telecenters from reaching their full potential (Lee, 2004).

The Sankhu telecenter was one of these 10 centers the principal investigator has worked with since 2004. Although this center has overcome some of the mentioned obstacles, it continues to struggle with sustainability. According to HLCIT, community members may or may not know the benefits of technology, telecenters often times have intermittent electricity and Internet access and gender divides prohibit females from fully accessing technology (Bhattarai, 2009b). The Sankhu site clearly represents some of the tensions mentioned.

Telecenters around the World

Telecenters offer a wide variety of services for their communities. The concept of telecenters has been around for the last decade (2000 – 2009). These are primarily used in developing countries where hardships of owning personal technology exist. Many telecenters provide a means for access to information technology. They tend to be in the public sector and are operated by government bodies or nongovernmental organizations. "Generally they serve a low-income clientele and have a community development mission" (Colle, 2003, p. 388). James (as cited in Colle, 2003) comments on the significance of telecenters:

> *Community access centers are the way to go. In many third world countries, there is little chance to find individual ownership of all sorts of ICTs. Even mobile phones. I always come across scenarios in rural Uganda where two or three people own phones and are 'forced' to offer public commercial calling services as a result of need. Telecenters create an aggregation of ICTs and enable the general public to access them at a nominal fee and benefit from the advantages they have to offer. [Since] a number of rural folk are not exactly financially liquid, it would be good for one to explore the possibility of accepting payment for services using alternative methods, e.g. farmer X brings a heifer to the telecenter, valued at an amount of XYZ and getting the services for the equivalent. (p. 24)*

As ICTs becomes a reality in the lives of those in both developed and developing countries, the Internet plays a vital role in narrowing the physical boundaries of the world. Not only does the Internet promote interaction, it has redefined learning. Developing countries have taken leaps that are unimaginable in previous times, and gained almost instant access to global knowledge (Gregson & Upadhaya, 2000).

Located in Nakaseke and Kaasangombe, Uganda, the Nakaseke Multipurpose Telecenter is regarded as one of the most visible telecenters in Africa. It was initially supported by the International Development Research Center, UNESCO, and International Telecommunication Union and hosts a library of over 3000 volumes. The Nakaseke Multipurpose Telecenter also provides access to various communication services such as telephones, photocopying, and faxing (Colle, 2003).

Other examples of telecenters also are beginning to emerge in literature. Telecenters in Ghana provide services including desktop publishing, community newspapers, sales or rental or audio and video recordings, book lending, training, photocopying, faxing, and telephone services. In Hungary, telecenters even provide postal, banking, and employment services (Colle, 2003).

Huerta and Sandoval-Almazan (2007) point out that physical access to ICTs only reduces the digital divide, a term used for highlighting the differences in opportunities to use ICT. However, when the skills to take advantage of the resources are not apparent, the digital divide still persists. Therefore, telecenters are only relevant solutions to bridging the digital divide if they address access, literacy, and computer literacy.

Literature Review Conclusion

As developing countries leapfrog into the 21st Century, technology access becomes a key factor. Like many other developing countries, Nepal responded to this need by creating telecenters. There appears to be some research done on telecenters around the world. In Nepal, technology and telecenter research is significantly less available. This lack of peer-reviewed research clearly points to a pressing need to better understand Nepali telecenters. A deeper investigation into the various types of tensions that exist within the Sankhu telecenter will begin to shed light on the various challenges telecenters face each day.

METHODOLOGY

Spradley (1979) defines ethnography as "the work of describing culture" (p. 3). Ethnographies attempt to paint the entire picture in an effort to describe, interpret, and analyze the subject of the study (Creswell, 2003). Roles of various individuals, mediating factors such as division of labor, rules, and even tools used, influence the complex web of decisions made within such an environment. Due to the complex tensions that exist within the Sankhu telecenter, the use of an ethnographic approach was necessary to gain an in-depth understanding (Patton, 2002). Since the tensions present are complex and likely to be cultural, social, and historic in nature, Activity Theory provided a solid framework for analyzing these tensions (Engestrom, 2005). The unique approach of analyzing ethnographic data using Activity Theory allows for insightful conclusions to be drawn.

Site Selection

Located 16 kilometers east of the capital Kathmandu, Sankhu is a Newari community. The Sankhu site was selected out of convenience. It is one of 10 telecenters the principal investigator has worked closely with since 2004. The Sankhu telecenter, also known as the Sankhu Youth Managed Resource Center (SYMRC), is located in the heart of the village. This center is a common meeting place for the community. On a typical day, the center opens at 7:30 am and services over 20 people per day. The center provides computer training for local community members and has services for photocopying, laminating, faxing, Internet, and email.

SYMRC was created by HLCIT in the early 2000’s and was one of approximately 20 centers created at that time. HLCIT hoped that after two years of full funding the community would embrace the concept of a telecenter and take over funding and sustainability. In the case of Sankhu, the abrupt halt to funding came as a shock to the community. Sustaining a telecenter is costly to a community like Sankhu because local villagers, like much of Nepal, makes under $1USD per day.

In 2004, when the center was near collapse, the Sankhu youth took a leadership role in finding ways to help the center become sustainable. For several weeks, they charged local youth money to play computer games in order to pay the electric bills and rent payments. Since then, youth volunteers have found other stable means of sustainability including collecting fees for services such as Internet access, photocopying, resume writing, and computer classes.

Participant Selection

Participant selection for interviews included 43 people, specifically 32 youth ages 18-26, and 11 adults or elders. For this study, it was important that all voices were heard and that there were equal representations of age, gender, and caste. Interviewees consisted of participants who interacted with the telecenters as well as locals in the community who were not directly involved. Institutional Review Board approval was granted by the researcher’s home institution, Azusa Pacific University. Local board approval was granted and all participation was voluntary.

Types of Data

Data for this study consisted of group interviews, individual interviews, field notes based on observations, pictures, videos, and careful examination of appropriate artifacts. In addition to the use of a translator, a cultural informant filled in the gaps when social and cultural background information was needed.

Strengths and Limitations

Ethnography is the methodology most appropriate for this study. When conducting ethnographic studies, the lens of data collection and analysis is the researcher (Patton, 2002). This can be either a strength or a limitation. To ensure that proper rigor is in place, the researcher used a cultural informant when necessary. A cultural informant is an individual with cultural knowledge as well as local awareness. Also, the researcher has extensive knowledge and skills working with technology, education, and youth, which all strengthen the lens of data collection.

When data were unclear or questionable, an expert panel made up of cultural and content experts was called upon to make sense of the data. If the expert panel was not able to provide proper direction, the data were discarded. This protocol ensures for internal reliability of data, thus strengthening a known limitation of an ethnographic study.

Data Analysis

It is important to understand that Activity Theory is a descriptive theory, not a predictive theory. (Center for Activity Theory and Developmental Work Research, 2009). Tensions within the system impact the activity of the subject, the object, and the outcome. These tensions are identified by arrows among subject, object, community, division of labor, community, and instruments (see Figure 1). By using Activity Theory, the researchers could identify underlying tensions within an activity system.

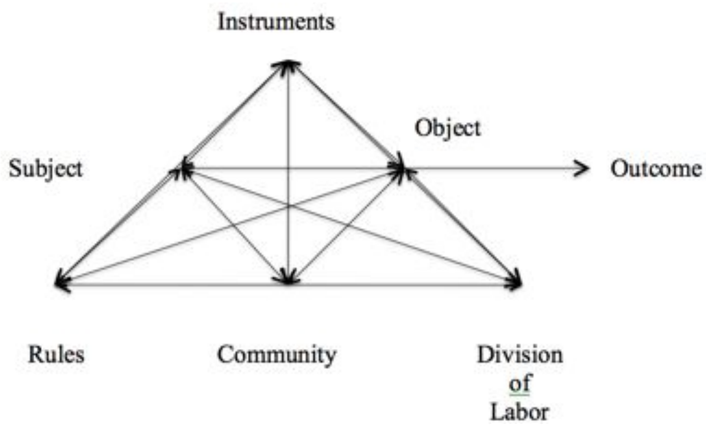

***Figure 1**: Activity Theory Triangle (Revised from Engstrom. Lompscher, & Ruckriem, 2005)*

The themes that emerged from data coding were then analyzed using the Activity Theory triangle. Data was sorted according to subcategories: instruments, rules, community, and division of labor (Engestrom, 2005). When the data were sorted, tensions (represented by arrows above) emerge. Once detailed tensions were mapped out, specific smaller triangles emerge. For example, should youth (subject) using technology (object) to find sustainable approaches for telecenters (outcome) run into barriers in the area of cultural norms (rules) relating to elders restricting access to technology because elders are in control of interactions within the village, then the below triangle would be identified and analyzed.

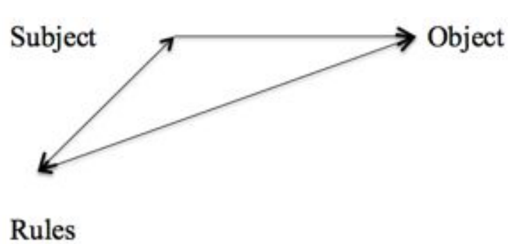

***Figure 2:** Smaller Activity Theory Triangle Focusing on a Rules Tension*

Because Activity Theory has a strong social-cultural foundation, it has been an important tool for research in the social learning field, specifically in three recent studies (Cummings, 2007; Wallace, 2007; Wilson, 2008). Activity Theory can be applied to an activity system, taking into consideration mediating factors in an activity system. This thus highlights tensions within the system.

FINDINGS

This study focuses on the tensions youth face when using technology in the Sankhu telecenter. Ethnographic data was captured and tensions were extracted from the data using Activity Theory. Once the data were coded and analyzed, some tensions were observed to be more prominent than others, resulting in a need for them to be categorized according to the frequency they appeared in the data. Table 1 displays the frequencies various tensions appeared.

Table 1: *Categorization of Tensions*

	Elder Men	Elder Women	Adult Men	Adult Women	Male Youth 18-22	Male Youth 23-26	Female Youth 18-22	Female Youth 23-26	Total
				Major Tensions					
Gender Norms		X	X	X	X	X	X	X	7
Old Board	X		X		X	X		X	5
Awareness	X	X							2 *
Funding		X		X	X	X	X		5
				Moderate Tensions					
Training		X		X				X	3
Lack of Time		X		X		X	X		4
				Minor Tensions					
Connectivity					X		X	X	3
Electricity					X		X	X	3
Location							X		1

**Note: Although the Lack of Awareness on the Benefits of Technology tension only has two total appearances in the data, it is categorized as a major tension.*

As seen in the table above, 33 frequencies of tensions were identified. Major tensions are defined as tensions that consistently emerge throughout various data points. Moderate tensions were identified as tensions that occur frequently, and minor tensions occasionally appear in the data. Although the Computer Training Tension occurred the same amount of times as some of the minor tensions, the expert panel recommended categorizing it as a Moderate Tension because it appeared to be thematic throughout many of the interviews.

Major Tensions

Gender norms tension. Figure 3 shows where Gender Norms Tension was extrapolated from the Activity Theory Triangle.

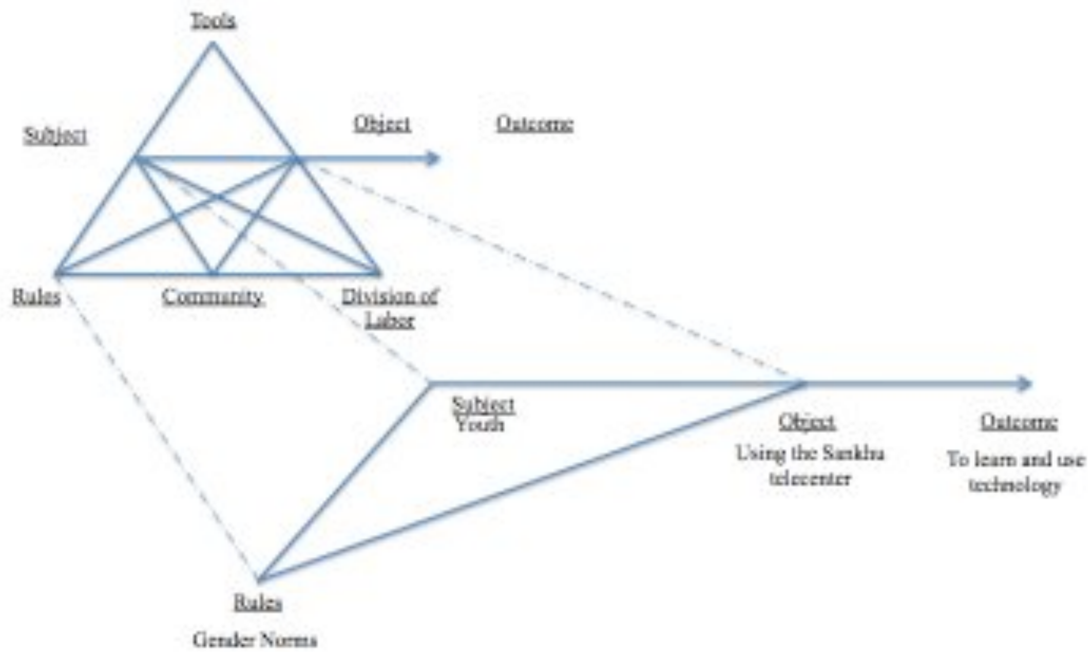

Figure 3: *Major Tension 1 - Gender Norms Tension*

In Nepal, gender norms dictate much of everyday life. Although women oversee and manage the activities within a house, men are the major decision makers for the family. Duties such as cooking, cleaning, farming during harvest time, and raising children are solely affiliated with women. Extended families live in large houses and the gender specific activities, although dominating every aspect of Nepali life, work seamlessly throughout the day. Boys are permitted to attend school and girls are typically limited to household responsibilities and do not attend school. It is a common Nepalese belief that it is a waste to educate a girl because she will be married to another family (Burchett, 2007).

During previous research in Nepal, the primary investigator has seen how this ideology dominates every aspect of life in Nepal. During the women's literacy movement a decade earlier, women were scolded for wanting to learn how to read and write. For example, men would say to women, "Why eat green cucumbers at the time of dying?" (Robinson-Pant, 2004, p. 1). This metaphor was used to scold someone that is doing something unnecessary because eating green cucumbers is considered a luxury in Nepal, and anything done 'at the time of dying' is considered a useless act. During the group interview with elder women in the Sankhu community, the primary researcher discovered that this metaphor is still used in 2009 when men scold young girls who use the Sankhu telecenter.

Old telecenter board tension. Figure 4 shows where Old Telecenter Board Tension was extrapolated from the Activity Theory Triangle.

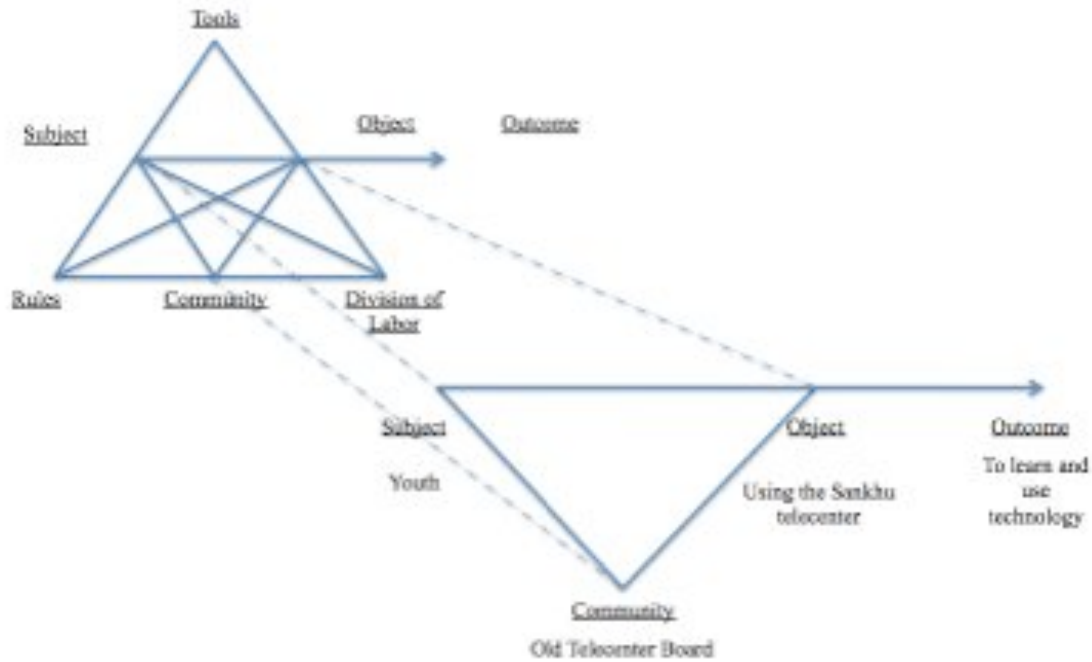

Figure 4: *Major Tension 2 - Old Telecenter Board Tension*

The Sankhu telecenter was initially created in 2004 with financial support from HLCIT. The initial governing board consisted of elder men in the community as a response to HLCIT's request for community leadership for the telecenter. Just as Wood (2006) discovered that elders locked up books in villages as a symbol of control and prestige, the initial Sankhu telecenter board took on the same approach. Previous visits to the telecenter revealed that much of the telecenter equipment was locked up and inaccessible for youth. In an interview with a youth telecenter leader, I asked who in the past has made it difficult for the center to operate. She said the following:

> *Yes. The old board, who is usually the elder political leaders. And sometimes even those that don't do anything. They always want to say something. They always like to disturb us. I have suffered lots of times. If I had lots of support, I could go so far, but I don't.*

According to this respondent, board members did not make decisions in the best interest of the telecenter. They only cared about their political advancement within the community; and as a result, sustainability of the telecenter was jeopardized by many poor decisions. The female youth respondent continued to explain that cameras and other equipment, although intended for youth to use in the telecenter, were often locked up and controlled by the elders. Such findings parallel Wood's experience and were also confirmed by the director of the HLCIT.

Sankhu youth went through a telecenter reorganization in 2004 and successfully created a governing board consisting of only youth (aged between 16 and 26). Equal representation of gender was also a major stipulation. In my comparison to other telecenters, the Sankhu telecenter appears to run much smoother, now that a youth board that is equal in gender representation governs it.

Lack of awareness on benefits of technology tension. Figure 5 shows where the Lack of Awareness of Benefits of Technology Tension was extrapolated from the Activity Theory Triangle.

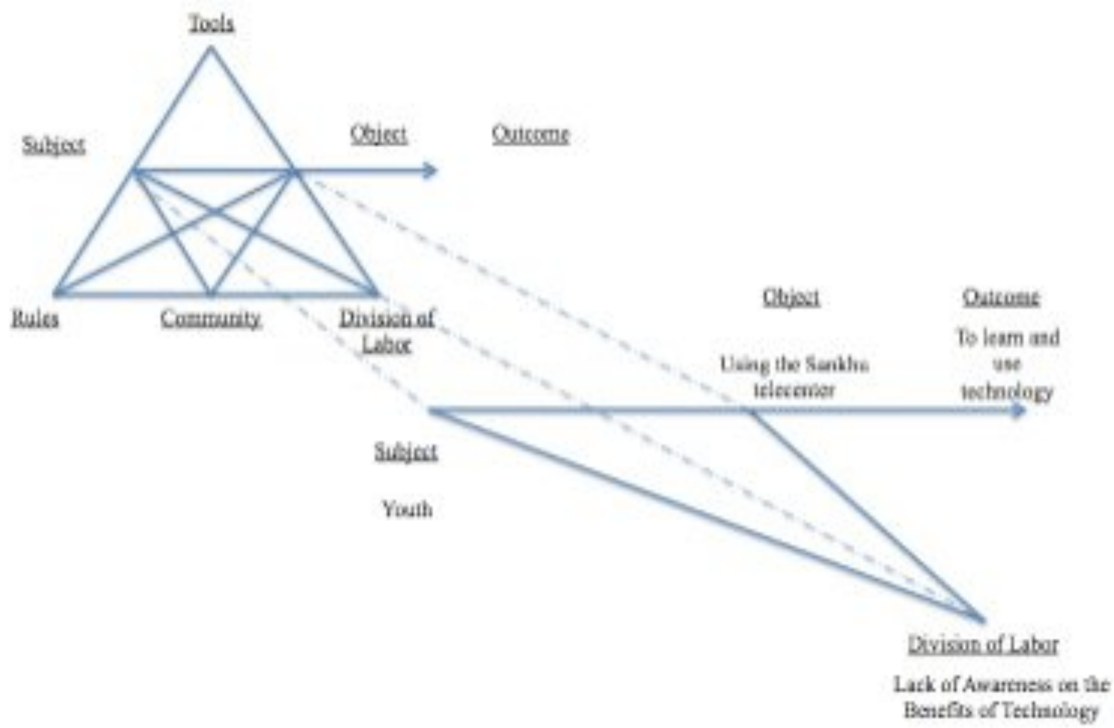

Figure 5: *Major Tension 3 - Lack of Awareness on Benefits of Technology Tension*

Another major source of tension the Sankhu telecenter faced was the lack of awareness on benefits technology can bring to the lives of villagers. It is important to note that the data in this section comes from the interview with the Vice Chairman of HLCIT. Since he has a macro view of telecenters in Nepal and he has significantly more experience with technology than those in the local communities, the Vice Chairman's vantage point on this issue is significantly more valid than those on the ground utilizing the services of the telecenters. As a result, the researcher, with the support of the expert panel, moved this tension from minor to major, despite the low frequencies in the data.

During an interview of elder women, one respondent stated, "After we learn how to use computers, what will we do next?" It is clear that although there seems to be an awareness of various technologies, there still seemed to be a disconnect between what the technologies are and the impact they may have on the lives of the community. Ultimately, many villagers still view technology as a mythical product.

Lack of funding tension. The figure below shows where the Lack of Funding Tension was extrapolated from the Activity Theory Triangle.

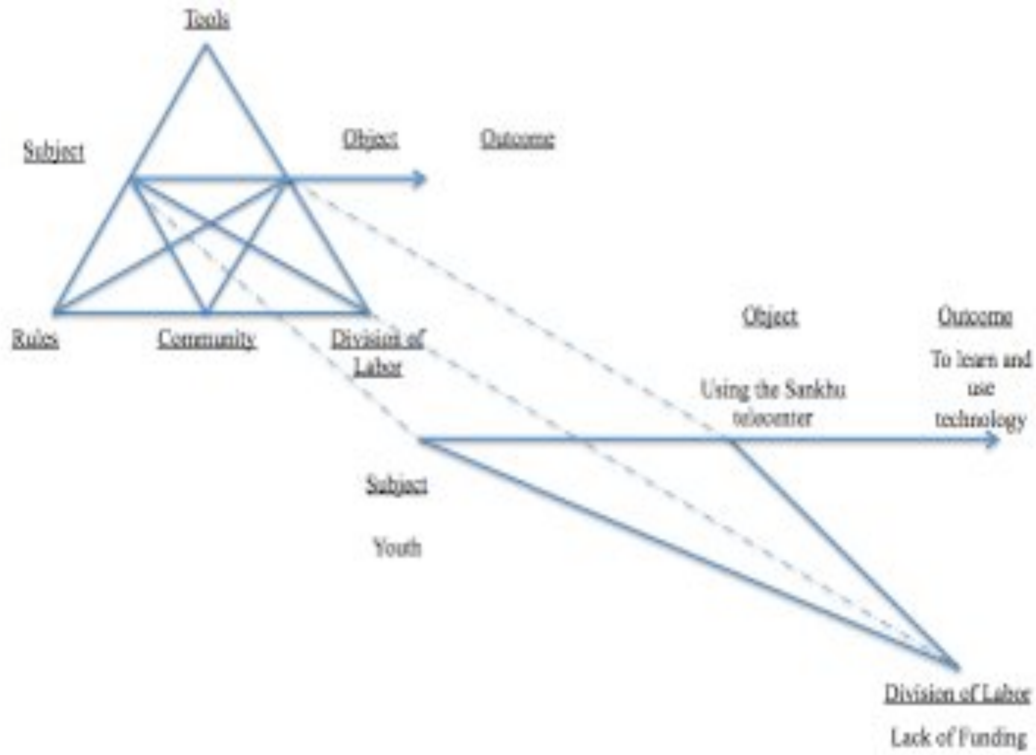

Figure 6: *Major Tension 4 - Lack of Funding Tension*

Funding for telecenters has been a major source of tension ever since the beginning of the telecenter movement. HLCIT funds the telecenters for two years. After the two-year period, telecenters must fend for themselves to come up the necessary funding for running the center. As a result, this problematic funding model limits the 80 telecenters ability to survive. The Vice Chairman of HLCIT stated,

> *But then again, this model, as I must admit, is a problematic model. You cannot realistically expect telecenters to fend for themselves after two years. So what happens is that after two years support, the expectation that the telecenters need to support themselves is not a realistic expectation. It is too short of a window to create a critical mass of users.*

The primary researcher, with ten years of experience working with telecenters in Nepal, has observed this major tension in all other telecenters. With the average daily wage of Nepal being $1USD per day, long term funding is near impossible.

Moderate Tensions

Computer training tension. The figure below shows where the Computer Training Tension was extrapolated from the Activity Theory Triangle.

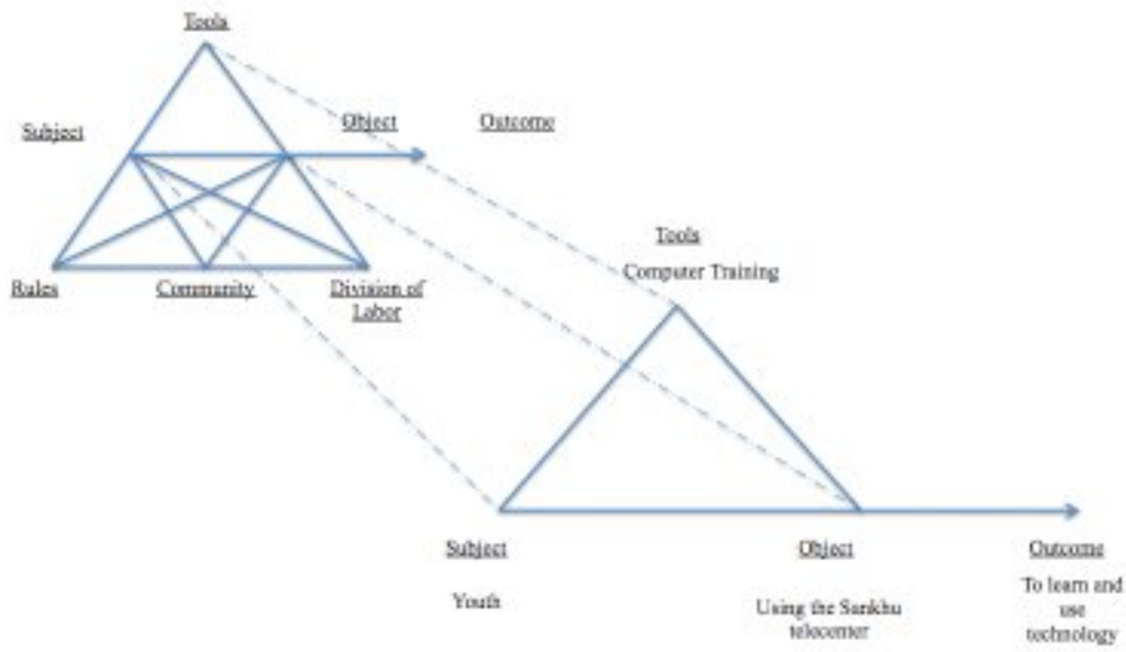

Figure 7: *Moderate Tension 1 - Computer Training Tension*

Computer training has been an identified need for the Sankhu telecenter since its inception in 2004. Beyond the need for more training, the Sankhu leaders identified a secondary need: a need for localizing learning content. The Sankhu telecenter attempted to engage with a community that has never been exposed to computer terminology. While the terms office, files, and folders, are quite common in the Western or developed world, they are foreign to those in the villages of Nepal. During computer training classes, telecenter leaders even needed to localize the content by telling the villagers, “these are not files or folders. These are houses (computers), rooms (hard drives), and cupboards (folders). You must store things in the proper places.”

This finding puts into perspective the global need for not just providing more training, but providing training that is appropriate and relevant to the local people.

Lack of time tension. The figure below shows where the Lack of Time Tension was extrapolated from the Activity Theory Triangle.

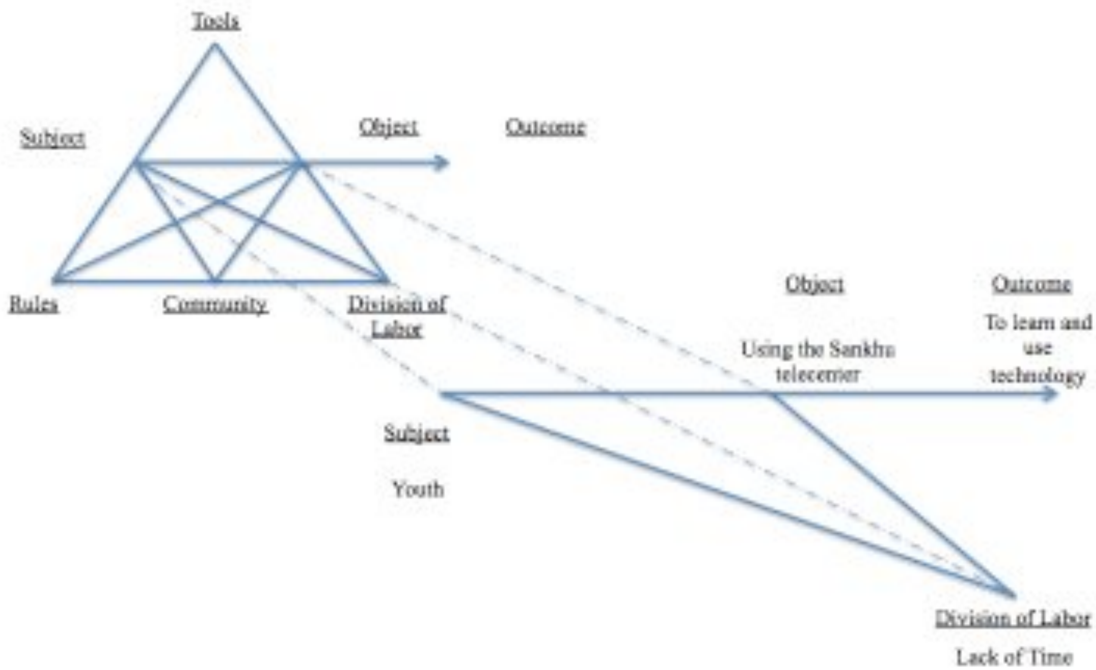

Figure 8: *Moderate Tension 2 - Lack of Time Tension*

In Sankhu, as in much of Nepal, farming takes up the majority of villagers' time each day. Women have duties that take up their time from morning to evening. Children and youth, in addition to attending school, labor in the fields to harvest crops. Ultimately, there is very little time available for community members to learn and use technology. There is also compelling evidence during late afternoon and evening visits to the telecenter where more boys attend than girls. Typically, boys are relieved of more home duties and have an easier time gaining permission to visit the telecenters by their fathers. As Nepal springboards into the 21st Century, gender norms have evolved dramatically. Gender equality is being realized throughout Nepal.

Minor Tensions

Connectivity tension. The figure below shows where the Connectivity Tension was extrapolated from the Activity Theory Triangle.

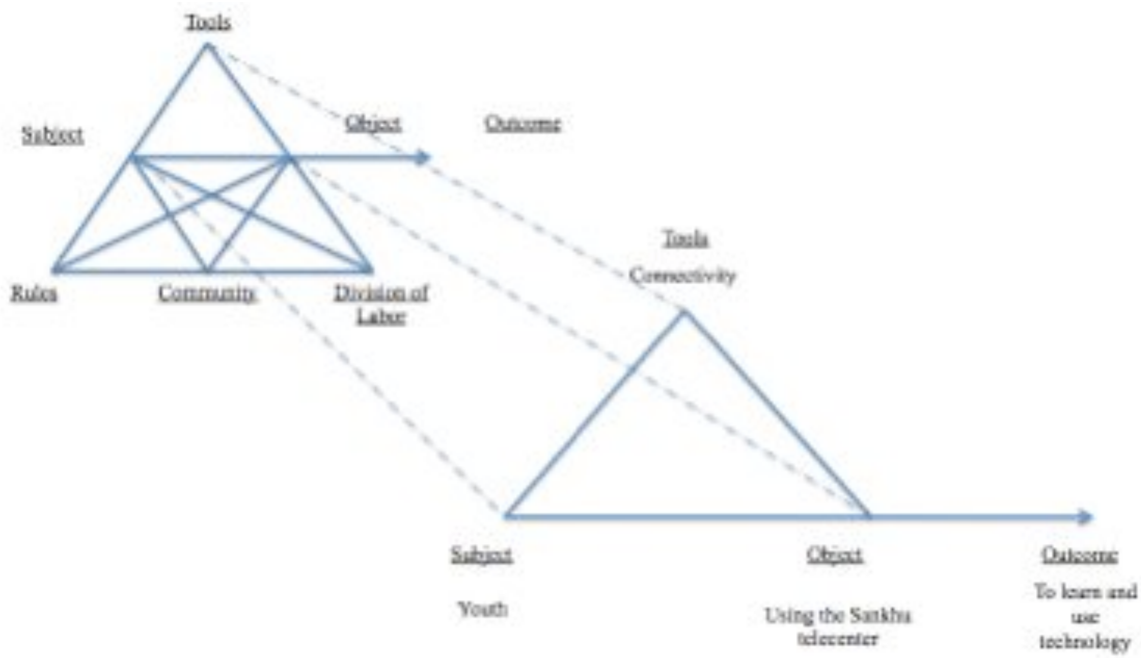

Figure 9: *Minor Tension 1 - Connectivity Tension*

Internet bandwidth is a major obstacle in Nepal. In 2009, a typical telecenter has only one computer that potentially can connect to the Internet. Internet is connected through telephone dial-up. When I asked the youth groups about their frustration with Internet, they typically respond in the following fashion:

> *Jeff: Is everyone frustrated with the slow Internet?*
> *All respondents: Of course (laughing)*

The laughing indicates a sense of acceptance and normalcy. Although the connections are spotty at best, the youth are optimistic and work through such challenges, knowing that it not is only the current state of technology in Nepal, it is the only access they have. Since the principal investigators' initial involvement in 2004, Internet connectivity has improved, despite the low rate. Sankhu telecenter was one of the first centers to acquire high speed Internet. It is important to note that Internet speeds in Nepal are rated at about 1 megabyte per second.

Electricity tension. The figure below shows where the Electricity Tension was extrapolated from the Activity Theory Triangle.

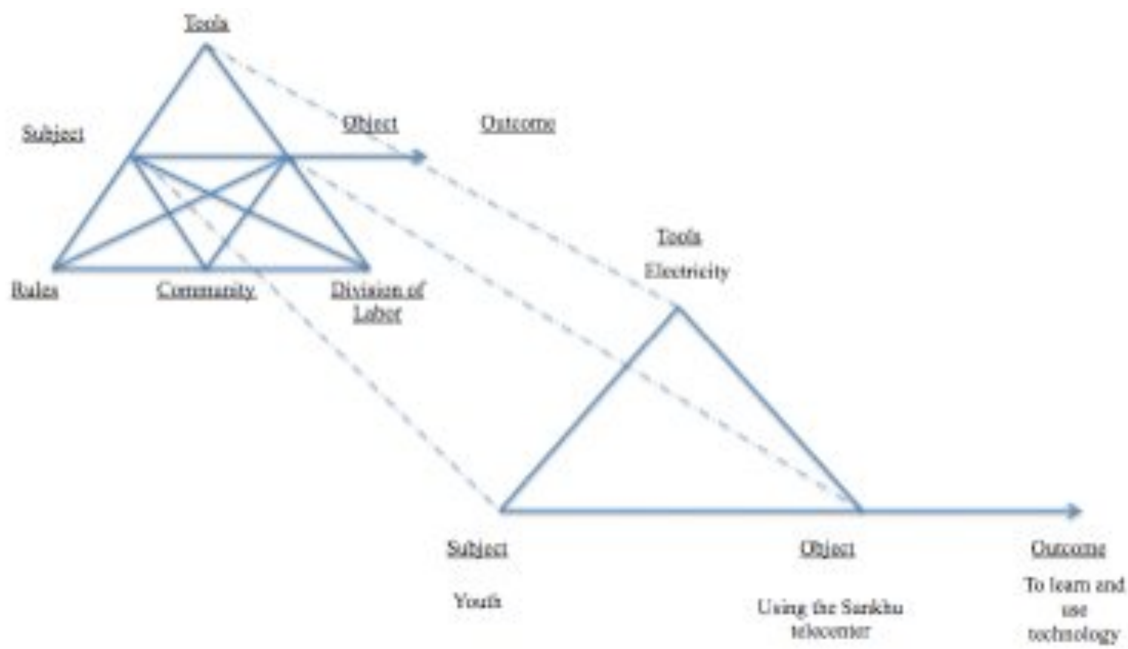

Figure 10: *Minor Tension 2 - Electricity*

Nepal's electrical infrastructure faces geographical challenges. Running electric lines across Himalayan mountaintops is costly and tasking. Additionally, lack of sufficient power generators forced much of the country to be handicapped with rolling blackouts. During the spring of 2009, when one of the three hydro-generators broke, the entire country faced blackouts averaging 14-18 hours per day. This lasted for several months. When asked about the effects of blackouts, also referred to as load shedding, one youth responded, "Of course it affects us. It affects our ability to come to the center." A female youth during the group interview of 23-26 year olds stated, "Yes at the time when there was shedding, I wanted to come. But I could not come. And I feel so bored. It was about 16 hours a day! I felt like the world was going to collapse!"

Location of center tension. The figure below shows where the Location of Center Tension was extrapolated from the Activity Theory Triangle.

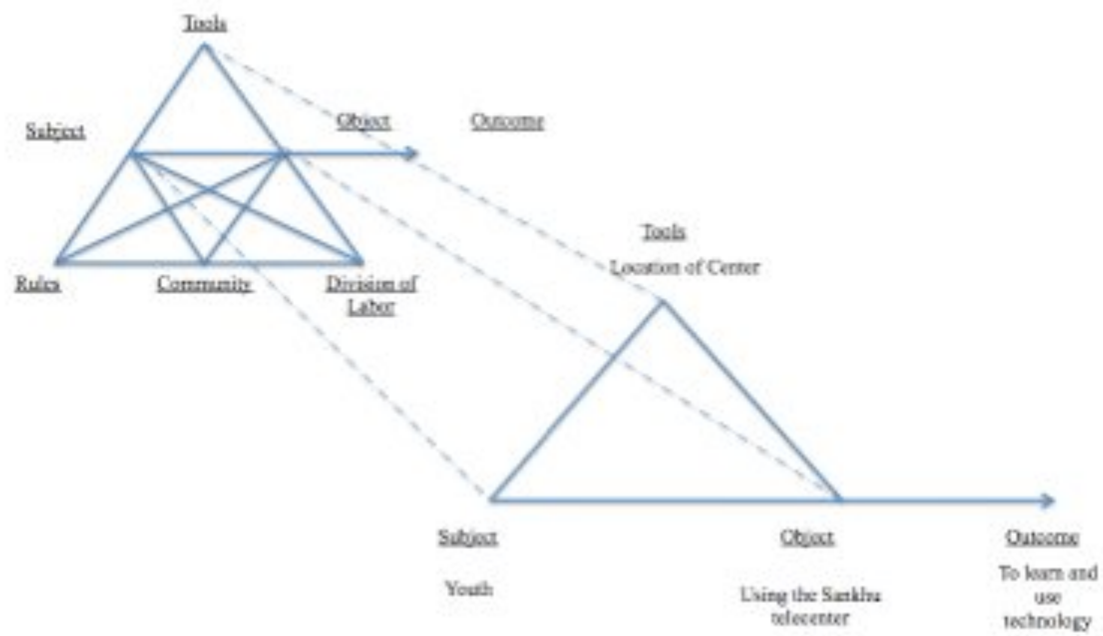

Figure 11: *Minor Tension 3 - Location of Center*

For the youth in Sankhu, the center's geographic location is important. Transportation challenges limit access to technology, especially due to Nepal's mountainous geographic setting. Roads and walking paths are often washed out. Very few people have access to motorized transportation, especially in rural areas. Western Nepal, for the most part, is only accessible by foot. However, for those that find value in using the telecenter, geographic obstacles can be overcome. Below is an account of a youth that travels five hours each way from a remote village to come to the Sankhu telecenter. He stated,

> *When I come to the telecenter to utilize computers that are here. I also use the telecom, which is the telephone. When I came to the telecenter at first I came here to learn how to use computers. This telecenter is important for us because I'm from quite far. My village is very remote. In my village some people do not know what is even a television. So I come here and get lots of information to share with my village. When I get more knowledge about the computer, I share the importance of computers and the benefits of computers to my village. So it is very hard for us.*

Summary

The data presented in this study offers perspective and insight into the culture of telecenters in Sankhu. As Genzuk (2003) explained that ethnographic studies offer a written representation of a culture or selected aspects of a culture. Ethnographies inform human conduct and judgment in innumerable ways by pointing to the choices and restrictions that reside at the very heart of social life (Van Maanen, 1988). This study offers both a glimpse into the inter-workings of the Sankhu telecenter and an analysis of the tensions that exist within the center.

CONCLUSIONS

The major tensions in this study are gender norms, old telecenter board, lack of awareness on benefits of technology, and funding. Moderate tensions are identified as difficulties in computer trainings and lack of time to learn technology. The minor tensions are Internet connectivity, lack of electricity and the location of the telecenter. Below are some conclusions drawn.

Females Have Fewer Rights and Less Access

Gender tensions permeate throughout Newari culture and dictate daily norms in Sankhu. This appears to be the greatest source of tension for this study. While youth are gaining more access to technology in 2009, males still have more access than females. Unlike the Banladesh telecenters where women have gained profitable income generating skills through telecenters (McConnell, 2001), the Sankhu community has yet to realize the opportunities that telecenters can bring for women.

Poor Infrastructure

Poor technology infrastructure continues to impede technological progress. Nepal's mountainous landscape presents major infrastructure challenges. Electricity is nonexistent in rural regions of Nepal (Gregson & Upadhaya, 2000). In terms of connectivity, Nepal has leapfrogged into the 21st Century with a mass infusion of mobile phones. Mobile phone signal towers cover every district in Nepal. In fact, Internet access can be achieved using a USB device called a CDMI card. This device uses the SIM card from a mobile phone and uses its signal to connect to the Internet. In the case of Sankhu, high speed Internet was installed in 2009.

This leapfrogging into the 21st Century can also be seen in the use of technology hardware, as Nepalese use digital cameras, not ever having used film cameras before. In terms of electricity, the few electrical generation plants in Nepal already cannot generate enough electricity for the country. When one is down for maintenance, or when one is malfunctioning, the entire country is greatly affected. In the spring of 2009, rolling blackouts called load shedding were upwards of 16-20 hours per day. To see the real potential of telecenters in Nepal, Internet and electricity infrastructure needs major improvements.

Lack of Time to Learn And Use Technology

In Nepal, cultural norms dictate daily activities. Like most communities in Nepal, farming communities such as Sankhu struggle to find extra time for community members to indulge in activities that are considered luxurious. Attending school and learning technology are considered to be luxurious in most communities. In addition to a lack of financial support, a lack of time is a major source of tension. This is especially evident during harvest seasons when entire families work in the crop fields for the majority of the day. During harvest time, those children who have the luxury of attending school oftentimes miss school to work in the fields. Likewise, during harvest time, attendance at the telecenter is low.

There seems to be an interest for equity from the newly established government. The voice of women is beginning to be realized in the Nepali democracy. It would be interesting to see the ripple effect of such a policy and governmental movement trickle down to the daily lives of Nepali villagers. Perhaps, more girls will be able to freely access telecenters in Nepal's near future.

Elders As Gatekeepers

The elder versus youth tension is a major tension presented in this study. Elders are the decision makers and gatekeepers of the community (Wood, 2006). As a result of this cultural rule, technology, a tool that many elders do not know how to use, becomes a pawn in the struggle for control. Furthermore, those who try to use technology are perceived as young people who are not wise enough to make major decisions in the village. The result is catastrophic in the struggle for telecenter sustainability. Those who control the telecenter are not understanding of three things: the benefits of technology, how to sustain and maintain a telecenter, and that elders can maintain control of a village while youth learn how to use technology (Rajalekshmi, 2007) This lends to an interesting dynamic that needs further development. More research needs to be done on how decision makers learn about the potentials of technology and how they provide more access to youth, despite their personal inability to engage with technology.

Funding Model for Telecenters Impede on Sustainability of Telecenter

The current funding model for telecenters was designed by HLCIT. This current funding model supports both the initial startup of telecenters and salary for one telecenter staff for one year (Bhattarai, 2009a). What the model does not account for includes:

1) Not all communities can take over and sustain funding.
2) Local communities may not have enough time to build capacity in one year to embrace technology as a significant tool in their lives.
3) One time startup costs are large when considered in the context of how much a Nepali family earns in one year. As a result, when hardware breaks, it is not possible for local communities to pay for repairing or replacing the broken part.

There is a need to provide more support on developing long-term sustainable models for telecenters. Although training on sustainability was not a consideration initially, this study yields an interesting conclusion on funding. When all participants have community buy in, there then needs to be consideration for one time cost items such as high speed Internet installation, equipment, and reoccurring cost items such as computer upgrades and replacements. Once these considerations are in place, the potential for sustainability increases.

Local Communities Are Not Aware of Benefits of Technology

The lack of awareness on the benefits of technology is a major tension in this study. Local communities have not had enough exposure to the current technology to understand the positive impact it can have on their lives. Although technology is beginning to penetrate its way into the families of local communities, it is still at its infancy stage. As a result, awareness building is a major obstacle for many telecenters (Bhattarai, 2009a). This study exposes the important need to build capacity for technology by involving local villagers in awareness opportunities. As explained by various respondents, many do not know how technology will fit into their lives even if they attend classes to learn the technical skills.

RECOMMENDATIONS

As quickly as technology is impacting life in Nepal, so must related research. In order to help inform decision makers, we must be sure that research is keeping up with the changing times. Below are recommendations based on the conclusions drawn.

Study other telecenters in Nepal for comparison. One limitation to this study is the fact that data collection took pace in only one telecenter. There are approximately 80 telecenters in Nepal. These telecenters possess a variety of different characteristics, such as technological hardware and software, staffing, funding, local community, social norms, etc. A similar study of other telecenters is recommended. Furthermore, this study suggests a need for a future studies focusing on leadership of telecenters in Nepal.

Study other developing countries for comparison. Future studies in other developing countries similar to Nepal would also be beneficial to the field. Conditions in selecting other countries for study should include: geographic region, geographic terrain, culture, social norms, and historical norms. Additionally, technological access to hardware, software, and connectivity should be considered.

Study successful youth leaders who are recognized internationally, but not locally. This study unveiled several cases where youth leaders were recognized internationally for their work. Gaining international recognition is easier, especially in the 21st Century, through the use of technology. Although these isolated cases of success may appear to be phenomenological in nature, it would be beneficial to see if there are trends that emerge. Additionally, case studies on these phenomena would also contribute to the current body of related research knowledge.

Study the impact of Web 2.0 on youth in developing countries, specifically looking at social capital. Since connectivity has significantly improved in the last decade, it is recommended that a study be conducted on the expanse of social capital a community gains from using a telecenter. While monetary capital might be scarce in a country like Nepal, youth seem to be extremely connected online with others in and out of their community, as well as around the world.

Explore whether technology can influence gender equity. Explore the possibility of formally set times and opportunities for females to use the telecenter in an attempt to balance out gender inequalities.

Explore the need for localizing learning content. Connect with those who are conducting training in Nepal and explore the need for learning content to be localized in a comprehensible fashion for villagers.

In the comparative international education milieu, there begins to emerge a special interest group (SIG) called Information and Communication Technology for Development (ICT4D). Members of this SIG, along with a small group of researchers around the world, investigate ways technology impacts developing countries. This article adds knowledge to a growing body of researched evidence and hopes to also bring awareness to the need for such research to be conducted.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 63-76

Unsystematic Technology Adoption in Cambodia: Students' Perceptions of Computer and Internet Use

Jayson W. Richardson, John B. Nash and Kevin L. Flora
University of Kentucky, USA

ABSTRACT

This study was designed to understand how upper secondary school students in Cambodia perceive the use of computers and the Internet. Data were collected from students in three urban upper secondary schools (n=1,137) in Cambodia using questionnaires. The data indicate that the more exposure a Cambodian student had to computers and the Internet the more favorable their attitudes were toward these technologies. Additionally, students with limited exposure to these technologies were more likely to have increased anxiety about using such technologies. The findings are discussed using Rogers' conceptualization of the Diffusion of Innovations theory. This study is the first of its kind aimed at understanding the perceptions and use of digital technology by Cambodian upper secondary students.

Keywords*: Student Use; Survey; Cambodia; Internet; Computers; Perceptions*

INTRODUCTION

The introduction of information and communication technologies (ICT) into the field of education has considerably changed the way teachers teach and students learn (Thang & Wong, 2010). With the pervasiveness of digital technologies in society, it is impossible to imagine future learning environments that are not supported, in one way or another, by ICTs. The United Nations Educational, Scientific and Cultural Organization (UNESCO) (2002) noted that the understanding of basic skills in ICTs is a fundamental aspect of education.

Unfortunately, less developed countries often experience difficulty with incorporating ICTs into their education system. This is particularly true in Southeast Asia where many countries lack a solid national infrastructure of electricity, Internet availability, human capital, and cell phone coverage. With core elements of a technological infrastructure not fully developed, school systems in this region experience dire challenges incorporating ICTs into the formal learning environment.

To integrate ICTs into the educational system of less developed countries, policy makers, funding agencies, politicians, and educators must understand the role of technology. This understanding includes how stakeholders perceive using technology, and what barriers they face when trying to use these technologies; both inside and outside of the formal school environment. The review of the literature that follows is intended to give the reader an understanding of digital technology in education in the Southeast Asia region with a specific focus on Cambodia.

LITERATURE REVIEW

Many less developed countries lack the funds, capability, and capacity to implement and sustain technology initiatives. Some researchers have argued that ICT access can be limited by a variety of micro and macro factors, including poverty and geographic isolation (Mariscal, Gil-Garcia, & Aldama-Nalda, 2011). With regards to ICT in education, each of the 11 ASEAN member countries can be assigned into one of three distinct groups (Southeast Asian Ministers of Education Organization, 2010). The most advanced countries have successfully incorporated ICTs into the education system. The second group includes those countries that are currently in the process of infusing ICTs into the education system. The third group includes those countries that have either started to develop and implement ICT in education policies or have implemented small scale ICT in education projects. Cambodia is part of this last group and is thus an interesting case to study because of its burgeoning development in the ICT in education sector.

Technology in Schools in Less Developed Countries

The Southeast Asian Ministers of Education Organization (2010) defines ICT in education as “ICT functioning as an integral or mediated tool to accomplish specific teaching and learning activities to meet certain instructional objectives” (p. 6). Given limited monetary resources and the need to improve educational quality, understanding how technology is being adopted in the education system of less developed countries is vital. In Western countries such as the United States, a decentralized system of educational control allows each state or region, and often times individual schools, to make decisions regarding the implementation of ICT in schools for teaching and learning. Outputs and inputs can vary greatly from one school to the next, and thus innovation adoption can look unique in each context. In countries with centralized education systems, like Cambodia, technology innovations (excluding pilot projects) are often rolled out across the country. Thus, understanding nuances of the technology adoption process in a limited number of schools in a country such as Cambodia, can inform planners, policy makers, and politicians.

Even with the many difficulties in obtaining and implementing ICT for teaching and learning, less developed countries are making strides in ICT use. Many Ministries of Education are aware of the research that shows the benefits of ICT in education and are taking steps to address this need (Banerjee, Cole, Duflo, & Linden, 2005). In Cambodia, the Ministry of Education has actively worked for over a decade in concert with various non-government organizations (NGOs) and aid organizations to implement technology in schools (Richardson, 2008; Richardson, 2011b).

Barriers to ICT Adoption in Less Developed Countries

Many ICT implementations in less developed countries tend to focus on one-to-one initiatives, which are led by both government agencies and NGOs. Richardson et al. (2013) compiled an open-access database of all large-scale one-to-one implementations across the world, demonstrating how countries in various level of development implement such efforts. The authors found that large-scale ICT in education implementations look drastically dissimilar in various countries with differences including type of machine, policy support, financial support, teacher training, leadership training, and Internet accessibility.

A core challenge for less developed countries is providing reliable electricity that is needed to power modern digital technologies (Adedoyin, 2008; Ale & Chib, 2011; Bass, 2011). Financial strain within less developed countries is an additional hindrance for ICT in education initiatives. For example, the government and individual NGOs often provide initial project funding and support. However, sustaining the recurring costs of electricity, computer repairs, and training is a responsibility borne by the local community. Adedoyin (2008) identified financial obligations of putting technology in schools as a persistent problem in less developed countries. This issue has led to the start of NGO initiatives within these countries, especially in rural and low-income urban communities, that are designed to address such a need (Brewer et al., 2005).

Des (2005) discussed various barriers that persist in Cambodia regarding technology. One barrier is the lack of a technology industry. As of 2005, 80% of the economy was based on traditional farming, making the use of technology insignificant for sustaining the country’s future of farming.

This mismatch of future and current needs is cause for slow adoption of any digital technologies in the country.

As noted above, cost and geographic isolation remains root causes of disparities between rural and urban schools. Despite being highly centralized, this is also the case in Cambodia (Richardson, 2006). In researching challenges to technology adoption in Cambodia, Richardson (2011a) found that educators across the country experience challenges in adopting ICTs due to language barriers, lack of electricity, lack of Internet, and lack of hardware.

Adoption of Internet by Consumers in Cambodia

The Cambodian Ministry of Posts and Telecommunications (Ministry of Posts and Telecommunications, 2011) is the policymaker and regulator of Internet and mobile communications within Cambodia. It reported that as of 2010, only 1.4% of the population had an Internet subscription. Additionally, 54.6% of the Cambodian population had a mobile phone subscription compared to 2.6% of the population who had a fixed landline subscription. It should be noted that other sources have reported mobile phone penetration rates as high as 87% as of late 2011 (BuddeComm, 2012). However, many Cambodians have more than one phone number by using multiple SIM cards. As evidence, Sokhean (2014) reported that mobile subscribers in Cambodia exceeded 20 million for a national population of only 5 million. This reality is coupled with the fact that high mobile penetration rates are often a way for mobile providers to flout the success of their company. The subscription rates therefore are not an accurate proxy of actual telephone penetration rates or of individual use.

Data on Internet subscriptions in Cambodia are also misleading. Given Cambodia's mobile phone penetration rates and the fact that mobile phones are becoming increasingly Internet accessible, fixed line Internet subscriptions do not provide an accurate portrayal of how many Cambodians are actually online. As late as spring 2012, advertisers within the country claimed the speed of mobile Internet connections surpassed that of most fixed line subscriptions.

Adoption of ICTs by Educational Stakeholders in Cambodia

Since the early 1980s, teacher training has been a critical focus for the government of Cambodia as a means to improve education (Duggan, 1996). Duggan (1996) stated that before 2000, 85% of the teachers were unqualified for their position. Teacher training around technology in the country has been rather limited. Much of the technology training in education that has been implemented has focused on teacher training colleges rather than classroom teachers (Richardson, 2007; Richardson,2009a, 2009b, 2011b). Unfortunately, individuals who engage in technology in education training and gain the knowledge necessary to maintain a strong technological infrastructure, are typically highly valued and quickly find jobs in NGOs or private institutions due to higher salaries and career advancement (Des, 2005). The future of Cambodia's education sector, particularly around technology, relies on both adequate training and retention of these qualified educators.

The end-stakeholder in any education system however is the student. Due to challenges faced by teachers in understanding and implementing ICT into the classroom, students may need to become leaders in their own learning (Abi-Raad, 1997). Even with students as change agents, computer anxiety exists for various stakeholders across the educational system in less developed countries (Fajou, 1997; Olatoye, 2011). This, coupled with findings that increased computer experience is associated with decreases in computer anxiety (Kian & Chee, 2002; Necessary & Parish, 1996; Olatoye, 2009; Wilson, 1999), suggests that, "it is essential that projects are designed with attention to the needs of the users, as opposed to the commonly adopted one-size-fits-all approach" (Ale & Chib, 2011, p. 55). Currently, research that examines students' use of technology in less developed countries is lacking. This is especially the case in the country of Cambodia.

One study has focused on comparing student perceptions of ICT in Cambodia and Japan (Elwood & MacLean, 2009). Elwood and MacLean (2009) used survey research to measure digital literacy of university students in both of these contexts. The authors found that Japanese students tended to discriminate between when best to use technology versus paper whereas Cambodian students tended to choose technology for every task choice. These findings indicate that Cambodian students may have unique perceptions related to using digital technologies. The current study is thus intended to add to the body of knowledge related to ICT adoption barriers and to understand how secondary students perceive and use digital technology.

THEORETICAL FRAMEWORK

The focus of this paper is on the adoption and integration of ICT in three Cambodian upper secondary schools. As such, we ground our conceptual framework in the constructivist work of Rogers (2003) who develope five characteristics of diffusion of innovations (DOI). This model of technology adoption addresses how and why end users choose to adopt a given innovation. The usefullness of such a theoretical framework allows for the understanding of the constructs associated with implementing technology in a less developed country such as Cambodia.

Using constructivist learning theory, researchers have come to understand that learning is achieved through experience, where thinking, creativity, and innovation blossom. In *Diffusion of Innovations*, Rogers (2003) formulated the diffusion of innovation theory as it applies to the spread on innovation and technology within a given system. Diffusion, Rogers argues, happens over time in a process where members within a culture communicate among each other. Rogers' model hinges on five perceptual factors of the end user: (1) relative advantage, (2) compatibility, (3) complexity / simplicity, (4) trialability, and (5) observability. The user's perceptions of the factors influence the extent to which the individual will adopt or reject the specific innovation.

The *relative advantage* factor takes into consideration whether or not the innovation is better than a preceding practice or idea. *Compatibility* refers to the alignment of the innovation with cultural values, past experiences, and the needs of the individual. The more *complex* an idea or innovation, the less likely it is to be adopted. Conversely, the more simple the idea or innovation, the more likely it is to be adopted. The factor of *trialability* involves being able to practice a new idea or innovation before full implementation. Self-efficacy can thus be increased by safely experimenting with the innovation. *Observability* refers to how visible the innovation is to others. Innovations are more likely to be adopted if an individual can observe someone else applying or using the innovation. Rogers' (2003) model of the diffusion of innovations theory allows for an understanding of how technology can be effectively interfused into a culture. Conceptualizing this study around this Rogers' model helped us account for a more complete understanding of the technology adoption process.

METHODOLOGY

Data were collected at three, urban upper secondary schools in Cambodia. These schools were purposively chosen to represent best-case examples of upper secondary schools in the entire country in terms of students to teacher ratio, training of teachers, ICT exposure for both teachers and students, student readiness, and general access to ICT resources. The instrument used to collect the data was a survey created by combing previously published instruments. More details regarding instrumentation are discussed in the following section.

Descriptive statistics were first used to describe the basic features of the data. One-way analysis of variance (ANOVA) was used across the multiple aspects of the data to determine if the variations between variables were significant. The following sections describe the creation of the instrument and the analysis of the results. Significant findings are reported by school to better understand the unique situation of ICT diffusion with a focus on differences and similarities across three upper secondary schools located in three different regions of the country.

Instrument

By combining elements from four previously published questionnaires that focused on computer attitudes, we were able to develop the Cambodian student perception survey on ICT. The four scales included: Attitudes Towards Computers Scale (ATC) (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989), the Computer Attitude Scale (CAS) (Raub, 1981), the Computer Anxiety Index (CAIN) (Loyd & Gressard, 1984), and the Blomberg-Lowery Computer Attitude Task (BELCAT) (Maurer & Simonson, 1984). The ATC contains factors focused on computer anxiety, computer use, computer appreciation, and societal impact. The CAS uses a Likert-scale to measure confidence, computer liking, and anxiety. Correlates of computer anxiety include experience, gender, and academic major (1987). Loyd and Gressard (1981) used the CAS to find that computer anxiety correlates with computer liking and computer confidence. The CAIN looks at the avoidance of, negative attitudes toward, caution with, and disinterest in computers. Maurer and Simonson (1984) found the CAIN to be correlated with state anxiety and computer comfort. The BELCAT measures attitudes toward learning with and about computers. The five subscales of the BELCAT include: computer liking, comfort with computers, usefulness of computers, attitude towards success with computers, and the perceptions that computers as a male domain. Erickson (1987) reported that an individual who places a high value on computers would be more likely to choose to use computers. The reliability between the four scales has shown to be very similar in two previous comparison studies (Gardner, Discenze, & Dukes, 1993; Woodrow, 1991).

The researchers compiled an initial set of items from each of the four questionnaires to create a draft version of a survey on student perceptions regarding computers and the Internet. The research team then discussed each proposed item and worked directly with our Cambodian collaborators to rephrase questions to fit the local context. Since the original items were tested and used predominantly in Western contexts, rewording and reconceptualizing of survey items was required. After the initial survey was developed, a Cambodian field team completed various oral think-aloud sessions with local students to test for readability, validity, and usability of the items. Editing and rephrasing lasted three rounds using the technique described above.

The survey had two sections. The first section was developed to determine students' use and perceptions of computers, while the second section was developed to determine students' use and perceptions about using the Internet. Both sections used a five-point Likert scale to measure students' level of agreement with each item. The computer perceptions section consisted of 20 questions, while the Internet perceptions section had 16 questions.

RESULTS

In this section, we discuss the population of each of three schools and the sample used in the current study. We then present the findings on how students reported using computers and the Internet. Finally, we will present the findings on how students perceive the use of computers as well as the Internet.

Population and Sample

The first school, Wat Koh Upper Secondary School, is located in the nation's capital city, Phnom Penh. It is one of 29 upper secondary schools located in an urban area of 2.3 million citizens. The second school, Pursat Upper Secondary School, is one of 14 upper secondary schools in Pursat province, which is home to 397,000 citizens. The third school, Angkor Upper Secondary School is located in Siem Reap. Siem Reap is the third largest city in the nation with 174,000 citizens.

Out of the 7,187 students in the three Cambodian schools included in the study, we had 1,137 complete the survey (15.8%). Using the sample size calculator created by Valiga (2012) and setting the results to a .05% acceptable error and a 95% level of confidence, we determined 337 responses from students at Pursat, 344 responses from students at Angkor, and 297 responses from students at Wat Koh were needed. Using proportional sampling of student populations at each school and by each grade, we oversampled by 10% to ensure we would reach our desired response rate. Table 1 provides details on this sampling procedure. Table 2 shows each school's technology infrastructure as ascertained from conversations with the principal of each of the three schools.

Table 1: *Student Enrollment and Sample by School and Grade*

School	Enrollment by Grade				Return Rate by Grade			
	10th	11th	12th	Total	10th	11th	12th	Total
Angkor	888	1060	1271	3219	96 (10.81%)	135 (12.74%)	163 (12.82%)	394 (12.24%)
Pursat	852	932	892	2676	123 (14.44%)	126 (13.52%)	128 (14.35%)	377 (14.09%)
Wat Koh	379	350	545	1274	111 (29.29%)	104 (29.71%)	151 (27.71%)	366 (28.73%)
Total	2119	2342	2708	7169	330 (15.57%)	365 (15.58%)	442 (16.32%)	1137 (15.86%)

Table 2: *Technology Infrastructure by School*

School	Computers for Students	Grade(s) that Receive Computer Training	Internet Access
Angkor	32	10th, 11th	None
Pursat	54	11th	Computer teacher only
Wat Koh	21	10th, 11th	Principal only

To understand the infrastructure of the schools, we asked each principal about the availability of computers, the Internet, and electricity. Electricity in each school is only used for administrative computer tasks and during the student computer course. All three schools offer computer classes for one-hour per week to select grades. Angkor is the only school that allows computer access for teachers outside of regular class hours. To conserve electricity, however, the teachers do not normally access these labs. None of the schools had Internet access for student use.

Student Perceptions about Computer and Internet Use

The researchers distributed the survey in November 2011 to students in the three upper secondary schools (grades 10-12). Data from the surveys were entered into SPSS (V.20) for analysis. Responses were examined across two categories: Computer Attitude and Internet Attitude. For computer perceptions, two variables (Computer Use [beginner, new, experienced, veteran] by Computer Attitude [strongly disagree, disagree, neither, agree, strongly agree]) were examined using an ANOVA. Likewise with Internet perceptions, two variables (Internet Use [beginner, new, experienced, veteran] by Internet Attitude [strongly disagree, disagree, neither, agree, strongly agree]) were examined by an ANOVA. The Computer Use and Internet Use variables have multiple subparts, providing the need to run an ANOVA between the variable of Computer Attitude and each subpart of the Computer Use variable. For example, the ANOVA ran between the perceptions of the statement, "computers make schoolwork more fun and interesting," which is a subpart question of the Computer Use variable. The rejection level for all analyses was set at p = .05. All significant scores assume that as computer and Internet experience increased, the attitude toward the computer and/or Internet is changed.

At the time of the data collection, student computer and Internet mean experience across all three schools fell in the *beginner* or *new* user category (i.e., most students had less that two years of computer and Internet use). Only 17.3% of students had three or more years of computer experience while 14% of students had three or more years of Internet experience. Tables 3 and 4 detail the student computer and Internet experience levels.

Table 3: *Student Computer Experience*

School	<1 year (beginner)	1-2 years (new)	3-4 years (experienced)	>4 years (veteran)
Angkor (*n*=310)	61.0%	24.8%	9.0%	5.2%
Pursat (*n*=284)	49.6%	37.0%	8.8%	4.6%
Wat Koh (*n*=353)	44.8%	30.9%	13.3%	11.0%
Average	51.8%	30.9%	10.4%	6.9%

Table 4: *Student Internet Experience*

School	<1 year (beginner)	1-2 years (new)	3-4 years (experienced)	>4 years (veteran)
Angkor (*n*=228)	54.8%	29.8%	12.3%	3.1%
Pursat (*n*=215)	54.4%	36.7%	6.0%	2.8%
Wat Koh (*n*=336)	49.4%	32.7%	11.3%	6.5%
Average	52.9%	33.1%	9.9%	4.1%

Student Perceptions of Computer and Internet Use

In this section, we describe the resulting factors of positive reactions to computer use, negative reactions to computer use, and apprehension related to computer use. A confirmatory factor analysis with a varimax rotation determined the factor loadings on each scale. The reliability across each scale can be seen in Table 5.

***Table 5**: Factor Loadings across Three Factors of Student Questionnaire*

Factor	Factor Loadings	
	Computer Attitudes	Internet Attitudes
Positive Reaction	.679	.742
Negative Reaction	.522	.637
Apprehension Toward Use	.344	.349

The Computer Experience and Internet Experience variables had four ordinal categories (1 = *beginner,* being less than one year of use; 2 = *new,* being between one and two years of use; 3 = *experienced,* being between three and four years of use; and 4 = *veteran,* being more than four years of use). Internet experience of students at each of the three schools increased with an increase in their computer experience. For those students with less than a year of computer experience (n = 340), the mean Internet experience was 1.24 (*beginner*). Students (n = 254) who reported having between two and three years of computer experience were identified as "*new*" in terms of Internet experience (M = 1.65). Although the classification category for Internet experience does not change as the computer experience steps up to the next level of *experienced*, the mean score of the Internet experience continues to increase (M = 2.31). Students who used computers for more than four years (*veteran*) had a mean Internet experience of 3.09, propelling their Internet understanding to an *experienced* level. Further school level data can be seen in Table 6, which details how Internet experience increases with the increase in computer experience.

***Table 6:** Mean Differences of Internet Experience by Computer Experience and by School*

School	<1 year	1-2 years	3-4 years	>4 years
Angkor	1.26 (n = 111)	1.66 (n = 70)	2.43 (n = 28)	2.87 (n = 16)
Pursat	1.21 (n = 87)	1.55 (n = 82)	2.28 (n = 25)	3.00 (n = 13)
Wat Koh	1.24 (n = 142)	1.72 (n = 102)	2.26 (n = 46)	3.21 (n = 39)
Total	1.24 (n = 340)	1.65 (n = 254)	2.31 (n = 99)	3.09 (n = 68)

Positive reactions. The student responses showed that as students use technology more, they tend to believe that: their schoolwork has the possibility to become more interesting and imaginative; computers can provide them with an opportunity to learn new skills; and technology is increasingly becoming essential in today's society. As students are learning about computers during their one-hour per week course or outside of school (e.g., at Internet shops or at home), the data showed an increase in positive reactions to ICTs. At Wat Koh, student scores showed the more they use a computer, the more they are able to see the advantages by having interesting and imaginative school work [F(3, 346) = 2.81, p = .04]. Wat Koh and Angkor student scores showed that being able to use computers more increases the opportunity to learn new skills [F(3, 340) = 5.57, p = .001] and [F(3, 299) = 4.12, p = .007].

Student scores showed computers are becoming a need in today's society at Wat Koh [F(3, 348) = 2.84, p = .038] and Pursat [F(3, 280) = 3.37, p = .019]. As Pursat students progressed from being a *beginner* to a *veteran* in computer user, the results suggest they believed that computers provided an advantage to learning [F(3, 271) = 3.61, p = .014]. In the one-hour per week use of computers for students and the out-of-school time spent using a computer, those students at Wat

Koh [$F(3, 345) = 4.73$, $p = .003$] and Angkor [$F(3, 301) = 3.03$, $p = .003$] who have more years of computer use agree that they will continue to use computers regularly.

Given that students do not get access to the Internet in school, the school is not teaching the usefulness of the Internet to students. Still, the students who have more experience with the Internet tended to better understand the benefits that it can provide. Wat Koh [$F(3, 332) = 2.71$, $p = .045$] and Angkor [$F(3, 223) = 2.78$, $p = .042$] student scores indicate a recognition that in today's world, the Internet is very important to know. Further advantages to the Internet were found with students at Wat Koh, who indicated that the Internet is a great contribution to human life [$F(3, 330) = 3.33$, $p = .02$] and by Angkor students who reported that the Internet allows them to do more interesting and imaginative work [$F(3, 222) = 4.28$, $p = .006$]. Angkor student scores also indicated that they believe the Internet makes society more advanced [$F(3, 220) = 4.13$, $p = .007$]. No significant disadvantages to Internet use were found across student scores. An ANOVA showed that Angkor students felt as though they can get whatever information they want from the Internet as they gain more experience from using it [$F(3, 222) = 5.07$, $p = .002$].

Negative reactions. Despite the advantages to ICT use, realization and understanding of those advantages is still lacking. Students at Pursat expressed that they would be equally prepared to attend a university without knowing how to use a computer [$F(3, 275) = 4.57$, $p = .004$]. Angkor students reported that they could do anything a computer could do [$F(3, 304) = 3.42$, $p = .018$]. Thus, it is probable that with access and learning of basic computer skills being limited within the formal school system, it is difficult to for students to understand the benefits that a computer can provide.

As students increased in their years of computer use, results from Wat Koh [$F(3, 342) = 2.70$, $p = .046$] and Angkor [$F(3, 300) = 2.88$, $p = .036$] indicated that students were increasingly afraid they might damage the machines. The researchers suspect that the scarcity of computers, lack of access, and fear of making a mistake or fear of damaging a computer discourages students from being more optimistic about using these technologies. Additionally, these perceptions may be a result of teachers transferring their own anxiety. Wat Koh student scores showed that as students use computers more (whether in school or outside of school), anxiety about using computers decreases [$F(3, 341) = 4.41$, $p = .005$].

Even though the Internet is not provided in the schools for student use, students at Wat Koh [$F(3, 330) = 3.09$, $p = .027$] and Angkor [$F(3, 223) = 2.38$, $p = .07$] were afraid of damaging something by using the Internet. The researchers believe the students are afraid of using the Internet because of a lack of training and exposure in the schools. The use of the Internet, however, mirrors the perceptions and attitudes of computer use. Student scores from each school showed a need for a skilled person to be nearby when using the Internet: Wat Koh [$F(3, 329) = 6.41$, $p = .000$], Pursat [$F(3, 210) = 4.24$, $p = .006$], Angkor [$F(3, 222) = 7.90$, $p = .000$]. Also, Wat Koh student scores show that they hesitate using the Internet because of the fear of looking stupid [$F(3, 328) = 4.35$, $p = .005$]. Angkor student scores regarding their increased experience with the Internet was related to students feeling uncomfortable online [$F(3, 221) = 3.00$, $p = .031$]. Feeling uncomfortable being online may be due to students' lack of access to the Internet, lack of Internet training at school, or issues with language. Nevertheless, in this study, experience with using computers and the Internet is related to students' anxiety.

Student scores at Wat Koh showed there is a hesitation to use computers for fear that the individual will make a mistake that they cannot correct [$F(3, 348) = 3.04$, $p = .029$]. This finding could be due to multiple factors. Our experience in these schools indicates that a student's view of computer usage is tainted after a student comes across a technology situation where a mistake was made and not rectified. If a problem arises with a computer, the data suggest that students can typically solve the issue as they become more familiar with computer use [$F(3, 347) = 4.51$, $p = .004$].

Student scores from each of the three schools indicated that the students desired a skilled person nearby (Wat Koh [$F(3, 347) = 3.34$, $p = .002$], Pursat [$F(3, 275) = 9.56$, $p = .000$], Angkor [$F(3, 301) = 7.72$, $p = .000$]). The need for a skilled person nearby for Internet use is listed in the *negative reactions* factor due to the difference in how computers and the Internet are used by Cambodian students. As mobile technologies become more pervasive in the country, students will have more experience with the Internet. Thus, needing a skilled person nearby for Internet use could be looked at as unnecessary. Another possibility is that students might feel ownership over personal telephones; and thus, students are more willing to tinker with the device. Transferring this idea of needing a skilled person nearby with computer use, the student may be more apprehensive due to the lack of knowledge or a fear of complexity of the computer.

As these Cambodian students continue to use the Internet outside of school, being able to understand the complexity of the Internet gets easier. The design interface of Internet browsers has advanced to the point that Internet-based errors have minimal consequences. This reality was demonstrated with student scores from each school that showed they believe they can solve problems of using the Internet: Wat Koh [$F(3, 329) = 3.30$, $p = .021$]; Pursat [$F(3, 210) = 3.50$, $p = .016$]; Angkor [$F(3, 221) = 6.55$, $p = .000$].

DISCUSSION

The exploratory research focused on how students in three Cambodian upper secondary schools perceived the use of modern digital technologies, in particular computers and the Internet. The conceptual framework of Rogers' (2003) diffusion of innovation model will be used to frame our understanding of the data analysis. This model of innovation adoption will help us frame the concepts into a meaningful and organized structure for better application. Although the three schools varied across the survey results, overarching results will be organized within this theoretical model.

In terms of *relative advantage,* the student responses suggest that as they use technology more, three things begin to happen. First, there is an increase in the perception that the technology becomes more interesting. Second, through use, students increased their perceptions that computers can provide opportunities to learn new skills. Third, as students use technology more, they increasingly believe that technology is an important aspect of everyday life. Whether students are learning about computers during their one-hour per week course, or outside of school, the data show a positive increase in students' view of the relative advantage of using the computer.

With *compatibility,* our results suggest that students at Pursat tended to believe that the use of computers in the classroom was significantly more beneficial as the individual increased in their computer experience. Although the responses from Pursat indicated that students perceived computers provide an advantage to learning, Angkor student scores indicated that increased experience with the Internet makes the students feel uncomfortable with this tool. This uncomfortable presence online may be due to students' limited access to the Internet, receiving poor Internet training at school, or a result of the messages given to them by their teachers.

The construct of *complexity/simplicity* appeared in a few ways in the study. Students seemed to fear making mistakes and damaging the computers while using them. With regards to the Internet, Angkor students perceived that they can gain access to the information they want, but Wat Koh students were afraid of damaging something by using the Internet. The perceived complexity of using these machines and the complex thoughts and fears that surround the use of the Internet may deter students from seeing the simplicity of technology.

Students from all three schools desired to have a skilled person nearby when using the technology. Thus for *trialability*, Cambodian students are becoming less scared about using the computer and the Internet and desired to use computers and the Internet regularly as they increase their level of use. Having the opportunity to become familiar with the computer and the Internet allows for more creativity and less apprehension. Students in each of the schools believed they could solve problems with the Internet, indicating a high level of self-efficacy.

In terms of *observability*, the students reported fear of looking incompetent while using both computers and the Internet. We believe that having students observe teachers and school administrators appropriately using technology will empower the students. The anxiety of looking inept could be coming from multiple factors including these role models. We believe, however, that the main factor is the lack of leadership and exemplars in the students' learning environment.

CONCLUSION

This study sought to understand how upper secondary school students in Cambodia perceive the use of computers and the Internet. While this study is the first of its kind to unpack the perceptions and use of digital technology by Cambodian upper secondary students, questions remain as to how much of their perceptions are accounted for by exposure at school versus exposure elsewhere. After all, most of the students in this study are exposed to computers in their school one-hour per week. School exposure may only account for a small amount of the variance in terms of how students arrive at the opinions they hold. Further research in this area could be useful. For instance, we wonder what role exposure to mass media may play in driving students' belief that the Internet makes society more advanced.

Nevertheless, the student responses suggest that as they use technology more, their belief that computers could provide them with opportunities to learn new skills increases. Because technology use in schools is primarily driven by strategy and vision, the Cambodian Ministry of Education can develop effective policies and funding mechanisms to provide access, time, training, and support for the use of technology in an educational setting. In these three schools, computer labs are already present. However, challenges persist regarding electricity expenditures and computer accessibility. Internet accessibility could be drastically improved for the entire school system, as these schools have no access for student access. The schools are lagging behind in the potential benefits that could arise from such a resource. The students' fear of looking incompetent and damaging the machine by using the computer or Internet indicates a lack of hands-on experience and adequate support. By training the administrators and teachers, the students will be able to observe and learn from their leaders, thus naturally becoming more comfortable with the use of technology.

Less developed countries such as Cambodia can encourage the growth of technology in schools in many ways–even through the use of mobile devices. What this study has shown is that student computer use and Internet use in Cambodia is occurring in unpredictable ways. Nevertheless, the data indicate that exposure to computers and Internet matters. For better or worse, this directly impacts students' perceptions of computers and the Internet. The future of the country lies in the hands of students who tend to be afraid of sitting in front of a computer and desire a skilled person to be nearby at all times. Imagine the many ideas, companies, and developments that could come from simply helping current students better understand and appropriately use technological devices in their everyday lives.

ACKNOWLEDGEMENT

This work was conducted under a grant from Freedom House, funded under USAID. The authors extend humble gratitude for their support, professionalism, and commitment to human rights issues. Deep appreciation is also extended to Ms. Lyda Chea from the Department of Media and Communication at the Royal University of Phnom Penh. Lyda served as the Cambodia field researcher who tirelessly collected the survey responses. Without her commitment and efforts to this project, none of this would be possible.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 77-88

ICT and Instructional Innovation: The Case of Crescent Girls' School in Singapore

Linda Shear[1], Chen Kee Tan[2], Deepa Patel[1], Gucci Trinidad[1], Richard Koh[2] and Stephanie Png[2]

[1]SRI International, USA
[2]Crescent Girls' School, Singapore

ABSTRACT

This paper describes a global professional development program called 21st Century Learning Design (21CLD), which helps teachers design academic lessons that integrate opportunities for students to develop 21st Century competencies in a variety of dimensions such as collaboration, knowledge construction, and the powerful use of ICT for learning. The framework and tools of 21CLD are grounded in learning science research, promoting aspects of these dimensions that have been shown to tie to deeper learning. The paper highlights the example of Crescent Girls' School in Singapore, which is implementing this program school-wide as a next step on its longstanding journey to leverage ICT for instructional innovation. Critical aspects of the school's supportive ecosystem include a clear and consistent vision for teaching and learning, strong teacher ownership and a common language of discourse, distributed leadership, and the use of ICT to support teacher professional development and lesson design. The paper describes results for teaching and learning through a Communicative Arts lesson that leverages place-based ICT tools for student knowledge construction. Although Crescent Girls' School is unusually well resourced and has a strong history of ICT use for learning, this case offers lessons that apply equally well for earlier-stage explorations into ICT.

Keywords: *21st Century Learning; Lesson Design; ICT for Learning; Teacher Professional Development; School Support Structures; Distributed Leadership*

INTRODUCTION

Teachers around the world have long felt a gap between global policy rhetoric on the imperative of promoting students' 21st Century competencies and the lack of specific tools for teachers to build these competencies into their lessons. In particular, it is tempting to believe images of the power of new technologies to transform schooling, making the learning environment more engaging and student-centered and the learning itself deeper and more powerful. But in real classrooms, the challenges of integrating information and communication technologies (ICT) and new pedagogies in ways that enhance rather than compromise academic success are ever-present, both in developing countries and in contexts such as Singapore that are further along the path. The research described in this paper offers a lens into what it takes to help ICT reach its potential for teaching and learning.

The focus of this paper is a global professional development program called 21st Century Learning Design (21CLD), which helps teachers design academic lessons that include opportunities for students to develop 21st Century competencies such as collaboration, knowledge construction, and the powerful use of ICT for learning. The setting of this study is Crescent Girls' School (Crescent) in Singapore, a high-performing, well-resourced secondary school for girls that has been on a journey to leverage ICT for instructional innovation for over a decade. Crescent adopted the 21CLD approach school-wide in 2012, and has since leveraged it systemically to deepen the 21st Century competencies embedded into its instructional programs while continuing to promote academic excellence.

A striking element of the description of Crescent, later in this paper, is the pervasiveness of ICT throughout the school, both in access and in instructional use. We offer this case to demonstrate principles that are important in any setting in which teachers wish to take steps toward ICT-enabled student-centered pedagogies, whether those are first steps or simply next steps.

This paper examines the process of ICT-supported instructional transformation from three vantage points:

1) A program that provides a framework and tools for teachers;
2) The leadership structures and strategies within a school that can encourage and enable teachers to innovate; and
3) The view from the classroom, with a case of a Communicative Arts lesson that uses ICT to promote students' knowledge construction and collaboration competencies.

THEORETICAL FRAMEWORK AND PROGRAM DESIGN

21CLD grew out of a global multi-year research program called Innovative Teaching and Learning (ITL) Research (Shear, Gallagher, & Patel, 2011). The intent of ITL Research was to study ICT-enabled educational innovation and its school and national-level facilitators across a wide range of countries. The conceptual framework that grounds both programs is strongly rooted in decades of research in the learning sciences (Bransford, Brown, & Cocking, 2000; OECD, 2010; Sawyer, 2006) and in leading international frameworks for 21st Century skills (ISTE, 2008; Law, Pelgrum, & Plomp, 2008; Partnership for 21st Century Skills, 2009; UNESCO, 2008).

In 21CLD, primary elements of 21st Century teaching and student skills are defined as six dimensions that research has shown to tie to improved student outcomes: collaboration, knowledge construction, skilled communication, real-world problem-solving and innovation, use of ICT for learning, and self-regulation (see Table 1). The focus of the program is the lesson (called a "learning activity" in 21CLD) and the opportunities it provides for students to learn and practice these skills. Based on a toolset developed in ITL Research and validated in multiple countries (Gallagher, Shear, Patel & Miller, 2011), 21CLD provides detailed definitions, examples and rubrics for each of these dimensions that help teachers analyse the strength of a given lesson through the lens of that dimension. For example, when students participate in this lesson, how strong are their opportunities to construct knowledge, to collaborate in meaningful ways, or to use ICT to deepen learning?

For each dimension, the levels of the rubric are based on elements that learning sciences research highlights as supportive of more meaningful learning (see key questions for each dimension in Table 1 below). For example, for the collaboration dimension, rather than simply working together to discuss an issue—which often passes for collaboration in classrooms—21CLD pushes teachers to focus on the substance of the collaboration. Lessons can be designed so that students are required to articulate their ideas, listen and build on the ideas of others, debate and negotiate, leading to deeper conceptual understanding (Brown & Campione, 1996; Scardamalia & Bereiter, 1994), and with responsibilities thoughtfully distributed so that each student plays an essential role (Nussbaum & Caballerio, 2013).

Table 1: *Key Questions by 21CLD Dimension*

Dimension	Key Question
Collaboration	Are students required to share responsibility and make substantive decisions with other people? Is their work interdependent?
Knowledge Construction	Are students required to construct and apply knowledge? Is that knowledge interdisciplinary?
Self-Regulation	Is the learning activity long-term? Do students plan and assess their own work, and revise their work based on feedback?
Real-World Problem-Solving and Innovation	Does the learning activity require solving authentic, real-world problems? Are students' solutions implemented in the real world?
Use of ICT for Learning	Do students use ICT to support knowledge construction? Is ICT required for that knowledge construction? Are students designers of an ICT product for an authentic audience?
Skilled Communication	Are students required to communicate their own ideas regarding a concept or issue? Must their communication be supported with evidence and designed with a particular audience in mind?

Similarly, the knowledge construction dimension focuses on whether students are primarily repeating information they have learned or participating actively in creating their own conceptual understandings (Bransford et al., 2000) through activities such as interpretation, analysis, synthesis, or evaluation, and making those understandings increasingly robust through subsequent application to new situations (Pellegrino & Hilton, 2012). According to the 21CLD framework, ICT is viewed within the context of support for broader pedagogical innovation and deeper learning, not as an end in itself. The use of ICT for learning dimension focuses on whether ICT is supporting knowledge construction, and whether it is being used in ways that enable new learning opportunities that would not be possible without it (Bransford et al., 2000).

The goal of the 21CLD program is to translate these and other powerful ideas for learning into classroom activities for students. It begins with a 3-day workshop designed to engage teachers actively in each of the dimensions. The workshop leverages the teacher-friendly definitions, examples, and rubrics for each dimension that were developed and refined through the three-year multi-national ITL Research program. For each dimension, teams of teachers collaborate in hands-on activities to work through definitions and examples of each "big idea" (the main constructs of the dimension); learn to recognize learning activities that do or do not promote these skills by applying the rubrics to strong and weak exemplars; act as designers to strengthen the learning opportunities a lesson offers in this dimension; and consider teaching strategies that best facilitate successful enactment of the big ideas. By the time the workshop concludes with a comprehensive lesson design activity, teachers have developed a common vocabulary for talking about 21st Century competencies, and have the building blocks to use these tools both for their own or collaborative reflection on the opportunities their instruction is providing for students to develop these competencies and for their own or collaborative lesson design.

Depending on the context in which it is used, 21CLD often serves as a first in-depth introduction for teachers to the concepts of 21st Century teaching and learning, and serves as a bridge between the language of policy/standards and concrete methods for the classroom. In the case of Crescent, the school itself already had a long history of focusing on ICT use and on 21st Century competencies for students. For them, 21CLD offered a common language to discuss 21st Century learning and a concrete way to focus on these competencies in the design of instruction, with the goal of more deeply incorporating them into the school's curriculum.

As with any supports for instructional change, a workshop is only the beginning. This paper will focus on how 21CLD was leveraged in ongoing instructional design processes at Crescent within an ecosystem of supports for instructional innovation, and describe the case of a communicative arts class that leverages ICT to promote students' 21st Century competencies and academic success. The paper focuses on three of the 21CLD dimensions: collaboration, knowledge construction, and the use of ICT for learning.

METHODOLOGY

This paper describes preliminary results of the school-wide implementation of the 21CLD program at Crescent Girls' School in Singapore through the lens of a communicative arts lesson. It represents an early stage in a larger study in which teachers are researching their own practice, with the support of SRI International to conduct a cross-case analysis of teachers' use of the 21CLD process to build lessons designed to deepen students' 21st Century competencies. In line with the literature on case study and cross-case analysis, we first create individual case records describing teachers' experiences implementing 21CLD-developed lessons in their classrooms before systematically analyzing across case records to understand school-wide 21CLD implementation (Merriam, 1991; Miles & Huberman, 1994; Yin, 1994). For this study, the case record includes the following data:

- Assessment of lessons using 21CLD learning activity rubrics
- Assessment of students using 21CLD student rubrics as well as content-specific assessments
- Peer classroom observations
- Teacher case reports reflecting on their implementation of 21CLD

To develop the case record, we use teacher-driven action research to collect information about the experiences teachers have implementing pedagogical approaches to develop students' 21st Century competencies in their own classrooms. Action research is an iterative process through which teachers investigate their classroom instruction, reflect on how they can improve, and make changes to their practice (Carr & Kemmis, 1986; Pine, 2009). Because teachers are the implementers of instruction, their inquiry into their own practice often uncovers valuable information about improving teaching practices and the effectiveness of school-wide instructional programs (Foley, 2009; Kaftan, Buck, & Haack, 2006; McGlaughlin, Watts, & Beard, 2000). Since we seek to understand school-wide implementation of 21CLD through individual teacher's classroom experience, action research creates a unique opportunity for teachers to collect data on implementation of their pedagogical approaches while reflecting on successes and areas for future improvement. This paper focuses on one teacher case.

This research places a heavy emphasis on the school-level context of innovation, and the structural and cultural components that promote classroom-level change. From the perspective of the global 21CLD program, the school has also been treated as a higher level of a "case", when we look at implementation models that support innovation in widely varying national and local contexts (e.g., Shear, Mikkonen, Sithamparam, & Tang, 2012). We gather data on school-level factors that influence the implementation of 21CLD through interviews with school leaders and teachers and reviews of documents describing school programming. We use these data in this paper to describe the critical school-level elements that influence classroom-level implementation of 21CLD at Crescent.

CONTEXT: AN INTRODUCTION TO CRESCENT GIRLS' SCHOOL

Crescent Girls' School in Singapore is a secondary school with about 1,100 students and a staff of about 90. The school has had a 1:1 learning environment since 2003, where each student owns a personal learning device provided by their parents and has access to reliable wireless connectivity and technical support thereby allowing for the seamless integration of technology into classrooms. Under the school's mobile learning program, students use their devices across all subjects for all levels. The mobile learning program is founded on the school's vision and strategies around curriculum, pedagogy, and assessment. A 1:1 learning environment has facilitated the creation of various ICT-supported innovations in teaching and learning, where technology is leveraged in unique ways.

Because students possess their own personal devices, learning can take place anytime, anywhere, and with anyone. Technology use is ubiquitous in the school – teachers naturally and seamlessly leverage Web 2.0 tools to facilitate collaborative learning and self-directed learning. To harness technology effectively and pervasively for learning beyond the school, Crescent has also developed a comprehensive suite of technologies to extend learning beyond the four walls of the classroom. For example, Trail Shuttle is a technology application that was developed by Crescent in collaboration with key partners. This web-based application enables both teachers and students to create exciting multimedia and location-based investigations called i-Trails, which are subsequently made available for both their peers and public to experience through their smartphones and other mobile devices.

In addition to these technology innovations, the Crescent curriculum features a number of ICT-supported instructional programs designed to support more meaningful and connected learning. For example, an integrated curriculum program in secondary 1, 2, and 3 (the first three grades of secondary school) draws theme-based content from multiple subject areas, applying skills, concepts, and processes in authentic and real-life situations so that students can see the connection across different disciplines. The Secondary 1 communicative arts program, which is the focus of the case presented in this paper, integrates literature and English and places a strong emphasis on the skill of effective oral communication.

Throughout its recent history, school leaders at Crescent have recognized the importance of systemic supports for innovation within a vision that emphasizes instructional excellence. The next section describes critical elements in the education ecosystem within the school and how those elements have been leveraged to guide instructional innovation through 21CLD. We then present the case of a Secondary 1 communicative arts lesson unit as an example of how these critical elements support the design and implementation of a series of lessons that seamlessly and pervasively uses ICT to support the development of knowledge construction and collaboration skills in students.

A school-wide ecosystem for ICT-supported innovation

Significant changes to teaching and learning are complex and too often do not reach their potential in practice (Cuban, 1993; Payne, 2008). School improvement efforts fail in spite of much promise because implementation issues are usually underestimated. The pace of change often occurs too quickly, and is frequently imposed from the top or the outside, leaving very little time and space for leadership capacity building (Harris & Chrispeels, 2008). This section discusses the key elements that have surfaced from the research at Crescent that support sustainable and scalable ICT-supported innovations.

Strong teacher ownership and a common language of discourse Teachers are the ultimate arbiters of change. Teacher beliefs and values underpin what they do in the classroom (Hill & Crevola, 1997). Hargreaves and Shirley (2009) describe lively learning communities where teachers share and learn from one another as one of the key principles for teacher professionalism. Changing the conversation in an organization can have profound impact on its culture and the day-to-day work of its people (Kegan & Lahey, 2001). Having a common language and precision regarding meaning of that language are crucial to the culture of discipline essential to effective schools (DuFour, DuFour, & Eaker, 2008).

Crescent has assessed 21st Century competencies since 2007. However, pedagogical practices surrounding development of these competencies were not apparent. 21CLD was introduced as a professional development framework to provide lenses for the design of learning activities that explicitly develop students' 21st Century competencies. 21CLD was introduced through a workshop conducted for all teachers. Teachers worked in collaborative teams to design lesson units using 21CLD and school leaders engaged in generative conversations in these teams. Structural elements were introduced to facilitate teacher ownership and collaborative discourse. Professional development time had been built into teachers' timetables so that time was protected for teachers to engage in collaboration and discourse.

Distributed leadership. One of the dimensions of effective leadership involves leaders promoting and participating in teacher learning and development (Robinson, 2008). School leadership has a greater influence on schools and pupils when it is distributed. Distributed leadership focuses on expertise rather than position. It serves to tap on "untapped" leadership in teachers, and achieves distributed accountability (Leithwood, Day, Sammons, Harris & Hopkins, 2010).

At Crescent, the change process has been deliberately facilitated by school leaders and owned by teachers, drawing on theories of effective and distributed leadership. Following the first series of 21CLD workshops, school leaders led conversations on 21CLD at various levels – from the middle management to department teachers. These conversations leveraged systemic structures like collaborative networks to catalyse change in teacher perceptions and practice. Teacher leaders were also identified and formed a "21CLD Think Tank" to pilot lesson packages in various subject areas. As teachers worked in collaborative teams, school leaders participated in the discourse and actively engaged teachers in the various aspects of the 21CLD framework.

Use of ICT to support teacher professional development Crescent teachers plan collaboratively using the 21CLD framework to build, review, and revise lessons to ensure instruction deliberately builds students' 21st Century competencies. At Crescent, teachers collaborate face-to-face during built-in professional development and also informally outside of that time to provide each other with feedback and suggestions on improvements to lessons. Realizing the importance of teacher collaboration for lesson development and the need for an easy way to collaborate outside of professional development time, a 21CLD web-based application was developed by the school. The development of the application was premised on design principles that arose to address challenges that were surfaced in the Innovative Teaching and Learning (ITL) Research (Shear et al., 2011), including the need to support consistent and purposeful lesson design across teachers and the benefits of teacher collaboration and peer support.

The application is currently being piloted and Crescent continues to refine it. Crescent teachers who have piloted the application reported that it has facilitated deliberate consideration of the

21CLD learning activity rubrics, and the corresponding pedagogical moves necessary to attain the requisite levels intended. The collaborative features also facilitated co-construction of learning activities, and served to maintain the rigor of the lessons designed as they are submitted for expert panel review.

CASE STUDY: SECONDARY 1 COMMUNICATIVE ARTS LESSON UNIT

Crescent teachers have been using technology to support student learning for over a decade. The introduction of 21CLD provided teachers with a framework to think more deliberately about how that technology can best support students in building their 21st Century competencies. A communications arts lesson unit on poems about World War II highlights how teachers at Crescent are using 21CLD in conjunction with technology to deepen students' knowledge construction and collaborative learning competencies.

The main objectives of the lesson were to deconstruct a poem to identify the uses of key literary devices and use what they learned through analysis to construct their own poem. To show their understanding for literary devices in poetry, the lesson culminated in students co-constructing a poem to help the reader visualize and empathize with what happened during the battle at Bukit Chandu – a historical World War II site in Singapore.

To achieve these objectives, the communicative arts teacher first introduced the poem "Andan and Comrades at Bukit Chandu" by Edwin Thumboo to build student knowledge of literary devices as well as content knowledge of Singapore during World War II. During this activity, students were prompted to answer questions in an online platform about their prior knowledge of World War II and reflections on the poem. Student responses were then shared with classmates via an online platform where they could easily be seen by every student. After introducing students to literary devices and activating their prior knowledge of World War II, the teacher took the students on a trip to Bukit Chandu. Using an i-Trails activity created by the teacher to support this learning journey (a journey of student discovery through place), students were prompted with teacher-developed questions and reflections as they moved around key locations within Bukit Chandu. Students worked in groups of four and moved through the facility with handheld devices, stopping at exhibits to learn about the personal experiences of Singaporeans during World War II and to respond to the corresponding reflection questions on Trail Shuttle. After building their knowledge for the time period and reflecting on what they had learned, students in each group co-constructed a poem to convey the sentiment of the time.

Figure 1: *Students on the Learning Journey*

Figure 2: *Poems Co-Constructed by Students*

Throughout the entire learning design process, teachers used 21CLD as a framework to provide key guiding considerations in the design of a lesson unit that deliberately fostered knowledge construction. In this lesson, the teacher used 21CLD to develop a technology-rich learning activity designed to deepen students' understanding. Instead of directly teaching students about the various literary devices, the teacher asked students to deconstruct "Andan Comrades at Bukit Chandu" to build their own understanding for how literary devices are used. To further push students' thinking, the teacher required students to use what they had learned about literary devices through the analysis of "Andan and Comrades at Bukit Chandu" to construct their own poem, thus requiring application of knowledge they had previously built. In addition, students constructed knowledge in history through the learning journey activity, fulfilling objectives in two disciplines simultaneously. The 21CLD knowledge construction's highest code requires students to apply their knowledge in another setting as well as provide interdisciplinary instruction, which this lesson skillfully fulfilled.

The collaboration dimension of 21CLD was keenly incorporated into various aspects of the learning unit. The notion of collaboration was not a new one to the teachers – collaborative learning as an instructional strategy has been frequently employed in Crescent classrooms. However, the collaboration dimension of 21CLD provided clearer articulation of what was expected of a learning activity that developed students' ability to collaborate. It was not merely about designing an activity where students worked in groups. Teachers used 21CLD as a lens to examine the depth of this collaboration by asking questions like "Do students have shared responsibility, or are they just working in teams?", "Are there segments in the learning activity that require students to make substantive decisions together?" and "Is the students' work interdependent?" What resulted was a lesson unit that had students de-constructing a poem together, learning together on the learning journey to Bukit Chandu, and co-constructing a group poem together. Students shared the responsibility of analyzing literary devices, had various substantive decisions to make together (like which literary devices to use at which parts of the poem), and the resulting group poem was not one that they could have devised separately. The co-constructed poem was one in which each student in the group had to make a substantial contribution. Thus, 21CLD added greater rigor to the notion of collaboration within the learning activity.

The use of ICT for learning dimension was explicitly used to push teachers' thinking about higher levels of use of ICT that are essential for knowledge construction. Online collaborative platforms were purposefully used to support collaborative knowledge construction in student groups. Reflection questions and prompts, designed and deployed on the ICT platform Trail Shuttle, were carefully crafted to elicit student responses and required students to interpret, analyse, synthesis and evaluate information. Teachers were conscious of designing a place-based experience at Bukit Chandu in which ICT use greatly added value to the students' acquisition of knowledge construction competencies.

DISCUSSION

This paper described a step on the journey of Crescent Girls' School as it continues to deepen its integration of ICT into teaching and learning in the service of students' 21st Century competencies. Prior to the start of this program, the school already had pervasive use of ICT and a set of teacher-developed definitions and rubrics for the 21st Century competencies they wished to develop. 21CLD supported the intersection of these two capacities: the design of lessons that take full advantage of the 21st Century learning opportunities that ICT can bring.

As described in the communicative arts case, 21CLD has helped teachers to sharpen their design focus on how ICT can support deeper learning. For example, while students' use of handhelds was already commonplace and the Trail Shuttle technology already existed, this teacher used the 21CLD rubrics to guide selection of the prompts and reflection questions students would respond to in the Bukit Chandu i-Trail to encourage knowledge construction. It is possible to design a learning trail that makes use of ICT to connect student learning to place-based experiences, but in which the learning still revolves around simple information retrieval and articulation. This lesson makes use of ICT to support learning that is doubly deep: it is richly connected to place, and requires students to construct knowledge about the place.

It is striking in this case that ICT is not used as an end in itself: it is part of a coherent pedagogical vision, and is used as an enabler of that vision. At Crescent the ultimate goal is a student-centered model of learning that produces graduates with well-rounded competencies for the 21st Century. In the communicative arts example, ICT is used as a support for the type of strong collaboration that learning sciences research suggests can promote deeper learning, and that can also help students to become effective collaborators as adults.

21CLD provides a set of concrete tools that help to define this coherent pedagogical vision. But no toolset can foster lasting pedagogical change on its own. What makes the program successful at Crescent is a carefully designed ecosystem of supports for innovation, based on strong teacher ownership, distributed leadership, and the embedding of the vision and 21CLD constructs into school-wide discourse so that ideas are debated using a common language and framework. These conversations are facilitated through multiple structures within the Crescent teacher organization, including the 21CLD Think Tank and disciplinary teacher teams that undertake collaborative lesson design. With an app for lesson design aligned to 21CLD, Crescent has also leveraged ICT to build the framework into the process of lesson design.

CONCLUSION

This paper described a program called 21CLD that offers tools and a process to help teachers design stronger opportunities for the development of 21st Century competencies into their instruction, including designs that use ICT in powerful ways to support deeper learning. Crescent Girls' School in Singapore is presented as a model of a school-wide ecosystem to support this vision of instructional change, with a case of a communicative arts lesson to illustrate results in the classroom.

It is important to note that this paper represents an early stage of research in the use of 21CLD to support innovative teaching at Crescent. It offers a single instructional case, which cannot be claimed to generalize to instruction throughout the school. In addition, the relatively unique context of Crescent means that possible implications for other school settings must be considered with care. Crescent Girls' School is clearly farther along the ICT adoption curve than the majority of schools around the world, and benefits from financial and technology resources and other capacities that most schools do not have access to. Studies are underway in other contexts that will contribute to a broader view.

Despite these limitations, this paper offers a number of important considerations for schools and teachers that are leveraging ICT to support student learning in any setting. The experience at Crescent suggests that when looking toward meaningful integration of ICT for learning, the ICT itself is not a sufficient first step. Instead, it is important to begin with a vision for the pedagogy and the learning that the ICT will enable, and to consider locally appropriate models for an ecosystem of supports that can give teachers both freedom and guidance to take steps toward that vision. In this way ICT is positioned as a means to an inspiring end, not a separate requirement that teachers must fulfill. Finally, this paper suggests that when it is time to implement in the classroom, the focus must be on learning activity design, with clear and practical supports for teachers in *how* to shift their instruction. While students might be engaged in using ICT in any number of ways, it is the design of the learning activity that shapes students' ICT use in support of deeper learning, which in turn puts ICT on a path to reaching its educational potential.

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Original article at: http://ijedict.dec.uwi.edu/viewarticle.php?id=1776

International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 89-102

The Effect of Using XO Computers on Students' Mathematics and Reading Abilities: Evidences from Learning Achievement Tests Conducted in Primary Education Schools in Mongolia

Shinobu Yamaguchi
Tokyo Institute of Technology, Japan

JavzanSukhbaatar
Institute of Finance and Economics, Japan

Jun-ichiTakada
Tokyo Institute of Technology, Japan

Khishigbuyan Dayan-Ochir
World Bank Mongolia, Mongolia

ABSTRACT

In 2008, Mongolia took part in One Laptop per Child (OLPC) project. Since that time, over 10,000 students in grades 2-5 in 43 primary education schools are using XO computers. This paper presents the findings of a study conducted in 2012 to evaluate the impact of the OLPC initiatives on students' literacy and math skills. This study covered 14 primary schools, of which 7 received XO computers and other 7 did not receive XOs. The schools were located in four provinces and two districts of Ulaanbaatar city of Mongolia. Over 2,000 5th grade students in these 14 schools were tested on Math and Reading skills, based on items from the 2008 National Primary Education Assessment. In addition to these tests, students were asked to respond to a questionnaire, which consisted of demographic and ICT-related questions and computer attitude measure for young student instrument. The findings of the study indicate that the use of XO may have enhanced students reading skills controlling for students gender, math scores, and hours spent for watching TV, doing homework and earning money.

Keywords: *OLPC; Primary Education; National Assessment Test; Math Skills; Reading Skills*

INTRODUCTION

The One Laptop per Child (OLPC) project is implemented by One Laptop per Child, a USA-based, non-profit organization created by faculty members from the MIT Media Lab. With the mission to empower the world's poorest children through education, this organization seeks to design, manufacture, and distribute sufficiently inexpensive laptops to every child in the world so that they can have access to knowledge and modern forms of education. The OLPC project allows children to use the laptops to access knowledge and to be engaged in their own capacity for learning, regardless of their physical location or financial limitations (OLPC, 2008). As of 2013, over 2.4 million children and teachers in 54 countries worldwide have received XO laptops (OLPC, 2013).

This article presents a brief description of the OLPC project in Mongolia, as well as a review of the OLPC literature. This is followed by our study methodology, and then followed by data analysis and findings. Within this study, over 2,000 5th grade students in 14 schools were tested on Math and Reading skills tests, which were also used in 2008 National Primary Education Assessment. The study findings are discussed in light of relevant literature.

OLPC INITIATIVES IN MONGOLIA

OLPC project intended to improve the quality of education in Mongolia by achieving the following objectives: 1) providing access to computers and learning materials in order to improve teachers' skills; 2) creating a strong learning network that connects children and teachers at the national and international levels; 3) create community-based initiatives using laptop networks; 4) empowering teachers to foster student-centered methodology; 5) allowing students to apply their learning into their life and community; 6) enabling easy access to information; and 7) strengthening math and science (OLPC, 2008).

The President of Mongolia and the OLPC Foundation USA signed an Aide Memoire during the official visit of the former President Enkhbayar to the USA in 2007 (Embassy of Mongolia, 2007). With this initiative, Mongolia agreed to receive 20,000 XO computers for the school children. Specifically, it was agreed that 10,000 XO computers would be donated from the OLPC Foundation and the Government of Mongolia would purchase remaining 10,000 XO computers using state budget funding (nearly 1.2 billion tugriks or 1 million USD).

The Ministry of Education, Culture and Science (MECS) was in charge of managing the project nationwide. To follow up this initiative, the Government Cabinet resolution was approved in 2008 to establish the National OLPC Project Organizing Committee, to allocate state funding to finance OLPC activities, including OLPC Project Management Unit (PMU) staff salaries, customs tax, delivery cost of XOs to rural schools, additional equipment, basic teacher training, and development of Mongolian content (Government of Mongolia, 2008).

In early 2008, the OLPC Foundation donated the first 1,000 laptops to the Mongolian government, and two schools, one in Ulaanbaatar and another in rural area, were selected as pilot schools. OLPC Foundation funded all the activities needed for the start of the project. This initial support included provision of educational guidelines, installing the basic programs and infrastructure needed to run XO computers in schools such as setting up wires or VSAT, access points and local networking, development of criteria for school selection as well as OLPC technical assistance team visits.

The MECS set basic rules and responsibilities related to the distribution of XO computers. First, at the initial stage, schools with electricity would have priority to receive XO computers. Second, Internet connection fees for schools would be covered from school operating cost. Third, schools receiving XO computers would do so through an agreement with parents of children in grades 2-5. Fourth, the PMU would be responsible for computer delivery, preparing teachers, developing lesson plans using XO computers, as well as maintenance. Fifth, teaching and learning contents were to be expected to be developed using free and open source software (Ministry of Education, Culture and Science, 2008a).

The strategic goals of OLPC expressed a three-part vision. By 2015, all the students in grades 2-5 would receive XO computers; and thus, teachers would receive necessary training and training manuals for creating lesson activities using XO computers. Further, the promotion of e-textbook was to be installed into school servers. From the infrastructure perspective, the project aimed at establishing high speed IT network covering all schools.

In total, 12,100 XOs were distributed to 43 schools in Mongolia. In those 43 schools, all primary education students (and teachers) of grades 2-5 received XO laptops (Ministry of Education, Culture and Science, 2008b). By the end of 2010, the following activities were implemented by PMU: 1) basic teacher training covered all teachers who received XOs; 2) content framework for XO computer use was developed for each grade level; 3) competition for students using XO computers were organized; 4) professional assistance to teachers for the use of XO computers were organized based on request from the provinces; 5) monitoring visits to school was organized for 23 rural schools and 19 schools in UB in 2010; 6) survey of 4,780 students on the use of XO computers were organized; and 7) provision of technical maintenance support to schools was conducted (OLPC PMU report, 2010).

PREVIOUS STUDIES

The OLPC project vision is based on constructionist theories of Papert (1980, 1993), who advocates independent, playful learning assisted by a tool to think with. This theory emphasizes enhancement of children's learning by combining guided and continuous self-learning. The initial idea of Negroponte (1996) for providing more learning opportunities to underprivileged children and Papert's constructionism, were reflected in five core principles of OLPC project, namely, child ownership, low ages, saturation, connection and free and open source.

The term "One-to-One" refers to the ratio of digital devices per child so that each child is provided with a digital device, most often a laptop, to facilitate learning (Severin & Capota, 2011). Despite considerable body of research on one-to-one experience of students, few studies have examined the impact of using computers on students' academic achievements.

A recent study of OLPC program in Peru by Santiago, Severin, Cristia, Ibarrarán, Thompson, & Cueto (2010) employed a similar study experimental design. Treatment (OLPC) and control (non-OLPC) groups of schools were formed and assessment was done comparing the two groups. The study found better attitudes and expectations among teachers and parents in the treatment group. For example, students with OLPC experience were more critical of school work as well as their own performance and a greater development of technological skills was seen among them. However, no impact was observed in learning.

A synthesis of research on the implementation and effects of one-to-one initiatives allows us to conclude that the studies that did measure outcomes consistently reported positive effects on technology use, technology literacy, and writing skills (Penuel, 2006). As this synthesis showed, there is a scarcity of OLPC research with rigorous designs.

A recent attempt of synthesizing OLPC programs in Latin America and the Caribbean was conducted by Severin and Capota (2011). Describing and summarizing one-to-one programs in over 20 countries worldwide, the authors distinguished economic, social and educational progress rationales that justify the implementation of OLPC projects. Economic rationales emphasize the development of human capital for global competitiveness and new labor market demands and social rationale aims to reduce digital divide and promote equity. Educational rationale of one-to-one programs is based on their potential for improving the quality of education, including potential for addressing internal efficiency, academic achievement and new skills required for the 21st century (2011). However, as the authors conclude, the effect of one-to-one laptop programs on academic achievement measures is largely unknown.

Math and reading abilities are important characteristics of academic achievement especially in primary education level. Although there are numerous studies which investigate factors influencing math and reading abilities of students, very few have focused on detecting effect of using ICT on these important abilities. As one of such example, Geske and Ozola (2008) found that reading literacy of students was affected by the factors such as gender, number of books, number of children, father's education and mother's education. Tian's study (2006) suggested that math achievements can also be influenced by family background factors such as number of parents, number of siblings, and father's socioeconomic status.

STUDY GOAL AND OBJECTIVES

Based on prior studies and investigation, our goal of this study was to evaluate the impact of OLPC project on student learning in math and reading. According to education standards of Mongolia, all graduates of primary education must comply with the requirements of education standards. These standards specify the basic level of children's mathematics and literacy abilities that they should possess upon completion of primary education grades.

Based on the education standards requirements, two research questions for this study were formulated as follows:

1. Is there any difference in students' math and reading abilities between those who used XO and those who do not?

2. Are the children who used XOs in grades 2-5 better in their math and reading abilities as a consequence of using XOs compared to those who did not use XOs?

METHODOLOGY AND INSTRUMENTS

The data from 2008 National Assessment Test (NAT) was used as baseline data and the same test was administered in 2012 for the 5^{th} grade students in the sample schools. This study was organized as a follow-up assessment of the National Assessment of Mongolian Language and Mathematics in 2008 administered by Education Evaluation Center (EEC) under the World bank-funded READ project. The assessment in 2008 was the first exercise to administer the large-scale student learning achievement in Mongolia with the goal of building the national capacity of education evaluation and education policy analysis. The two subjects assessment teams composed of experienced educators and curriculum developers were hired by EEC, and they developed and utilized detailed assessment blueprints that appear to be soundly based upon Mongolian curricula and draws upon relevant cognitive theories.

Specifically, the Math test covered four domains of mathematical competencies, namely, number and numeracy, algebra, geometry, and probability. About 70% of skills prescribed by primary education standards of mathematics were included for the assessment. As for the Reading test, three skills, including listening, reading and creative writing skills, were tested.

As for 2012 testing, two additional questionnaires for students were utilized. First, the questionnaire form was developed by the OLPC research team in order to reveal the level of using computers in everyday learning by students. For OLPC or treatment school students, extra questions about the use of XO laptops were included. The questionnaire forms were attached to the test booklets and were administered at the end of the test. Second, the international instrument, Computer Attitude Measure For Young Students (CAMY), designed to reveal the attitude of students towards ICT devices and their interests was used. This questionnaire was also attached to the test booklet and was administered for both treatment and control group students.

SAMPLING

In total, 4,750 students from 166 schools participated in the National Achievement Test (NAT) of Mathematics and Reading conducted during the school year of 2007-2008. These students who took part in the exam in each school were randomly sampled in 2008 from different student groups.

Of these 166 schools, only about 15 schools were introduced with the OLPC XO1 laptops in 2008-2009. Out of OLPC schools that participated in 2008 NAT, we selected schools that represent different regions of Mongolia. Thus, Khovd province from western region, Sukhbaatar province from eastern region, Dornogobi from the south and Darkhan-Uul from the north were selected. From nine districts of Ulaanbaatar, the capital city of Mongolia, three districts, Bayangol, Khan-Uul, and Songinokhairkhan were selected for the study. Once the province is selected, an OLPC school and a control school similar to OLPC school in the provincial center were selected in consultation with Education and Culture Department (ECD) of the province. Similarity included the aspects on school size, relatively similar level of student achievement, and distance from the province center. One of the criteria for OLPC school selection was that school policy allows students to take XO laptops home.

The final list of sample schools consisted of two groups, control (non-OLPC) and treatment (OLPC) each comprised of 7 schools. It was decided to conduct the same level of difficulty tests as NAT of 2008 for entire 5th grade students in both groups of schools. The following table presents a list of study schools.

***Table 1**: List of Sample Schools*

Province / District	School Name	Number of Grade 5 Students	OLPC Start Year	Taking XO Home Allowed?
Dornogobi	School # 3 (OLPC)	90	2008	Yes
	School # 2	156		
Khovd	Tsast Altai (OLPC)	125	2008	Yes
	School #2	155		
Sukhbaatar	Sukhbaatar School (OLPC)	215	2008	Yes
	Temuulel	227		
UB-Bayangol	School # 51 (OLPC)	94	2008	Yes
	School # 40	110		
UB-Khanuul	School # 52 (OLPC)	168	2008	Yes
	School #18	90		
UB-Songinokhairhan	School # 12 (OLPC)	177	2009	No
	School # 62	205		
Darkhan-Uul	School #4 (OLPC)	131	2009	Yes
	School #14	57		

Note. OLPC means treatment schools in which students in grades 2-5 use XO laptops.

STUDY DESIGN

The study uses quasi-experimental design with control and treatment groups of students. Math and Reading abilities of students are measured before and after the treatment, which in this case is the use of XO computers (see Figure 1). The study utilized difference in difference approach in measuring students' learning achievement: adjust difference between control and treatment groups by over-time progress and initial difference. In addition to comparison between XO and non-XO groups, a multivariate regression analysis method is used to determine net effect of using XO computers on Math and Reading abilities controlling for some other factors such as gender, family size, father's education level, mother's education level, family income, student's place for living, the way student comes to school, number of books in home, hours student spent for watching TV, doing homework, hanging round with friends, playing games and earning money.

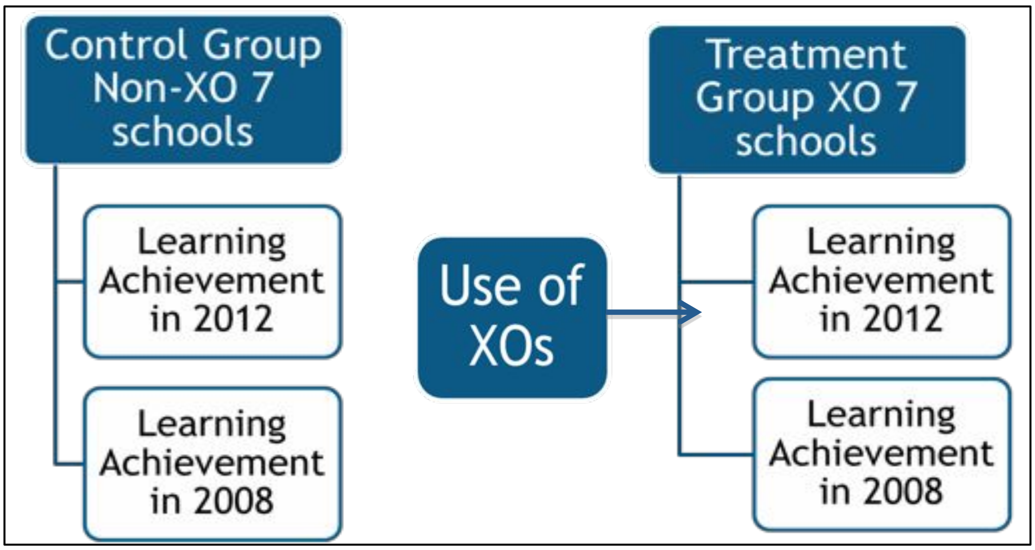

Figure 1: *Study Design*

The study covered 14 primary schools (of which 7 received XO computers and other 7 did not receive XO computers) located in 4 provinces and two districts of Ulaanbaatar city of Mongolia. Over 2,000 5th grade students in these 14 schools were tested on Math and Reading skills tests, which were used also in 2008 NAT. In these tests, Math achievement was calculated as percent of right answers in total number of right answers and math score was the sum of right answers.

$$\text{Math achievement} = \frac{\text{Math score}}{44} \times 100$$

Reading (Mongolian Language) achievement was measured as combined score of students on reading, writing and listening test.

$$\text{Reading achievement} = \frac{\text{Listening} + \text{Rreading} + \text{Writing}}{49} \times 100$$

Reading score was the sum of right answers on the tasks 1-49. For the simplicity, in this article math and reading scores were used instead of their percentages as achievement indicators.

The data collection was conducted simultaneously in four provinces and three districts of Ulaanbaatar city between September and November in 2013. In order to conduct the study, the following main activities were implemented by the researchers: editing test booklets, layout design and preparing the final version for printing, contacting with all the schools and negotiating on conducting the study, developing OLPC questionnaire, developing manual for enumerators, hiring and training of enumerators for conducting Math and Reading tests, printing of booklets, preparing scoring guideline and database sheets, data collection at schools and quality control of data collection by research team members, developing variable coding, data entry and data analysis. In addition, the research team visited Khovd province, a site of research, in order to conduct interviews with teachers, school administrators and students.

DATA ANALYSIS

Demographic Information

In total, 2,011 5th grade students participated in the study. A half of the students studied in schools which did not receive XO computers, and the other half studied in OLPC schools and had access to XO computers at school (2-3 times in a week) and home. A little over 40% of students come from schools located in Ulaanbaatar city while the remaining students studied in schools located in the centers of 4 different provinces (see table). Gender composition of students was 51% girls and 49% boys. By ethnicity 96.4% was Khalkh-mongol, 2.3% -Khazakh and the remainder was distributed among Buriad, Durwud, Tuwa and others. The absolute majority of students (76.3%) come to the school by walking, 14% use public transportation and around 9% use private car or motorbike for coming to school. In terms of living, 89.3% live home, 9% of students stay together with relatives or family friends and 1.8% live in school dormitories.

***Table 2**: The Number of Students Participated in the Study by Provinces and UB Districts*

No.	Provinces and Districts of Ulaanbaatar	Number of Students	% in Total
1.	Darkhan-Uul	189	9.4
2.	Dornogobi	246	12.2
3.	Khovd	279	13.9
4.	Sukhbaatar	447	22.2
5.	Ulaanbaatar Bayangol district	206	10.1
6.	Ulaanbaatar Khan-Uul	263	13.1
7.	Ulaanbaatar Songinokhairkhan	383	19.0
	Total	2011	100.0

Difference in Difference

The quasi-experimental design employed in this study allowed comparisons of students' math and composite reading scores between OLPC and non-OLPC schools and between 2008 and 2012 studies. In this way, it was possible to detect net difference in students' math and reading scores between XO and non-XO schools adjusting for initial difference in 2008 and compare over-time progress in two groups.

In order to see if there was any initial difference in students' math and reading scores, national achievement test results of 2008 for the schools covered by this study were isolated from entire data set of 2008 NAT. Then, the average math and reading scores were calculated and T-test for independent samples was conducted between OLPC and non-OLPC schools.

There was a statistically significant (at 0.001) initial difference in math score between OLPC and non-OLPC schools. In 2008, OLPC school average math score was 17.03 compared to 15.22 of non-OLPC schools (see table 3). However, in terms of reading abilities both groups performed similarly in 2008 (21.99 vs. 22.02), the difference was not statistically significant (see table 3).

Table 3*: Math and Reading Initial Differences*

	Group	N	Mean	Std. Deviation
Initial Difference in Math	Non-OLPC	208	15.22	5.53
Score in 2008	OLPC	215	17.03	5.82
Initial Difference in Reading	Non-OLPC	208	22.02	9.30
Score in 2008	OLPC	215	21.99	8.38

Table 4 compares math and reading scores of OLPC in 2012 and 2008. As we can see, the average math and reading scores in 2012 were much higher than in 2008: average math and reading scores increased by 6.69 and 6.39 points respectively. Similarly, average math and reading scores of non-OLPC group in 2012 also significantly exceed 2008 averages. Over the four years, average math and reading scores of non-OLPC schools increased by 6.95 and 2.64 points respectively (see table 5). This kind of improvement in students' math and reading abilities perhaps can be attributed to overtime improvements in quality of teaching and learning and other factors that have nothing to do with the computers. While increase in math scores in both OLPC and non-OLPC and the increase in OLPC reading scores were quite similar to each other, the progression of reading scores in non-OLPC schools was notably slow only 2.64 points over 4 year period.

Table 4*: Math and Reading Scores in 2012 and 2008 in OLPC Group, Average Score (difference significant at 0.001)*

	Group	N	Mean	Std. Deviation
Math Scores in 2012 and	2012	1006	23.72	8.30
2008 in OLPC Group	2008	215	17.03	5.82
Reading Scores in 2012 and	2012	1006	28.38	9.49
2008 in OLPC Group	2008	215	21.99	8.38

***Table 5**: Math Scores in 2012 and 2008 in Non-OLPC Group, Average Score (difference significant at 0.001)*

	Group	N	Mean	Std. Deviation
Math Scores in 2012 and 2008 in Non-OLPC Group	2012	1005	22.17	9.28
	2008	208	15.22	5.53
Reading Scores in 2012 and 2008 in Non-OLPC Group	2012	1006	24.66	10.65
	2008	215	22.02	9.30

Table 6 compares average math and reading scores in 2012 between OLPC and non-OLPC schools. Independent sample t-tests were also conducted between OLPC and non-OLPC schools. As we can see from the table, average math scores of OLPC school students exceed average math score of non-OLPC school students by 1.55 points. This difference was statistically significant at 0.001 level. In terms of reading score, OLPC school students performed much better, 3.72 points higher than non-OLPC students.

***Table 6**: Comparison of Math Scores between OLPC and Non-OLPC Groups, Average Score (difference significant at 0.001)*

	Group	N	Mean	Std. Deviation
Comparison of Math Scores between OLPC and Non-OLPC Groups	Non-OLPC	1005	22.17	9.28
	OLPC	1006	23.72	8.29
Comparison of Reading Scores between OLPC and Non-OLPC Groups	Non-OLPC	1006	24.66	10.65
	OLPC	215	28.38	9.49

Figure 2 and Figure 3 illustrate math and reading scores in 2012 for OLPC and Non-OLPC groups.

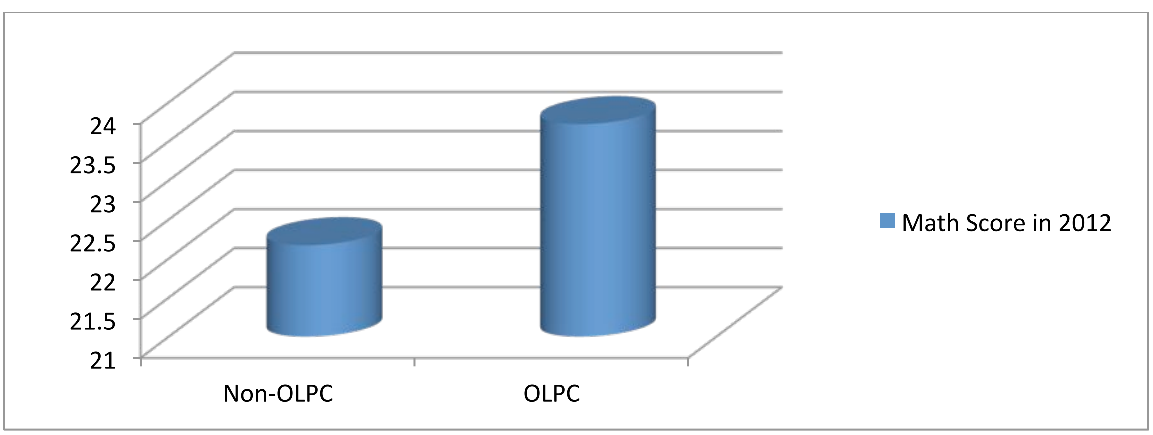

***Figure 2**: Math Scores in 2012*

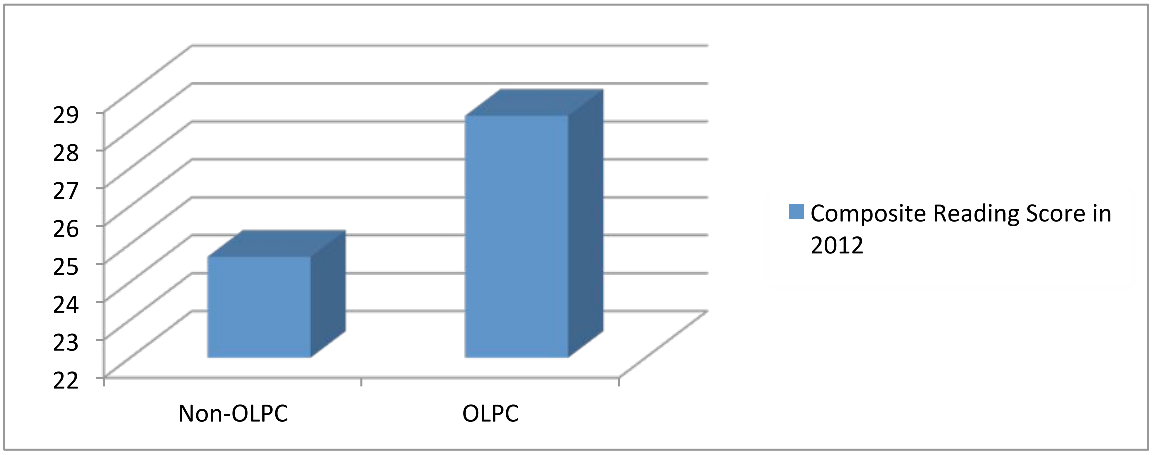

Figure 3: *Composite Reading Score in 2012*

Higher performance of 5th grade students using XO computers in math and reading tests compared to those who do not use XO computers can, of course, be attributed to the very fact of using XO laptops, in the absence of any other plausible factors. However, because we have data for 2008, before introducing XO computers, we should adjust these differences in math and reading scores in 2012 by the initial differences in 2008, before making any assumptions (See the following calculations).

Calculation of Net Differences (Difference in Difference)

Math

2012 difference between OLPC and Non-OLPC: 23.72-22.17 = 1.55
2008 difference between OLPC and Non-OLPC: 17.03-15.22 =1.81
Net difference = 1.55 – 1.81 = -0.26

Reading

2012 difference between OLPC and Non-OLPC: 28.38-24.66 = 3.72
2008 difference between OLPC and Non-OLPC: 21.99-22.02 = -0.03
Net difference = 3.72-(-0.03) = 3.75

These calculations show that

(a) In terms of Math scores there was virtually no difference between OLPC and non-OLPC schools: after adjusting by initial difference statistically significant difference in 2012 disappears.

(b) In terms of Reading scores, there was a statistically significant difference between OLPC and non-OLPC groups. This difference exists even after adjusting by initial difference forming a net advantage of OLPC students over non-OLPC students in reading score equal to 3.75 points.

Net Effect of Using XO Computers

Once we determined a difference in students' reading scores which was attributable to the use of XO laptops, we attempted to discern net effect of using XO computers controlling for some other factors. For this purpose a multivariate regression analysis was conducted with a dependent variable of reading score and independent variables such as math score, gender, use of XO computer, family size, father's education level, mother's education level, family income, student's place for living, the way student comes to school, number of books in home, hours student spent for watching TV, doing homework, hanging round with friends, playing games and earning money. Since our intention was not to determine the relationships between specific, pre-determined independent variables, we used stepwise procedure for entering independent variables, which allows gradual exclusion of variables that has insignificant effect on the dependent variable.

The most parsimonious model that SPSS multivariate regression analysis comes up with was as follows:

$$\mathrm{RS} = 7.11 + 0.56\mathrm{X1} + 2.48\mathrm{X2} + 2.48\mathrm{X3} + 0.68\mathrm{X4} - 0.38\mathrm{X5} + 0.37\mathrm{X6}$$

Where: RS was the dependent variable, Reading Score.

X1 – math score;
X2 – use of XO computer;
X3 – student's gender;
X4 – hours spent watching TV;
X5 – hours spent for earning money; and
X6 – hours spent for homework.

Model was significant at 0.05 and explained 30.6% of variations in reading score. This model suggests that the use of XO computers had a significant net effect on student's reading score controlling for students gender, math score, and hours spent for watching TV, doing homework and earning money.

Model also indicates that (a) Student's math skills can positively influence their reading score; (b) girls average reading score is significantly higher than that of boys; (c) those who spent more hours watching TV have better reading scores; (d) those who spent more time doing their homework have better reading scores; and (e) those who spent more hours for earning money have less average reading scores.

DISCUSSION

The main findings of the study can be summarized as the following six points.

First, there was a statistically significant initial difference in math score between OLPC and non-OLPC schools. However, there was no initial difference in students' reading scores. No initial difference in math and reading scores would be expected to exist if the schools were quite similar, especially in the quality of teaching and learning. However, small but significant difference in math score can be attributed to better math teaching in OLPC schools, because teacher factor has strongest correlation to student mathematics and reading performance (Linda, 1999).

Second, in terms of the comparison of test scores between 2008 and 2012, both math and reading scores increased significantly in 2012 compared to 2008 in both OLPC and non-

OLPC groups. However, for OLPC group reading scores increased at much higher rate than non-OLPC group. This finding can be better understood in view of Gulek and Demirtas (2005) study which suggests that the use of laptops may enhance students' grades for writing, English-language arts, mathematics and overall GPAs. In our case, the use of XO computers can be a factor that positively affected reading, writing and listening abilities of students.

Third, there was a statistically significant difference in reading score in 2012 between OLPC and non-OLPC groups. Reading scores of OLPC group exceeded non-OLPC by 3.72 points. Santiago, et al. (2010) study found that the students with a higher score in the reading comprehension test obtained 0.204 points more in the ICT test than those who obtained a lower score in the reading comprehension test. Similarly positive, but reverse relationship was found in our study: reading scores can be improved with the use of XO computers.

Fourth, after adjustment of the scores by initial difference between OLPC and non-OLPC groups, there was no difference in students' math scores between OLPC and non-OLPC groups. Although one of the objectives of OLPC in Mongolia was to strengthening math and science, this finding indicates that the initiatives did not meet this objective. It can be assumed that introducing one-to-one laptop does not automatically result in strengthening ability of math and science. Existing studies did not really detect big progress in math achievement as result of technology use, instead, a positive but modest effect on mathematical achievement can be produced by the application of educational technologies (Cheung and Slavin, 2013).

Fifth, net advantage of OLPC group over non-OLPC group in reading score was 3.75 points. This means that those who used XO computers gained 17% advantage over the average reading score of 2008. Underlying mechanism of such advantage may be related to the fact that XO computers provided more reading opportunities for the students. Students provided with XO laptops obviously spent more time using the computers i.e. exploring different applications and reading contents that were translated into Mongolian.

Sixth, multivariate regression analysis suggests that the use of XO computers may enhance students reading ability controlling for students gender, math scores, and hours spent for watching TV, doing homework and earning money.

This finding is also consistent with previous studies which found that the use of laptops can influence writing skills because reading score in our case is actually a composite of reading, listening and writing scores (Penuel, 2006; Gulek & Demirtas, 2005).

It was found that some family background variables had net effect on reading scores in addition to the use of XO laptops. Similar findings have also been demonstrated by several studies. For example, Aksoy and Link (1999) and Trautwein (2007) found that homework and time spent on homework can positively affect the achievement. Geske and Ozola (2008) found that reading literacy of students was affected by the factors such as gender, number of books, number of children, father's education and mother's education. Watching TV usually has a negative effect on the achievement (Geske & Ozola, 2008; Aksoy & Link, 1999). However, in our study, hours spent watching TV had a net positive effect on reading score. This finding can be understood in the rural school context of Mongolia, in which, TVs often serve as a main source of information and educational content.

CONCLUSION

In conclusion, the findings of our study contribute to the body of research that shows positive effect of using XO computers on students' academic achievement. This study for the first time points out that the use of XO computers may enhance students reading ability controlling for students gender, math scores, and hours spent for watching TV, doing homework and earning money. Further research in this direction is needed to provide more evidence on the effects of using XO computers.

There are two aspects that the readers should bear in mind when using findings of this study.

First, the schools, training managers and teachers were cooperative in administering the study. Some training managers helped to organize the classes ready for test administration. However, teachers feel quite sensitive when their students need to take tests that measure their knowledge related to education standards. Because teachers thought that the results of the study can be used to judge teachers work performance which often affect their wages and salary, we should be aware that some teachers may have tried to help students to answer the questions. This would affect test results. However, research team provided necessary explanations and tried to persuade teachers on proper administration of the tests.

Second, a clear limitation of the study is the relatively small number of students who participated in 2008 national assessment test from two groups of schools selected for test administration in 2012. Out of 4,750 students covered by 2008 assessments only about 200 (one class of 30 students per school) come from either from OLPC or non-OLPC schools selected under our study. Therefore, readers should bear in mind that the comparison of 2012 and 2008 math and reading scores are based on the means for entire 5th grade students in 2012 and the means of one class in 2008.

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International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 103-119

Increasing Student Engagement in Math: The Use of Khan Academy in Chilean Classrooms

Daniel Light and Elizabeth Pierson
Education Development Center: Center for Children and Technology, USA

ABSTRACT

Khan Academy, an online platform offering educational videos and exercises in different content areas, has awakened intense interest among foundations, multilateral organizations, policy makers, and educators about how this tool can help meet the educational challenges facing countries around the world. With support from Intel, Education Development Center (EDC) researchers sought to understand how this technology fits into the complex realities of schools in a developing country. In August of 2013, researchers traveled to Santiago, Chile to conduct research in five schools where teachers are using Khan Academy. We found that the way Khan Academy functions as a digital learning environment changes the ways and the degree to which students engage with and are engaged by the math content; it also changes the way teachers and students interact with each other. Even though the use of Khan Academy may plant the seeds of deeper pedagogical changes such as mastery learning or differentiated instruction, teachers did not need to change their entire teaching model to start using it. Khan Academy's straightforward approach of providing an endless bank of practice exercises makes it an inviting and universally adaptable tool across different types of teachers, classrooms, and countries.

***Keywords**: Blended Learning; Khan Academy; Mathematics; Chile*

INTRODUCTION

For three years, Intel has been supporting a pilot project using the online learning platform, Khan Academy, in Chile. Khan Academy, a platform offering educational videos and exercises in different content areas, has become a worldwide education phenomenon in just a few years. As a free online learning resource that supports blended and personalized learning, Khan Academy has awakened intense interest among policy makers and educators about how this tool can help meet the educational challenges facing countries around the world. With support from Intel, the Education Development Center (EDC) was able conduct an initial set of case studies with Chilean teachers using Khan Academy. We spent two weeks observing their classrooms and interviewing them and their students about their experiences using Khan Academy.

As of February 2014, Khan Academy was being used in 200 countries, though 75% of its users reside in the United States. Although the Khan Academy name and brand are widely known (Ani, 2013; León & Reinah, 2013), research on the website and its use in schools is sparse. Much of what has been written is from Khan Academy itself (Khan, 2012; Koeniger, 2013; Maxwell, 2012; Schmitz & Perels, 2011), and is based on opinion (Izumi & Parisi, 2013; León & Reinah, 2013) or expert review of the resources (Ani, 2013; Kronholz, 2012; Strauss, 2012). On its website, Khan Academy has classroom case studies that offer videos, one-page briefs, and longer reports describing how Khan Academy is being used in classrooms around the world. These are not research but rather a space to showcase teacher and student experiences using the resources on the site. Nine of the showcases are schools in the US, two are from Europe (Ireland and Spain), and the one showcase from Latin America is a first person account of a staff developer's trip to Peru to train teachers on Khan Academy. However, there is no description of how teachers used Khan Academy in Peru.

There are two independent research studies of Khan Academy both of which were conducted in the United States. Khan Academy is one of the blended learning products explored in the *Blended Learning in Practice* Series (Bernatek, Cohen, Hanlon, & Wilka, 2012; Wilka & Cohen, 2013). In their case study on a California school, Bernatek and colleagues (2012) found that teachers used Khan Academy for students to do mathematics exercises. The other study is a two-year study of Khan Academy conducted in 20 United States schools from 2011-2013 (Murphy, Gallagher, Krumm, Mislevy, & Hafter, 2014). Researchers of this study found great variation in how Khan Academy resources are used across the schools. The researchers felt it was "methodologically unsound to conduct rigorous evaluation of Khan Academy's impact on learning" (p. 2) because the resources on the site are changing so frequently. Overall, they find that Khan Academy is used as a supplemental resource in mathematics. However, they were able to collect test data from two sites that suggest that students who spend more time on Khan Academy mathematics exercises do better on an end of year achievement test.

There is great interest in using Khan Academy as a tool to improve education in the developing world. However, there is a lack of research around the use of Khan Academy outside the United States. This study sought to explore the use of the site in a developing country context. Specifically, we wanted to better understand how teachers blended the Khan Academy resources with their existing resources and practices. We sought to document the strategies and practices of teachers who use Khan Academy. This report is an exploration of the ways in which Chilean teachers are integrating Khan Academy into their lessons and how that use is impacting teaching and learning.

RESEARCH QUESTION

We wanted to examine how Khan Academy is merging and blending with teachers' classroom practice by interviewing teachers about their use of Khan Academy resources and capturing their reflections on that use. According to Vygotsky's (1978) socio-cultural theory of learning, all learning is situated and embedded into a context. His theory envisions learning as a social process where students develop and grow intellectually in interaction with other people, and where *tools* play a fundamental role in this process. Our exploration of Khan Academy in Chile is grounded in these theories where ICTs represent new sets of tools that replace, displace, or combine with previous tools and strategies. Khan Academy, like any other new tool being integrated into a preexisting environment, may be used in new ways, or it may be spliced into old practices. Every digital resource, like Khan Academy, is a unique tool that may enable certain instructional practices just as it may impede others based on the functionality its creators build into it. With this in mind, our focus was on the use of Khan Academy and our findings may not necessary extend to other digital resources if their design features are different from Khan Academy.

Sample Selection

The Intel-funded project worked with 48 schools around Chile. For the current study however, we decided to focus on schools from a non-profit school network called Sociedad de Instrucción Primaria (the Society for Primary Instruction, SIP). The SIP's mission is to provide high quality education for at-risk populations. The SIP network supports 18 K-12 schools serving 5,000 students from low-income families. In order to attend, students take an admissions test and families pay a small fee in the Chilean context, equivalent of $25USD a month per child. The SIP network was chosen because the mathematics teachers at the SIP schools are part of a professional community thinking about Khan Academy and we hoped to tap into that emerging knowledge base. The teachers who participated in the study were purposely selected in collaboration with the Centro Costadigital at the Pontificia Universidad Católica de Valparaíso

(Costadigital), to identify teachers who are thoughtfully integrating Khan Academy into their teaching so that we could learn from their experiences and reflections.

Four schools from the SIP network were selected, but a fifth municipal school that was not part of the initial design was added during the fieldwork phase. The public school was added to the sample because our Chilean colleagues from CostaDigital thought it was important to visit a municipal school. From our observations the level of resources available to the SIP schools were roughly equivalent to the municipal school, the primary difference was the level of professional support that the SIP teachers have because they are part of the SIP network. Mathematics teachers at the municipal school were working to integrate Khan Academy into their 5th-8th grade classes with support of a mathematics coach provided by a foundation, but the SIP teachers had access to pedagogical coaches and mathematics supervisors from the network. We conducted exploratory case studies of eight mathematics teachers in five Chilean schools to examine how they are embedding Khan Academy resources into teaching and learning. Since the Chilean schools are only using Khan Academy in mathematics, we limited our focus to math teachers.

The Chilean educators thought carefully about whether to use Khan Academy. For example, the SIP's Director of Mathematics and her department reviewed the Khan Academy resources. Upon reviewing the site, SIP decided that Khan Academy would be appropriate for their middle school curriculum. Becoming mathematically proficient has multiple components: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning and productive disposition (Cuoco, Goldenberg, & Mark, 1996; Kilpatrick, Swafford, & Findell, 2001). The SIP mathematics department believed that the elementary grades needed more hands on activities and manipulatives than a virtual environment would provide. The SIP leadership also felt that Khan Academy resources were not appropriate for supporting the more complex mathematical skills needed in high school math. However, they felt that Khan Academy would be an excellent resource supporting middle school students' need to develop procedural fluency (Kilpatrick et al., 2001) through increased practice. The SIP leadership also valued the Khan Academy platform as a sustainable choice because of its free, high quality exercises, and consistent online supports.

METHODOLOGY

The goal of this study was to document the types of teaching and learning practices that Chilean teachers are developing around this popular new learning platform as a means to better understand the tool's role in an emerging market context. We did this through interviews, focus groups with students, school walk-throughs, and classroom observations.

In total, we observed 25 math lessons both with and without using Khan Academy. None of the teachers had sufficient computer resources to use Khan Academy in their classroom, and all of the lessons observed with Khan Academy took place in computer labs. Classes ranged from 4th to 12th grade. We also conducted informal conversations with students during the observations to ask students about the exercises they were doing on Khan Academy. The researchers used an observation guide and recording sheet to capture the layout and set up of the classroom, as well as to document how teachers and students were interacting around the Khan Academy platform.

In addition to interviewing the eight teachers, we interviewed six school administrators, and 32 students. We used an interview protocol that asked questions around the use of Khan Academy in the classroom and for lesson planning, as well as impacts and challenges of the site. Administrators at each school worked with the teachers to pick students for the focus groups. We asked administrators to select students with a range of abilities from classrooms of our focal teachers. The focus groups were organized by gender, and when possible, by ability. The focus group protocol focused on their use of various components of the site and any perceived impacts on their learning.

The research team also participated in meetings with the SIP leadership team and mathematics department, Intel, and Costadigital to better understand their roles in bringing Khan Academy into these schools and classrooms. In total, we interviewed 15 program staff from SIP, Intel, and Costadigital.

KHAN ACADEMY OVERVIEW

Khan Academy is an online learning platform started by a former hedge fund manager, Salman Khan, with the stated mission of “changing education for the better by providing a free world-class education for anyone, anywhere” (from the Khan Academy website: https://www.khanacademy.org/about). The site offers over 5,000 online instructional videos in an array of subject areas, an extensive repository of math exercises, and real-time data and analysis features (Koeniger, 2013).

There are three principal components of the Khan Academy website that we examined: videos, exercises, and data. These sections of the site work together to create what Khan Academy calls a “personalized, mastery-based, interactive and exploratory online learning environment” (Koeniger, 2013, p. 7). Though Khan Academy offers content in numerous subjects, by far its most comprehensive topic area is mathematics.

Intel and their Chilean education partner, the Centro Costadigital, selected and oversaw the translation of 650 math and biology videos into Spanish. The Chilean students have access to these videos in Spanish, but used the exercises in English. The Khan Academy platform is changing frequently. Right before we started the fieldwork, the site launched a full Spanish version that includes the exercises.

Videos

The videos of the founder teaching different subjects are the best-known feature of Khan Academy. There are short videos organized by discipline. These videos are designed to be the primary content delivery mechanism used to teach facts and procedures via a simulated blackboard and the voice of the instructor explaining the steps.

Math Exercises

Though all subject areas have some exercises for learners to complete, Khan Academy offers a seemingly inexhaustible bank of online practice exercises in mathematics. Learners pick a skill and, as they finish each problem, they get a new problem.

The math problems are dynamically generated and no two students get the same problem at the same time. Progress is tracked with check marks (✔) or cross outs (✗). If a learner gets five problems correct in a row, they have reached the first level in that skill. If the learner gets the fifth problem wrong, the count starts over and they need to get another five correct in a row. Khan Academy’s exercise bank offers hints to help students. Users can get step-by-step hints that reveal each step of the process allowing students to realize on their own what step of the procedure they were missing, but not just give the answer. Each page also links to a video related to the skill they are practicing.

Gamification and Data

The entire site is gamified in that students earn points and badges for doing exercises and watching videos. Access to real-time and accumulated data allows students and their teachers to track the number of videos watched, number of exercises attempted, including which ones were correct and which were incorrect, the amount of time spent on each exercise or video, the wrong answers given, and the number of hints used.

Teachers can track progress of a group of students or an individual. And they can track progress in the past or in real time. Data is color coded so that coaches can get a sense of progress quickly (e.g., red indicates the student is having difficulty while dark blue indicates topic mastery).

THE CHILEAN SCHOOLS

All five of the schools in the study are very similar in infrastructure and layout. The typical Chilean school layout provides a large open courtyard where students play and socialize before or after school and during recess. Classes in SIP schools reach about 40 students and the municipal school had around 30 students per class. In the classrooms, students sit at desks organized in rows facing the front of the room. There is very little technology in the classrooms for students, though teachers have a laptop and projector to use if needed. All schools have at least one computer lab. The SIP computer labs have about 40 computers set on desks in various configurations around the space. The municipal school has a computer lab with 21 desktop computers.

Typical School Day in Chile

Our case study of Khan Academy focuses on how that tool is incorporated into teaching and learning and embedded into teachers' and students' classroom practice. In order to fully understand the impact of Khan Academy in the classroom, it is important for readers to keep the context of Chilean schooling in mind. Unlike many developing countries, Chile has full day schooling (at least 7 hours) and students start around 8 A.M and finish about 3 P.M. The students are together in the same classroom all day. This cohort generally stays together from year to year as they move up. In elementary school, students have the same teacher for all subjects, but by 7^{th} grade students start to have different teachers for each subject. The students stay in their classroom and subject teachers rotate into that classroom. This means that content teachers do not have their own rooms with specialized teaching materials for their content areas. The only exceptions are the computer lab or when students need a science lab. Also, unlike many other developing countries, all Chilean students have their own textbooks or workbook for each subject provided by the Ministry of Education (See http://www.textosescolares.cl/).

Math Class in Chile without Khan Academy

The typical math class without Khan Academy that we observed is not unlike lecture-based math classes elsewhere. For lessons when they are introducing new material, the teachers work with the whole class demonstrating a problem and a new concept on the interactive whiteboard or standard whiteboard while students follow along in their workbooks. At key moments, the teacher might ask students for suggestions or to explain a procedure. After completing a demonstration problem, the teacher might ask a student to do a problem on the board and then have the whole class review the procedure.

After presenting new material, the teacher assigns workbook problems which students do individually or in small groups while the teacher moves around the classroom helping. In our observations in the Chilean classrooms, students typically work in small groups and their conversations were a mix of math as well as gossip. The teachers respond to any request for help, but many students do not ask the teacher for help. Most students ask friends for help. Often, requests to a peer for help result in one student simply giving the answer. Once all students have completed the problems, the teacher might lead a review session, where a student might put up the solution to each problem on the board and review the procedure. In a 45-minute lesson, the class might do a total of 10 problems – some done as a whole class and the rest done in small groups – with the answers being checked at the end of the class. It is important to keep these patterns of doing math in a classroom context in mind, because the uses of Khan Academy that the Chilean teachers have developed intersect with and begin to transform these processes.

KHAN ACADEMY IN CHILEAN SCHOOLS

The Chilean teachers we worked with were selected specifically because they were integrating Khan Academy into their lessons. Teachers in Latin America often distinguish between theory classes and practice sessions. In math, the practice often comes as homework, but these teachers made decisions to dedicate part of their instructional time to having students use Khan Academy. The Khan Academy sessions were principally used for students to practice skills and develop procedural fluency and not for direct instruction. The teachers felt this was a worthwhile trade because their students were doing substantially more math exercises, but they also felt that aspects of how Khan Academy functions increased student engagement in mathematics and improved performance. These teachers did not use all of the features of the Khan website. Of the three key components (i.e., videos, exercises, and data), teachers and students in Chile utilized the exercises the most often.

Looking across the observations and interviews, four instructional objectives emerge: two general objectives and two objectives around differentiation. All of these objectives are focused primarily on the exercises and “doing math.” Except for enrichment, the videos are presented to students as helping aids if they are lost or confused on how to do a procedure. The teachers we observed use Khan Academy for two main reasons:

1. Practicing and reinforcing recently learned skills. This was the most common goal we saw. As in the typical session described above, students would go to the computer lab, log on, and start doing math exercises.
2. Revisiting or refreshing previously learned content for test preparation. In particular, some of 8th grade students we observed were using Khan Academy to review a range of math topics to prepare for the national exam, which is given in 8th grade. In these sessions, the students were often tackling wider ranges of skills, since Khan Academy allows student to focus on whatever skills they are weakest. Teachers feel this was a clear benefit of Khan Academy. One teacher explained, “Khan saves time when reviewing old material or refreshing students’ memories on specific content. It does not save time when teaching new things. Students still need to practice that in the classroom.”

In Chile, the extent to which teachers can vary the curricular resources for each student is limited. The teachers report that they are expected to keep students moving along at a similar pace. Also, the government provides one math textbook, so teachers have limited access to diverse curricula. One teacher commented that in the classroom they “do every thing the same” for all students.

However, with Khan Academy, teachers are envisioning ways to support the learning needs of slower and faster students. The Chilean teachers use Khan Academy to support two levels of personalization.

1. Enrichment for more advanced students. Teachers used Khan Academy during elective math classes as well as during afterschool math clubs. The huge amount of content allows the most advanced students to access information beyond what is in the textbook. Students can move through the site at their own speed, exploring new topic areas and exercises with the teacher as a guide rather than the primary mode of knowledge delivery.
2. Remediation for students falling behind. According to the Chilean teachers, Khan Academy adapts to the needs of struggling students by giving them an endless supply of problems to work on, and because success is based on getting five-in-a-row and not on the percent of problems correct. Those students who need more practice to master a procedure can do more exercises in class and continue working outside of class.

When deciding which topics to assign students, the alignment with the Chilean curriculum is most important. Most teachers made sure the actual exercises linked to the content they were currently teaching.

Typical Math Class in Chile with Khan Academy

Across observations, the math classes using Khan Academy share common patterns of teacher and student practices. The classes without Khan Academy also share common practices. However, the classes with and without Khan Academy were quite different from each other.

First, in the labs, most of the students sat at individual machines. By far, the most common practice was for teachers to have their students complete exercises. Only in two observations did teachers assign video in addition to exercises. In those classes, most students either had the video running in another window while they did exercises, or said they would watch the video later.

Most of the teachers assigned students the goal of reaching the practice level (i.e., getting five-in-a-row) by a certain date. We observed teachers assigning anywhere from one to five skills in a single class. One teacher we observed started her students on five math skills during a computer lab session mid-week and they had until the following Monday to do five-in-a-row for each skill. Once a learner successfully completes five-in-a-row, he or she moved on to the next skill.

After an initial introduction, all students started working individually doing math exercises, each with different sets of problems. In some classes, the students were working on different skills. Students were mostly quiet and focused on their computer screens – most doing math problems. In the Khan Academy sessions, the students were visibly asking the teacher for help more frequently than in the traditional classes. The teachers never stopped going from student to student answering questions or providing support. A number of teachers commented that since using Khan Academy, their students are more comfortable asking questions.

The students talked with their neighbors while working on the computer. As in the non-Khan Academy math class, the conversations were a mix of gossip and math. But in the lab, when a student asked a friend for help, the friend could not simply give the answer because each student had a unique problem in front of him. What we observed however were students trying to explain the math procedures.

In two of the classes we observed, there were also student mentors walking around helping their peers. The teachers explained that a common strategy in Chile is to choose a few more advanced students in a specific class to be mentors to their peers.

TEACHER AND STUDENT USE OF THE KHAN ACADEMY

This section is organized around the three main components of the Khan Academy website: exercises, videos, and data. This section details the degree to which these teachers are using each component, the specifics of how those resources are being integrated into teachers' instruction, and how their use is changing students' learning activities.

Doing Practice Exercises

At first glance, doing exercises in Khan Academy might not appear to be drastically divergent from completing problem sets from the back of a textbook. However, the interactive, web-based mechanics behind the Khan Academy exercises differentiate it from paper-based problems sets. Given how Chilean teachers are using Khan Academy during class time, seven features emerge as potentially important to creating an enhanced learning environment for their students. Khan Academy:

1. offers a workbook with an infinite number of problems;
2. generates individualized problem sets: in math, problems are randomly generated which means students are never working on the same problem;
3. gives the user immediate feedback after each answer is submitted;
4. provides hints and video lessons if needed;
5. uses multiple rewards systems to motivate students;
6. utilizes a mastery approach to advancing users through the material: the teachers used the five-in-a-row level built into Khan Academy as the indicator of successful mastery of the skill;
7. illustrates complex concepts some of which are difficult to show on a conventional one-dimensional black or whiteboard.

When students are on Khan Academy in the computer labs, these features combine to transform how students engage with math and develop procedural fluency. The following section describes some of the key differences between using Khan Academy or traditional paper-based exercises based on teacher reflections and what we observed in the classrooms.

Self-paced and individualized. The fact that each student has his or her own set of problems to work on during the class appears to increase the number of problems they do and has allowed students to work on problems at their current skill level. In the typical classrooms we observed, teachers generally used a combination of whole class instruction and individual seatwork as the whole class moves through the same set of problems. In total, students might go through 10 problems during the class, but it is uncertain whether individual students actually do the problems, simply get answers from peers, or go through the motions while copying from the teacher. When the students were on Khan Academy in the computer labs, all the students were engaged in doing problems and teachers floated around the room. Khan Academy enabled students to move at a pace that is more appropriate to their learning needs. Students who understood the material quickly moved on while others completed as many exercises as needed to learn the content. The teachers reported that students are doing more math problems than they would in a standard classroom.

Re-conceptualizing mastery through immediate feedback and endless opportunities to try. The possibility for infinite practice to reach mastery and the immediate feedback of the website changes the way students engage with the math content. Instead of completing ten problems and going over them in class only to find there is a misunderstanding on the first problem, with Khan Academy students know immediately if they are right or wrong on each exercise.

If students get the answer wrong, they need to decide how to proceed: recheck their work, review the procedure, get a hint, watch a video lesson, ask a friend, or ask the teacher. We observed a few students who continued with the same strategy for a problem or two. However, since they continued getting answers wrong, they soon sought help. Since Khan Academy never runs out of math problems, students can keep practicing. Additionally, since mastery on an assignment is five correct in a row not the total percent correct, students were motivated to keep trying because a few wrong answers do not ruin their grade. One teacher commented that she now has more students getting full credit for their homework.

Increased pathways for getting help. Having students use Khan Academy during class time creates a need to seek help while also providing multiple pathways to get help. The platform offers hints and relevant videos for each exercise. But, since the Chilean students were using Khan Academy at school, they also had access to teachers, peers, and notebooks. In Chile, we observed that even though students had the imbedded supports, they preferred turning to peers and teachers. The most common first step we observed was to ask a more math-savvy peer for help. Because each student had unique problems, Khan Academy transformed the typical peer-to-peer interaction from the exchange of correct answers to one of facilitation and guidance. Students were forced to work through the problem together, and were more likely to share procedural advice than actual solutions. Peers became facilitators rather than answer sheets.

Other students still preferred to get help from the teacher who they saw as a more trusted and accurate resource. Asking the teacher was the safest option because students do not want to make a mistake and be forced to accrue check marks again.

Students utilized the embedded support features less frequently. Some students were wary of using the embedded hints for assistance because it meant they would not earn points for that exercise. Once a student clicks on the “hint” button, they automatically receive an ✗. This interrupts their accumulation of ✔ marks and requires them to rebuild back towards five-in-a-row.

Gamification of learning as a motivator. It is clear from talking with students that getting immediate feedback and seeing the ✔marks build up is motivating and gave them a sense that they are mastering different procedures. But, Khan Academy also has other reward systems built into it. Because of incentives like points, avatars, and badges, some students saw Khan Academy as a place to play as well as a place to learn. Students called the site “fun,” “dynamic,” “motivating,” and “game-like.” Though not universal, many of the students we talked to were motivated to complete math problems in order to accumulate energy points and earn new badges. But the motivation was not always to accumulate points: with points one can buy more interesting avatars. There are also a few students who saw the points as proof they were getting better at math.

The teachers and administrators of the SIP also used the points to motivate students. Both at the individual school level as well as the SIP network level, contests were used as an additional motivation for students to complete more problems. Winners were tallied at the end of a given period (weekly or monthly) to earn prizes such as homework credit, technology devices, or simple bragging rights.

More in-depth ways to explore math content. Khan Academy also gives teachers and students access to graphics and illustrations that are hard to replicate at the blackboard. These visualizations are built into certain exercises. Figure 1 shows an example of a math problem with an interactive, graphic of the concept being assessed. In the Solid Geometry example, students can see full three-dimensional images that turn as they mouse-over the figure. One teacher spoke of using this feature instead of trying to draw the images on a whiteboard for each class period. Using this tool, students have access to a higher quality and dynamic image right in front of them.

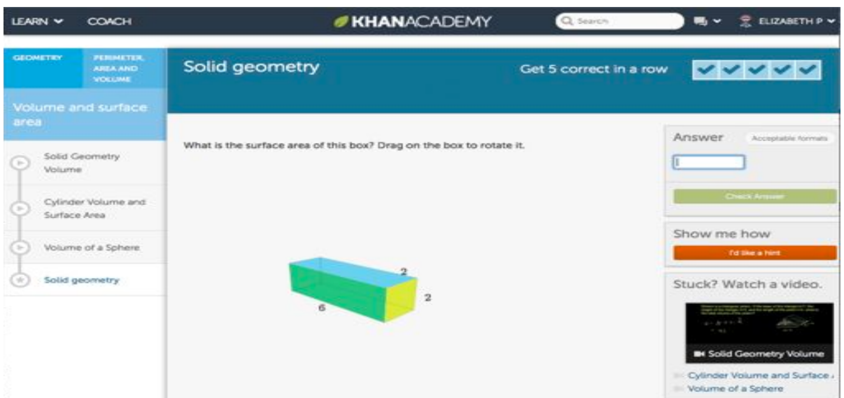

Figure 1: *Demonstrating Concepts through Khan Academy Graphics*

Using videos. Similar to case studies in the United States (See Bernatek et al., 2012), the video component of Khan Academy is not as highly utilized or valued as the exercises. As mentioned above, teachers sometime assign videos along with exercises and in those instances we observed students running the video in the background while doing exercises.

There are a number of reasons that teachers do not frequently assign video. One reason was the insufficient bandwidth at the schools. Teachers and students complained of slow connections when all of the machines were being utilized. Streaming 30+ videos would overload the system and make viewing nearly impossible.

Next, the videos are not always available in Spanish. At the time of our visit, translated videos were not stored on the Khan Academy site. Rather students had to go to YouTube where subtitles were available. The English videos with Spanish subtitles were also problematic because they require students to read subtitles while also watching someone write out math equations. The subtitles also frequently contained unfamiliar terms and new words that presented a reading challenge to the student.

Students and teachers agreed that instruction delivered by their own teacher was better than any video. Students preferred to listen to their own teacher lecture in their own language than listen to a stranger on a screen. One student explained, “The teacher can teach me more than the video.” Some teachers also reported that the videos were too long to be really feasible for classroom use.

Using Data

The Khan Academy platform generates a lot of data on the users. These Chilean teachers were using the data in five different ways.

Tracking energy points. The most common use of data was to track the number of points students earn. Teachers tracked and posted student scores to foster motivation, engagement, and excitement around doing math.

Assigning a grade for Khan Academy work. Teachers also used the data to verify student work and assign grades. Most teachers required students to complete five problems correct in a row and students who reached five got full credit, or partial credit if they did not reach five. However, a few teachers required that students earn a minimum number of points during each class period (1,000).

Tracking student progress. The other main use of data was to monitor student progress through the material. One teacher said he used the Khan Academy app on his phone to monitor student progress. Teachers could more easily distinguish which students needed to be spending their class time more productively, and who was doing extra work over the weekends. The monitoring process also helped teachers create student homework assignments because students who did not complete all of their assigned goals during the class period, would be expected to finish the rest for homework.

Monitoring student work during class. Three of the teachers we observed made interesting use of the real time data function to monitor student progress during the class. Teachers would project the data so students could compare their own progress to their peers as a way to motivate students and to generate a level of competition. The teachers could also see how much students are working. Even though, Khan Academy is self-paced, some students still needed a little oversight. In one session, the teacher reviewed the data 20 minutes into the class and called out students who had only attempted two problems, while highlighted others who had done many more.

Using data to identify instructional needs. The data also helped teachers see if there was a topic troubling a large portion of the students so that they could re-teach that concept. In two of the lab sessions, we saw teachers bring the class together to focus on the whiteboard while they explained a concept. One teacher used data from Khan Academy to help formulate groups either pairing students with similar abilities, or matching more advanced students with struggling peers. Another teacher said he checks students' progress on the platform every Sunday night to see what mistakes students are making and what topics they are struggling with. That information then feeds back into his instructional decisions around what to teach and what videos to assign.

Student use of data. Although many students kept track of their points and badges, the students rarely looked at any other data or statistics about their progress. However, this may be because the students had not had a chance to explore the full site in Spanish. The Spanish version of Khan Academy launched while we were in Chile. We did observe students being surprised that the site had vital statistics and other data. This suggests that perhaps the students simply did know what the data was.

DISCUSSION

Our research sought to explore the nature of how teachers blend the Khan Academy resources and online learning practices with existing resources and practices in Chile. The way these teachers were using Khan Academy as a digital learning environment changed the ways and the degree to which these Chilean students engaged *with* and were engaged *by* mathematics content. It also changed the way teachers and students interacted with each other. These findings are similar to what research around the use of Khan Academy in U.S. schools have found (Bernatek et al., 2012; Murphy et al., 2014; Wilka & Cohen, 2013). In Chile, we observed that Khan Academy provided the opportunity for students to do more math through having contact with more math exercises. This increased interaction with math impacts both student engagement and learning.

Teachers Are Changing Instructional Practices and Beliefs

From the observations and interviews, it was clear that the Khan Academy math resources have been quickly and deeply integrated into these Chilean teachers' math instruction. The major change that these teachers made was to dedicate class time to using Khan Academy in the computer labs. During classroom observations, we observed teachers maintaining many of their traditional instructional practices while integrating Khan Academy at specific moments where its use aligns with the traditional practice of having students do exercises. However, the easy fit between Khan Academy and these teachers' prior instructional practices does not mean that nothing is changing. The observations and interviews suggest that these teachers changed their practice while using Khan Academy with their students.

Teachers used more facilitation along with direct instruction*.* The introduction of Khan Academy pushed teachers to play a different role while in the lab with their students compared to the classroom. While using Khan Academy to support students' mathematics practice, the teachers in this study were clearly facilitating students learning rather than using a more traditional method of direct instruction. When a class of students entered the computer lab to work on Khan Academy, the power dynamics shifted. Instead of the teacher standing in front of the class "doing math", the students were the ones "doing math" non-stop for 30-40 minutes. The teacher's role was in support of the students.

As the teacher stepped out of her traditional role, students took on more control of their own learning experience. When using Khan Academy resources, students had to make more decisions for themselves about their learning path and became more self-sufficient learners. Students had more resources to help support their own learning needs allowing them to act more independently from the teacher. At least two teachers in the study talked about the value of Khan Academy to teach students skills such as responsibility and self-discipline. One teacher reported that he did not dictate how much time students should spend on Khan Academy at home rather he left it up to them to decide. This was his way of teaching them responsibility for later in life.

Teachers' use of classroom time also changed with Khan Academy use because they no longer needed to develop problem sets and spend less time worrying about classroom resources and logistics. The teacher did not need to spend precious class time drawing precise mathematical formulas and figures on the board each time they were needed.

Teachers are changing their beliefs about assessment*.* There are elements of a mastery learning approach emerging in the way these Chilean teachers were using Khan Academy. Mastery learning is a complex and effective pedagogical strategy (Guskey, 2010; Hattie, 2009) built on the idea that, given sufficient support and resources, all children can master the material. Although mastery learning has more key elements than we saw with Khan Academy, two core features were present: numerous feedback loops on small, well-defined chunks of content and variability in time allowed to reach the goal.

Students in the study were doing more mathematics because they had more opportunities to succeed at math because Khan Academy changed the criteria of success. Moving from valuing the percent of correct exercises to achieving five-in-a-row was shifting students and teachers to a mastery-based view of success. This increased students' motivation to persist until they mastered the skill and demonstrated fluency. One teacher reported that Khan Academy worked best with his students who struggle the most because it gave them a chance to succeed. The students who most needed it got more chances. It is more difficult for students to slide through the system because teachers and students can track individual progress and see how much work they are doing and where they are struggling.

Students Are Doing More Mathematics

The Khan Academy site allows students to have increased access to mathematics exercises. In traditional classes we observed, students might see 10 to 15 exercises; but the teacher could never be certain how many students actually engaged in doing the exercises or how many copied the answers. Khan Academy fundamentally changes that dynamic. Through an infinite bank of unique exercises, students had to do the work on their own. They could not peer over a classmate's shoulder to get the answer because, undoubtedly, that person was working on a different problem. Similarly, students could not haphazardly fill out a worksheet with incorrect answers just to say they completed it. With Khan Academy, the user is required to input the correct answer before moving on.

But it is the features of immediate feedback and access to just-in-time assistance that help keep students engaged with math and completing more exercises. Students did not need to wait for a teacher's assistance; they could get help from peers or from the Khan Academy platform. There was no longer a bottleneck of information transfer with the teacher trying to help all students in one class period; there were two additional pathways for students to get support, allowing more students to move through more material more quickly. Additionally, because students could access the Khan platform wherever they have an Internet connection, they could work on problems during recess, after school, and at home. Learning was not confined to the 47-minute class period.

Students were more engaged in math. Some research has found that gamification can increase student engagement (See Plass et al., 2013). The elements of gamification on the site appeared to motivate many Chilean students to do more math exercises. Most of the students we spoke with described Khan Academy as fun and made references to the game-like elements. However, the points and badges appeared to motivate in different ways. Some students clearly wanted to earn as many points as possible, while other students just wanted to earn points to gain access to a new avatar. There were also students who saw the points as proof they were mastering each skill.

Self-regulated math learning was a motivator. Research has long suggested a connection between self-regulated learning and academic achievement (Zimmerman, 1990) and particularly in math (Dignath, Buettner, & Langfeldt, 2008). There are aspects of students' experience with Khan Academy that suggest classroom use might encourage self-regulation. Self-regulated learners "plan, set goals, organize, self-monitor and self-evaluate at various points during the process of acquisition" of knowledge or skills (Zimmerman, 1990, pp. 4-5).

While teachers manage students' entry into the system (through assigning skills and tasks), once they are there, students take control over much of their own learning. This ownership is at the heart of what makes Khan Academy's math exercises so engaging for students. First, students are able to move at their own pace and choose in which order they want to complete the assigned skills. Next, Khan Academy provides two types of feedback that might serve as a "self-oriented feedback" loop that theorists believe is fundamental to self-regulation (Zimmerman, 1990, p. 6). One feedback comes from the immediate response after each exercise; but students are also constantly monitoring overall progress through ✔ marks, points, and badges. Both of these feedback systems invite the learner to monitor their own progress and learning methods.

Just-in-time help supports metacognition. Since the Chilean teachers used Khan Academy with their students in a lab, the students had access to multiple supports and, in particular, help from their teachers. A key component of developing self-regulation is metacognition, which is the ability to reflect on your own learning and know when to seek help (Zimmerman & Tsikalas, 2005). When students come up against a procedure they do not understand, students have to decide how to proceed: get a hint, watch a video, ask a friend, ask the teacher, or simply try again. With Khan Academy, students know immediately if the answer is wrong. Students are required to reflect on their procedural choices and problem-solving approaches in the moment, not days later when a paper worksheet would be graded and returned.

In fact, getting help when they need it means students were more likely to stay engaged and on task instead of getting distracted while waiting for the one teacher to finish assisting other students. Because students were able to get help from multiple sources, as mentioned above, the teacher could spend more time with the struggling students who most needed her attention; this prevented that vulnerable group of students from falling further behind and potentially disengaging all together.

Students were encouraged to tutor each other. There was much more student discussion in the Khan Academy sessions than in the regular class, and the conversations were notably different. The way Khan Academy was used in these Chilean classes supported a certain type of student-to-student interactions. Since the activities were individual, Khan Academy did not support collaboration, per se. But, students did turn to each other for help. In traditional paper exercises, students also turn to a peer for help but this often means copying their answer. Since students on Khan Academy all have different exercises, they cannot share answers. The only option is to explain the process, which we observed frequently in the Khan Academy sessions.

Students worked on tasks appropriate to their level. The way Khan Academy functions in letting faster students advance more quickly while allowing other students to take time to grapple with the math skills they find challenging helped create a more equitable learning environment and reduced frustration and boredom. Some students needed more practice to solidify their operational ability, others needed to work with the teacher to clear up a misconception, and others wanted to move on to more advanced skills by themselves. Now, they all have the time and opportunities to do that.

Students are mastering more math skills. As students did more math problems and were more engaged in learning math content, it is not surprising that their skill level would also increase. Teachers, students, and the SIP leadership all felt that the students who were using Khan Academy were learning more mathematic content. Most of the students we spoke with liked math class. Some student said that this was a change for them. A few directly attributed Khan Academy for this shift. For example, two girls we interviewed felt that Khan Academy made them better at math. Another student believed that using Khan Academy improved his mental calculation skills. One teacher reported that many more of her students were getting 100% on their homework. Other students also reported doing better on the practice college entrance exams. Although we were not able to analyze pre or post-test results in this study, other studies have found a connection between Khan Academy exercises and improved scores on basic mathematics (Murphy et al., 2014)

Students perceived themselves as math learners. Students felt more confident in their math skills from using Khan Academy because they could *see* their learning through points, badges, and charts. Similarly, when students are forced to stop and get help, they saw that getting that support actually works. Because Khan Academy provides infinite opportunities to practice problems and get things right, students have many opportunities to feel successful in their learning. They also noted that, with practice, they could learn, achieve, and master something. Some of the students also felt that Khan Academy had helped them value math. For example, two young women talked about how Khan Academy has helped them understand the value of math in their daily lives. One girl, whose confidence in math has increased since working with Khan Academy, works at the market with her father where she is now better able to use her math skills to help sell products.

CONCLUSION

Educational policy makers around the globe often talk about Khan Academy with great expectations for deeply transforming teaching and learning, with the concept of “flipping the classroom” where students receive direct instruction via video outside the classroom and then work with the teacher doing math in the classroom. What we found in this developing country context was something quite different at least in the context of mathematics. Similar to other studies (Murphy et al, 2014; Wilka & Cohen, 2013), in these Chilean schools we found Khan Academy being used in ways that improves students’ math skills, but it is not by flipping the classroom.

After reviewing the resources and piloting them for many months, the administrators at SIP and their teachers felt that Khan Academy was useful for improving the procedural skills but not necessarily at promoting deeper mathematics learning or teaching difficult concepts; face-to-face teachers are still the best at that. Expecting students from these low-income families to have home computers and Internet access also means it is unrealistic to assign Khan Academy for home use. Instead, these teachers dedicated one lesson period a week to using Khan Academy in school computer labs. Teachers still provided direct instruction in their classroom, but teachers were taking on new roles in the labs. This also changed how students engage with math in powerful ways.

Even though the use of Khan Academy may plant the seeds of deeper pedagogical changes such as mastery learning or differentiated instruction, our findings suggest that teachers do not need to change their entire teaching model to start using this tool. Teachers assign exercises and students complete them; the practice appears the same as in the days of workbooks. Khan Academy does not require teachers to embrace a complex or novel view of teaching for them to make it useful and worthwhile. We observed teachers embedding Khan Academy resources within their traditional instructional practices and creating a decidedly non-traditional – yet improved – learning environment.

While some critics might emphasize its lack of reform approach as a fault, Khan Academy’s straightforward approach of providing an endless bank of practice exercises may make it a more universally adaptable tool across different types of teachers, classrooms, and countries. The fact that it does not diverge much from what mathematics teachers already want to be doing with their students makes its adaption less intimidating and integration more feasible.

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Original article at: http://ijedict.dec.uwi.edu/viewarticle.php?id=1766

International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 120-141

Planning and Evaluating ICT in Education Programs Using the Four Dimensions of Sustainability: A Program Evaluation from Egypt

Sarah Pouezevara, Sabry William Mekhael and Niamh Darcy
RTI International, USA

ABSTRACT

This paper presents the findings from a program evaluation of an ICT in education project within the USAID-funded Girls Improved Learning Outcomes (GILO) program. The evaluation uses a framework of four dimensions of ICT sustainability to examine the appropriateness of the design and implementation of the project, which provided simple, relevant technology to 166 schools in Upper Egypt. Project implementation, as described in this article, was carried out with a view towards both rapid and efficient rollout and long-term sustainability. The evaluation study aimed to determine the extent to which the ICT component inputs were still in place and being used by the school and community one year after direct project support had ended. The findings suggest that ICT in education projects must favor neither the hardware nor the pedagogical aspects of the technology. Instead they layer the pedagogical use of technology on top of a deliberate technology infrastructure. The technical and pedagogical aspects of the program should be treated as two distinct efforts with separate, but complementary goals. Paying attention to social, political, economic, and technological dimensions during the process can make a difference in sustainability and, ultimately, success of the initiative.

Keywords: *Egypt; ICT in Education; Hardware; Infrastructure; Maintenance and Support*

INTRODUCTION

School-level expectations driving the adoption of information and communication technologies (ICT) in education worldwide include: increased quality of learning through access to more—and more effective—learning resources; more student-centered, active, and constructivist learning environments; improved critical thinking and analytical skills (Jonassen, Peck, & Wilson, 1999; Newhouse, Trinidad, & Clarkson, 2002); enhanced productivity through classroom and system management tools (Hepp, Hinostroza, Laval, & Rehbein, 2004; Jhurree, 2005); and increased student motivation, student productivity, and learner independence (Newhouse et al., 2002; Passey, Rogers, Machell, & McHugh, 2004). At a broader level, national ICT in education policies and strategic plans are often linked to such ambitious development goals as: supporting economic growth; promoting social development; advancing education reforms, including promotion of 21st century skills; and supporting education management (Jhurree, 2005; Kozma, 2008; Neil Butcher and Associates, 2011).

Yet, integrating ICT in education is not simple. Choosing the right technology, training the right people to use it and maintain it, and adjusting classroom and school schedules to accommodate it are just a few of the steps required for educational planners. Many reports of ICT in education projects suggest that too much emphasis is placed on the hardware provision, without sufficient attention to what it was expected to accomplish to the associated staff development necessary to effectively use the hardware (Hepp et al., 2004; Warschauer, 2003). As important as it is to consider ICT in education from a pedagogical perspective, one cannot neglect to adequately plan for the supporting information technology (IT) infrastructure, including the people, processes, and technology that successful use depends upon (Lacey, 2006; Microsoft, 2003). The planning and preparation that precedes technology integration may in fact be the key driver of success

(Jhurree, 2005; Rusten, 2010; Venesky & Davis, 2002), but elements of IT planning are under-documented in international literature focusing largely, if understandably, on pedagogical use and outcomes. Most case studies look at what happens after hardware and training are delivered and at what may have contributed to or prevented desired outcomes. This leaves important questions unanswered. For example, what are the specific consequences of certain courses of action during the planning stage? What configurations are likely to lead to sustainability? How does one select an appropriate technology package?

This evaluation study attempts to fill this gap by taking a close look at the planning processes of an ICT in education program embedded within a larger educational improvement project. In particular, this study focuses on the IT that was selected to support improved teaching and learning. It discusses the largely hardware-related processes of procuring and delivering equipment, providing software and training to manage the infrastructure, and creating an enabling environment in which to use that infrastructure. The GILO case is viewed through the lens of sustainability factors identified in prior research of ICT in development projects, thereby putting GILO's approach into a larger context and allowing a reliable framework for planning and evaluation of such programs to emerge.

THEORETICAL FRAMEWORK FOR SUSTAINABLE ICT IN EDUCATION

The ultimate goal of any short-term, externally funded project should be to enable stakeholders to benefit from the project inputs—both material and intellectual—long after project funds and technical assistance have ceased. ICT in education programs often receive attention for being unsustainable, due to costs or poor long-term planning at the outset (Adam, Butcher, Tusubira, & Sibthorpe, 2011). Sustainability commonly evokes the financial aspects of a project, such as ensuring adequate sources of funding for recurrent costs, maintenance, and upgrades. However, adequate staff capacity and management systems to support use of the equipment, as well as leadership and commitment from school leaders and community, are also part of observable sustainability (Rusten, 2010). In the case of ICT investments, "sustainability" arguably means that, at minimum, the project is still functioning and the equipment is still in use. Ali and Bailur (2007), however, argued for a broader view, de-emphasizing sustainability in favor of planning for and supporting capacity to innovate and respond to change in a constantly evolving environment. Ali and Bailur's point of view is particularly important for ICT in education projects, which will inevitably be affected by rapidly changing technologies and usage habits. Unused ICT may be "sustainable" in the sense that it remains in working condition, but it is hardly a worthwhile investment. True sustainability is a function of both longevity and use.

A review of ICT in development and ICT in education literature does uncover some recurring lessons learned and considerations that can guide program planning towards success and/or sustainability (for example, Derndorfer, 2010; UNESCO, 2009). To evaluate GILO's technology component, this program evaluation uses the following dimensions of ICT sustainability - technological, individual and social, economic, and political - which capture the most common recurrent themes.[1]

Technological Dimensions of Sustainability

Technological dimensions of sustainability concern choosing technology that will serve for an extended period because it is in demand, appropriate to the context, and easy to use, maintain, and repair. This involves complex choices between the latest technologies on the market vs. more tried and tested ones; locally available materials vs. products imported through donations or grants; centrally located computer labs vs. mobile, shared technologies; and more cost-effective bulk purchases of a standard set of equipment vs. more tailored packages that meet the needs of each school or classroom. Hepp et al. (2004) and Strigel, ChanMow, and Va'a (2004) warned of the "one-size-fits-all" approach and externally imposed technology that ignores the local realities. Centralized labs may be less complicated and expensive to maintain but also less conducive to teacher involvement and cross-curricular use of technology at the expense of teaching computer literacy (Hepp et al., 2004). Cossa and Cronjé (2004), Hosman and Cvetanoska (2013), Richardson (2011), and Rubagiza, Were, and Sutherland (2011) also highlighted the importance of addressing the human and financial costs of maintaining equipment, lest the technology remain off-limits for fear of breakage.

Individual and Social Dimensions of Sustainability

Introducing ICT in education is a process often surrounded by excitement and curiosity, as well as caution and criticism. For this reason, addressing community needs, creating ownership, managing expectations, and providing adequate training are all considered part of the individual and social dimensions of technology that should be addressed in program planning and implementation. Cisler (n.d.) linked successful projects to the degree to which a community takes responsibility for them. This is especially important, as described above, to ensure that technology meets the needs of the target beneficiaries. Similarly, Adam et al. (2011) emphasized the connection between imposed technology, lack of ownership, and high levels of waste; along with Jhurree (2005) and Hosman and Cvetanoska (2013), they recommended that schools develop their own plans to integrate technology based on identified needs and involving all stakeholders. Hepp et al. (2004) also pointed out that an active application process can require teachers and administrators to think carefully about costs and potential use of the technology; thus, giving importance to the future investment, and boosting motivation, ownership, and commitment. These elements can also be considered "demand drivers", which have also been cited as a key factor in sustainability (Healey, 2013).

Regardless of technology choice, there will always be different levels of capability among target groups, and implementing technology in education requires careful attention to initial and ongoing training and support, covering technical, pedagogical, and content knowledge (Kohler, 2011). It can be very difficult to change teachers' pedagogical culture and beliefs about ICT (Hepp et al., 2004; Hosman & Cvetanoska, 2013); yet, a growing body of experience suggests that delivering training through a series of classes or incorporating follow-on support can be more effective than one-time workshops and that peer learning can be effective for school-based training (Guskey, 2002; Hepp et al., 2004; Pouezevara & Khan, 2008; Strigel et al., 2008). Hosman and Cvetanoska (2013) went one step further in insisting that teachers be recognized as the key agents of change in a process that may take years, citing evidence that the more teachers are involved in the planning and implementation processes, the greater the chances of successful outcomes.

Economic Dimensions of Sustainability

The economic dimensions refer to costs, cost recovery, and the overall financial environment in which the project is situated. External projects aiming simply to introduce ICT in schools are in particularly sensitive positions regarding economic dimensions of sustainability because while they may have funds to provide equipment and support at first, by their nature, that support is going to end. It is common in ICT programs to focus too much on the initial fixed costs—purchase of equipment, construction or retrofitting of physical facilities, installation, security, insurance, and materials production—while ignoring the recurrent or variable costs such as those associated with replacement/upgrade, operation, change management, insurance, security, and disposal (Paterson, 2007). Studies of the use of computers in classrooms show wide variance in how to calculate total cost of ownership, but some estimates of recurrent maintenance range from 15-20% (Moses, 2003) to 30-50% of the initial purchase costs (Tinio, n.d.). A study of the Jordan

Education Initiative concluded that hiring computer technicians was the most significant cost associated with computer labs. Total recurrent costs were about 47% of the total budget, with projectors being the single most expensive hardware input due to maintenance requirements and replacement bulbs (USAID, 2007). Costs must be calculated for each particular context, without neglecting some of the less evident costs such as training, equipment maintenance and security, staffing of computer labs, virus protection, insurance, and responsible disposal of non-functional hardware in the future. The Samoa SchoolNet project found that since enrollment fees play a role in overall school budgets, technology packages need to be aligned with school enrollment rather than providing equivalent packages to all schools; if not, small schools may end up with too much equipment that they are unable to sustain. The same analysis of sustainability noted the importance of personal and institutional “demand drivers” for creating the motivation for schools to allocate financial resources to initiatives that they feel are most important (Healey, 2013).

Many ICT in education programs are also designed to earn revenue, or offset costs through community participation or by charging fees for use of the school equipment after school hours. After estimating initial and recurrent costs and potential sources of revenue, schools and school districts need to secure funding through regular budget channels, which usually requires significant lead time.

Political Dimensions of Sustainability

Budgets, training programs, and pedagogical objectives at the school level are ultimately highly political issues that must be aligned with national policies and favorable to local political leaders. ICT in education plans can be the product of attractive political promises, but oftentimes plans do not materialize into programs because politicians have misjudged the scale of needs, are under pressure from vendors, or cannot mobilize funding (Hepp et al., 2004; Jhurree, 2005). Within schools, new governance structures and change management processes may have to be put in place to foster an enabling environment for technology integration. According to Cisler (n.d.), political dimensions of sustainability involve ensuring support for the project through local and national politics, policies, and individuals. This can be accomplished, in part, through promoting achievements and successes. Strigel et al. (2008) noted that raising awareness and generating champions had an important effect in Samoa. Moreover, establishing channels of communication and collaboration between schools and the central ministry’s technology integration department accelerated technology adoption in the participating schools and provinces.

Political dimensions also involve the policies that either support or prevent effective use of technology for education. As previously mentioned, at the institutional level, stakeholders including teachers, school administration, and parents should be involved in decision making about technology management and usage policies (Jhurree, 2005; Strigel et al., 2008). Taking it one step further, political dimensions concern long-term administrative support for change management, which also should be considered at the outset of all projects (Hosman & Cvetanoska, 2013). Managing technology within the school generally involves one of two basic choices: either require a teacher to serve as a technology coordinator in addition to teaching duties, or recruit a technology coordinator directly through the school system or outsourced through a private contractor. Schools that try to save money by implementing the first choice (i.e., volunteer teachers as ICT coordinators) may find that the demands on the teacher’s time are too great and therefore not sustainable (Hepp et al., 2004; Strigel et al., 2008). However, the alternative (i.e., hiring a technology coordinator) is also a potential tradeoff in terms of opportunity costs, and finding a person with the appropriate technical (hardware and software operation) and pedagogical (technological integration) skills can be challenging.

ICT IN EDUCATION IN EGYPT AND THE GILO PROJECT

Egypt was preparing for 21st century education through technology as early as the 1990s. Together, the Egypt Education Initiative (2006–2009) and the Egyptian Information Society Initiative included many programs targeted at specific populations and sectors, including rural and disadvantaged communities. Programs aimed to: increase access to ICT-related services, improve ICT competencies, promote innovation in IT, and expand access to educational opportunities through e-learning (Ministry of Communications and Information Technology [MCIT], 2005). More recently, the convergence of government policies and private sector support for ICT in education in Egypt offers new and promising opportunities. All ICT in education efforts have been shaped by the MOE's guiding principles of standards-based content, active learning methodology, and integration of ICT, assessment, and learning materials. The five-year MOE National Strategic Plan for Pre-University Education Reform in Egypt, 2007/08–2011/12, reflected government and citizen aspirations for better education. A new strategy covering the period 2012–2017 aims at investing in Egyptian potential and achieving digital citizenship through innovative technology applications. Table 1 provides key terms and definitions of important concepts in the Egyptian educational system referenced throughout this paper with abbreviations.

Table 1: *Definition of Terms and Concepts Related to Education in Egypt*

Ministry of Education (MOE): Responsible for the quality of pre-university education in Egypt.
Technology Development & Decision Support Center (TDC): Established under the MOE in 1994 under the name Technology Development Center. Has a presence in all of the governorates and is responsible for providing technical support for school multimedia labs and computer lab computing equipment.
General Authority of Educational Buildings (GAEB): Part of the central MOE, responsible for school design, construction, maintenance, and furniture. GAEB has offices in each governorate (muderiya).
Board of Trustees (BOT): A school board, which is democratically elected at each school, typically consisting of school staff /principal, parents, and community members.
Muderiya: One of 27 educational administrative divisions between the district (idara) level and central MOE level, equivalent to the political governmental unit of muhafaza.
Idara: A district, or sub-governorate (smaller than muderiya) administrative division that has authority over a cluster of schools.

Equitable Access to Education: The GILO Project

In line with these reforms, GILO, a five-year program funded by USAID[2] that began in 2008, aimed to expand equitable access to education by focusing on girls, to improve early grade reading as a foundation to learning, and to improve community partnerships with the schools. The inclusion of an ICT component aimed to improve teacher lesson planning, teaching, continuous learning, and professional development. A secondary goal was to provide student and community access to computers to enhance communication, problem solving, and research skills. The project design assumed that immediate implementation objectives depended on empowering the GILO schools to use, support, and maintain the technology; without this foundation, the teaching and learning goals would not be achieved. Two main principles that guided the IT approach taken were:

- provide simple, reliable, and sustainable school IT systems, infrastructure, maintenance, support, and capacity building; and

- carry out all GILO IT activities in partnership with the government (GAEB, TDC) and schools.

GILO[3] committed to supporting 2,700 to 3,000 classrooms in kindergarten, community, primary, preparatory, and basic education schools in the four muderiyas of Beni Sueif, Fayoum, Minia, and Qena, in selected idaras. Schools were selected following a process agreed upon by GILO, the Ministry of Education, and USAID. First, priority communities were identified. Priority schools within the communities were then identified (based on rural locations and current girls' enrollment rates). Next, schools were selected based on a demand-driven application process using an objective scoring mechanism. Finally, GILO selected schools to be phased into the program in three cohorts (2008, 2009, 2010).

In practice, there was a clear distinction between IT (hardware, infrastructure, functionality, etc.) and its applied use in the classroom (for convenience, referred to as ICT) in the GILO project. The IT team focused on computer and network design, site preparation, and the creation of a maintenance and support team to support the network, computers, and applications. The GILO IT team also developed IT management applications such as asset management software and a maintenance and support helpdesk. All of this was done in collaboration with the ICT team responsible for classroom-level pedagogical use of the technology. The ICT team focused on building teacher skills in using ICT to improve professional development, designing specific computer-based media to meet critical professional development needs, and developing skills of the administrative staff to use school management information system software. The ICT team also identified and supported at least two staff per school to provide ongoing mentoring and support to other teachers and administrators to encourage them to integrate ICT in their work. Between the IT and ICT teams, there was a constant exchange of ideas to ensure the infrastructure met the required goals.

The GILO Technology Implementation Process

The process of providing the IT packages to schools took more than 18 months[4] and proceeded in three main phases: (a) site preparation; (b) procurement and installation; and (c) Internet connectivity, training, and asset management. This was all done within a guiding framework of a memorandum of understanding between the Technology Development and Decision Support Centers (TDC), representing the Ministry of Education, and GILO. The memorandum of understanding outlined each party's contribution towards the realization of the ministry's strategic plan within GILO-supported schools. In doing so, the ministry stipulated that GILO would make use of the resources already existing in these target schools and that the ministry would complement GILO's contribution. For example, the Ministry of Education would secure a commitment from its TDC and the Educational Computer Department to fast track their hardware, software, and capacity building efforts within GILO's project lifespan. To prepare for the purchase of the technology, the IT team of GILO IT specialists, school staff, and local TDC staff led an equipment inventory and site survey of each of the GILO schools. This assessment looked at existing computing equipment and infrastructure conditions, security, cooling, electrical supply, staff capacity, availability of other digital media (TV, digital cameras, etc.), and available IT services in the school community.

According to GILO's vision to improve the education process within the school, the project allocated technology across school entities (e.g., teacher room, administrators, library, classroom, student/community ICT lab, dedicated computer for kindergarten) in a flexible way that met the expressed needs of each school. A redundant (not dependent on a single source—whether hardware, software, or human resources) and flexible design for the IT system was intended to maximize resource sharing and use by providing, for example, a combination of desktops in a computer lab and several laptops with a projector that could rotate between classrooms. There were also dedicated teacher and administrator computers and a printer, scanner, and digital camera that were in a separate teacher room. The final package of technology for each school (see Table 2) was dependent on the number of classrooms and "educational floors" in the school and on the existing inventory of functional and appropriate hardware (including peripherals). For example, small schools received two laptops and two projectors; large schools up to nine laptops and five projectors. Hardware inputs were associated with appropriate software applications and training. GILO also provided Internet access to 92 of the 166 schools and provided IT training in three phases to the two identified maintenance and support staff per school.

Table 2: *GILO Basic IT Package Provided to Each School (166 schools)*

Equipment Item	Quantity
Desktop computers	1,380
Notebook computers	858
Projector, spare lamp bulb, display screen, and laptop	1 per educational floor (max. 3 per school)
Laser printer	332 (2 per school)
Flatbed scanner	330 (2 per school)
Universal power supply	332
Digital camera	166 (1 per school)
Webcam; headsets	996 (6 per school)
Dust covers (for each desktop and printer)	1,712
1 voltage stabilizer (each computer, printer, and network component)	2700 total
Warranty package	3-years, including in-school service
Filtered Internet service (target 50% of schools with ADSL coverage)	In 92 schools

Evaluation of the IT Component

The program evaluation design included the use of interviews, document review, and follow-up phone calls with the schools and school staff. Instruments included a questionnaire with qualitative and quantitative interview questions aligned to the four dimensions of sustainability described above. The program evaluation design and instruments received RTI International Institutional Review Board exemption. The aim of the evaluation was to determine how the technology and associated interventions were being sustained in the schools one year after GILO had transitioned out of direct support to the schools.

One of the criteria for inclusion in the evaluation sample was that the school had M&S staff remaining. The GILO team called all 166 schools in advance to determine which schools met these criteria and at the same time inquired informally about how many operational computers they had. Out of 166 schools total, there were at most 15 schools[5] that no longer had GILO-trained M&S staff. There were 156 schools that reported having fully operational computer equipment (approximately 94%). The formal evaluation proceeded to determine in more depth what factors contributed to the sustained use of the technology.

Fifty-three out of 166 GILO-supported schools (31.9%), covering all 15 TDC idara and 4 muderiya staff, were included in the interview sample. Three different interview groups (see Table 3) answered questions together as a group interview with multiple respondents. School selection depended on the number of schools in each of the 15 idaras, so the distributed weight of the sample is equal to the weight of schools of each idara.

At the start of the study, the GILO IT evaluators gave a verbal overview about the study and the entirely voluntary nature of the participation. The participants were then asked for verbal consent. Additional document review including GILO project reports, the warranty vendor report, school equipment logs, and follow-up phone calls with each of the 53 school contributed to the full program evaluation presented in this paper.

The program evaluation activities took place from March to May 2012, which corresponds to four years after the project began, about a year before it ended, and 18 to 21 months after hardware was first installed in the schools. All information was collected on paper, reviewed, and then entered (with data validation checks) into the project monitoring and evaluation system, and then the results were exported into Excel worksheets for data analysis and interpretation. Limitations of the evaluation design include the exclusion of the 15 schools without maintenance and support (M&S) staff. Because of lack of variation among the schools, the evaluation could not compare differences in circumstances between schools with apparent sustainability versus those without. Finally, all of the authors were involved in implementing GILO and draw on these experiences in describing the processes and in interpretation of the findings, therefore some bias may be present.

Table 3: *Total Questionnaire Sample Size Distribution by Group*

Questionnaire Groups	Participants per Group	Group Sample Size
M&S team in the school	1 to 4	53 groups (92 individuals)
Management, administration, and BOT team in the school	2 to 11	53 groups (221 individuals)
TDC idara and muderiya staff	1 to 6	13 groups (21 individuals)

PROGRAM EVALUATION FINDINGS

In this section, we first describe GILO activities related to each aspect of the sustainability dimensions; and then report relevant findings for that dimension. Most of the evaluation findings are informed from the aggregated results from the questionnaires, with additional information provided from the warranty vendor report, school equipment logs, and follow-up phone calls noted separately.

Technological Dimensions

Procurement and configuration. GILO worked with schools and the Ministry of Education in selecting technology matching the schools' needs, yet consistent with a set of standards and hardware models that could be purchased in bulk. Schools were expected to raise funds (direct or in-kind) and contribute to site preparation by, for example, securing windows and doors; upgrading existing computer memory, storage, or networking configurations to meet the standards of the new equipment; making curtains; or hosting fundraisers in the school. Site preparations were done by the Ministry of Education and communities under the technical supervision of a General Authority of Educational Buildings (GAEB) engineer with cooperation from the GILO IT team.

According to the evaluation, schools and ministry of education stakeholders were satisfied with the technology configurations provided. Distributing the equipment across multiple cadres within the school (teachers, students, and administration) emerged as very positive and was one of the differences that a majority of respondents observed between GILO and non-GILO schools. Respondents most frequently rated the laptop/desktop mix the most satisfactory and considered least satisfactory the schools' email and websites.[6] Very few schools re-arranged the equipment after it was delivered, but instead found the original semi-circle seating arrangement the optimal way to accommodate students.

Maintenance and support. GILO developed school-based expertise equally in preventative maintenance, troubleshooting, and repairs. According to evaluation data, most schools had no major problems with the technology for at least 18 months. When they did, they were able to get warranty support or solve them with their school maintenance and support team or the Ministry of Education's Technology Development and Decision Support Center (TDC). Respondents rated the communication between schools, the TDC, and the warranty provider as very positive. The main sources of breakdown or support were malfunction of the projector lamp, operating system boot errors, print errors, and viruses. These were usually solved through the school maintenance and support teams or idara TDC staff by installing a new disk image, referring back to video training materials, or activating technical support from the vendor.

A notable finding from the questionnaires was that schools were asked what they had done before GILO to deal with equipment malfunctions. 51 schools answered that before GILO they would have had to file a report on malfunctions to TDC and the General Authority on Educational Buildings (GAEB) and then wait for officials from GAEB to activate a solution. Because of slow responses to such reports, many schools had existing, but sometimes obsolete or malfunctioning equipment. After GILO, however, schools solved malfunctions through the school-based maintenance and support team, contacting the TDC for additional support (such as license activation), or dealt directly with the warranty company for hardware maintenance.

Social and Individual Dimensions

Community involvement. GILO involved the community at each step, starting with the IT site survey, then ongoing follow up and site preparation, and finally the IT training. The latter was delivered in three phases aligned with the IT installation and rollout schedule. Prior to the start of each phase, GILO conducted an orientation first at the MOE, and then shared the plan for implementation of the next phase with idara, school staff, and school boards. These sessions were intended to create awareness, gain credibility, and select the best candidates from each school to receive the training and join the maintenance and support team. All subsequent visits included follow-up on the prior phase as well as orientation to the next phase.

As a girls' project working in more rural and closed traditional areas, GILO was proactive and held many orientation sessions about filtered Internet for school and community access to avoid any misunderstanding or resistance. Beyond only involvement in planning and installation, the community was considered a key stakeholder, vital to ongoing support and sustainability, since the computer labs were intended to be open to the community when not in use by the school. Each school maintained an access and usage log for the computer labs. These logs show that community use was mainly for accessing the Internet (Internet search, email, voice/video calls for out-of-the-country family members, social networking). Some schools delivered software training programs for the community. Asked whether the technology was meeting the needs of the community, the answer was rated positively across all schools surveyed.

Training and alignment with needs. When maintenance and support teams were asked whether the technology met the needs of different groups (teachers, students [male and female], community, school management, and the Board of Trustees), more than 80% of respondents answered yes, except in the case of the community, where only 73% of respondents felt it met their needs. A limited number of hours of access was most likely one of the reasons why it was rated less suitable for communities.

Training under GILO began early and was ongoing. From orientation sessions for the school staff and TDC during the site survey and prior to any IT delivery, to formal training workshops, GILO embedded several approaches to ensure the trainees were able to apply what they learned. These included:

- customizing training topics to school needs and developing a custom GILO IT training curriculum;
- having GILO training representatives from each muderiya work together as a team and train outside of their own region;
- approaching the training in phases, each phase having a small number of training topics;
- leaving sufficient time between trainings to ensure the GILO IT team could visit the schools for coaching and mentoring;
- including trainees as active participants in post-training implementation of specific activities (such as hardware installation);
- providing a school troubleshooting reference handbook and digital reference materials;[7] and
- partnering with the TDCs from idara and muderiya levels, and encouraging them over time to deliver some of the training modules.

The results of the evaluation showed that training programs were effective, with maintenance and support teams increasing their comfort level nearly two-fold in providing IT maintenance and support after working with GILO. The evaluation showed that approximately 40% of participants requested additional training time on expanded topics covering more IT skills as well as other preventative maintenance strategies.

Interestingly, the schools engaged by their own initiative in cascade training, expanding the number of trained individuals by at least 45% outside of program efforts (at least 284 people). Although the survey data did could not verify these reports nor make any assumptions about the quality or completeness of these cascade trainings, the fact that so many additional people were trained on hardware maintenance can only improve the chances for sustainable use of the technology in the future. Digital training materials were reported useful and contributed to the ability to cascade training to others.

Improvement at the school level also created pressure on idara and muderiya staff to spend more time and effort on their own professional development in order to keep up with the knowledge and capabilities of the school staff. This was done outside of project efforts (as reported during TDC interviews). On the other hand, these government entities were provided training without being provided the same equipment as schools. This limited their ability to practice and created some resentment (to be discussed further below).

Feedback from a concurrent ICT program evaluation[8] (looking at teachers' pedagogical use of the equipment and its effect on teaching and learning within GILO) found that teacher interest in using technology for teaching and learning was very high, with 87% to 91% of surveyed teachers confirming that the IT was aligned with the needs of the school because:

- computers improve student learning and the education process;
- Internet use enhances research and study;

- they feel comfortable using ICT in teaching;
- they want more ICT information and training; and
- computers save them time and effort and make them more productive.

Economic Dimensions

Costs and cost recovery. GILO invested in forward-looking solutions that would support the project's goals after it closed. For example, the digital training resources and management applications mentioned above helped to support professional development in the long term. The procurement process also ensured that the initial investment in hardware, software, and networking costs included some spares as well as an extended three-year warranty and an anti-virus subscription covering the period after the project was expected to end. GILO also negotiated a reliable Internet speed at a cost that would be affordable to schools after GILO (about $20–22 per month, with email and domain services at about $70/month with local support service).

To address fixed versus recurrent cost issues from the start, GILO underscored the need for schools to supply their own funds over time, even though the Ministry of Education does allocate funds for technology and support. Although project funds were available to do all Phase 1 site repairs and retrofitting, GILO required schools to contribute to site preparations (see above). Respondents indicated that, on average, schools contributed 8,236.00 Egyptian pounds (approximately $1,183) towards the site preparation process.[9] As a result, GILO only spent a fraction of what was budgeted and reinvested those funds into other areas. More importantly, although this process created some delays in implementation, it was expected to strengthen the sense of ownership of the equipment at the school by all stakeholders. Similarly, GILO delayed delivery of supplies (i.e., paper, ink cartridges, USB flash drives, etc.) to schools until 6 to 10 months after they received the technology to encourage them to find sources of funding for these supplies—which many did. The lack of project-funded supplies did not delay use of the equipment, according to monitoring activities and the evaluation.

The evaluation indicated that Internet access had been factored into fewer than half of the schools, even though administrators may consider it critical for the school. Of those who did not think Internet access was critical before GILO, 44.4% now think that it is. The top three anticipated sources of funds for paying for new supplies (e.g., paper, DVDs, etc.), as indicated by the school management team and Board of Trustees respondents were: (1) technology development funds allocated by the Ministry of Education to each school, (2) community participation (fees to use the computer lab), and (3) the board of trustees. Therefore, these findings suggest that it can take a long time to work with schools to factor recurrent costs into their budgets with available funds and tied to their budget cycle.

Political Dimensions

Management and support. GILO opted to train maintenance and support teams within the schools rather than rely on outsourcing to external vendors. The selection of the maintenance and support team was carried out during the IT site survey to recruit the most qualified individuals within each school based on their prior experience with computers and motivation to fill the role. GILO emphasized women's participation in the maintenance and support team. By the third phase of training, 14% of team members were female. Appropriate staffing of computer labs was important since GILO intended to give the community access to the labs; some schools refused to do so without sufficient staffing out of concern for the safety of the technology.

The evaluation showed that 52.8% of school management teams said that they had made changes to give maintenance and support teams more support for their work. The top examples of changes included:

- providing monetary and moral support;
- reducing the number of classes assigned to them; and
- facilitating collaboration with other colleagues in attending training on how to use hardware to minimize efforts of maintenance specialists.

According to maintenance and support team interviews, 79.2% of respondents noticed changes in how other staff perceived the role of the maintenance and support team within the school. Most common was that the team was recognized and appreciated, receiving full cooperation from other staff in the school. Overall 42 schools reported 45 positive changes, and 13 schools reported negative or no changes. Some challenges to providing support occurred where the law did not allow the school to change the number of classes for teachers and where there was already a shortage of teachers and no way to provide additional support.

Local political engagement. All GILO IT activities were conducted in close partnership between implementers at central, muderiya, idara, and school levels. Local political stakeholders were involved in the site survey and preparation activities, encouraging them to cascade training they had received to other non-GILO schools, and involving ministry of education and Technology Development and Decision Support Center (TDC) technical staff in the delivery and installation activities. This was important for capacity building and ownership and as a clear demonstration that GILO IT staff were not trying to supplant the TDCs' role. TDC staff was responsible for reviewing the equipment usage logs, random spot-checking the IT equipment to make sure it was working, and reviewing the schedule and balance sheet of the community access component. The General Authority of Educational Buildings (GAEB) was instrumental in getting approval for classroom allocations for IT labs or creating new labs when an existing room was not in the original school blueprint or had been allocated for other activities.

The questionnaires revealed that in 96.2% of all schools the board of trustees got involved in workshops and meetings to discuss community usage of the IT package. The three most common reasons given for board participation were: as a service to children, community, and country. Most TDC respondents reported that cooperation was positive, specifically in the areas of equipment delivery and training. The TDC at idara and muderiya levels and GAEB got involved in the site survey, site preparation, and site installation to different levels; the TDC staff was most involved in installation, and GAEB with the site preparation (as reported by the management and administration [MGT]/and Board of Trustees [BOT] (see Figure 1).

Of note, GILO had not provided equipment to the TDCs at the idara and muderiya levels, which was raised as an issue and led to some perceptions of insufficient GILO collaboration with the TDC. Providing a computer with the school management information system software on it for the school principal proved to be a good a way to encourage school technology usage and reduce running costs. A similar strategy at the TDC level might have helped to achieve a greater impact on cascade training and support to schools.

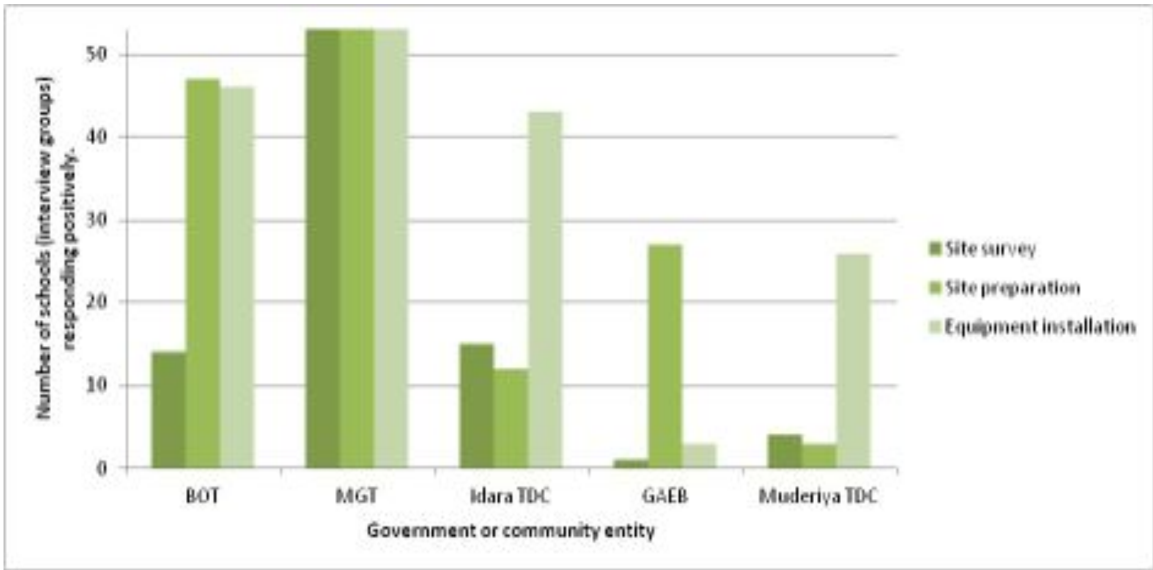

Figure 1: *Participation in IT Planning and Implementation Processes*
Source: GILO ICT evaluation data (management and administration and BOT survey)

Policy alignment. The GILO program was aligned by design with national policies and priorities. Decisions and approvals by MOE on all procurement choices, all software content, and Internet/email school schema usage at times slowed down program implementation but were critical for ensuring this alignment. The IT activities, specifically, supported the Egyptian Education Initiative and the ICT strategy, especially the focus on increased access for rural schools, activation of the use of technology in the education process, and provision of community access to technology. The Technology Development and Decision Support Center staff from each school reported one to three examples of the way in which the GILO work was integrated with national and regional education strategies.

Local government officials were important to maintaining maintenance and support teams by minimizing transfer of trained staff from one school to another, which is common in Egypt where a large number of teachers are contract teachers. There was only about 10% turnover in the maintenance and support staff in GILO schools.

DISCUSSION

If sustainability is considered a function of longevity and use of technology, then the GILO IT program could be considered sustainable at the time of this evaluation. Maintenance and support teams were still active in most schools where they were established and equipment was still functioning and being used despite the political upheavals that took place in the last year of the program. Impressive personal efforts were made by schools to protect their equipment during the 2012 political revolution and ensure that it was put back in use as soon as possible afterwards. Additional follow-up is needed to confirm long-term sustainability and use, but the findings to date suggest the following implications for IT planning within each dimension.

Technological Dimensions

Locally appropriate technology can be implemented successfully in rural schools by working with schools and the government decision-makers to provide a package tailored to school size, needs, and a range of users rather than a one-size-fits-all approach. Working within the existing IT support systems, after determining how these currently operate at every step, from equipment selection and installation to maintenance and support and monitoring and evaluation, is an effective way to ensure appropriate and sustainable technology. Training school-based maintenance and support teams is critical to ensuring sustainable use of the equipment. This does not mean that maintenance and support teams need to know how to repair the technology themselves. It can simply mean planning for warranties and ensuring that maintenance and support teams know to activate the warranties and get support from local vendors. Empowering these teams to make decisions independently with regards to the technology emerged from this evaluation as a key factor in for ensuring equipment upkeep.

Individual and Social Dimensions

Establishing school-based maintenance and support teams is the first step. Ensuring that they have training in basic as well as advanced topics is the next. A focus on preventative maintenance is as important as troubleshooting and fixing malfunctions. Having a team (i.e., more than one person) ensures that maintenance and support are not subject to a single point of failure, and less susceptible to staff turnover. The phased approach to training with more frequent, but more focused content each time contributes to sustainability. Although it is tempting to try to adopt existing, broad curricula for IT training, a customized and focused approach enables training on more complex IT activities that require an important degree of depth, such as imaging of equipment, virus checking, and filtered Internet services - these skills were highly valued. Reusable digital training materials can encourage trainees to cascade training to other schools or other individuals within the schools.

Proactive communication and school stakeholder involvement with all intervention activities proved beneficial. Most schools saw the benefits of participating and understood that not just the school, but also the community (including students who are community members) would benefit. They also found the constant communication ahead of activities helped them participate in all activity rollout. By matching community efforts with project inputs, GILO demonstrated that the technology belonged to the school and community and not the project, and showed that it was therefore the community’s responsibility to help maintain it. This also helped establish and foster demand for the technology.

Economic Dimensions

Financial sustainability takes time. Deliberate efforts to encourage long-term financial planning such as requiring counterpart funds for site preparation, delaying delivery of supplies to schools, and discussing financial planning were necessary, if not sufficient, to see results. The GILO experience supports other literature that emphasizes the importance of long-term financial planning for sustainability, but the qualitative feedback also suggests that schools must first be convinced of the value of the investment (i.e., Internet connectivity) before they will allocate the budget for it. For this to happen, schools need enough time to work with the technology to see the benefits while the recurrent costs are covered, which also includes time to include these required recurrent costs into their school’s budget cycle, and time for the MOE to ensure these line items are included in budget models. Therefore, projects may provide an important service by covering recurrent costs at the outset, but will do a disservice in the long-term if they have not built the capacity of schools to gradually adopt these costs under their own funding mechanisms, which includes both own source funds as well as MOE (or local government) provided fund allocations.

Projects and their beneficiaries must understand budget cycles for public institutions, or they may run into surprises with delays in budget allocations and transfers.

Political Dimensions

Managing IT equipment involves economic dimensions as well as political and social ones such as policies related to access and use. Constraints to accessibility of the equipment limit sustainability in terms of use, although they can be necessary for sustainability in terms of longevity of the equipment.

The evaluation confirmed other findings that suggest finding and supporting local champions at national and local levels is important. Importantly, these leaders need to have and use the same technologies that they are expected to promote, so that they can maintain their own skills and lead by example. Although collaboration with government entities may slow down implementation at times, it is important for sustainability. The fact that the Ministry of Education issued a decree preventing the transfer of GILO-trained staff is a strong example of how government participation can impact sustainability through creation of an enabling environment. Cooperating with the central ministry to get approval for all GILO IT activities ensured that the activities fit within the ministry's short- and long-term strategies, even as priorities changed. Encouraging the ministry's decentralized Technology Development and Decision Support Centers' at idara and muderiya levels to partner in training delivery and, over time, to deliver some of the training modules themselves strengthened their role as backup IT support to the schools and built their relationships with the school IT maintenance and support teams. In this way, during training and installation activities GILO received meaningful interaction from the staff at the schools because they were not just informed, but consulted, in advance.

The phased approach to site preparation, installation, and training had positive repercussions in terms of managing expectations, garnering support, and providing effective training. This was not limited to administrative approvals or showing token interest in local participation; it was a proactive and sustained process of change management. This has emerged as one of the most important factors in technology integration. There are many agents of change from national governments to teachers themselves; and change management processes need to align and communicate roles, responsibilities, and expectations effectively.

CONCLUSION

To conclude, we are faced with trying to answer the question: does technology that is sustainably planned and implemented lead to more (and more effective) use of technology in the classroom, or does a clear need based on personal and institutional demand drivers of technology use in the classroom ensure sustainable technology implementation? It is well documented that technology alone is not a magic bullet that improves teaching and learning by its presence. Yet ultimately, it is basic computer literacy that serves as a toolbox from which the teacher draws to make appropriate pedagogical decisions and enhance the learning objectives of a lesson through the affordances of technology. Without first having made the right configuration of hardware and infrastructure, and supporting their sustainable functionality through effective maintenance and support, the teachers would not even be in a position to either use or not use the computers. ICT in education projects must favor neither the hardware nor pedagogical aspects of the technology, but instead layer the pedagogical use of technology on top of the IT infrastructure as two distinct efforts with separate, but complementary goals.

GILO's experience supports findings from other experiences along the technological, individual and social, economic, and political dimensions, and the evaluation process demonstrates that these four dimensions can be a useful framework for IT implementation from a sustainability perspective. Even though the GILO IT component focused specifically on hardware and software provision, aligned with the national IT strategy, it was done in a way that also facilitated school-community coalitions, recurrent teacher training programs, and school-based support. All of these areas were addressed early and fostered throughout GILO's duration through a balanced approach that neither favors nor neglects the technology aspect. GILO's focus on separating technological and pedagogical aspects of implementation ensured a strong foundation upon which to build appropriate pedagogical use of the technology.

ENDNOTES

[1] Drawn primarily from Chasquinet, cited in Cisler (2010). However, the authors felt that the Chasquinet dimensions were missing a pedagogical dimension, or ensuring that teachers' knowledge and use of computers evolves and continues after initial training or support ends. For the purposes of this paper, we have combined what they call "knowledge and organizational sustainability" within the "social dimensions" category, and renamed it "social and individual dimensions."

[2] The implementing partners, led by RTI International, included World Education, Inc., Keys for Effective Learning, and CID.

[3] Given principles mentioned, it should be assumed that throughout this report, any mentions of "GILO" or "the project" means a collaborative effort between program staff and national counterparts.

[4] Four months to process procurement waivers while GILO completed the schools site survey and ICT inventory, then one year from December 2009 to December 2010 for procurement, site preparation, and installation. Due to the Egyptian revolution in January 2011, the filtered Internet was completed in April 2011.

[5] Eleven confirmed and four that could not be reached.

[6] Due to the political revolution, installation and set-up of email and Internet services were delayed until a few months before direct GILO support to the schools had ended; therefore, insufficient time for training and use most likely explains this finding.

[7] A DVD containing all training materials, including video footage of all the trainings, with a HTML interface to allow users to quickly locate the training module of interest.

[8] The evaluation also took place in May 2012, but was in a different sample of schools and using different evaluators.

[9] This figure includes one school that listed the cost for site retrofit as 150,000 Egyptian pounds. If this school is not included, the average decreases to 5,546.00 pounds. Self-reported figures were not verified.

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SUPPLEMENTARY TABLES

Table A1: *Findings Related to Technological Dimensions of Sustainability*

Question/Evaluation Metric	Finding	Number of Respondents (Source)
Time since last report of broken, unrepaired, or obsolete equipment	18 months	NA (Warranty Vendor)
Requests for assistance through warranty vendor	6 calls in 2011; 4 calls in 2012 (up to July only)	NA (Warranty Vendor)
How do you rate the computers, network, and peripherals installed with GILO in your school?	3.8/5.0	91 (M&S)
Have you re-arranged the lab chairs and computer tables? (If yes, provide reason).	No: 92.5%	92 (M&S)
Did the GILO IT M&S training help with your problem solving for IT issues?	Yes: 93.8%	85 (M&S)
IT M&S team solves equipment and software problems or contacts TDC, warranty vendor for support	100%	221 (MGT/BOT)

Table A2: *Findings Related to Social Dimensions of Sustainability*

Question/Evaluation Metric	Percent Affirmative Responses or number of schools	Number of Respondents (Source)
Was technology a component of the decision to get involved or not?	94.3%	210 (MGT/BOT)
Did BOT participate in site survey activities, site preparation, equipment installation? *(Number of schools)*	Equipment Installation: 46 Site Preparation: 47 Site Survey: 14	221(MGT/BOT)
Did the BOT participate in workshops and meetings to discuss how the computers, networks, and peripherals could be used by the community?	96.2%	221 (MGT/BOT)
Did the school management and administration team (MGT) participate in site survey activities, site preparation, equipment installation? (*Number of schools*)	Equipment Installation: 53 Site Preparation: 53 Site Survey: 53	221(MGT/BOT)
Does the technology GILO provided meet the needs of teachers, students (male and female), community, school management and BOT?	All – 80.8% Teachers – 85% Male students – 81% Female students – 81% Community – 73.4% MGT and BOT – 88.2%	88 (M&S)

Table A3: *Reported IT Training and M&S Indicators*

Question/Evaluation Metric	Percent Affirmative Responses	Number of Respondents (Source)
Have you used the GILO digital training materials?	84.6% 94.3%	35 (TDC) 92 (M&S)
Did you find the DVD materials useful?	98.1% 100%	92 (M&S) 35 (TDC)
Before GILO, were you comfortable providing IT maintenance and support?	49.1% 92.3%	92 (M&S) 35 (TDC)
Has your comfort level to provide IT maintenance and support increased since attending GILO IT training?	96.2% 92.3%	92 (M&S) 35 (TDC)
Did the GILO IT M&S training help with your problem solving for these issues?	94%	85 (M&S)
Do you consider the GILO IT M&E training, better, similar, or worse than other IT trainings you have taken?	94.2% Better, 5.8% Similar 69.2% Better, 30.8% Similar	90 (M&S) 35 (TDC)
Have you taken what you learned about IT maintenance and support under GILO, and offered any training to other teachers or staff in your school?	60.4%	92 (M&S)
Have you shared what you learned with teachers or staff from other schools in your idara?	7.5%	92 (M&S)
Did you share these DVDs with others in your school, community, or other schools?	45.3%	92 (M&S)
Can you describe the school communication/correspondence (requesting support) with TDC/GAEB and computing equipment vendors before and after GILO?	Before GILO: Either wait for GAEB to visit, or file report with TDC/GAEB After GILO: 100% deal directly with warranty company, 62% just deal with school M&S team	221 (MGT/BOT)

Table A4: *Findings Related to Economic Dimensions of Sustainability*

Question/Evaluation Metric	Percent Affirmative Responses	Number of Respondents (Source)
Did you think Internet access was critical before GILO?	15.1%	221 (MGT/BOT)
If no, did you change your mind about the Internet service benefits to your school after GILO Internet service?	44.4%	185 (MGT/BOT)
Do you think that the Internet connection is critical now?	96.2%	221 (MGT/BOT)
If yes, is this a high priority line item in your budget request?	84.9%	221 (MGT/BOT)
Has the Internet access been factored into next year's budget as a line item?	43.4%	221 (MGT/BOT)
Can you estimate the cost of your contribution to the site preparation activities?	8,236.00 Egyptian pounds (approximately $1,183)	217 (MGT/BOT)

Table A5: *Findings Related to Political Dimensions of Sustainability*

Question/Evaluation Metric	Percent Affirmative Responses or Number of Schools	Number of Respondents (Source)
Did the idara TDC participate in site survey activities, site retrofit, equipment installation?	Equipment Installation: 43 Site Preparation: 12 Site Survey: 15	221 (MGT/BOT)
Did GAEB participate in site survey activities, site retrofit, equipment installation?	Equipment Installation: 3 Site Preparation: 27 Site Survey: 1	221 (MGT/BOT)
Did the muderiya TDC participate in site survey activities, site retrofit, equipment installation?	Equipment Installation: 26 Site Preparation: 3 Site Survey: 4	221 (MGT/BOT)
Can you describe 2-3 examples (such as IT strategy, policy, activities, MOE approvals) that the IT work you were doing with GILO was linked to the MOE? (top 3 reasons)		
Activation of use of technology in the educational process by using laptops and Data Show inside classrooms	38%	35 (TDC)
Planning monthly meetings with the participation of lab specialists and officials responsible for GILO schools to activate use of technology	23%	35 (TDC)
The method of distribution of hardware inside schools to serve all staff involved in the educational process	23%	35 (TDC)
Can you list 2-3 examples of where government leaders (in your idara and muderiya level) have demonstrated support for the GILO IT program of IT M&S training and IT equipment? (top 2 reasons)		
The decision of non-transfer of trainees from GILO schools to other schools	38.4%	26 (TDC)
Coordination between departments, the directorate, and the school to obtain the training courses provided by GILO	30.8%	26 (TDC)

International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2014, Vol. 10, Issue 2, pp. 142-150

Ten Guiding Principles for Designing Online Modules that Involve International Collaborations

David Porcaro
Seward Incorporated, USA

Carol Carrier
University of Minnesota, USA

ABSTRACT

As ideas and personnel flow across borders, there are many opportunities for instructional designers to collaboratively design online modules with international teams. These collaborations can take many shapes, as varying levels of localization and within-team communication are employed. This paper looks at ten guiding principles that are shaping the work of an online module development project for training inservice teachers in Jordan. These principles can be effectively applied to a variety of cross-national collaborations for a wide range of settings.

Keywords: *Collaborative Design; Culture; Guiding Principles; Instructional Design; International; Project Management*

INRODUCTION

Opportunities for partnerships that produce high quality online learning materials for both pre- and inservice teachers in developing countries are increasing as more governments, ministries of education, and donors look to online learning as an efficient and motivating approach to developing teacher skills. This article provides guiding principles that have proven useful to experienced instructional designers who have worked across multiple countries to design and implement such online teacher training projects. Regardless of the specific country where the materials will be implemented, common challenges and obstacles arise that face the instructional design team. A set of guiding principles is presented, using as an example an online teacher development project in Jordan which serves as a substitute to live, face-to-face training for teachers and other school personnel who are new to teaching and working in transformed schools in that country.

INTERNATIONAL INSTRUCTIONAL DESIGN

Cross-cultural instructional design issues have become much more relevant to instructional designers in recent years. As online technologies connect learners, designers of these learning experiences must grapple with cultural issues that arise from global interactions. As designers undertake more useful context analysis, they must make cultural considerations a priority (Perkins, 2008). However, there are several different types of international or cross-cultural contexts to consider when designing online learning. For instance, due to the growing number of international students in places like the United States (Institute of International Education, 2011), a common issue in Western higher education settings these days is the need to design online courses for international students within a local university (Erichsen & Bolliger, 2011; Liu, Liu, Lee, & Magjuka, 2010; Wright & Lander, 2003). Even instructional designers who never leave their home face the challenge of communicating ideas within an increasingly multicultural classroom.

The ease with which online lessons and courses can be transferred to new settings has created additional opportunities for educators to be asked to design for settings and languages which are not their own (Wright, 1997). As they design for this new and unknown cultural setting, they often make unforeseen mistakes along the way (Edmundson, 2006). In response, some suggest that designers should not spend too much effort in designing for culture, since they do not have the time nor the resources to devote to cultural adaptability in their design (DeBry, 2002). Others suggest that learners will simply accept the design as is and make their own accommodations for cultural elements (Henning, Westhuizen, Maseko, Diseko, & Gravett, 2004). It is possible, however, that instructional designers can gain cultural sensitivity and reflexivity within their own practice through exposure to projects from a variety of cultures and settings (Rogers, Graham, & Mayes, 2007).

Increasingly common are courses designed for one setting but reused in others. In these cases, Learning Objects (LO) and Open Educational Resources (OER) can be built from the ground up with repurposability in mind (Gunn, Woodgate, & O'Grady, 2005). This can be done, for example, through Learning Objects with Multicultural Affordances, which highlight cultural issues and place them at the center of discussion and learning (Amiel, Squires, & Orey, 2009). But as Perkins (2008) points out, localization is not a simple thing; and there are many levels at which learning can be localized. Designers are often limited in the resources available to them and too often these LOs and OERS are left without contextual anchors or fail to meet the needs of the new context. More often than not, the resources spent adapting a LO or OER could be better spent custom-building a new learning experience rather than attempting to recontextualize an existing learning object.

While these arguments point to the value of custom-designed instruction, not all instruction need or ought to be built in the West and distributed to the Rest. Local capacity for instructional design and development is increasing world-wide and local designers have the greatest capacity to understand the local context and adapt accordingly (Arias & Clark, 2004; Perkins, Gwayi, Zozie, & Lockee, 2005). However, while local instructional designers may provide the most contextually-bound understanding of what learners need and how to communicate ideas to them in the most motivating and relevant way, too often they lack the capacity or resources to take on the many large ID projects that are needed in their countries. In these cases, it may be best for international instructional designers to work collaboratively with local designers to create online learning.

Although this collaboration brings together the resources and expertise of internationally-recognized designers or firms with the contextual knowledge of local designers, the marriage is not without its rocky roads and miscommunications. This paper seeks to present guiding principles for successfully managing such international collaborations in designing online learning. We seek to present as a case the design of online teacher professional development modules for an education development project in Jordan.

PROJECT CONTEXT

This project was part of the USAID-funded Education Reform Support Program (ERSP), which seeks to collaboratively develop policies, strategies, and outreach systems to support the Jordanian Ministry of Education's vision for the future of education in Jordan. This program focuses on four areas: Early Childhood Education; Youth, Technology, Careers; Professional Development; and Data Use for Decision Making. The client in this instructional design project was Creative Associates International, Inc. under contract with USAID Jordan. As part of this program, ERSP provides support to several new schools that have recently been built as part of the USAID-funded Jordan Schools Project. The ERSP program was designed to transform the primary and secondary education system with new forms of teaching and learning. These include active and cooperative learning, new roles and responsibilities for all teachers and administrators, and new models of community-parent-school interactions. Many kindergartens have also been refurbished while new early childhood teachers and administrators are being trained in methods of effective early childhood education. In addition, a school-to-career program is being developed that includes a Management Information Stream e-module guiding a project-based course for high school students.

To support this transformation, the ERSP program has produced and delivered an extensive face-to-face training program for Jordan teachers and other school personnel with support from partner organizations that include Save the Children along with two Jordanian organizations, CADER (ChangeAgent for Arab Development and Education Reform) and ASK for Human Capacity Building. The original trainings were designed to be face-to-face and meet the training needs of the school personnel. To address the needs of future teachers and to extend the reach of the trainings, Seward Inc. was asked to develop online trainings that would target selected key topics addressed in the existing face-to-face training curricula. The goal in this online course design is not to replicate all of the ERSP trainings but instead to focus on key ideas and information that school personnel will find critical to their effective functioning and which were the most suitable for online delivery.

GUIDING PRINCIPLES

As we reflected on our work throughout this project, we recognized that there were ten principles that guided our collaboration. It is important to note that these guide the work, not define it. Throughout the project, we acknowledge the many instances where we did not follow these principles totally. Failures in these areas happened as did successes. But having guiding principles helped us to communicate through our failures and keep the project moving successfully forward.

10 Guiding Principles for International Collaboration in Online Learning

- **Project management**
  - Use a written vehicle to memorialize the understanding with the client, of what will be delivered, at a high level, and to clarify roles and responsibilities.
  - Be deliberate about establishing a foundation of trust and rapport from the very start of the relationship.
  - Foster regular, ongoing contact between the instructional designers and key client personnel during the design/ development process.
  - Work with partners to establish a schedule of due dates and milestones that is realistic.
- **Online Module Development**
  - From the very beginning, manage the expectations of clients regarding the capabilities and limitations of the technology systems in the schools.
  - Acknowledge the efforts and communicate respect for the ways in which that content has been developed and presented in its original format.
  - Demonstrate respect for cultural norms and symbols.
  - Plan to accommodate extra time for working with multiple languages.
  - When video and animation must be restricted, leverage other capabilities that encourage schools.
  - Throughout the design process, keep in mind the perspective and capabilities of the end-user.

Figure 1: *10 Guiding Principles for International Collaboration in Online Learning*

These principles seem to fit into two broad categories. The first four deal with general project management, and may, to some extent, parallel established project management practices. However, we found them to be essential in ensuring cross-cultural online learning design was successful. The second group of six principles is more specifically related to online module development. For both groups, it is worth considering each of these principles in light of how they apply within the context of the collaborative international design and development of online instruction for teachers and other school personnel project.

1. Use a Written Vehicle to Memorialize the Understanding with the Client, of What Will Be Delivered, at a High Level, and to Clarify Roles and Responsibilities

The format for this understanding is not critical, but its purpose must be to communicate in writing what will be delivered, including schedules of deliverables as well as roles and responsibilities. Seward Inc. uses an approach called the Macro Design Document to express the design features of the product for the client. Intended to serve as a communication tool at a high level, including aspects such as timelines, general look and feel of the training, learning objectives, technical requirements, etc. The client reviews what is planned and must sign off on that plan, to minimize misunderstandings of expectations.

Because this is produced and discussed early in the process, there may be elements that must change once the translated content is clearly laid out and the implications of how concepts are to be treated is better known. In effect, the Macro Design Document sets the stage for the product and provides the client with a clear vision of what will be produced. Discussions of this Macro Document with the client at an early stage help to clarify and solidify agreements about the overall direction of the project. It also serves as an important tool to layout accountabilities for each partner.

2. Be Deliberate about Establishing a Foundation of Trust and Rapport from the Very Start of the Relationship

Wherever feasible, a live, face-to-face meeting between the design team and the key players representing the client is the optimal start to a project. These meetings should allow every attendee to provide a brief introduction about themselves and their respective roles in the project. Using a simple but short “ice-breaker” activity which allows attendees to relax and chuckle a bit can diffuse tension with groups who do not know each other, but who know they must work together first come together.

Due to the initial live meetings between the ERSP and partner staff who developed and delivered the initial training and the team from Seward Inc., when Seward Inc. developers began to make decisions about which elements of the content to select for online training, it was much easier to broach these decisions with key personnel later. Both groups had the opportunity to spend some time with each other in small group discussions. Some degree of familiarity and trust developed, even within the short period of one week. Later, as emails were exchanged and materials were critiqued, these early interactions supported a sense of working as a team to make the best choices for the project.

3. Foster Regular, Ongoing Contact between the Instructional Designers and Key Client Personnel during the Design/Development Process

The instructional design team must show initiative in ensuring that regular contact and communication take place between their team and the subject matter experts (SMEs), or other personnel working on the project occurs. Once the instructional design team left Jordan and began to work on the design of the materials, many questions naturally arose.

While the Design Document served as the guide to the product, as translated materials became available, it was clear that certain changes would make the product stronger. These changes needed to be communicated and buy-in gained. Given the differences in time zones, it made most sense to exchange emails with the client and to send documents that could be reviewed electronically. Ensuring that emails were worded in a clear manner and that return emails from the client were acknowledged and responded to in a reasonable timeframe was another important element of establishing a productive working relationship.

4. Work with Partners to Establish a Schedule of Due Dates and Milestones That Is Realistic

A delicate part of any project involving international partners can be the back and forth exchange of information and input so critical to the success of the product. Like many projects, the Jordan project had a client and subject matter experts with a variety of different projects and priorities and this project competed with others for their time and attention. Often there were unpredictable elements in the ministry's calendar, long timelines for revisions, and unforeseen signoffs needed to upload materials to the ministry's servers.

Recognizing this, it is the design/development team's role to take the initiative and continue to keep things moving as well as push for deadline dates to be achieved for key aspects of the schedule. It is important that this role be done with diplomacy and persistence. When this is done gracefully and diplomatically, in a positive spirit and with humor, clients and subject matter experts come to respect the role of the timekeeper. Multiple emails may need to get sent, reminding clients of the need for their input and response, of missing information that only they can supply, or simply to seek their input before moving on to a next step in the process.

A helpful tool we employed was a color-coded chart showing the signoff dates for milestones, which provided a visual picture of the location within the process of each course, and who was currently responsible to move the course forward. With different time zones and calendars in international projects, this role is not as straightforward as it would be in a domestic project. It is easy for the instructional designer to be unaware of, or to have forgotten, a critical national holiday where offices are closed or people are on holiday. Or to try to make a phone contact when international partners are still in bed!

5. From the Very Beginning, Manage the Expectations of Clients Regarding the Capabilities and Limitations of the Technology Systems in the Schools

When a product is to be delivered across a broad array of schools, it is not uncommon to find great variation in the bandwidth capacity within these schools. Differing capacity means that the product must be targeted for the lowest level of capacity or the most common capacity. Clients who themselves may be used to a higher level of power in their daily work can be disillusioned about the finished product if these constraints are not made clear at the beginning. In many of the schools in Jordan, capacity would not permit video or complex, extensive graphic animation. While both of these instructional assets would have strengthened the product, threshold capacity was simply not currently available.

Because this product was to be used across hundreds of different school locations where technology capability varies widely, the decision was made to target the modules at a level where teachers and others could complete them without unnecessary slowness. The existing portal, Eduwave, was already accessible in the ministry and the schools and was the choice of the client for delivery of these new modules. This decision led to certain advantages as well as some disadvantages. The advantages were that the technical support staff understands the portal well and knows how to maintain it. Many users are familiar with it as well. On the other hand, the portal limited screen real estate considerably and constrained navigation to the program's interface.

For these reasons, it was important to be explicit about the findings from this delivery system analyses which were conducted by the design team. In an early client meeting, the team laid out both the advantages and disadvantages so the client did not inadvertently develop a mental image of what the product would do, only to find that it did not deliver key features they hoped to experience.

6. Acknowledge the Efforts and Communicate Respect for the Ways in Which That Content Has Been Developed and Presented in Its Original Format

Having one's content critiqued by others for inclusion in online materials can be a threatening experience. If not handled well, it is likely that the original creators of materials can feel discounted or not respected.

In the Jordan project, a massive curriculum had been developed to prepare teachers and other school personnel for the new approach to the schools and for school personnel's new roles and responsibilities in making the schools effective. This training was intended to be delivered to the entire current population of professionals. Because the Seward Inc. project could only sample elements of that massive curriculum, it was important to pick wisely those pieces of information and content that would be most impactful. Under these circumstances, it is important to find the balance of using existing materials "as is" versus selecting or blending ideas so that they can be delivered efficiently.

7. Demonstrate Respect for Cultural Norms and Symbols

In most cases, the instructional designers are not familiar with the cultural norms and patterns of the foreign country so it can be tempting to make incorrect assumptions. The willingness to ask honest questions about what is appropriate can prevent unnecessary gaffs in visual or verbal materials. In this project, these modules were to be used in Jordan schools, requiring visuals that reflected representative people and scenes from Jordan schools.

Having said this, the Jordan culture is not monolithic. People attend both mosques and churches; some women wear traditional dress, others wear western style clothing. Efforts to recognize that diversity is an important foundational principle for the new schools also needed to be reinforced in the materials developed to prepare teachers and administrators who will work in these schools. Ensuring the review of the modules by local experts regarding this dimension is a fundamental activity that will surface inappropriate selections. In one case, the client changed a picture during review, in order to reflect the fact that teachers in a government girl's school would all be women.

8. Plan to Accommodate Extra Time for Working with Multiple Languages

When multiple languages are involved, and translation is required, the development time is greatly increased. Identifying competent translators who can deliver the product in the timeframe needed is not always a straightforward task. Establishing a small cadre of translators who can be called upon, and relied upon, is a good strategy for the design team to pursue.

In this project, the content materials were originally created in Arabic which had to be translated into English in order for the designers and developers to work from them. The English version of the modules was then reviewed by the client, whose first language is Arabic. Following this review, and after responding to the feedback to the English version, the modules are then translated into Arabic to be reviewed once again by the client who now was viewing them in Arabic, her first language.

This process can lead to some uncertainties for the designer. Were the initial translations accurate? Would the client approve the Arabic version or find different issues once the material has been converted to Arabic? Is there a terminology that the ministry uses that may be different from local practitioners' use? In one case, the team in Jordan was not satisfied with translation in Arabic, but felt they lacked the expertise to make editorial corrections to the content. Thus, an external Arabic editor was hired to work with the translated text. These back and forth translations double the time needed for review of the product and introduce the possibility that some changes made to initial feedback will have to be undone when the second version is reviewed.

9. When Video and Animation Must Be Restricted, Leverage Other Capabilities that Encourage Interactivity within the Module

This situation can present a difficult challenge to a designer who finds his or her toolbox limited when such familiar capabilities cannot be tapped. On the other hand, it challenges instructional designers to "dig deep" and produce alternatives in their designs that motivate and challenge the end user. Due to constraints placed upon the Jordan instructional modules by less than powerful bandwidth capacities in the schools, opportunities for animation and video were restricted in our example's module development. This increased the need to use techniques that users could respond to which engaged them in some degree of interaction within each module.

Several strategies were used. Screens of content were kept brief with opportunities for reveal bullets, drag and drop exercises, etc. Audio was used sparingly but strategically, such as to present a quotation or to highlight a key idea. In one case, video dialogues were created with only pictures, text and buttons that moved the learner from one part of the dialogue to the next in a slide-show fashion. In this way the experience of watching a video of a teacher and student interacting could be simulated without bandwidth-hogging elements.

10. Throughout the Design Process, Keep in Mind the Perspective and Capabilities of the End-user

The international designer may get exposure to learning context through an initial site visit. However, the time and expense of international travel typically does not allow for frequent visits by the designer to the learning site. Nor does it allow the designer to have extensive interaction with the learners to fully understand their needs.

In this project, our interaction with the targeted teacher population was very limited during our initial visit. The designers had to envision in their minds the capabilities of the end user, as well as how the design would impact education in Jordan. The ERSP project partners supplied Seward Inc. designers with CDs loaded with pictures of classrooms and students in Jordan, which allowed us to visualize more fully the schools, teachers, and students. This brought a reality to the work that was hard to experience thousands of kilometers away. Other times, it meant understanding design preferences, technical abilities and expectations of the end user, which could be quite different from those of the designers.

CONCLUSION

For both designers and content experts, the process was challenging and at times frustrating. Focusing on these guiding principles helped us to manage this project in a way that allowed working through miscommunications, misaligned expectations, and misunderstandings in a professional and respectful manner. While many of these guiding principles mirror typical project management principles, their use in an international online course design process makes them worth reflecting on, especially those that are specifically related to online module development. As other instructional designers work with local and international education development partners—whether they are donors, contracting agencies, instructional designers, or subject matter experts—they can apply, adapt and add to these guiding principles in their own practice. This may lead to more effective, and culturally relevant, collaborative instructional design with less effort, cost, and frustration.

ACKNOWLEDGENT

This work was part of the USAID-funded Cooperative Agreement No. 278-A-00-09-00305, subcontracted under Creative Associates International Inc. The opinions expressed do not represent those of project partners or funders. This paper is based on a presentation given at the 56th Annual Conference of the Comparative and International Education Society on April 26, 2012 in San Juan, Puerto Rico.

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Original article at: http://ijedict.dec.uwi.edu/viewarticle.php?id=1755