Technology, Teachers, and Training: Combining Theory with Macedonia's Experience

Laura Hosman and Maja Cvetanoska

***Abstract*— Numerous developing countries are currently executing or planning—pouring both hope and money into—projects that introduce technology into their educational systems. This paper puts forth the assertion that developing world ICT-in-education projects will continue to disappoint until they are reconceptualized and redesigned to incorporate three transformative concepts: teachers play the key role in determining the success or failure of such projects; change is a years-long process and not a one-time event; and teachers need ongoing support to adopt the technology and should be treated as stakeholders in the innovation-adoption process. In the Macedonian nationwide computers-in-schools project herein described, teachers received extremely comprehensive advance training in both computer use and methods of actively incorporating technology into their curriculum and teaching. Still, the majority of teachers are not successfully employing technology in the classroom three years after the training and deployment were carried out. This paper applies the Concerns-Based Adoption Model (or *CBAM*, which describes how individuals' concerns evolve as they undergo the process of change and how these concerns may be addressed over time) to Macedonia's experience. CBAM serves as a lens through which to examine ICT-in-education efforts and determine whether they effectively match up with how teachers experience change and where there is room for improvement in such efforts.**

***Index Terms*—Computer aided instruction, educational technology, developing nations, technology social factors.**

I. Introduction

INTEREST and investment in projects designed to bring new technologies to the developing world have risen dramatically in recent years; this trend mirrors the high expectations placed on the ability of technology—information and communication technologies (ICT) in particular—to improve quality of life and assist in economic development.

Education—crucial to the development of the technologically literate workforces able to participate in the information societies and economies of the present and future—is seen as a primary mechanism for the empowerment of individuals, communities, and societies. As such, education frequently becomes the target of ICT-for-development projects.

Numerous developing countries are investing in projects that introduce ICT into the educational environment—in hopes of realizing the gains mentioned above—yet planning, implementation, and evaluation concerns remain. Scarce resources are being poured into these efforts and the desire to see results is strong. Insights into best practices regarding these ICT-in-education projects may be gained from examining what has been learned in countries where the introduction of ICT into the classroom has been both taking place and studied for many years.

Over the past several decades, numerous efforts have been made to introduce technological innovations into classrooms across the United States. Scholarly examination of these projects has followed. Unfortunately, Wesley and Franks identify a pattern of widespread failure. Many, if not most, attempts made between 1970 and 2000 have resulted in the wasting of vast public sums on "unused, underutilized, or misapplied technologies and the loss of opportunity to apply those innovations effectively to reform" [1]. Policymakers have placed most public blame for these failures—and their associated wasted expenditures—squarely at the feet of teachers, who are seen as resistant to change [1]-[4]; by doing so they leave scholarly work that has identified multiple culprits unheeded.

As technology is increasingly introduced into the realm of education, there is a troubling persistence of the attitude that the mere provision of technology will lead to its adoption and implementation into teachers' pedagogy. Although this issue has been identified and acknowledged by researchers for decades [5], it remains, and is exacerbated by the intensifying pace of change and technological advance. Gitlin and Margonis [3] point out that teacher resistance can be for good

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cause, and that reasons given for it should be taken into consideration, since teachers often understand their vocation far better than those designing policy programs intended to modernize or improve educational output.

A much bigger problem is that many programs and projects aimed at introducing technology to improve or modernize the educational experience do not recognize teachers as the key agents of change responsible for promulgating innovation (or not); in addition, change is often seen as an "event," and not a process that takes years, not weeks or months [6]. Thus, the incorporation of technology into an educational curriculum cannot be accomplished simply through initial training of teachers in computer use, nor even through higher-level instruction in the incorporation of computer-related technology into their teaching.

The process of technology adoption must be accompanied by years-long support that reflects teachers' concerns as they adjust to the new technology and make changes in their teaching styles and modes to adapt to it. The more complex an innovation is, or the more change that is required of a teacher, the longer the change process will take, and the less likely an innovation is to be successfully adopted [7]. By contrast, the more that teachers are involved in the change process (one recognized to be long-term in nature), respected as stakeholders in the change-promoting effort, and offered multiple forms of appropriate support and incentives by change facilitators, the greater the chances of successful outcomes [8],[9].

An even larger challenge looms for the developing world: technology (often in the schools) is now widely seen as the next "quick-fix panacea" to address development goals [10]. Numerous developing country governments are purchasing laptops for all of the children within their territories, having bought into the notion that the youth of their country need technological skills and a modernized educational experience if their state is to compete in the global knowledge and information economy of the future. Unfortunately, teachers are rarely given consideration in this scenario; training is most often not a part of the government's budget plans for technology implementations, and teachers are neither consulted nor considered stakeholders crucial to successful technology adoption. In other words, developing country governments are making the same policy and implementation decisions that led to decades of widespread failure in the United States. This need not be the case.

This paper examines a large-scale (nation-wide) computers-in-the-schools project in the country of Macedonia in which teachers were, in fact, given a great deal of consideration. This project provided the most comprehensive advance training we are aware of in a developing country context, and it was carried out on a nationwide scale: The entire population of primary school teachers received multiple trainings in both how to use technology and how to actively incorporate it into their curriculum and teaching before the computers were deployed [11]. However, three years after project implementation, the majority of teachers still are not using ICT in the classroom—even though the vast majority of them are using ICT in their daily lives and lesson planning. The mystery remains: Why are so many teachers unable or unwilling to make the transition from using ICT in their personal lives to using it while teaching (the goal of the program)? Our research addresses this question with evidence that the long-term administrative support required to promote successful change is neither present in this initiative, nor designed as a part of the program from the outset. Fortunately, it is not too late to adjust behaviors and attitudes and provide a greater level of support to teachers in terms of technological adoption. This paper identifies areas in which improvements can still be made to address Macedonian teacher concerns and to assist in the long term change process.

Further, this paper is of significant value to other developing countries embarking on technology promotion within their schools; it recognizes the importance of teachers as the stakeholder-agents of change and identifies best practices throughout the adoption-of-innovation process. As noted above, a teacher-focused reconceptualization of the entire technology-in-the-schools endeavor is both necessary and urgent, as numerous developing nations are pouring both hope and money into such projects at the present time.

The paper proceeds as follows: after presenting our theoretical framework for examining change and the adoption of innovation, our methodologies are briefly discussed. This is followed by a presentation of the case study—a description of the computers-in-the-schools deployments and training programs undertaken in Macedonia—the presentation of our data, and a discussion section that compares our findings with the theory and literature review. Before concluding, we offer recommendations for improvements that will address teachers' concerns and assist them in adjusting to and incorporating (technological) change into their teaching, both in the specific case of Macedonia and in other ICT-in-education projects elsewhere.

II. Theoretical Framework

The theoretical framework for adoption of innovation this paper utilizes is based upon the Concerns Based Adoption Model (CBAM), developed in the 1970s by the Research and Development Center for Teacher Education in Austin, Texas [12], which itself is based upon the foundational research carried out by Fuller [13] on stages of concerns experienced by teachers regarding the development of their teaching skills and abilities. The CBAM model has been widely adopted and validated in the academic fields of education and educational psychology since its introduction, but has not, to our knowledge, spread beyond these fields. Yet there is much that this framework has to offer to those from nearly any field studying technology for development, because the process of change in adopting innovations must be understood and addressed if similar projects are to have a greater chance at succeeding.

As noted above, this paper argues that teachers are the key to educational improvement; their willingness to adopt innovations will determine whether those innovations succeed or fail. The CBAM model views change as a process experienced by individuals seeking to—or asked to—change their behavior in particular ways [6]. Thus, instead of focusing on improvement of student test scores or other final stage outcomes resulting from a technological intervention—the metric(s) of many policymakers and development and/or aid-organizations—this paper focuses on the process itself and on the individuals crucial to innovation adoption—the teachers. Several additional points regarding the concept of change underpin the CBAM model: change is accomplished by individuals, and it is a highly personal experience. It involves developmental growth in feelings and skills, and it can be facilitated by interventions directed toward the individuals, innovations, and contexts involved [14].

CBAM comprises two major dimensions. The first—Stages of Concern (SoC)—describes the feelings and concerns experienced with regard to an innovation. The second—Levels of Use (LoU)—involves the individuals' behaviors as they experience the process of change.

Under the Stages of Concern dimension, the CBAM model posits the existence of a sequence of specific concerns through which adopters of innovations progress over time. Adopters advance from early stage concerns about self-oriented issues (Awareness, Informational, and Personal concerns), to intermediate level task-related concerns about the effective management and use of the innovation, to eventual higher-level concerns regarding the impact of the innovation on students and how to collaborate more effectively with fellow teachers to aid with the integration and even creative adaptation of the innovation (Consequence, Collaboration, and Refocusing concerns).

This model is expressly developmental in its construct. It proposes a predictable order of the emergence and progression of these concerns, theorizing that earlier concerns will, in general, subside in intensity before later, higher-stage concerns are expressed [1]. These concerns may re-cycle themselves as teachers advance through the stages. For example, once a teacher reaches a higher-level stage of collaboration and refocusing concerns, they may formulate or adopt new techniques for making use of the innovation; this may have the effect of "re-cycling" them through lower-level stages of utilization, management, and time-management concerns. However, if the lower stages of concern are not resolved or addressed, then the higher states are not likely to attain or materialize.

Table I. Stages of Concern About the Innovation

Clusters		Stages	Description of Expressed Concerns
Self Concern	0	Awareness	No awareness or concern about the innovation
	1	Informational	General awareness of or interest in innovation, noncommittal or unaware of personal investment
	2	Personal	Interest in uncertainty about the change in roles and new demands on skills and time brought about by innovation
Task Concern	3	Management	Attention predominantly paid to daily tasks and best realization of innovation possible. Focus on issues relating to efficiency, organizing, managing, scheduling, changing time demands, functionality of innovation
Other/Impact Concern	4	Consequence	Concerns over impact on students' learning experience and outcomes, and of how to use the innovation to improve outcomes
	5	Collaboration	Focus on increasing innovation's impact on students through collaboration with others
	6	Refocusing	One sees alternatives to current use of innovation, mainly to improve impact, and explores possibility of putting such improvements into practice

Adapted from Hall, 1975

The second dimension of the CBAM model is the Levels of Use, which reveals how performance and activities change as the individual becomes more familiar with an innovation and more skillful at using it [6]. Like the Stages of Concern, the Levels of Use are also developmental in nature. Once users have become aware of the innovation, they begin gathering information about it and preparing for its first use. After initial use, user behavior typically shifts to the mechanical level, upon which users generally stay until they figure out how to use an innovation with little effort, eventually becoming accustomed to the point that their behavior may be described as routinized. This behavior corresponds to the Task or Routine stage of concern. At that point, the individual may either move to any of the higher levels, back to level III Mechanical use, or remain at the Routine level indefinitely, according to whether his or her concerns have been addressed, and whether their motivations ultimately correspond to innovation adoption. At higher levels of use, behavioral changes are made based on the perceived needs of students, reflecting an Other, or Impact, level of concern.

Table II. Levels of Use of the Innovation: Typical Behaviors

	Levels of Use	Behavioral Indicators
0	Nonuse	No action taken
1	Orientation	User seeks information about innovation
2	Preparation	User prepares to use innovation
3	Mechanical Use	User focuses most effort on short-term, day-to-day mechanical use of innovation with little time for reflection or creativity. Superficial use, attempting to master ability to use innovation
4	Routine	Use of innovation stabilizes, few changes made in ongoing use
5	Refinement	User varies use of innovation to increase impact on students, focuses on both short-term and long-term consequences of use
6	Integration	User combines own efforts with those of colleagues to achieve collective impact at greater level of effectiveness
7	Renewal	User reevaluates quality of innovation's use, seeks modifications or alternatives to achieve increased impact and effectiveness, explores new goals for self and system

Adapted from Hall, 1975, Hord, 1981

The type of concern correlates with stage of innovation use [15]. In order for teachers to be able to create a learning environment that enables students to achieve advanced skills in terms of analysis, evaluation, and synthesis of information through the use of new technology in the classroom, basic computer productivity skills are a necessary (albeit ultimately insufficient) condition. Teachers themselves first need to become sufficiently technologically literate to analyze, evaluate, and synthesize information through the use of the new technology. Only then can they reexamine fundamental beliefs about traditional classroom approaches to teaching and speak of true integration of computers into education: of being able to think with computers in order to solve authentic problems, construct new knowledge, and develop higher order thinking skills [16].

However, teachers' actual progression along this continuum is by no means guaranteed. Sheingold & Hadley [17] report that even teachers who take the initiative to upgrade their skills may require as many as five years to master computer-based practices, while van den Berg and Ros find that in 40% of Western European schools involved in the many large-scale innovation projects they examined, the majority of teachers have not progressed past the (middle) level of self-concern three years after technology introduction [16]. Similar surveys have not yet been carried out in developing world contexts. Our paper thus makes an important contribution in this area.

Over time, CBAM has been accepted as both valid and reliable when assessing dimensions of change [2]. What is more, the predictability of the appearance and progression of teachers' concerns regarding the change process—and resulting behaviors—is a salient aspect of the model that allows for the possibility of planning effective methods of meeting teachers' needs and addressing their concerns as these develop and change over time.

As acceptance of the theory grew from the 1970s to the 1980s, the CBAM formulators extended their research to examine the question of what promotes more effective innovation adoption, with a focus on what can be done by those holding leadership roles within schools. According to the insights gained from studies focused on change facilitators, the CBAM model has added a further supposition: change interventions will be more effective if they address the concerns that teachers express, at the time they are expressing them. Here, we define intervention as any action, event, or set of actions or events that influence use of an innovation, while those responsible for carrying out the interventions are change facilitators [9]. Change facilitators may include principals, administrators, teacher-trainers/teacher-leaders, curriculum coordinators, superintendents, staff developers, or anyone perceived to be in a position of leadership when an innovation is to be implemented.

In order to be effective, interventions should address teachers' concerns as they develop through the (predictable) stages mentioned above. The interventions themselves must change and progress over time in order to address the teachers' own evolving concerns.

III. Research Methods

Data collection and interviews informing this paper were carried out from February–December, 2009. The methodology is based on a combination of field methods, such as individual interviews, surveys, and focus group discussions. Our multiple methods approach is intended to triangulate information from diverse sources and allow for a more robust interpretation of findings.

Quantitative data collection was carried out primarily by a team of 12 local final year university students or recent graduates with previous experience in carrying out surveys and leading focus group interviews.

The sample was designed as a combination of stratified and convenience sample: all eight regions in the country are represented by two schools (one city and one village school), including schools with both dominantly Macedonian and Albanian language of instruction (represented accordingly). The actual schools were randomly selected from the list of all primary schools. In total, the sample consisted of 16 primary schools. The subjects (teachers and students) were selected in the school among those who were available at the time of survey and focus group data collection. We requested 20 teachers per school and 90 primary school students to fill in a questionnaire. Surveys were carried out at each school, while focus group discussions took place in six randomly selected schools. In addition, there were individual interviews with the school director or some representative of the administration in each school. All of the surveys, interviews, and focus groups were carried out in the local language, either Macedonian or Albanian, and subsequently translated into English.

The authors also carried out one-on-one semi-structured interviews with teachers and administrative officials from primary and secondary schools, ranking officials from the Macedonian Ministry of Education and the Ministry of the Information Society, the on-site project director responsible for the Macedonia Connects project deployment, the post-deployment project director, and other senior program directors and project managers at the related ICT-in-education and technology promoting projects.

IV. Case Study: Macedonia's Computers-In-The-Schools Programs and Teacher Training

The Republic of Macedonia is a small country in the middle of the Balkan Peninsula that gained independence in 1991, after the fall of the former Yugoslavia. It is a diverse country, both in landscape and ethnicity. Macedonia strives to keep up with the latest technological improvements in order to build capacities that are competitive in the modern market-based world. Over the past 10 years Macedonia's government policy has focused on developing an information-based society by

promoting technological opportunities among the institutions and citizens.

The initial idea for placing computers in Macedonia's schools dates back to May, 2002, when the late President Boris Trajkovski—a strong believer in the need for Macedonian children to learn modern IT skills—returned from an official visit to the People's Republic of China with the promise of a donation of nearly 2,000 computers from the PRC (an additional 4,500 desktop computers and 450 servers were subsequently added). Microsoft donated over 6,000 licenses for software [18]. Deployment of such a large amount of computers required serious planning and additional funding. Consequently, the President approached USAID—an organization already funding projects in Macedonia—which agreed to support the computerization process.

USAID has now initiated and run several projects in different sections of Macedonian society, taking the leading role in computerization in the field of education. USAID's projects have included the following: e-Schools (2003-2008), MK Connects (2004-2007), and Primary Education Project (2006-2011). These projects have been created and function under USAID's Strategic objective: To mitigate the adverse social impact of the transition to market-based democracies. They have been working on two levels: Provision and deployment of ICT equipment, software and Internet infrastructure; and teacher training for ICT integration.

There are, in fact, two separate computers-in-the-schools programs in Macedonia, taking place in two stages, and it will aid the reader's comprehension to understand this distinction. The first stage comprised that which we have begun to describe above: multiple-approach programs aimed at training, provision of equipment, and connectivity, all of which were carried out under the auspices of USAID in the approximate time range of 2003-2008. As a result of these initiatives, every primary and secondary school is equipped with a computer lab, an Internet connection, and has undergone comprehensive training, as described below. This project is the focus of our research.

The next stage of the computers-in-the-schools plan for the entire country of Macedonia is the Government's project: "One Computer per Child" (OCPC), introduced in 2007 with the aim of providing computers to all students in primary and secondary schools throughout the country. This represents a scaling up of computerization in the schools by an order of magnitude: from one computer lab per school to one computer per child. It involves provision of entirely new equipment and the use of open source software applications such as Linux OS and Edubuntu.

Also important to note is that USAID's role is ongoing—as are those of its partner and supported organizations, such as the Primary Education Project—particularly in terms of training and support of the government's initiatives. In other words, USAID projects are no longer in charge of the deployment and provision of equipment, but the Primary Education Project will, in fact, be carrying out the training sessions that will accompany the government's OCPC program.

Our goal for this paper was to measure teachers' Levels of Concern, and Levels of Use, regarding the computerization in the schools associated with the first deployment: the USAID/e-Schools programs. The research informing this paper was carried out approximately three years after the project deployment took place, and may be triangulated against program evaluation reports created (by PEP) shortly after the initial trainings took place. Thus, approximately three years have passed since initial trainings were completed and surveys were performed to assess teachers' general levels of satisfaction with the training they had received. In fact, after three years, the teachers' level of satisfaction with the training they received and their reported ease of using computers and levels of actual use have all decreased. We believe this gives evidence that the teachers are not receiving ongoing, active support in the form of interventions that could enable change in their teaching methods. We also believe that the government's OCPC project will present teachers with multiple changes and challenges, underscoring the salience and timeliness of the findings in this paper.

A. Teacher Training

All of the trainings implemented by USAID's projects aim to build local capacities by involving teachers as trainers and contributors to the creation of learning materials as well as equipment operators. For many of the trainings, master trainers and teacher trainers were selected from among the teachers by either self-identification or nomination by school directors. The capacity building also involved advisors from the Ministry of Educational Development as master trainers and active members in the development of materials teams.

During these projects a number of different trainings were offered, ranging from basic ICT skills aimed at enabling teachers with basic technical computer skills, to trainings aimed at integration of the technology into the curriculum. They were organized over a period of four years, during which time 14,000 teachers from all 360 primary schools received training.

The trainings provided through the USAID projects were comprehensive and directed at empowering teachers and school administrations to use technology to improve the teaching process and enable students to develop the skills and knowledge necessary in a modern society. In general, they were assessed by the teachers positively. A large percentage of teachers expressed the need for further training: 95% would like training in specialized educational software; 82% in subject specific training; 65% in the use of Internet technologies; and 37% in basic training for use of ICT. Also, many teachers expressed uncertainty regarding the use of computers vis-à-vis their students: they consider their students to be far more skilled and knowledgeable then they are and do not want to compromise their authority as teachers by putting themselves into situations where they might encounter a problem that they can not handle [19].

V. DATA

Our questionnaire was completed by 212 primary teachers in total. In terms of demographics, most of the teachers included in the sample were female (72%), belonged to the middle age group category, from 31-50 years (56%), and were of Macedonian (75%) and Albanian (23%) background.

Most of the teachers surveyed (76%) said that they have received training in basic ICT skills, while 49% said they have received training for how to use ICT in their instruction.

In terms of assessing the training they received, 51% believed it was sufficient or more than sufficient, while 49% of the total assessed the training as being less than sufficient. In terms of additional training, a large majority of teachers are interested in receiving more training in the use of ICT in their area of instruction (70%).

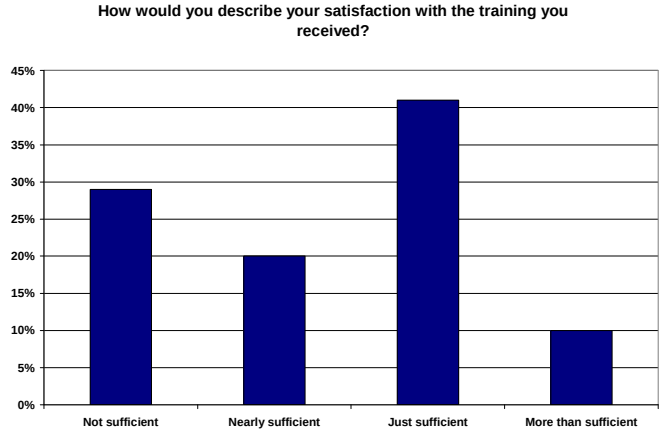

Figure 1: Satisfaction levels regarding teacher training

Half of the teachers that were surveyed (51%) say that they spend a few hours a day with a computer, in general, either for personal or instructional purposes, while only 18% report that they do not spend any time with a computer at all.

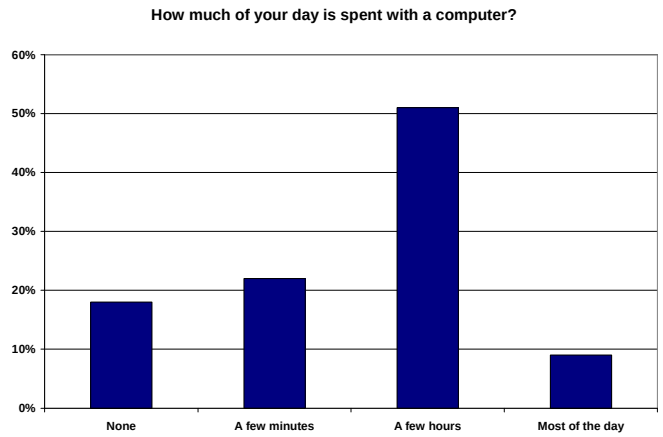

Figure 2: Amount of time spent daily with a computer

Despite the findings that only 18% of teachers spend no time during a normal day using a computer, there remains a considerable percentage of teachers (44%) that have never used computers in their classes to date. A similar percentage of teachers report to have used this technology only a few times (42%), while only a small group of teachers say that they use computers very often (15%).

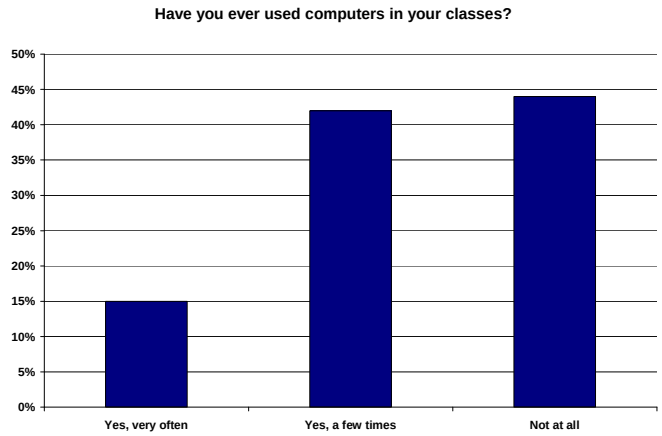

Figure 3: Teachers' use of computers in their classes

When the time frame is shortened, however, the results are even more pronounced. When asked how often they have used computers in class during the previous two months, the category of teachers that have not used them at all increases to 65%, while those using ICT a few times decreases to 25%.

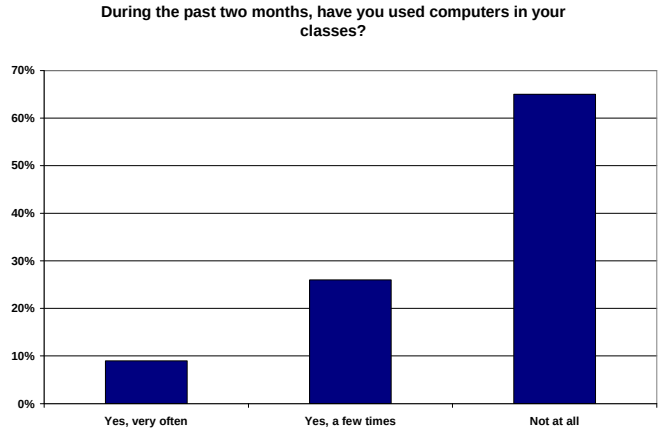

Figure 4: Teachers' classroom computer use prior two months

Regarding the frequency of computer use for instructional purposes, nearly 60% of the teachers say that they rarely-to-never use ICT, about one-third (30%) say that they sometimes use ICT, while a smaller number (10%) say that they use it quite often or all the time.

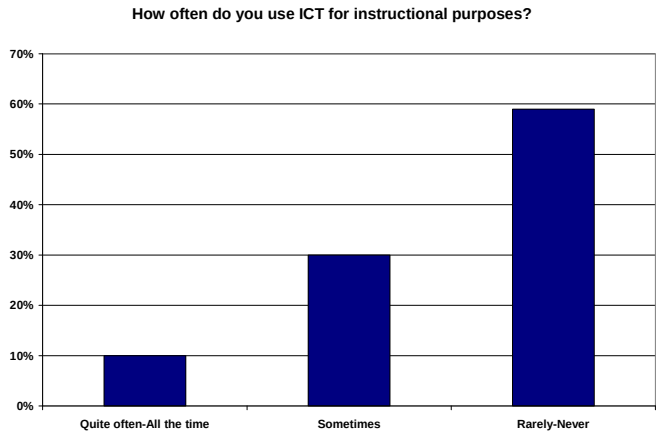

Figure 5: Frequency of ICT use for instructional purposes

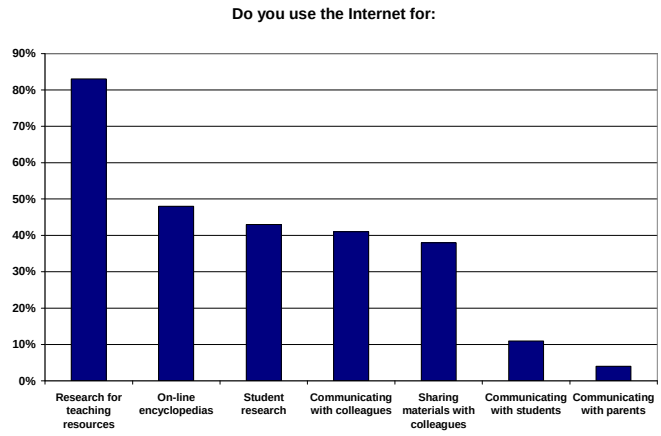

Figure 7: Purposes of teachers' Internet use

Given the statistics above, it is surprising that a rather large percentage of teachers report using ICT for preparing teaching materials and tests (72%), and for lesson-planning (63%). Yet less than a third of the surveyed teachers use ICT for activities with students, including activities such as: projects (30%); research (34%); working with data (26%); and student assessment (23%).

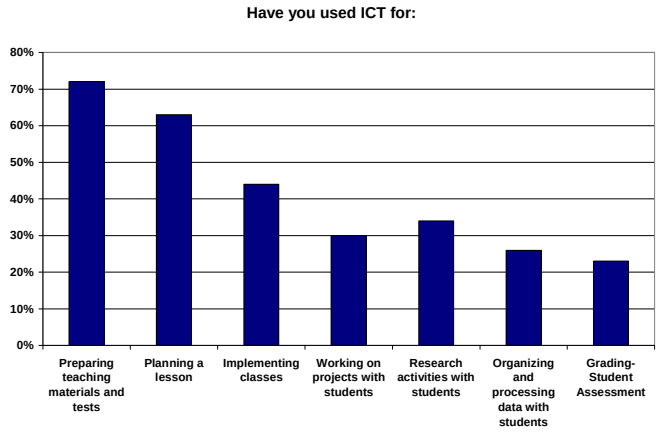

Figure 6: Teachers' uses of ICT

A very high percentage of teachers report using the Internet for research for teaching resources (83%); while a significant number use ICT for student research (43%); communication with colleagues (41%); and consulting on-line encyclopedias (48%). However, this technology is used by very few teachers for communicating with students (11%) or parents (4%).

The majority of teachers are computer users in their personal lives as well: 43% report using them very often and 32% occasionally. Sixteen percent of teachers report using them, but only rarely, while only 9% do not use computers in their personal lives.

Regarding the difficulties encountered while organizing and implementing the instruction with computers, teachers in the focus groups point to the lack of material or equipment resources, but also express their awareness of being uncertain and lacking confidence in their possession of the ICT skills needed for the implementation of a class.

On the whole, the teachers are very positive about the idea of ICT in the schools. An overwhelming majority (86%) indicated that they believe that the school is the right place for students to learn basic computer skills. There is, however, a disconnect between such a positive attitude and the findings above, which indicate that nearly 60% of the teachers have never used ICT in their instruction. This apparent contradiction may be attributable to a number of factors. One of these is an overriding concern, expressed by the teachers during the focus groups discussions, that they lose control over the class when students each have a computer that they can pay attention to instead of the teacher, and that for successful realization of ICT in the instruction, it is necessary that the teacher retains control and knows when to turn off the computer, as one cannot learn solely using the computer. Another factor is the higher degree of technological expertise teachers attribute to their students vis-à-vis themselves, which leads to a feeling of insecurity and loss of authority.

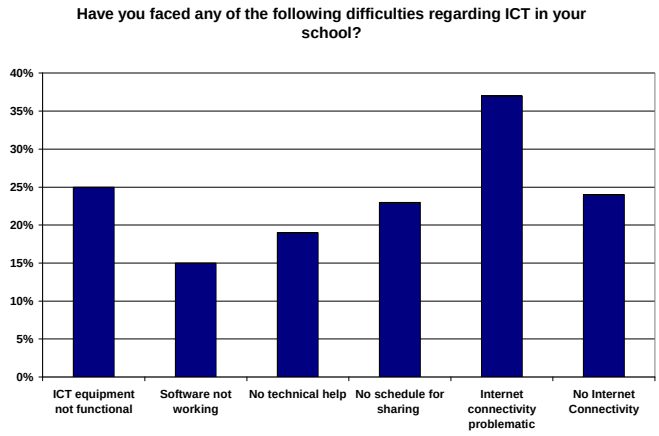

Figure 8: Teachers' difficulties in use of ICT

Regarding maintenance issues, 44% of the surveyed teachers say that there is no single person responsible for maintaining the ICT equipment. Twenty-two percent report that when problems do occur, they are not managed efficiently, while 23% report that the equipment is not safe (parts of or entire computers have been stolen).

More than half of the teachers surveyed (56%) do not know whether their school has prepared an annual plan for the use of ICT equipment, while 29% say that such a plan has not been developed in their school. Only 15% report that their school does have an annual plan for the use of the ICT equipment. This is an indication that the vast majority of school administrations have not been providing a comprehensive program of support for teachers. If such a plan exists but teachers are not aware of it, then they clearly have not been involved in its formulation or implementation.

In general, teachers feel that the school administration supports them in using the computers: 53% assess administrative support as being either complete or sufficient, while 37% think that they could do more. However, in our opinion, teachers may not be aware of what the administration could be doing to support them. Support, in this context, may refer simply to the imparting of a positive attitude and verbal support. We argue that support must include a system of actions and interventions that will help the teachers deal with change; this would involve making an annual plan for ICT use in the schools (which includes the teachers in plan formulation), offering additional trainings, supporting teacher collaboration groups, and providing encouragement and positive recognition where appropriate. In this way, ICT will become more widely incorporated into the classroom teaching environment.

On a positive note, nearly all of the teachers agree that the introduction of technology into the schools has been useful for them as teachers (98% partially-to-completely agree). At the same time they resoundingly agree that it has been a challenging experience for them (93% partially-to-completely agree).

VI. Discussion

Our literature review indicated that even overwhelmingly positive attitudes towards change on the part of teachers was not enough to bring about the successful implementation of a new program, curriculum, or method of teaching. This was clearly evident in our data, as 86% of teachers surveyed in Macedonia were positive about using computers in the classroom, but three years after the initial computerization effort, only 34% report actually having used computers in their instruction within the previous two months, while 65% had not used computers at all during this time period. In addition, 44% of the teachers reported never having used computers in their classes to date. This data indicates that approximately half of the teachers that have had both training and access to technology have never progressed above Level 0, (Nonuse) in our Levels of Use framework, indicating that their corresponding concerns about using technology have not been addressed.

Despite our findings of widespread non-use of computers in the classroom, teachers are, in fact, making use of computers in their daily lives, and in their work-related planning, preparation, and information-gathering, on a much more frequent basis: 75% of teachers indicate using computers in their personal lives, 72% use ICT to prepare teaching materials and tests, and 83% use the Internet to search for teaching resources. Only 18% don't use a computer at all during their normal day. We believe this indicates that nearly three-quarters of teachers have progressed to at least Levels 3 and 4 in the Levels of Use categories (Mechanical and Routine use) in their personal lives and teaching preparation, but have not been able to make the transition to using technology in the classroom in a meaningful way. Less than a third of teachers reported using ICT for activities with their students.

When asked in the focus group setting about their concerns regarding technology use in the classroom, we found the majority of teachers' stated concerns to be at both early- and intermediate-level stages, which include self-concern and task/time management issues. Statements that reflected these levels of concern included concerns about insecurity in using ICT in front of students, or of being able to retain control of the classroom while using technology. In addition, desire for additional training, hardware, equipment, and software was expressed. There were no statements we could locate that reflected higher order concerns, about, for instance, the technology's impact on students' learning experience and outcomes, a desire for increased collaboration among teachers, and/or the proposing of alternatives for improvement of technology in order to increase impact. We believe this indicates that there is room for improvement in addressing teachers' concerns, which should correspond to increasing levels of technological integration and implementation into the teaching, instead of remaining at the lower-order level of simple mechanical and task-oriented use of technology.

The literature that focused on the role for administration identified a number of success factors, in terms of what the administration can do to support teachers confronting change. These interventions involved both asking and anticipating teachers' concerns in an ongoing fashion over a long period of time (at least three years), addressing these concerns by offering multiple and varied trainings over the years as skills and interest levels change, and facilitating opportunities for group formation and collaboration among teachers. In our survey, the teachers rated the administration positively overall in terms of supporting them in their use of ICT. However, we are not aware of administrators in these schools taking an active role in any of the interventions described above. It may be the case that administrators are not familiar with these methods for supporting teachers, and that teachers themselves are not habituated to expect this kind of support from their administrations. We argue, however, that instituting a program of active interventions, for a years-long period of time, will result in more positive outcomes for the teachers, in terms of adapting to change and to technology adoption.

One method for facilitating this process would be to involve the administration in the training process from the outset of project implementation: to enlighten them to the fact that the change process is a years-long experience for teachers and what their role can be in this process; to offer them a separate training in how to support teachers and actively intervene to alleviate teachers' concerns during the change process; and to encourage them to allow for increased group formation and collaboration among like-minded teachers. To our knowledge, this type of training and information sharing has not been carried out in the Macedonian context, but it is not too late to start including administrators in such trainings, which are scheduled to continue for the teachers.

One obstacle worth noting, in the context of the Macedonian case, is the political appointment of school administrators. School directors are changed often, perhaps every four years, when local mayors from different parties are elected. Thus, even if one school director is "on board" with the type of support and interventions mentioned above, if she/he is replaced every few years, the administrative support system that has been developed will fall apart. Macedonia's Ministry of Education has recently announced its intention to depoliticize administrative positions in the schools; we believe this to be an important step toward ensuring continued support of teachers during times of significant change.

Two other related areas in which a great deal of room for improvement exists are the putting forth of a plan for using ICT in the schools (on a school-by-school basis), and the establishment of a plan for computer maintenance and upkeep. Our data showed that more than half of the teachers surveyed did not know whether their school had prepared an annual plan for the use of ICT, while 29% knew that their school did not have such a plan. That left just 15 percent of teachers who knew that their school had promulgated a plan for the use of ICT. The development of such a plan would offer an opportunity for discourse between teachers and administration; teachers could express their concerns and offer input for the administration's response. Not developing a plan not only misses this opportunity entirely, it also leaves a school rudderless, without a plan, setting no expectations for use of computers by either teachers or students; this can leave teachers confused and directionless.

In a similar vein, our data showed that 44% of teachers reported that there was no person responsible for the maintenance of ICT equipment and security of the equipment remained a major concern. Project implementers must consider allocating funds for a full-time maintenance staff for each school, and possibly a security staff, if every single student and teacher will now have a computer at their disposal at all times.

Macedonia's nationwide computers-in-the-schools programs have been of a "top-down" nature; that is to say, imposed on the schools from above. Although we believe that there can be benefits from this approach, particularly in terms of efficiency, economy of scale, and equality of opportunity and provision, there are also potential drawbacks. Our literature review identified significant obstacles to teacher buy-in when, for instance, they have not been involved as stakeholders in the process in any meaningful way, when their opinions have been disregarded or not solicited in the first place, when they are not given sufficient training or support to manage a change, or when they are not allowed room for creativity in the implementation of the change. We find that there is much more room for soliciting teachers' input in the current technology rollouts in Macedonia, and in fact, the need for this is much more urgent at present, because the government's OCPC program will require a greater degree of change on the part of teachers, in terms of learning new software, having a computer at the desk of each of their students (as opposed to having a computer lab available within the school), and being required to use the computer in a minimum number of subjects. If the government does not act in good faith to solicit teachers' input on the multiple changes they are facing simultaneously, our literature review suggests that they will likely face a significant amount of foot-dragging and even backlash from the teachers.

The USAID-led trainings have, to date, taken steps towards involving teachers in the process of training other teachers. However, the teachers do not, in fact, take part in the decision-making (or curriculum development) process; they are merely implementing what others have already planned. More could be done to involve teachers and solicit their input in the future.

One positive point to note is the exceedingly high percentage of teachers expressing interest in additional training. The majority of our survey respondents expressed satisfaction with the training they had received up to the time our research was carried out, and a still greater number expressed the desire for even more training in the area(s) in which they teach. Additional trainings are already in the works, as the government's decision to utilize open source software will require such. Therefore, it is not too late to take teacher input into consideration in the context of these future

trainings.

Another best practice—identified in the literature—to encourage teachers in the change process is the offering of incentives. Financial incentives may not be practical, or feasible, in many developing-country contexts. However, there are other methods for incentivizing. First, while in Macedonia there exists a system of career development in the letter of the law, it is not yet implemented in reality. USAID's Primary Education Program recently developed a certification procedure for schools that have implemented their training, as well as a model for mentoring. These programs were presented to the State Secretary of Education, who expressed great interest in the program and set up meetings to discuss the subject further. Thus professional certification represents a potential area for incentivization for teachers.

Another possible area for the incentivization of computer utilization in the educational process is that of competitions or events where teachers can show the results of their (or their students') work. Such competitions and challenges are in the process of being organized (by USAID's Primary Education Project) on multiple different topics.

As noted above, PEP has identified the need for a continuous school-based support and mentoring program for teachers. One proposed method is to establish an Educational Technology Support Teacher (ETST) in each school. The ETST would provide teachers with hands-on training in the use of different ICT equipment and support them by suggesting manners in which ICT can be integrated into different subjects. PEP plans to introduce this model once the computers from the "One Computer Per Child" project are functional in the schools.

We believe that we have identified some success factors, as well as areas for improvement in addressing change in the classroom, particularly in the context of computers-in-the-schools projects, both in Macedonia and elsewhere.

VII. Conclusion

This paper advocates a complete rethinking of the design, implementation, and evaluation of developing world computers-in-the-schools projects. It posits that the success—or failure—of such projects hinges on the changes experienced by teachers; that such change takes place over time, and that teachers must have their concerns addressed as this evolution takes place. The CBAM model was presented as a framework for the understanding of these concerns and the levels of technology use that corresponds to them; it is through this framework that concerns may be addressed and the projects given a greater chance of succeeding.

Past policy efforts in the United States have been driven by the misguided belief that the simple provision of technology will foster change; this has been mirrored in many developing world ICT-in-education projects, leaving teachers out of the equation. The Macedonian nation-wide computers-in-the-schools program herein studied emphasized teacher training in both technology use and implementation. However, computer use in the classroom and integration into the pedagogy has not yet been achieved three years after the technology and trainings were provided; quite clearly there is room for improvement.

Administrators must take active roles in the technology adoption scenario; they must address teachers' concerns regarding the changes necessary to the process, and intervene to address those concerns as they evolve over time. This active involvement may include in-service training and the encouragement of collaborative work between teachers.

The promulgation of a school-wide plan for ICT is necessary to inform teachers of what is expected of them; the inclusion of teachers into the development of such a plan involves them as stakeholders and allows the projects to benefit from their input and an understanding of their concerns. We have also advocated the creation of the role of "technology support teacher" in the Macedonian context, but acknowledge that budget constraints in other countries may not allow for the creation of such a position, or at least for the presence of such a person in every school. However, all computers-in-the-schools projects must consider the costs and manpower necessary for upkeep, maintenance and repair—and often security—from the outset; regardless the limitations of the budget, these expenses cannot be ignored.

As identified in this paper, the three transformative concepts of ICT-in-education projects are as follows: teachers will determine the success or failure of such projects; change requires time; teachers need ongoing support to adopt the technology and should be treated as stakeholders. If these concepts are ignored, we predict that these projects will follow trajectories similar to those witnessed in the United States, where provision of technology alone was considered sufficient to its adoption and the blame for project failure was, time and again, placed on teachers. Fortunately, these pitfalls can be avoided. New projects can adopt these insights and existing projects can be amended to incorporate them; this paper identifies specific measures to do so. Basic computer productivity skills are indeed necessary to achieve real integration of technology into the educational experience, but these skills alone will not enable the creation of meaningful synthesis for learners. Fundamental technological change in the classroom requires that teachers and learners alike must be able to think with computers in order to solve problems, construct knowledge, and develop high order thinking skills.

References

[1] M. T. Wesley and M. E. Franks, "Advanced adoption of computer technology in the classroom and teachers' participation in voluntary innovation adoption activities," presented at the Annual Meeting of the Mid-South Educational Research Association, Tuscaloosa, Alabama, Nov. 6-8, 1996.

[2] N. Adams, "Educational computing concerns of postsecondary faculty," in *Journal of Research on Technology in Education*, vol. 34, no. 3, pp. 285-303, 2003.

[3] A. Gitlin and F. Margonis, "The political aspect of reform: Teacher resistance as good sense," in *American Journal of Education*, vol. 103, pp. 377-405, 1995.
[4] V. Richardson, "Significant and worthwhile change in teaching practice," in *Educational Researcher*, vol. 17, no. 7, pp. 10-18, 1990.
[5] M. Fullan and A. Pomfret, "Research on curriculum and instruction implementation," in *Review of Educational Research*, vol. 47, no. 2, pp. 335-393, 1977.
[6] S. F. Loucks and G. E. Hall, "Implementing innovations in schools: A concerns-based approach," presented at the American Educational Research Association annual meeting, San Francisco, April 12, 1979.
[7] G. E. Hall, "The effects of 'change' on teachers and professors—theory, research, and implications for decision-makers," presented at the National Invitational Conference on Research on Teacher Effects, Austin, November 3-5, 1975.
[8] D. Brzycki and K. Dudt, "Overcoming barriers to technology use in teacher preparation programs," in *Journal of Technology and Teacher Education*, vol. 13, no. 4, pp. 619-641, 2005.
[9] S.M. Hord and L. Huling-Austin, "Effective curriculum implementation: Some promising new insights," *in The Elementary School Journal*, vol. 81, no. 1, pp. 97-115, 1986.
[10] L. Hosman, "Policies, partnerships and pragmatism: Lessons from an ICT-in-education project in rural Uganda," in *Information Technology for International Development*, vol. 6, no. 1, pp. 48-64, 2010.
[11] L. Hosman, "Policy considerations from a nationwide IT-in-education initiative: Macedonia Connects," in *Journal of Information Technology and Politics*, vol. 7, no. 4, submitted for publication.
[12] G. E. Hall and S. M. Hord, *Change in Schools: Facilitating the Process*. Albany: SUNY Press, 1987.
[13] F. F. Fuller, "Concerns of teachers: A developmental conceptualization," in *American Educational Research Journal*, vol. 6, no. 2, pp. 207-226, 1969.
[14] S. E. Anderson, "Understanding teacher change: Revisiting the Concerns Based Adoption Model," in *Curriculum Inquiry*, vol. 27, no. 3, pp. 331-367, 1997.
[15] R. van den Berg and A. Ros, "The permanent importance of the subjective reality of teachers during educational innovation: A concerns-based approach," in *American Educational Research Journal*, vol. 36, no. 4, pp. 879-906, 1999.
[16] V. T. Gershner and S. L. Snider, "Integrating the use of Internet as an instructional tool: Examining the process of change," in *Journal of Educational Computing Research*, vol. 25, no. 3, pp. 283-300, 2001.
[17] K. Sheingold and M. Hadley, *Accomplished Teachers: Integrating Computers into Classroom Practices*. New York: Bank Street College of Education, Center for Technology in Education, 1990.
[18] G. Nairn, "Broadband network is the envy of the West," in *Financial Times London*, March 28, 2006.
[19] USAID's e-Schools Project. "Formative impact report for the primary school level." Skopje, Macedonia, 2007. Unpublished.