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Digital inclusion of secondary schools' subject teachers in Bolivia

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ABSTRACT

The government of Bolivia planned to introduce information technology in secondary education through establishing computer labs in schools and through granting each subject teacher a laptop. This initiative was tested for the first time in 2012 with three public schools in La Paz. Most of the subject teachers have never used a computer before. The Swedish Program for ICT in Developing Regions (SPIDER) supported teachers' training in basic digital skills. This was not sufficient for the teachers to adopt the technology in their daily practice. Within a follow-up research project a constraints driven model for overcoming the barriers teachers faced was developed and applied. The aim of this paper is to provide an overview of the whole process of digital inclusion with focus on the design and implementation of this model. Teachers' adoption of the technology and changes in their skills, attitudes and beliefs were assessed through the analysis of the qualitative data obtained in focus group discussions and observations, as well as through the quantitative data collected through a longitudinal survey. The results show that the adopted model proved to be a successful complement to the government policy. From persons intimidated by the laptops, the subject teachers became confident users of digital technology capable of creating numerous educational units and interactive teaching tools.

Keywords: Subject teachers; Bolivia; La Paz; Computers in schools; Adoption of technology

INTRODUCTION

Tremendous advances in the Information and Communication Technology (ICT) have transformed the way we learn, get employed, work, travel, entertain and approach the problems society faces (Brynjolfsson & McAfee 2011). Both, the governments in the developed and in the developing countries have acknowledged the importance of this disruptive technology for experiencing economic growth, providing better education accessible to all, enhancing democracy, and offering e-services to the citizens. They have established visions and policies in support of their views in all sectors of the society including education.

In the developing countries children and youth constitute a large part of the population; hence making the technology a part of the education is often considered to be a priority (Kozma & Vota 2014). The two most important rationales are the social rationale – students need to learn how to use the technology, and the pedagogical rationale – using the technology to learn or as a medium for teaching and learning (Voogt 2008). The first rationale is usually addressed through a new subject mainly teaching basic e-skills, added to the school curriculum under different names. The second rationale is much more difficult to implement because of teachers' low-level computer literacy and lack of resources in schools. It requires equipment in every classroom, as well as additional subject teachers' engagement in creating pedagogically sound activities within their subject fields. Therefore achieving pedagogical rational with ICT usually lags behind.

Educational ICT policies differ from country to country. Some of them focus on introducing infrastructure in schools others on teachers' professional development necessary for increasing efficiency in education, and some are limited to introducing the technology as a subject within the curriculum, with basic digital literacy taught to the students. In 2010 the Ministry of Education and Culture of Bolivia, similarly to other Latin American countries, took action towards incorporating the technology in the teaching/learning process through issuing a document about the state policy with respect to introducing ICT in secondary education. Regional education informatics units to assist with implementing the state policy were established (Labbé & Hinostroza 2011). The schools were supposed to obtain computer labs and all subject teachers were granted laptops. There were many obstacles to implementing this policy in the whole country, which is spread over more than 1 million square kilometers and with a population of about 10 million people, the majority with indigenous ethnicity. Bolivia is a landlocked country with the lowest Human Development Index (HDI) in the region and with a very large proportion of the population living under the poverty level. It still ranks at or near the bottom of Internet development in the neighborhood. Only 9.45% of the households had connectivity and only 23.36% possessed at least one computer, according to the statistics from 2012, with the connection speed being one of the worst and the most expensive in the region (Vargas 2014). Hence, introducing ICT in the secondary schools in this kind of environment is a big challenge.

Private and public schools are common for the education system in Bolivia. Secondary schools accommodate children age 13 to 18. The government funds the public schools; hence no tuition is required. The private ones are expensive and not affordable by most of the families. ICT was already introduced in many private schools through adding Computing as a separate subject in the curriculum and by building one or several computer labs for the students. However, the public schools had to wait for the government initiative from 2010. Three public schools in La Paz were selected as a test-bed for this initiative. In 2012 the schools obtained a laboratory with 15 desktop computers and each subject teacher received a laptop. The expectation of the government was that the students will learn about ICT using the desktop computers and that the subject teachers will increase the efficiency and quality in teaching through exploiting the capabilities of the laptop. The computers and the laptop were running Windows operating system and had the Office suite installed. In addition the laptops had JClick and Constructor, two educational software packages. All the software was in Spanish, the official language of these schools. No teacher in Computing was hired and no computer literacy training was organized for the subject teachers.

Most of the teachers have never used a computer before; hence they kept their laptops at home without even opening them. To help in making the expectation of the government a reality the Swedish Program for ICT in Developing Regions (SPIDER), funded the connection of the computer labs to the Internet and the teachers' training in basic digital skills. The project was operationalized through the local NGO Foundation La Paz. Nevertheless, this proved not to be sufficient for the teachers to be able to use the technology. Finally, a small-scale research project, a follow-up to the SPIDER project created the necessary conditions for the subject teachers to make the technology a part of their daily teaching practice.

The rest of the paper is organized in the following way. The next section shortly describes the literature we studied in a search for a suitable model for integrating the technology in the schools in La Paz. This is followed by the portrayal of the whole process of the digital inclusion of the subject teachers. The first part of this section is an overview of the SPIDER project as an effort to complement the government initiative. The second part presents the follow-up research project together with all the elements of the constraints driven model that was constructed and implemented throughout this project. Separate sub-section describes the barriers teachers encountered identified as the constraints in this model leading to the learning with ICT to be recognized as a paradigm to follow. The next two sub-sections describe the actions necessary to implement this paradigm. The graph of the constraints driven model obtained through assembling

the constraints, the paradigm followed and the two actions taken is presented in the last sub-section. Finally, the method for estimating how successful the adoption of the technology was and the findings obtained are portrayed. The paper ends with the conclusions.

MODELS FOR TECHNOLOGY INTEGRATION IN SCHOOLS IN DEVELOPING COUNTRIES

There is no consensus about a single model for introducing ICT in schools and for integrating the technology into the curriculum of various subjects. However, there is a consensus that meaningful learning with ICT can be accomplished when a teacher has the requisite knowledge about the technology, understands the content of the subject taught, and applies the right pedagogical approach when using the technology to increase students' interest in certain topics and to induce learning (Chai, Koh, Tsai, & Tan 2011). With respect to developing countries, the adoption of ICT by subject teachers depends on many issues such as who is conducting the project, what ICT infrastructure exists in the school, who the stakeholders involved are, how the training is conducted, what technical and pedagogical support is provided, etc.

At the beginning of our research we studied several models for technology integration in schools in developing countries. The actions proposed in order to successfully implement ICT in educational practice were also considered throughout the research process. A short overview of these models and actions is provided in the text that follows.

The project for introducing ICT in several Fijian schools used the efforts of researchers and volunteers from developed countries to provide technology resources and support to schools, as well as to engage and educate teachers for the benefit of the learners (Chandra, Chandra & Nutchey 2014). The Share, Engage and Educate (SEE) project adopted a four-phase model for ICT integration. The phases are structured as a cycle and defined as objectives, implementation phase, feedback phase and reflection phase. The cycle is repeated as many times as needed, for times being necessary in the case of Fijian schools. The project is focused on building teachers' capacity and involving all relevant stakeholders in order to achieve success.

Unlike the SEE project focused on several schools in Fiji and using individuals' hard work and engagement, the Macedonian nationwide computers-in-schools project was mainly government driven. The teachers received comprehensive, advanced training in both computer use and methods of actively incorporating technology into the teaching and learning process. The research conducted three years after the project was over, showed that the majority of teachers were still using ICT in their daily lives, however not as much as pedagogical tool in the classroom or for changing their teaching practices (Hosman & Cvetanoska 2013). The Concern Based Adoption Model (CBAM), which describes how individuals' concerns evolve as they undergo the process of change and how these concerns may be addressed over time, was used to examine ICT-in-education efforts and to determine whether they match up effectively with how teachers experience change and where there is room for improvement in such efforts.

The Evolutionary Development Model (EDM) emerges from a developing country perspective on the use of ICT where efficient use of resources is very important (Rodríguez, Nussbaum, & Dombrovskaia 2012). The model aims to produce an incremental cost-effective and sustainable implementation of ICT in education. It consists of iterative cycles of design, testing and refinements after performing formative and summative evaluations in the previous cycle. The authors point out that the model is flexible and can be implemented in different contexts and in programs of various scales. It was used to create the Eduinnova ICT for Education (ICT4E) program in Chile in the period from 2004 to 2006.

A low-cost computing project for education in India showed that shared rather than single-user devices constitutes a more realistic approach for the rural Indian classroom (Patra, Pal, Nedevschi, Plauche, & Pawar 2007). The effectiveness in education, economic feasibility and socio-cultural suitability were taken into consideration. Sharing computers in a classroom proved to be a more economically viable option for many developing countries, yet it allowed collaboration among children and it offered teachers an opportunity to stimulate learning through the use of technology.

Recognizing the disruptive nature of the new technologies and the augmented needs that learners have in the new millennium, 70 leading researchers, policymakers and practitioners discussed the use of ICT in primary and secondary education in 2009. The outcome that was developed was known as "Call to Action" (Voogt, Knezek, Cox, Knezek, & Brummelhuis 2013). It summarizes the main action points where policy, research and leadership need to join forces in order to implement ICT successfully in educational practice. Four actions that are called are related to the teaching and learning processes. They are concerned with the use of ICT for formal and informal learning, restructuring schools so that they can use the technology to address learners' individual needs, the design of new assessment practices to measure the outcomes of using the technology, and understanding learners' experiences with technology in formal and informal settings. Two actions are emphasizing the role of teachers and schools through establishing models for teachers' training and through developing distributed leadership models for the use of technology in schools. Finally, the last two actions are directed towards the policies for ICT integration.

The models and the action calls presented in this section provide only a broad framework for introducing ICT in educational projects in developing countries. Whenever a researcher or a practitioner is faced with making decisions regarding a particular project, the knowledge from previous experiences as well as the intuition, the rational thinking about the context and the limitations in the particular settings, and also brainstorming together with all stakeholders in the project are to be considered. All of this was utilized at different points of the process of introducing ICT in the three public secondary schools in La Paz.

The next section presents the whole process. The first subsection is a short description about the government initiative supported by the SPIDER project. The second one provides the details about the research project that finalized the digital inclusion of the subject teachers.

THE PROCESS OF DIGITAL INCLUSION OF TEACHERS

The process is a part of a large government initiative to introduce ICT in public secondary schools in Bolivia. Figure 1 graphically presents how different initiatives and contributions interplayed when the initiative to introduce ICT was piloted in the three secondary public schools in La Paz.

The text in the following subsection provides an overview of what is presented in the upper part of Figure 1. The next subsection presents the details of the research project as portrayed in the lower part of Figure 1. The description of the development and the implementation of the constraints driven model are central to this subsection.

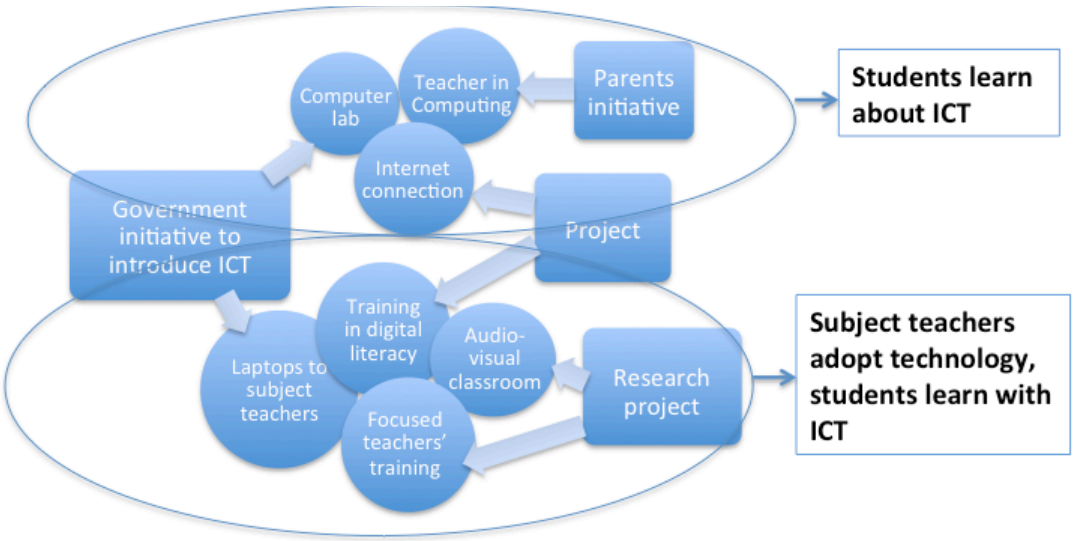

Figure 1: *Interplay of different initiatives and contributions in introducing ICT*

The project

Lack of buildings for public schools is a large problem in La Paz. The primary and the secondary schools are planned to be on the walking distance for the students. The public transport in the city spread over many hills is poorly organized and the school transport is non-existent. The buildings for the schools are small and inadequate with classrooms that usually accommodate about twenty students. In order to incorporate all the students, the schools operate the morning and the afternoon shift. Each building actually accommodates two schools under the same name, the morning shift being from 7:30 to 14:00 and the afternoon shift from 14:30 to 19:00. Private schools have much better buildings and can accommodate the students in one shift.

In 2012, the municipality of La Paz equipped the three public secondary schools, Copacabana, René Barrientos, and Dora Schmit, with a room to be used as a computer lab during the morning and the afternoon shifts. All subject teachers were granted a laptop and the Ministry of education and culture published a guide about the digital knowledge subject teachers should have. However, no funds were allocated for teachers in Computing, for connecting the labs to the Internet, for the training of the subject teachers, for the projectors and the other necessary digital equipment in the classrooms.

The initiative from the parents helped in hiring the teacher in Computing, a new subject that was supposed to provide students with knowledge in basic digital skills and some programming. The parents interested their children to learn about the digital technology decided to provide the salary for this teacher.

In 2013, SPIDER funded the connection of computer labs in the three schools to the Internet. A part of the funds was used for the teachers in Math, Science, History and English to obtain basic digital skills. The training followed the official guide produced by the Ministry of education and culture. The teachers learned the basics of using Windows operating system, Microsoft Office and the Internet. The training was organized by the local NGO Foundation La Paz, outside the official working hours of the schools, as required by the school leadership.

The teachers in all subjects showed tremendous interest in the training sessions despite the fact that they had to spend two evenings per week at the schools and that they placed extra effort on gaining basic skills in using their laptops. Even the subject teachers from a nearby private school La Salle joined the group. Subject teachers in this private school did not use the technology in their teaching. There were two computer labs in the school building exclusively used for the classes in Computing. There were no projectors or any other digital equipment in the classrooms. The teachers were thrilled to learn how to use the computer and the Internet and they were eager to introduce the technology in their daily teaching practice. Owning to this large interest, the same training sessions were organized several times to accommodate all interested teachers.

The research project

Each SPIDER project is accompanied by a small-scale research study related to the project with the budget of SEK 100 000, equivalent to about USD 12 000. The research associated with the project in Bolivia started in January 2014 and ended in October of the same year. The objectives were to identify and overcome the challenges for integrating ICT into the daily practice of subject teachers and to introduce change in their attitudes towards technology. The research was conducted as collaboration between the Swedish researcher and the Bolivian practitioner, with the inclusion of the school leadership and the teachers. The following subsections describe the development and the implementation of the model we called constraints driven model.

Identifying the constraints

Barriers to successful teaching and learning with ICT can be different depending on the region's economy, political situation, available infrastructure and the culture. Practice so far shows that the major barriers for teachers are a lack of training, appropriate software and hardware, skills in integrating ICT, and technical and administrative support (Goktas, Yildrim, & Yildrim 2009). Similar barriers were present in the three schools in La Paz. Several brainstorming sessions with all stakeholders were held in each of the three schools. They were used mainly to raise the awareness of the school leadership about the necessity for teachers to be offered opportunities to incorporate the technology into their everyday teaching activities. The discussions and conclusions from the brainstorming sessions served as a basis for the development of the constraints driven model, presented in the last subsection. The model includes the constraints identified, the paradigm defining the manner in which technology could be used under the constraints and the actions to take for the teachers to make the technology a part of their daily practice. The following constraints were recognized.

- The existent equipment consists of the laptop that each teacher has at home and the wired Internet connection in the school's lab. Computers in the lab are used only to teach basic skills in ICT and are occupied throughout the day.
- The available space in the school building is scarce. The building accommodates two schools. Both the morning and the afternoon school use the same classrooms and the same computer lab. There is no physical space in the school available during the whole day. The only space not fully utilized is the storage room.
- The available funds are those from the research project. They are sufficient for basic equipment in all three schools and for additional teachers' training.
- Teachers' skills and beliefs are yet another constraint. Most of the classes are held in ex-cathedra mode. The teachers do not have any support or training in teaching with ICT.
- Students' computer time is very limited. The computer lab is used exclusively for classes in Computing. There is no possibility for subject teachers to use it. Most of the students do not have computers and Internet connections at home.

Selecting the ICT paradigm and the actions

The literature about integrating ICT in the curriculum differentiates between learning about ICT, learning with ICT and learning through ICT (Voogt 2008). Learning about ICT is supposed to provide skills and knowledge about the technology. This is already practiced in the three educational units in La Paz through a separate course about digital literacy. Learning through ICT usually presumes the schools to have some learning management system for delivering content to the students, creating various activities through which students can learn, using ICT for assessment, contacts with pupils' parents, etc. Under the constraints listed above, learning through ICT is hardly possible for the public schools in La Paz, leaving learning with ICT as the only option. Under the listed constraints, learning with ICT can become a reality if at least a single audio-visual room with a projector is provided for each school and additional teachers' training focused on using the technology for teaching and learning is organized. The rationale behind each of these actions and their implementation are presented in the next two subsections.

Creating the audio-visual room

The constraint about the available space in the school buildings motivated the action to transform the storage rooms into audio-visual classrooms. The constraint about the funds available was decisive in the decision on how this transformation to take place. The garbage in the storage rooms was removed, the old furniture was refurbished into desks and chairs for the students, the rooms were painted and the windows were dressed up with dark curtains. A projector with projecting canvas, a desktop computer with wireless network interface card, audio equipment and a printer were purchased for each school. In addition, a wireless access point was provided so that the Internet access can be provided for the computers outside the computer lab. After the equipment was installed and tested the new classroom was referred to as audio-visual room. This room was created so that it is available to use by all subject teachers who wanted to integrate the digital education units into their teaching style that in turn will make the teaching more efficient, interesting and motivating for their students.

Designing and implementing the focused training

Technology could hardly change the practice that teachers had used for a long time. In order for teachers gradually to recognize the power of ICT and to transform their current pedagogical approach, they needed additional training. According to Koehler and Mishra (2009), the development of the Technological Pedagogical And Content Knowledge (TPACK) framework by teachers is critical for effective teaching with technology. ICT serves the purpose of the learners being able to grapple the new knowledge in an easy and fun way only if the teachers integrate their skills in using technology with their pedagogical knowledge and the knowledge about the content that they teach. Another issue important for the teachers from the three schools in La Paz was the awareness about all the constraints they had. Some of these constraints were associated with the technology available, others with their attitudes and beliefs or the skills they possessed. Therefore we extended the TPACK framework into the TPSACK (Technological, Pedagogical, Substance And Constraints Knowledge) framework. The graphical presentation of the both frameworks is presented in Figure 2.

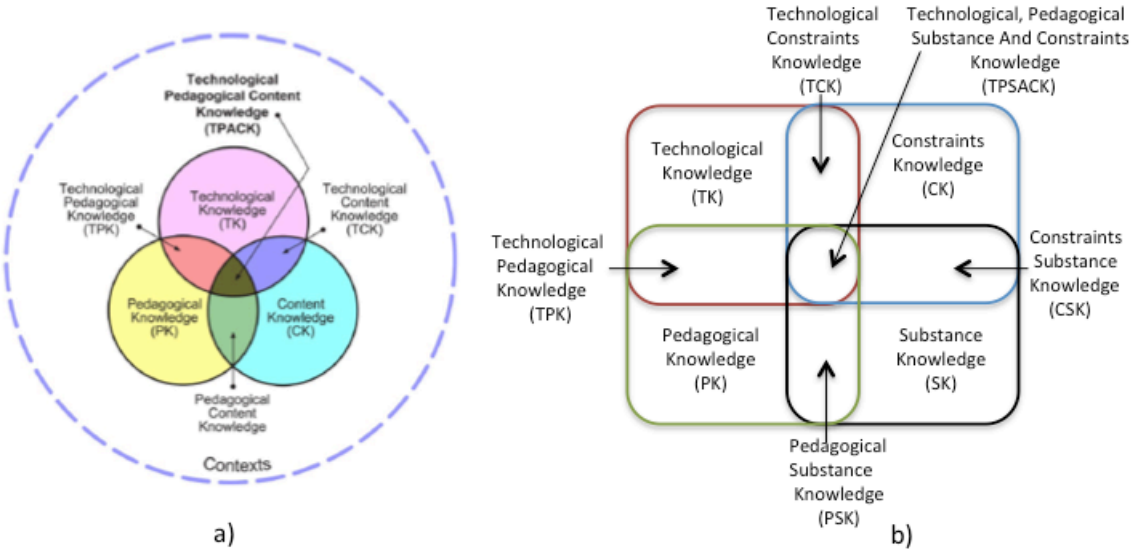

Figure 2: *a) TPACK framework (Koehler & Mishra 2009) b) Extended TPSACK framework*

The focused training aimed to help teachers produce digital tools in the way that they can integrate their technological knowledge obtained through the training in basic digital literacy, the pedagogy suitable for their learners, their knowledge on the topic taught and their knowledge about the constraints. The lack of the time and the diversity of the subjects did not allow implementation of the framework on each subject. However, the constraints with the low speed Internet connection and the software available on the laptops were taken in consideration. The focused training consisted of several sessions where the teachers learned how to create and use educational units with PowerPoint (PPT). By using pictures, video clips, and interactive quizzes the teachers developed digital tools that could make their teaching more efficient in terms of the time necessary for explaining certain substance in the subjects taught. The educational software JClick and Constructor made possible the construction of other tools for motivating students. Despite the slow Internet connection and the short computer time students had, the training also focused on using the search engines, e-mail portals, wikis, blogs and other Web 2.0 tools, as well as the pedagogy behind using them in achieving some of the learning outcomes.

In addition to the training sessions, teachers were provided with support upon request. The local practitioner, being an expert in using ICT in schools, provided consultation and advice about how to incorporate the pedagogy and the knowledge about the substance within the topic taught with the technology and at the same time how to keep to mind the constraints related to the resources available, in terms of the limited time spent with students in the audio visual room, the software available, the slow and unreliable Internet connection and the technical skills teachers learned. The training sessions and support on an “as needed” basis took place during the period February to July 2014. Teachers were given freedom in selecting the activities for their students and they were encouraged to collaborate and to share their knowledge and problems that they encountered. A large number of educational units with ICT incorporated were created, most of them being designed as static or interactive PPT presentations, some as puzzles and crosswords created with JClick, others as group assignments for students to create small projects using ICT, and a few with interaction between teachers and students through blogs. Search engines were used to find pictures or video clips illustrating the topics taught to students.

The constraints driven model

All the elements of the research project, the constraints, the paradigm adopted for integrating ICT in the classroom and the actions taken to make this possible, were assembled in a model. The graphical presentation of the model is shown in Figure 3.

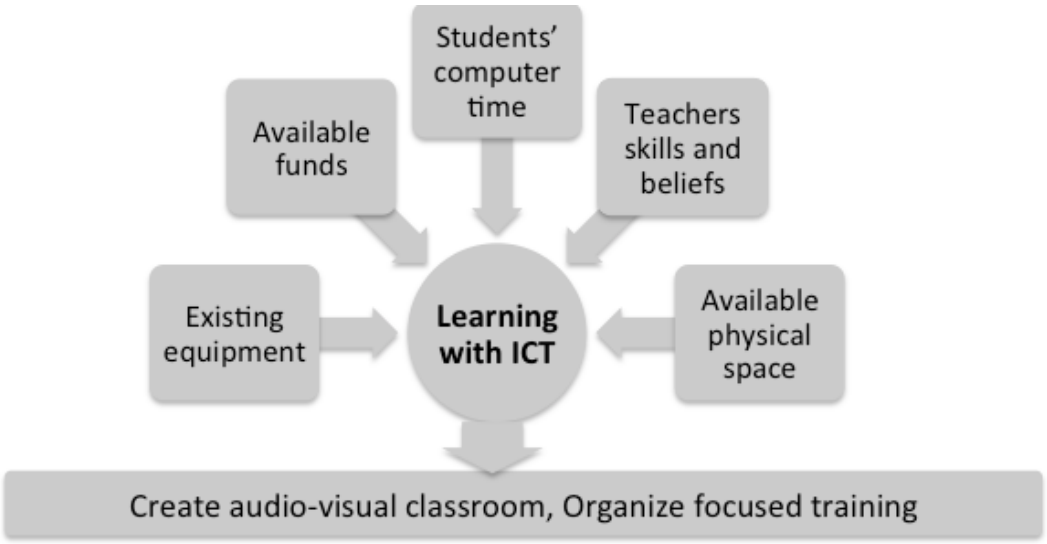

Figure 3: *The constraints driven model*

The upper part in the picture presents the challenges leading to the choice of Learning with ICT paradigm. The bottom part shows the actions necessary for this paradigm to become a reality. All the elements of this model were described in the previous subsections in the chronological order of implementation of the model.

TECHNOLOGY ADOPTION BY TEACHERS

This section describes the method used to estimate whether the teachers adopted the technology and started using it to improve the efficiency and quality of teaching and the findings obtained from the data collected.

Method

A mixed method (Denscombe, 2010) was selected to investigate the change in teachers' daily practice in using ICT. Observations of teachers and students during the use of the audio-visual classroom and focused group discussions with teachers were used to gather qualitative data. Quantitative data were collected through a web-based questionnaire aimed to measure teachers' perceptions regarding the changes in their knowledge and skills before and after the training, their confidence in implementing the technology, and their attitude towards incorporating it in their daily practice.

The observations were performed during the 10 days the Swedish researcher spent in La Paz in August 2014. For evaluating the effect of the change introduced in the teaching/learning process, the audio-visual rooms in all three buildings of the public schools were visited while the teachers and students were having classes, once during the morning, and the second time during the afternoon session. The photographs and the videos taken were later analyzed to estimate the adoption of the technology.

There were four focus group discussions with the teachers from the three public schools and one with the teachers from the private school who joined the training. The groups consisted of a minimum of eight and a maximum of 14 teachers and the duration of the discussion was about one hour together with the time being necessary for translation from English to Spanish and vice versa. The questions asked were mainly concerned with the knowledge and the skills that the teachers gained through the focused training, their expectations of using the technology, both positive and negative, and their perceptions about how and why to incorporate the technology and the knowledge gained into the curriculum of the subjects being taught. The notes taken during the sessions served as the basis for the data analysis.

The bias with the observations and the focus group discussions might have been present because of the close relationship established between the local practitioner, who acted as a trainer in the focused training and as a translator during the discussions, and the teachers. Therefore, additional data were collected through a longitudinal survey, with an online questionnaire as an instrument for data collection. The survey was supposed to estimate teachers' perceptions about the changes in the digital skills that they gained, as well as about the changes in their attitudes towards the technology before and after the focused training. Permissions by the school authorities, as well as the teachers, were obtained ahead of the data collection. They were informed about the researcher's policy in preserving the anonymity of the teachers and in using the data collected only for the purpose of the research. The questions were constructed following a similar research in the literature (Albrini, 2004), (Buabeng-Andoh, 2012), (Papanastasiou & Angeli, 2008). Some modifications necessary to adjust the questions to this particular research were made. The questionnaire consisted of four parts, the first with introductory questions, and the other three measuring three composite variables: perceptions of teachers knowledge and skills in using the technology, confidence in using ICT in the classroom, and attitudes towards incorporating ICT in the daily teaching practice. Each of the variables was measured using more than 10 questions. The questionnaire is available via the following link.

https://docs.google.com/forms/d/1ZbH4XGfrfqk_sV_Qc5svonrWeoV5EPKoPrGe6sloihk/edit

The same questions were used before the start and after the end of the focused training with some exceptions. A single question was added to the questionnaire used after the training. This question asked about the software and the tools that the teachers had used most when incorporating the technology in the everyday classroom activities. The number of responses to all the questions before the focused training came from all 68 teachers who started the focused training hence comprehensive sampling was in place. Participation in the focused training was on a voluntary basis hence some teachers joined the training later. 80 of them answered the questionnaire after the focused training. The difference in the number of respondents to the questionnaire before the start and at the end of the training, as well as the anonymity of teachers, was the main reasons for treating the samples as being independent.

Findings

The visits to the audio-visual classrooms in all three public schools, in the morning and in the afternoon sessions, showed that they were actively used in the teaching/learning process. Figure 3 shows the transformation of the storage room into the audio-visual classroom in one of the schools.

Figure 4: *From a storage room to an audio-visual classroom*

Most of the teachers were still using the ex-cathedra teaching with the PPT presentation being used instead of a blackboard. The teaching style on two occasions included interactive learning with students who were asked to solve the crossword or to answer questions posed by the teacher. For this purpose, the teachers created interactive PPT presentations or crosswords using JClick. There were exceptions to this practice. The teachers at the public Dora Schmidt school asked students to collaborate on preparing their own presentations on sensitive topics, such as sexually transmitted diseases, home violence, early pregnancies and use of the tobacco and drugs by children. In Barrientos morning school the audio equipment was used for performing national dances. When students were asked about their opinions about having their everyday activities in the audio-visual classrooms some of their answers were the following.

> *It is more interesting to follow these lectures than those with a blackboard and chalk.*
>
> *The teacher has more time to answer our questions.*
>
> *Lessons illustrated with videos are really motivating.*

During the focused group discussions with teachers, they pointed out to the following perceived outcomes of the support that they received while incorporating ICT in the teaching-learning process:

- Increased ICT skills;
- Improved learning environments;
- Better strategies for finding videos and other illustrations available on the Internet;
- More ways to keep students motivated to learn;
- Increased understanding of the possibilities and options with ICT.

When asked what they valued the most from the use of technology, the teachers provided answers pointing to the usefulness of some of the software or the built-in features. Here are some of their views:

> *Grading students using MS Excel requires less time. I love the cut-and-paste feature in all the programs.*
>
> *With PowerPoint I can create audio-visual presentations that are appealing to pupils and interactive quizzes to test their understanding.*
>
> *JClick and Constructor are excellent tools for creating crosswords, matching games and other learning activities.*
>
> *With the search engines I can easily find many pictures and videos that I can use to enhance my lectures.*

Negative aspects were also discussed. Teachers were aware of the problems with IT security, such as viruses and Trojans, and the content on the Internet that can influence students in a negative way. Here are some of their concerns:

> *Students bring viruses via memory sticks.*
>
> *Students use Facebook most of the time instead of searching for educational content.*
>
> *Internet connection is slow and unreliable; hence downloading video is difficult.*
>
> *Communicating with parents via e-mail is not possible because 95% of them do not use the technology.*

Before analyzing the data obtained through the survey, we checked the internal consistency of the answers associated with each of the three composite variables. Table 1 presents the Cronbach's alpha and the statistics obtained from the two surveys, one conducted before and the other after the focused training. The first column shows the composite variables with the range of possible values, the second the results from the survey before the training and the third one the results after the training.

The high values of Cronbach's alpha for each of the three variables showed good consistency with respect to the answers obtained to the questions used for each variable. The changes in the variables before and after the training were measured by performing t-test to find out if there were statistically significant differences in the means. The differences were calculated for significance at $p<0.05$. The t-test showed that there was significant positive change in the knowledge and skills in using the technology (t-value at 3.5, p value at 0.00038). There was no significant change for the confidence in using ICT in the classroom (t-value at 1.6, p-value at 0.054) and for the attitude towards incorporating ICT in teachers' daily practice (t-value at 1.5, p value at 0.072). Nevertheless from the means and the standard deviations one could see that the average values for all three variables were rather high in both occasions, before and after the training with not very big values for the standard deviations indicating the teachers' adoption of the technology. Further tests and investigations regarding these variables were not performed because the main purpose with the survey was not to evaluate the focused training. It only served as a control to the findings obtained with the observations and focus group discussions.

Table 1: *Cronbach's alpha and the statistics from the survey*

Variable	Before focused training		After focused training	
	Cronbach's Alpha	Mean (SD)	Cronbach's Alpha	Mean (SD)
Knowledge and skills in using technology (4–64)	0.98	36.97 (14.1)	0.98	44.31 (11.5)
Confidence in implementing ICT in the classroom (0–52)	0.89	32.0 (11.8)	0.91	35.0 (10.1)
Attitude towards incorporating ICT into the teacher's daily practice (0-43)	0.97	34.7 (6.9)	0.99	32.9 (7.7)

The data from the questionnaire at the end of the training revealed that most of the teachers used the Microsoft Office suite in their daily practice (43%), that the second most used technology was the search engines for finding video clips and pictures to illustrate presentations (36%). Only 20% of the subject teachers used JClick or Constrictor to create interactive activities and 1% used blogs to communicate with their students. Owing to the slow Internet connection, the teachers avoided the use of wikis and social networks though they were included in the focused training. The answers to this question showed that all the teachers tried to construct some digital educational tools for their students. A question about the schools of the teachers was not included in the questionnaire because of the ethical approach. However, it is our assumption that the teachers from the private school La Salle were the ones who used blogs because of the higher speed Internet connection and the longer students' computer time in their school.

CONCLUSIONS

ICT is already an integral part of the existing curriculum in the secondary education in many countries. The initiative of the government to integrate ICT in the secondary schools in Bolivia could have been understood as an effort to catch-up with more developed countries and to prepare the children and teachers for the information society. However, the pilot implementation test with the three schools in La Paz proved that not all necessary pre-conditions had been met and that more extensive preparations should have been undertaken before the implementation. The deficiencies of the plan were discovered and mitigated as the process of ICT integration in the three schools evolved. This study showed that providing teachers with laptops and basic digital literacy was not sufficient for the technology to become a tool in their teaching practice. Incorporating the technology in the curriculum of each subject taught in schools is a long process. It requires a lot of time and resources and constant adjustment to the new developments in the technology and the pedagogy.

The main contribution of this study is the development of the constraints driven model as a novel approach to identify the constraints and the actions to be taken at a certain stage of the process of digital inclusion of the subject teachers. Despite the scarce resources and other constraints, the teachers from the three schools in La Paz started to use their laptops in many ways. Many of them were able to merge the knowledge about existing limitations with their ICT skills, the knowledge of the content they taught and the pedagogy in presenting it to the students through

creating learning activities leading to particular learning outcomes. The findings showed that the teachers and the students were enthusiastic about the audio-visual classroom and the ways that technology assisted the teaching/learning process. This was confirmed through a significant number of learning activities where technology was incorporated, created by the teachers and through active participation of students when the activities were performed in the classroom.

The findings from the longitudinal survey confirmed the adoption of the technology. The knowledge and skills in using technology improved although the confidence in implementing ICT in the classroom and the attitude towards incorporating ICT into their daily practice did not show significant change. This kind of findings can be interpreted as the teachers being in the first stage of the adoption of the technology where they were still exploring the possibilities of the limited environment (a shared audio visual classroom, low-speed Internet connection). The can also mean that teachers did not fully built the knowledge in technology, the knowledge in the substance they taught, the pedagogy and the constraints present. Another interpretation can be that the focused training contributed towards the increase in the knowledge and skills sufficient for the early adopters to start using the technology in the classroom. This could also be a sign that the findings from the analysis of the qualitative data were not completely compliant with the findings from the survey. Regardless of how this is interpreted, it is our belief that the penetration of the broadband in Bolivia and the reduced prices of various devices such as tablets and smartphones will largely contribute to the technology becoming an irreplaceable part of the teaching/learning process.

An additional contribution of this paper is the extension of the known TPACK framework into TPSACK framework for building the teachers' knowledge necessary for the technology to become a part of their daily practice. The knowledge about the constraints is very important in particular for developing countries where teachers face additional challenges compared to those faced by teachers in developed countries. The scope of this small-scale study limited the further research about the TPSACK framework. This was left for the future work.

The lessons learned from integrating ICT in the three secondary schools are further used by SPIDER in the project supporting the integration of ICT in 30 secondary schools in the municipality of La Paz, with teachers from Copacabana, Dora Smidth and Barrientos taking the role of the local practitioners in training the other teachers. Moreover, based on the positive experience from the pilot project in the three schools, SPIDER is scaling up the project to 30 educational units in the municipality of La Paz, with teachers from Copacabana, Dora Smidth and Barrientos taking the role of the local practitioners in training the other teachers. We hope what is presented in this study will be helpful for other researchers and practitioners in integrating ICT in the schools in developing countries.

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