Integrating ICT in Kenyan secondary schools:

An exploratory case study of a professional development program

Abstract

This study explores the introduction of Information and Communication Technology (ICT) in Kenyan secondary schools. Specifically, it is a case study of four schools with no previous access to ICT. The professional development program from which data for this study were drawn was designed to support teachers learning to integrate ICT in the curriculum. Using a mixed method research approach, we collected data from multiple sources and triangulated the views of various stakeholders: questionnaires with teachers, focus groups with teachers, school leaders and ICT coordinators, field observations and document analysis. While the broader program focused on the use of ICT, the results highlighted in this study focus on the development of the four schools with respect to 1) vision building, 2) leadership, 3) collaboration, 4) expertise, and 5) access to adequate resources. The discussion centers on the challenges and opportunities inherent in understanding how to prepare schools in developing countries to integrate ICT in education.

1. Introduction

"A few years ago, the emphasis on ICT in education in Kenya was put on the provision of computers to schools, after which it was left for individual schools to figure out what to do with the computers"

Kizito Makoba, SICTiT member

Global interest groups are calling for learners to have the requisite knowledge and skills to engage and perform in emerging knowledge-based, digital societies (Aesaert et al., 2013). These commonly referred to 21st century competencies include inter-alia: critical thinking, problem solving, collaboration, creativity and communication (Abbott, 2010; Voogt & Pareja Roblin, 2012). According to Selwyn (2007), pupils have a great potential to develop such 21st century skills when learning opportunities are presented through the utilization of ICT. In view of this, the Kenyan Ministry of Education expects ICT to be widely deployed for teaching and learning in primary and secondary schools across Kenya (e.g. Quality Education and Training for Vision 2030).

One of the main failures of many past programs, not only in Kenya, was that schools were provided with expensive equipment, but with little or no support for teachers' professional development (PD) (Spector, 2012). A simple placement of hardware and/or software will not guarantee a sustainable change process in the context of ICT use within educational settings (Tondeur, Cooper & Newhouse, 2010). There is no escape from the fact that putting

technological devices in schools places a very heavy demand on the PD (training) system of the country carrying through the change (Hawkridge & McMahon, 1992). Moreover, the PD needed in Kenya is extremely complex and the skills required to deliver it are scarce (Ogembo et al., 2012).

The starting point of this study was to examine the context specific processes of technology integration within four secondary schools in Kenya, and to identify various conditions that influence the success and/or failure of technology integration in these schools. This perspective was informed by researchers who have argued for a more holistic approach to research that encompass the interconnectedness of personal, pedagogical and organizational contexts of influence on ICT-integration (Krug & Arntzen, 2010). More specifically, we examined a PD program designed to support complex school contexts and technology adoption in four Kenyan secondary schools. We aimed to gain insight into whether and how this PD program affected the schools capacity building with respect to a reinterpretation of the Four-in-Balance (FIB) model that includes: vision building, leadership, collaboration, expertise to use technology, and access to adequate resources.

2. Background

2.1 Technology in the context of secondary schools in Kenya

The use of ICT in developing countries has generated a significant amount of interest in recent years, in large part due to the One Laptop per Child program (Kozma & Volta, 2014). With the rapid development of emerging technologies, the use of ICT in education has increasingly also attracted the attention of educational authorities in Kenya (Evoh, 2007). According to the Ministry of Education in Kenya (2012), digital technologies are expected to

be widely deployed for teaching and learning in primary and secondary schools. It seems that education is put forward as the central actor to pursue and attain the objectives of the ICT policy; other sectors are expected to benefit indirectly from this approach. To illustrate this, the national authorities in Kenya proposed in their ICT Strategy for Education and Training (2012), that the integration of ICT should support teaching and learning in the delivery of the various curricula to achieve improved education outcomes, to develop diversified skills needed for industrialization and a knowledge-based economy. Their aim is that all levels of the education sector become ICT literate.

The integration of technology in secondary education is a significant issue, especially across the diverse contexts of Kenya, where only 32% of all school-age children attend secondary school (Ministry of Education, 2012; Ngware et al., 2006), with challenges ranging from a lack of electricity, infrastructure, connectivity and finances, to challenges with respect to the capacity building of all the stakeholders (Hennessy, et al., 2010). Based on this review, the Kenyan Government and donor agencies tend to seek infrastructural investments as a panacea for the needs of schools, without having a plan for how they will be utilized, why they want technological devices, or what existing deficits the technology will address. As a result, the actual use of technology in teaching and learning processes remains restricted, despite considerable growth in the numbers of computers acquired by schools in Kenya (Ford, 2007; Ogembo, et al., 2012).

2.2 The complexity of technology integration in education

According to Earle (2002), technology is integrated when it is used in a smooth manner to support and extend curriculum objectives and to engage students in meaningful learning. The

Kenyan Ministry of Education (2012) has adopted the following definition for ICT Integration: "ICT-integration and Education means the incorporation of information communication technologies to support and enhance the attainment of curriculum objectives, to enhance the appropriate competencies including skills, knowledge, attitudes and values and to manage education effectively and efficiently at all levels".

Research shows that what influences the effectiveness of learning is not the availability of technology as such, but the pedagogical practice of using technology in schools (Mandell et al., 2002). This aligns with a considerable amount of research including Koehler and Mishra's (2009) idea of Technological Pedagogical Content Knowledge (TPACK) based on the early research of Shulman's (1986, 1987) Pedagogical Content Knowledge (PCK). Koehler and Mishra (2009) created TPACK as a conceptual knowledge-base framework teachers should understand in order to effectively teach with technology. Research has extended earlier findings adding technology knowledge is also influenced by specific school cultures and their changing educational contexts that benefit and/or hinder any carefully aligned configuration of content and pedagogical knowledge (Krug & Moll, 2008; Tondeur et al., 2012; Voogt et al., 2012). In this respect, research suggests that pedagogical change lays a tremendous responsibility on teachers to be knowledgeable about not only acquiring ICT-skills but, more importantly to understand methods for teaching to enhance student learning. (Davidson, 2003; Krug & Arntzen, 2010).

2.3 Key components for technology integration in schools

One challenge facing the field of education is to integrate technology into teaching and learning. A teacher cannot manage this task alone. It necessitates school leadership and the

support and collaboration of other professionals. In this respect, Stoll (1999) emphasized the importance of having a shared vision that is based on real school needs to direct educational change, being realistic, achievable, and effective. The involvement of all stakeholders in the preparation and execution of a school vision was also identified as a catalyst in the adoption of ICT (Evoh, 2005). Having a strategic ICT-plan formulated with the stakeholders in a school, that sets clear goals and defines the means to realize these goals, is another crucial development towards technology integration in schools (Vanderlinde et al., 2010).

Once ICT educational goals are established and the role of ICT for the school are clarified and broadly supported by team members, leadership is necessary to build the school's vision (Dexter, 2008). Several studies support the claim that leadership is a key component for capacity building and for merging ICT and education (Dexter, 2008; Vanderlinde et. al., 2010). School leaders (principals, ICT coordinators, teachers) are in a position to create the conditions for the effective use of technology (Tondeur et al., 2008). When teachers partner with school leadership and the team supports working through eventual problems, teachers are more likely to engage with and adopt pedagogical changes (Hargreaves, 1994).

Another key component is the importance of supporting teachers to improve their expertise to integrate technology in teaching and learning. This encompasses more than organizing training sessions for teachers to improve their technical competencies. It is also about deepening knowledge and developing beliefs for teaching and deliberately using ICT for learning (Hermans et al., 2008). Several studies confirmed that teachers who use technology do so because their conceptions of using it fit into their existing teaching perspectives or belief system (e.g., Ertmer, 2005; Krug & Arntzen, 2010). In this way, ICT in the classroom

is much more than adding technology to existing educational practices. Consequently, sustained and evolving PD is crucial.

According to Jacobsen and Lock (2004) teachers required continued PD as they began to experience and reflect on what it meant to teach in ICT infused learning environments. Collaboration was identified as an important component in the active production of ICT-supported curriculum materials (Jang, 2008). Koehler and Mishra (2009) advocated learning to design curriculum materials to foster the development of TPACK, to make rational decisions when selecting how to use technology for teaching specific content to a particular target group (Koehler & Mishra, 2009). Agyei and Voogt (2012) studied how Ghana pre-service teachers developed lessons grouped in design teams and then taught the lessons for the first time in a technology-based environment.

Another key component is school access to appropriate and well-supported infrastructure. Without adequate resources, there is little opportunity for teachers to use the technology within their educational practice. Fundamental to having access to appropriate and well supported infrastructure is the school having electricity and being connected to the Internet. However before school leaders can make informed decisions on designing and purchasing hardware and software, they need information, expertise, and support from knowledgeable people. Only then can school leaders develop school procedures for supporting the operation of ICT-infrastructure. Making choices about purchasing from the many technologies that are available can be a daunting task. How can the school leadership identify the ones that best fit their particular school culture and setting? Deciding what technologies are appropriate requires sensitivity to the schools population, practices, and physical structure (Gioko, 2013).

One possibility includes purchasing refurbished devices for schools that are in most cases acquired from developed countries. Isaacs' (2007) study conducted in Zambia demonstrated that refurbished computers become an immediate burden to the institution as the technology often has a very short life span.

The components mentioned above are part of the FIB model (Figure 1), a scientifically researched framework for the implementation of ICT, from a school-improvement point of view (Kennisnet, 2013).

< Figure 1 >

The central idea behind the FIB model is that the use of ICT for educational purposes is a matter of a well-balanced deployment of four key components: vision, expertise, content and applications, and resources. The underlying theoretical outline was developed and tested based on comparative data from several countries (e.g. Brummelhuis, 1995). The PD program discussed in this paper was designed to use the key components from the FIB model in order to support ICT-integration in four secondary case study schools.

2.4 Research context: PD program for ICT-integration

The aforementioned key components are necessary for developing the pedagogical use of ICT. The research conducted focused on one of the result areas in a wider VVOB Capacity Building program on ICT-integration in Education. VVOB is the Flemish Association for Development, Collaboration and Technical Assistance, founded in 1982 as a non-profit organization. Our PD program included peer learning and sharing of ideas and experiences

between schools in combination with intra-school learning. The two-year program consisted of five phases (Fig. 2) described below.

< Figure 2 >

The first phase included the Ministry of Education in Kenya tasking the PD program ICT-integration Team (ICTiT), a group responsible for coordinating and harmonizing all ICT-initiatives within the Ministry, and VVOB, to develop a strategy for ICT-integration in Kenya's secondary schools. A small team was appointed to set-up an intervention designed by bringing together the Ministries' experiences from previous ICT-integration initiatives. They reviewed lessons learned from benchmarking and current literature and aligned this information with the Ministry's view of ICT-integration in education.

In the second phase, four secondary schools were identified and communication started to identify the participating school's stakeholders (Principal, representatives of District Education Office, Board of Governors, and Parent Teacher Association) and bringing them together to discuss an intervention (PD program). School-level collaboration building workshops were organized where representatives from the Ministry visited each school with the aim of demystifying ICT integration and helping teachers learn about the possibilities of using digital technologies. To manage the many obstacles and changes that ICT-integration might bring, schools were encouraged to form small teams comprised of teaching and non-teaching staff to oversee planning and implementation in each school. These teams are referred to below as the School ICT-integration teams (SICTiT).

Phase three (intervention) started with a three-day workshop on development of ICT school policies. Each school delegated a representative and the workshop was facilitated by an instructor to encourage peer and inter/intra school learning. SICTiT members returned to their schools to brief their colleagues and to prepare for more comprehensive capacity building workshops. Another set of workshops involved gathering all SICTiT members from each of the participating schools to learn about the key components of the FIB Model (Fig. 1). Each school was expected to use the knowledge gained to develop an ICT school policy plan. The final element of the intervention phase saw each school select two representatives to visit educational institutions in Belgium so as to conduct school observations and benchmarking while the rest of the SICTiT members visited schools in Kenya that were already using ICT in their teaching and learning. To help implement their ICT school policy planning, each school was provided with 14,500 Euros (approximately 1.5 million Kenya Shillings). SICTiT members at each school were tasked with deciding how they would use the funds to purchase ICT equipment.

The first activity of Phase Four was five days of workshops learning to develop ICT-supported lessons. During these workshops teachers were asked to organize themselves by subjects and to work within these design teams for the duration of the workshops to encourage peer learning. The instruction encouraged the teams to identify challenging content and practices in their own teaching and to brainstorm how ICT could support and offer an advantage in teaching these challenges. The workshop instructors helped the teachers brainstorm pedagogical strategies and learn ICT-skill(s) required to overcome their challenge. At the end, each team presented the lessons to the rest of the teams and collaboratively shared

strategies for improvement. This sequence of ICT-supported lesson planning activities was repeated each of the five days during the workshops.

In the final, fifth phase visits were conducted to monitor the progress of schools and to identify topics for a second round of PD workshops. The second round of PD workshops were similar to the ones conducted in phase four, but more emphasis was put on the use of the Internet as a resource with strategies on the management of ICT-supported lessons. The teachers once again worked in design teams and consulted with the workshop instructors who followed them to class to observe how they managed a lesson with students. All teams then came together for critique sessions and improvements were formulated. Towards the closing of the PD program, all the participants involved were brought together in three days of closing sessions to review and reflect on their learning and to discuss future practices.

2.5 Objectives of the study

The PD program from which data for this research were drawn was designed to support teachers learning to integrate ICT in four Kenya secondary schools. While the broader PD program also included instruction in the effective use of technology, this study reports on five key components for integrating ICT in the four case study secondary schools 1) vision building, 2) leadership, 3) collaboration, 4) expertise to use technology, and 5) access to adequate infrastructure.

3. Method

3.1 Sample

A case study was conducted involving four Kenya secondary schools. We examined processes of ICT-integration in schools that had no previous experience with ICT. Since there were many schools that fit that description in Kenya, we defined our selection criteria:

1) multiple random Kenya provinces;

2) school districts within a 6 hour drive from Nairobi;

3) four school districts from different provinces;

4) district Education Officers each selected two schools.

The Education Officers used the following criteria:

a. must be public secondary schools;

b. no previous benefits from ICT-related initiatives.

5) four schools that represent gender equity balanced between rural/urban schools.

As a result of this selection process four secondary schools were identified for this case study research.

< Table 1 >

Table 1 describes background characteristics of the sample schools. All of the schools had never received instruction from an ICT PD program. Three of the four schools consistently performed below average on the annual national examination. School 1 scored above average and was currently in transition from a co-educational to becoming a boys-only school due to the low enrollment of girls. It was financially well-off with support from parents. Enrollment included the better exam performing district students. School 2 students and teachers were

taxed to attend and remain in school due to challenges in road access and regional cattle rustling. School 3 was in a financially well-off location, but had too many students for its facilities and its physical infrastructure (e.g. classrooms, dormitories, and dining area) was inadequate compared to the other schools. School 4 was located in an underprivileged part of the country and had insufficient funds to maintain its facilities. Being a Community School it could only charge its students small fees. Most students and teachers covered long distances to attend school and the school only recently introduced lunch for pupils, which encouraged students to attendance.

3.2 Procedure and instruments

This mixed-method research critically evaluated the prospects and challenges of the PD program through the lens of different stakeholders. Examining PD processes, both quantitative and qualitative data collection were employed for the case. Data were collected during school site visits by a researcher over several days. At each school, the data collection included:

- Teacher questionnaires;
- Focus group discussions (ICT coordinators, teachers, ICTiT and SICTiT members;
- Infrastructure inventory assessment and;
- Review of ICT policy plans.

A questionnaire was used to gather information from the teachers about their educational ICT-use and the school contexts. Fifty teachers from the four schools participated and

responded to the survey representing an 81% response, of which 34% were female. Teachers' age range varied from 20 to 52, with an average age of 36 (*SD* = 15.2).

Scales were developed to examine school "supportive leadership" (Hoy & Tarter, 1997); "Teacher participation in decision making", and "Innovation orientation" (Maslowski, 2001). Example statements for the supportive leadership scale (Hoy & Tarter, 1997) were "All teachers work together to accomplish our school goals" and "Some of the teachers have opinions that do not fit in our school." Teacher participation in decision-making encompassed concepts of "democracy" and "joint decision-making." The innovation orientation scale contained items such as, "At our school we try to be attentive to developments in society" and "Teachers at our school are expected to try something new". Respondents were asked to rate each statement on a five-point scale: 1 = "strongly disagree", 2 = "disagree", 3 = "neither agree nor disagree", 4 = "agree" and 5 = "strongly agree". Controlling psychometric quality of the research instrument insured a high level of internal consistency (α>.70).

< Figure 3 >

No overall significant differences were found with respect to the four schools' cultural contexts. This is important as it reduced the impact of other research conditions. Items from the Tondeur et al. (2007) study (Table 2) were used to examine the use of ICT. Control of the psychometric quality of the research instrument reveals a high internal consistency level (α=.87).

Data were also collected through focus group discussions each lasting between one and two hours. The researcher assured discussions covered the five key components mentioned above and that all respondents were given sufficient opportunity to contribute their views. Moreover, the focus group discussions provided stakeholders' a chance to talk about affordances and limitations of technology for teaching and learning. Focus group participants included: 1) teachers of the SICTiT, 2) deputy principals, and 3) parents, and school board and District Education Office representatives. Sessions were videoed and subsequently transcribed.

3.4 Analysis

The qualitative data were analyzed to explore the potential and possible biases in the coding procedure (Miles & Huberman, 1994). Then, the data from each teacher were brought together and a vertical or within-case analysis was applied. This information was used to create, organize and present the interpretative data of each school in a case-specific report. Next, the results of the vertical analysis of each case study school were submitted to a horizontal or cross-site analysis and systematically compared for similarities and differences. During these phases of analysis, within-case and cross-case content was examined and discussed among the researchers safeguarding against misinterpreting the data. Survey data from teachers were used to describe their background and school characteristics and their current use of ICT (Table 3).

4. Results

4.1 Access to adequate resources

Based on school visits the ICT-infrastructure was mapped and inventoried in each of the four schools (Table 2). Each school selected creating a school desktop computer lab, purchasing some laptops, digital cameras, and except for School 1, a printer.

< Table 2 >

A budget of 14,500 euros (Ksh 1.5 million) was provided for each school. Their SICTiT members selected the type, number, and placement of the equipment in each school. Each school created a PC-lab. School 1 installed a *thin-client solution* for their lab, linking 9 displays to 1 master computer. Importantly, school and equipment security was a major concern for not locating PCs in classrooms:

"Our decision to have a computer lab set-up was mainly motivated by security."

[Teacher, S3]

In order to use technology in the classrooms, each SICTiT purchased laptops. This smaller sized device somewhat alleviated the lack of physical space in classrooms, however large class populations also created challenges:

"Lack of enough infrastructure and space is an obstacle to good integration. Teachers have too many students in class to use ICT at an optimum level."

[Board of Governors, S2]

Based on the results of focus group discussions the results indicated the SICTiT vision did not adequately articulate the type of technology required and the location for the technology in each of the schools. In this respect, the lack of access to electricity in the classrooms and power breakdowns are critical issues to locate all the PCs in one PC-lab:

"Unreliable electricity is a big obstacle to proper use of ICT."

[Teacher, S1]

4.2 The development of a shared vision

As to the presence of a shared vision on technology in education, none of the schools developed a comprehensive ICT school policy plan that included clear goals for supporting ICT-integration during or after the PD program. Even though principals acknowledged the importance of developing a school ICT policy plan, a shared vision that involved all stakeholders in the decision making process was difficult to achieve:

"No we do not have one [ICT school policy plan]. We see its importance though as our SICTiT has been a little shaky.

[Deputy S3]

"Our policy seeks to empower all the school stakeholders and give them responsibilities for ICT-integration."

[Board of Governors, S2]

Formulating a shared vision was also difficult due to a lack of educational knowledge about the role of ICT in education. Research participants indicated feeling ready to develop an ICT school policy plan only towards the final days of the PD program:

"The more we learn, the better we are becoming at generating a vision for ICT-integration"

[Teacher S1]

During the closing workshops each of the four schools presented their school vision (ICT policy plans). An analysis of their ICT policy plans revealed that each school desired to become an ICT-integration center of excellence, but did not understand what was needed to achieve this goal. School 1's goals were to integrate ICT into the curriculum, acquire more digital content, and provide an ICT refresher workshop every term. School 2's goals were to use ICT to improve academic performance and ICT literacy. School 3 identified goals such as the use of ICT as a supportive device (e.g. timetabling, communication with pupils) and for delivering content through teaching and learning. School 4 also set goals to use ICT as a supportive mechanism for lesson preparation, financial management, and exam analysis. Although School 4 would like to have one PC for every two students, the reasons for using ICT in the classroom were not expressed in their ICT policy plan. The other three schools established a goal of moving from using ICT as a supportive device for lesson preparation to eventually using ICT in their classroom practices.

4.3 Leadership and collaboration

Leadership and collaboration are presented together because they seem closely related in the findings of the focus groups. It was clear from the interviews and focus group discussions that the SICTiT led the facilitation of using technology in their schools. Nevertheless, additional support was required from administrative school leadership. The school administrator had the authority to requisition the installation of electricity and connectivity in each class and provide release time for the SICTiT members. School administrators were crucial role models for the teachers:

"The principal played a crucial role and she leads by example in that she integrates ICT in her lessons."

[Teacher S4]

At the same time leadership was also perceived as a possible obstacle. Focus group discussion data from School 1 indicated that "*the principal and management are not supportive"* [Teacher S1]. This is in line with the results from the teacher survey with a relative low score for "supportive leadership" and "participation in decision making" in School 1 (Table 2). The teachers in this school pointed at the need for a closer link between ICT-integration and local educational authorities on the one hand and empowerment of the SICTiT members on the other hand:

"*We would like to rotate positions and leadership in the team and increase meetings so that we can come up with the best possible policy*."

[Teacher S1]

Apart from School 1, SICTiT members were able to guide school ICT policy planning and day-to-day preparation for using ICT. Constructively, findings suggest that the PD program promoted collaboration among the school members:

"I have observed better unity among my teachers. My teachers are consulting and collaborating a lot more because of the ICT. This is very nice for me as a principal."

[Principal S4]

It is important to stress that the participants also benefited from the collaboration among the four schools. Moreover, they were ready to share their knowledge and skills with neighboring district teachers:

"We would also like to reach out ourselves to train teachers in neighboring schools on ICT-integration so that we can increase the pool of teachers around us who are integrating ICT. This will be beneficial to us as much as it will benefit our neighbors."

[Teacher S1]

A challenge reported numerous times during focus group discussions was the lack of time to develop new ICT-enhanced lessons. In this respect the SICTiT members of School 2 pointed at the importance of informal learning:

"*We also support one another as teachers through informal talking and sharing while in the staffroom*."

[Teacher S2]

4.4 Expertise to use ICT in education

A question remained as to what degree the teachers in the case schools were able to integrate ICT into teaching and learning activities. It has to be stated that none of the participating teachers used ICT for pedagogy before the start of the PD program (intervention). At the end of the two-year PD program the results of the teacher survey suggested that these teachers were only starting to use ICT in their classrooms (Table 3).

< Table 3 >

Based on collected data (Table 3), teachers were only beginning to use ICT to enhance learning. Field notes and findings from focus group discussions confirmed that the use of ICT was steadily increasing in the schools but at the same time suggested that the technologies were mostly used by the teachers to gather information and for presentation puposes:

"*I use ICT as a way of assisting me to put across my message to the learners and to motivate them. I also complement my lessons with various applications of ICT to make them more interesting and to show things that are not familiar to the students such as icebergs*."

[Teacher S4]

Apart from the use of ICT to structure the lesson and *"to bring reality to the classroom"* (Principal S1), most of the teachers typically utilized ICT for support to prepare and design their lessons. Examples of ICT use included: "email with colleagues" [Teacher S3], "to prepare lessons" (Teacher S1), "for examination analysis, to store data, to make timetables and to track students' progress" etc. (Teacher S4). Although previous results showed that the schools did not invest in mobile devices, the findings revealed that mobile phones were also used for educational support:

"*We also use mobile phones a lot for communication and we have integrated SMS messaging into communication at school*."

[Board of Governors S3]

The participants realized that ICT was rather poorly used by the pupils, but the teachers involved in the focus group discussions were likely to explore how ICT could be used with the curriculum and to improve pupils' learning outcomes.

"*We still have a couple of teachers who only show videos in class and call it ICT-integration. We are still trying to make our teachers understand that it is a lot more than that and that it takes time and effort."*

[Teacher S4]

We noted that based on the results of the focus group discussions School 1 was the least successful to introduce technology to all the teachers. A possible explanation was the resistant

attitude of some of the teachers:

"Some teachers find it challenging to use ICTs and their negative attitude can be difficult to overcome."

[Teacher S1]

Leadership and collaboration in that school were perceived as obstacles in School 1. Eventually teachers agreed to address challenging issues by working collectively and to allocate responsibilities depending on ones ICT knowledge and abilities. To tackle this problem they have agreed to work collectively and to allocate responsibilities depending on ability. Before, the task allocation in School 1 did not work as well as they had hoped due to the limited expertise in the field of ICT in education.

5. Discussion

In the long run, technology is expected to be widely deployed for teaching and learning in primary and secondary schools across Africa (Quality Education and Training for Vision, 2030). The Kenyan Ministry of Education for instance proposed in their ICT Strategy for Education and Training that ICT should support teaching and learning in the delivery of the various curricula to achieve improved education outcomes. Many countries in Sub-Saharan Africa have or are formulating national ICT policies that involve significant investments in hardware and software (Kozma & Volta, 2014). As stated before, one of the main failures of past nation and local programs was that schools were provided with technology, but were provided with little or no support for teachers' PD. Since the program of this study was launched, a number of lessons regarding integrating technology into education in the

developing world have been learned.

5.1 Technology integration in Kenyan schools: a balance between elements

Reflecting on the four sample schools, the findings have identified a range of challenges such as teachers' (limited) expertise to facilitate pupil-centered ICT-use, lack of time, the number of pupils, etc. At this point, the requirement that ICT should be integrated across curriculum areas was not yet mirrored in the actual use of ICT in the four Kenyan schools. It seems that some teachers were beginning to use ICT for teaching and learning in their subject area (e.g. to present information), but most of the teachers were not using ICT to support their educational practice outside the classroom (e.g. to prepare lessons or to email with colleagues). Supportive ICT use refers to using technology outside the classroom for curricular development and administrative teaching tasks. In the literature, supportive ICT use was considered a predictor of future classroom use of ICT. Sang et al. (2011) argued that teachers who are regular users of ICT for supportive tasks will also become more confident in using ICT for teaching and learning (see also Krug et al., 2006).

The integration of ICT in class activities is complex, influencing and being influenced by multiple historic, social, cultural, economic, and political contexts (Tondeur et al., 2008; Krug & Arntzen, 2010). Leadership in the case schools faced daily challenges produced partially by the Kenyan Ministries new curriculum policy on ICT integration, but also because of the specific social, physical and cultural conditions of each school's context (e.g. collaboration, infrastructure, and school relationships). These challenges required finding a balanced coherence of the key components through supportive leadership. According to ISTE (2009), changing schools into digital age places of learning requires leadership to create the

appropriate conditions to effectively use technology for learning, such as partnerships and collaboration within the school and the community. Vandeyar (2014) identified a lack of leadership impacted negatively on the schools ability to implement e-learning in South-African schools. In the current study three of the four school principals demonstrated leadership by providing a conducive school environment for collaboration, accommodating teachers' requirements for PD, and managing resources.

It has to be stressed that along with the principal, SICTiT members led school ICT integration PD gatherings. This is akin to the concept of distributed leadership, where a number of individuals pool their expertise and work together in a concerted way. As a consequence, a larger number of people are involved in technology support, trusted with information, involved in decision-making, and participating in knowledge creation and communication (Dexter, 2008). Tondeur et al. (2009) found that both the structural and cultural characteristics of a school's contextual condition are important catalysts for ICT integration in the classroom. Leadership and collaboration are characteristics of a school's cultural context and ICT support and ICT planning are examples of structural characteristics. Leadership and collaboration among teachers were important components of the PD program.

Agyei and Voogt (2012) also identified collaboration as a pivotal characteristic in ICT integration PD in Ghana. By sharing knowledge and materials, common goals could be reached. Angeli and Valanides (2009) discussed that collaboration with peers provided a low threatening learning environment for teachers, which reduced anxiety and avoidance of taking risks. Our case study suggested that collaboration needed to occur at the school level as well as at the district and regional levels. In three of the four schools participants collaborated with

each other and shared ideas with colleagues. In turn, a sense of responsibility formed among the participants promoting professionalism.

Finally, access to appropriate and supportive infrastructure will probably continue to be an issue in secondary schools in Africa in the coming years. According to Ford (2007) limited access to infrastructure and electricity in combination with a high poverty rate has kept Kenya from making advancement in ICT integration in education. Rubagiza, et al. (2011), reported the limited access to computers and other technologies in Rwandan schools negatively impacted how students learn to exercise control over technology and content. Integrating ICT in African schools will take time to overcome fundamental infrastructure deficits. We were not surprised to see that a computer lab was the popular strategy to deal with infrastructure challenges. If these contextual conditions are left unaddressed they will influence the ability of schools to integrate ICT.

Zandvliet (2006) argued PC-labs reduce optimal chances for ICT integration in learning activities because the technology is separated from and the classroom. Tondeur et al. (2008) suggested that computer lab availability influenced the learning of technology skills whereas the placement of ICT within a classroom positively contributed to the use of technology for learning. Unfortunately, in our case the location of infrastructure was effected by a lack of 1) security, 2) electricity and power breakdowns in schools and 3) physical space in the classrooms. Ogembo et al. (2012) advised the potential of cell phone technology as a pedagogical instrument to help facilitate the use of ICT in Kenya. According to these authors, the mobile phone industry in Kenya has enjoyed unprecedented growth during the last decade. Nevertheless, apart from the use of mobile phones for supporting student communication,

pupils were not allowed to use their own mobile device during class time.

5.2 Towards a synthesis of bottom-up and top-down approaches

The approach used in this PD program encouraged the participants to use their own plans for ICT-integration, to implement these plan, and manage their resources. The SICTiT members were asked to facilitate ownership of these changes and to engage school colleagues in self-reflection and re-evaluation so to help them better understand their own learning and school goals (Fullan, 2007). But our case study results clearly demonstrated that it was difficult for the SICTiT members to develop the schools ICT policy plan and to decide what type of ICT infrastructure was best for their school. While getting schools equipped with the appropriate infrastructure was a crucial step for ICT-integration, other contextual conditions of a schools culture needed to be considered.

This PD program built upon the teachers' existing practices, reinforced by collaboration in design teams to prepare curriculum materials. Koehler and Mishra (2009) suggested design teams were a promising strategy for developing TPACK materials. Through collaborative experiences, teachers acknowledged the importance of sharing and applying their ICT knowledge in their own settings (Tearle & Golder, 2008). Clift et al. (2001) concluded that PD program designers should deliberately create experiences in which teachers share their attitudes and abilities with one another.

This approach is in accordance with findings of other studies that stress the importance of PD as a continuous process aimed at extending and updating the professional knowledge and beliefs of teachers in the context of their work (Krug & Arntzen, 2010; Sang et al., 2011).

Lim et al. (2013) argued that the integration of ICT in education is a process of learning, rather than just a process of design and engineering. Krug and Arntzen (2010) recommended instructing teachers on learning a critical inquiry approach that continuously cycles through: (1) direct experiences, (2) observations and reflections, (3) deliberation and dialogue and (4) taking action. Teachers should be able to conduct inquiry to extend and update their educational and technological knowledge. Also the results of the current study suggest that informal learning in school, e.g. from the ICT coordinator or colleagues, and out of school, such as visits to other schools, should be considered (cf. Tondeur et al., 2010).

Past programs for ICT-integration in developing countries have often failed due to a mismatch between the educational change and the meanings attached to that change by those involved in the instructional process (Hennessy et al., 2010). The results presented in this fueled the development of theory concerning the complex conditions of integrating ICT in education, with a special focus on developing countries. We think of technology as a concept and object that is always relative to something and, in the context of education, it is relative to the cultural conditions of particular people using them, the educational system, desirable curricular goals, and strategies for teaching and learning. To illustrate, the education reform rhetoric about the need to develop students' 21st century skills gives legitimacy to knowledge building as a preferred pedagogical approach. Assessment systems however use rigidly defined curriculum content and as such places unnecessary pressure on teachers to avoid risk taking such as encouraging students' 21st century skills (Laferrière, 2012). Future research should therefore consider the relational use of technology in view of teachers' pedagogical beliefs and school cultures (cf. Krug & Arntzen, 2010), national and local curriculum organization and the societal characteristics of educational systems in developing countries.

6. Conclusion

This study investigated the introduction of technology in four secondary schools in Kenya. The findings of the case study suggested that the involvement of all stakeholders was crucial for the ownership of ICT-integration in education. Consequently, the process of effective technology incorporation should not be facilitated as stand-alone events. Rather, PD programs should be part of a cycle of inquiry that supports teachers learning, try out and receive feedback. Teachers' will need opportunities to share their successes and failures, face challenges, and make new discoveries. A critical dimension of what we learned in the current study was that ICT-integration requires being flexible and tempered by the contextual conditions of the schools cultural day-to-day practices. For those involved in integrating ICT into curricula in Kenyan schools, PD will require constant reiterations of learning about emerging technologies and pedagogical practices that are in balance with the national ICT initiative but more importantly the changing contextual conditions of specific school cultures and communities.

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