# TEACHERS' PERCEPTIONS ABOUT THEIR OWN AND THEIR SCHOOLS' READINESS FOR COMPUTER IMPLEMENTATION: A SOUTH AFRICAN CASE STUDY

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**ABSTRACT**
This case study, involving 30 participating teachers from six previously disadvantaged South African schools, provides data on teacher perceptions of the challenges related to implementing Information and Communication Technology (ICT). The schools had minimal resources as a residual result of the South African apartheid policy prior to 1994 and are located in areas that lack basic infrastructure. Twenty computers were provided to each of the schools by a donor solicited to support an ICT training intervention conducted by academics at the Nelson Mandela Metropolitan University (NMMU) in South Africa. A quantitative Likert scale questionnaire, qualitative interviews and a qualitative open-ended questionnaire were used to gather data. These data suggest that, despite the fact of the schools were provided with computers and teacher training, several first and second order barriers still exist. Examples of these barriers are insufficient ICT resources for the large classes that have to be taught, lack of project leadership within the schools, and a need for ongoing training and support. These barriers appear to have not allowed the teachers and schools to go beyond an initial integration phase. The data generated, the literature consulted, as well as the involvement of the authors in the ICT implementation and training process over a period of two years, underpin the suggestions made for consideration when attempting to implement ICT focused interventions, particularly in schools with limited infrastructure and support. An implementation heuristic is proposed for consideration by those involved with ICT implementation in comparable situations.
**Keywords:** Barriers, challenges, ICT implementation, perceptions, ICT enablers, ICT integration

## INTRODUCTION

Internationally there are calls by students for technology to play a more integral part in their learning (Conole & Creanor, 2007). However, in South Africa (Department of Education, 2004; Howie, Muller & Paterson, 2005; Mlitwa, & Nonyana, 2008), Africa (Africa Partnership Forum, 2008), Southern-Asia (SEAMEO, 2010), and other less developed countries, schools may have great difficulty in providing children with access to computer hardware and internet connectivity. In the South African context the majority of learners are disadvantaged as their schools are situated in poor township areas where basic amenities are lacking. In spite of progressive curricula introduced since the first democratic elections in 1994, township schools do not have the same resources that more privileged schools situated in middle- and upper-class neighborhoods have and, despite the fact that many of the learners have access to mobile phones, they remain 'digital immigrants' (see Prensky, 2001) with little to no access to computers (Department of Education, 2002, 2004). However, the national curriculum demands that children become computer literate and that schools integrate ICT across the curriculum (Department of Education, 2004). Education authorities have provided a three phase plan for schools to prepare learners to be digitally competent from 2010 (Department of Education, 2004), but the reality in 2011 is that few township schools had been supplied with ICT resources. Also, the governments' *'one laptop per teacher' initiative* (Mail & Guardian, 2010) had not materialized as teachers - who are expected to secure personal financing to buy a laptop, and thereafter claim a subsidy from the Department of Education - are not considered creditworthy by South African banks (Timeslive, 2011).

This study attempted to determine the barriers to ICT implementation (Akbaba-Altun, 2006; Ertmer, 1999; Ely, 1999; Goktas, Yildirim, & Yildirim, 2009; Topracki, 2006; Ogiegbaen & Iyamu, 2005) as perceived by a sample of teachers in six disadvantaged township schools in Port Elizabeth, South Africa. The question that was asked was 'How ready are these participating schools and teachers for ICT implementation and integration as perceived through their own eyes?' The rationale behind this question was to provide data to develop a heuristic that could provide useful guidelines to government, schools, Non-Governmental Organizations (NGO's), and other ICT facilitators when implementing ICT within similar contexts.

**Background**

A number of assumptions usually underpin studies which elicit teacher perceptions, as well as the attempts made to analyze the data generated. In order to make the assumptions in this paper explicit in terms of what successful integration entails and how it can be best promoted, the first part provide a brief overview of some literature findings related to integration types, phases of integrations, barriers to implementation and approaches to ameliorate these barriers. Thereafter the data generated are presented and used to motivate the heuristic that is proposed.

**Types of integration**

While the term 'technology' includes digital cameras, mobile phones, dvd players, ipods, etc., only traditional desktop, laptop or netbook technology are implied in this paper. Also, the use of the term 'integration' does not refer to the mere placement of computer hardware in a classroom where the focus is primarily on technology *per se* (Smaldino, Lowther & Russell, 2008), nor does technology integration refer to using computers to support traditional or prevailing methods of teaching, for example learning 'from' the computer through tutorials, drill-and-practice, simulations and hypermedia applications (Morrison, Lowther & De Meulle, 1999; Reigeluth & Joseph, 2002). Rather, technology integration is seen as transcending traditional teacher centered pedagogies where learners use the technology to learn *'with'* and *'through'* computers (Jonassen, Peck & Wilson, 1999).

Hodgkinson-Williams (2006) and Du Plessis (2010) note that three types of integration are prevalent are prevalent in South Africa. The first type is *'Learning about computers'*, focusing on implementation without integration. This approach often results in *'computer literacy'* that merely involves using computer applications without any link to what is happening in the classroom. The second type refers to *'Implementation with integration to achieve traditional goals'*. This type of so-called integration often results in learning *'from'* the computer where the computer becomes a tutor and the result is that the computer becomes the transmitter of knowledge (see Jonassen, Peck & Wilson, 1999). The third type is *'Implementation with full integration within a constructivist learning space or context'*. This type of integration refers to learning *'with'* or *'through'* using computers (Jonassen, Peck & Wilson, 1999) is also referred to as the generative use or mode in which computers or ICT's are used as cognitive, mediational, or transformational tools (Hodgkinson-Williams, 2006). An analysis of the SAIDE (2003) report and the '*Managing ICTs in South African schools: A guide for school principals*' (Bialobrzeska & Cohen, 2005) suggest that generative mode integration is not the norm in South African schools.

**Phases of integration**

Several extant models or frameworks related to the phases of integration exist. The Apple Classrooms of Tomorrow (ACOT) project concluded that there are five stages or phases of technology adoption, namely entry, adoption, adaptation, appropriation and invention (Sandholtz, Ringstaff, & Dwyer, 1997). Toledo (2005) states that a five-stage developmental model of computer technology integration has emerged in teacher education curricula in colleges and departments of education; namely pre-integration, transition, development, expansion and system wide integration. In the South African context, Miller (1997) developed and implemented the *'Evolutionary Model'* which also describes integration as a five phase process; namely introduction, entry, intermediate, penultimate and creation. The UNESCO (2002) report suggests a four-stage continuum of ICT integration which includes emerging, applying, infusing and transforming, while Kopcha (2008) has suggested a systems-based mentoring model for integration which highlights the importance of mentoring, modeling, apprenticeship, just-in-time assistance and the forming of communities of practice. The apparent acceptance by researchers and institutions that individuals and schools develop through different stages - some faster and some slower – suggest that it would be fruitful to develop a heuristic for teacher preparation and participation which could assist and accelerate the adoption and integration process.

**Barriers to implementation**

Ertmer (1999) argues that the barriers to ICT implementation can be categorized as first order barriers and second order barriers. First-order barriers are extrinsic to teachers and include aspects such as (1) lack of access to appropriate resources (software, hardware and internet access), (2) lack of time, (3) lack of support and (4) lack of training (Ertmer, 1999; Ely, 1999; Ogiegbaen & Iyamu, 2005; Akbaba-Altun, 2006; Goktas, Yildirim, & Yildirim, 2009; Topracki, 2006). Second-order barriers are intrinsic to teachers and refer to (1) attitudes, (2) beliefs of teaching, (3) beliefs related to learning, (4) practice and (5) inherent resistance in teachers (Ertmer, 1999; Ely, 1999; Ogiegbaen & Iyamu, 2005; Akbaba-Altun, 2006). While access to hardware, time and support are fundamental, attention to second-order barriers are equally important as teachers' pedagogical beliefs about teaching and learning are ingrained and of a personal nature. These beliefs result in a dogged persistence in terms of teaching as they have been taught (Pajares, 1992), and if the positive attributes noted above do not already

exist they are difficult to inculcate and strongly militate against attempts to successfully integrate technology in schools (Cuban, 2001; Fullan & Smith, 1999).

**Approaches to ameliorate first-order barriers**

Bialobrzeska and Cohen (2005) and Creighton (2003) suggest that one of the starting points when dealing with first order barriers should be the creation of a shared vision of technology implementation and integration, including a technological plan that clearly shows the way ahead. Bialobrzeska and Cohen (2005) highlight using a 'Strengths, Weaknesses, Opportunities and Threats' (SWOT) strategy towards planning in order to avoid a situation where teachers feel *"We're Wired, Webbed, and Windowed, Now What?"* (Trillig & Hood, 1999). Such planning should consider equity of teacher access to technology (Flanagan & Jacobson, 2003) and the provision of the infra-structure; administration and financial support (Surry, Porter, Jackson & Hall, 2004). In the South African context the role of the private sector through sponsorship has played an important role in the past, something which is recognized by Department of Education (2004) and which has official exploration of opportunities to assist teachers to procure their own desktop or laptop and an internet connection at home (see the *One laptop initiative'*; Mail & Guardian, 2010).

Fishman and Zhang (2003, p. 17) suggest that the school vision should focus on "planning for the pedagogical and educational over the technological", i.e. not simply on how to improve traditional ways of teaching (Schiller, 2002). In addition, the preparation for any implementation process should allow for collective planning that includes not only the principal, staff, governing body, parents and community (Fullan & Smith, 1999; Hinson, LaPraire & Heroman, 2006), but also the insights of the learners (Joseph, 2006). Equally important is that ongoing staff development focus not only on technical training, but on classroom integration (Creighton, 2003). Castro and Alves (2006) believe that the establishment of discussion groups, which meet on a regular basis to share successes and challenges in order to establish professional learning communities within the school and among other schools, are vital. Coupal (2004) states that collegial mentorship should be promoted during staff development, i.e. emotional, technical and informational support in order to enhance self-efficacy (Ertmer, 1999). Gibson (2002) and Creighton (2003) proclaim that the role of the school principal is a key feature in the process, and in order to succeed they have to play the role of a technology leader, head learner and initiator, and not merely be a manager of the process.

Weinbaum, Allen, Blyth, Seidel and Rubin (2004) promote reflection as an approach to ameliorate first order barriers to implementation. They see the value of reflection by the school as an organization and personal self-reflection by teachers on their current ICT practice(s) as fourfold. Firstly reflection is seen as a learning activity; secondly reflection helps with school introspection (where the school and the self are currently); thirdly it makes explicit where the school and staff come from technologically; and fourthly it assists with planning how to go forward technologically (Hoban, 2002). They believe that all of these processes should be helpful in taking an ICT implementation process forward.

**Approaches to ameliorate second-order barriers**

Ertmer (1999), Fullan and Smith (1999), Mouza (2005), and Prensky (2008), amongst others, believe that teachers hold the key to successful technology or ICT integration in schools. However, as noted earlier, they do not change their practices easily (Cuban, 2001). Fullan and Smith (1999) state that for change to occur re-culturing is required and that, in order for this to happen, opportunities must be provided for teachers to challenge their current beliefs. Mumtaz (2000) believes that change could be achieved when teachers become conversant with educational teaching and learning theory related to using technology, and when they experience the fruitfulness of new technological practices. Fullan and Smith (1999) promote the formation of learning communities as a fruitful approach to changing teachers' beliefs and practices.

The aforementioned researchers agree that one cannot *'force'* ICT or technology implementation, and that teacher development is a process. Not all teachers will embrace it in the same manner. Teacher development sessions pertaining to ICT or technology usage and integration planning must aim for increased teacher self-efficacy, i.e. raising personal beliefs regarding the ability to learn or perform ICT related skills and classroom implementation strategies at a certain levels (Ertmer, 2001, 2004). Personal mastery, observing how people model or implement a strategy or practice, verbal and social persuasion as well as emotional arousal are important issues in the process (Ertmer, 1999; Schunk, 2004; Bandura, 1997). Containing anxiety (George & Camarata, 1996) and the creation of a climate care (Havelock & Zlotolow, 1995 are also important. Like Fullan and Smith (1999), Hung and Koh (2004) suggest that the establishment of communities of practice could assist develop teacher self-efficacy, and that adopting a multi-faceted socio-cultural approach that acknowledges school structures, classroom dynamics, teacher beliefs and student (learner) behaviours are important.

## RESEARCH DESIGN AND METHODS

### *Setting*

The Dell Foundation was approached by NMMU staff to assist four designated primary schools and two high schools in the Missionvale area of Port Elizabeth acquire computer hardware and software. The result of this solicitation was that each of these schools received 20 desktop computers and a Linux based office suite, drawing software, and paint and mathematics educational software. As these schools did not have any internet connectivity, funds for the installation of 'line of sight' Internet connectivity installation by NMMU ICT specialists was also successfully solicited from the Hermann Ohlthaver Trust.

### *Participants and ethical considerations*

The schools which were considered in this study are similar to many other township schools in South Africa. School principals were asked for permission for their teachers to participate and the Department of Education (Port Elizabeth District Office) was approached *via* a letter addressed to the district director, after the project was discussed telephonically. After a letter of approval had been received the principals and representative teachers from their schools were invited to attend a series of meetings where the research project and its requirements were explained and which preceded a year-long continuous professional development programme run by the researches aimed at ICT integration in the participating schools. The teachers were volunteers and could terminate their participation at any point in the process.

### *Data collection tools*

A seven-point Likert scale questionnaire consisting of 94 statements based upon aspects drawn from ICT implementation literature was designed to determine which first- and second-order barriers (Ertmer, 1999), as perceived by the participants, existed in the schools. Initial data generated reflected the teachers' perceptions before the new sponsored computers had arrived and connectivity was established. A 1 on the scale indicated 'strongly disagree' and a 7 'strongly agree.' Initial inspection of the data revealed that the responses could be grouped. Responses ranging from 1 to 3 were grouped as disagree, responses greater than 3, equal to 4, or equal to 5, were grouped as neutral or uncertain, and responses greater than 5 to 7 were grouped as agree (Ary, Jacobs & Razavieh, 2002). Items which could not be grouped in groups of two or more statements pertaining to the same aspect are presented individually. For the purpose of this paper, only the summary of the first- and second order barrier items (See Table 1 and 3) as well as eight individual items, i.e. items where the Cronbach alpha could not be calculated, are reported.

An open-ended questionnaire allowed the participants to freely voice their concerns and make suggestions related to ICT implementation Follow-up semi-structured individual interviews were also conducted regularly during the implementation process over two years (Rubin & Rubin, 2005). All interviews were recorded on a Dictaphone. Examples of interview questions are "Does your school have a vision for computers? If YES, please tell us what the vision is", "If your school has a vision for computers, how did it arrive at this vision?", "Do you have regular staff meetings to discuss computer issues? What are discussed during these meetings?", "What problems do you foresee for computer integration at your school?", "How computer literate are the staff members? Why do you say so?" and "Do you think that your staff members will be able to manage computer integration well? Explain." The open-ended questionnaire contained question such as "At the moment, can you count on support from the Eastern Cape Education Department or District Office to help with computer integration? Yes or No. Please tell us why you say so." And "What does or should the Eastern Cape Education Department or District Office do to help schools with computer integration. List the things they should do or get in place." Audio recording of the interviews allowed reliability checks (McMillan & Schumacher, 2006, p. 205) and the data provided by the three sources was triangulated to provide a 'snapshot' of the teachers' perceived reality.

### *Data reliability and trustworthiness*

Cronbach alpha (α) reliability scores were calculated for the Likert scale data. Multiple sources of evidence, namely a quantitative Likert scale questionnaire, an open-ended questionnaire, and a qualitative interview were used in order to explore the anticipated barriers and triangulated to validate the findings (Yin, 1994, 2003a, 2004b). While it is accepted that generalizability cannot be claimed for the findings of a case study, it is however possible to make modest extrapolations which could lead to applicability in other similar, but not identical, situations (Patton, 2002). Hence, the results from the case study should provide some insights for dealing with, and planning, ICT integration in similar contexts (Stake, 1995).

## RESULTS

The results are framed as first order- and second-order barriers with subheadings indicating a variety of aspects encompassed by these barriers. The reliability of the test items, which range between excellent (α≥0.9) and just greater than unacceptable (α≥0.5), illustrated in Table 1 (George & Mallery, 2003).

### *First order barriers*

The first order barriers as perceived by the participating teachers are illustrated in Table 1 and reported on in the text below.

*Limited, but evolving vision, focus and goals*

The summarized data from the Likert scale questionnaire revealed (See Table 1) that only 33% of the participants felt that their school had a vision and had identified the goals needed to realize it, while 53% were uncertain. Interview data suggested that where there was a vision, it was very limited and only focused on the initial stage of familiarizing the learners with basic computer literacy and then moving to using the computer for learning. One teacher stated, *"With computers we want to be computer literate and also make our own learners computer literate, and we especially want to teach the kids to search the information on their own. They can do their homework and assignments and do it well."*

Table 1: First order- or extrinsic barriers as perceived by the participating teachers

| Summary of items | n | □ | Mean | SD | Low 1,3<br>1<=x<=3 | | Avg 3,5<br>3<x<=5 | | High 5,7<br>5<x<=7 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Vision & goal setting | 30 | 0.50 | 4.51 | 1.19 | 4 | 13.3% | 16 | 53.3% | 10 | 33.3% |
| Computers and related infrastructure | 30 | 0.40 | 2.97 | 1.08 | 15 | 50% | 15 | 50% | 0 | 0% |
| Department of Education support and training | 30 | 0.57 | 2.02 | 1.20 | 25 | 83% | 5 | 17% | 0 | 0% |
| Support for computer based teaching | 30 | 0.79 | 6.39 | 1.01 | 1 | 3% | 1 | 3% | 28 | 93% |
| Existing participation & consultation related to computer integration | 30 | 0.84 | 3.30 | 1.35 | 10 | 33% | 18 | 60% | 2 | 7% |
| Importance of participation and consultation | 30 | 0.67 | 6.30 | 0.62 | 0 | 0% | 1 | 3% | 29 | 97% |
| Colleagues with computer skills | 30 | 0.77 | 3.46 | 0.89 | 12 | 40% | 17 | 57% | 1 | 3% |

Another teacher mentioned "We would like to have our teachers and community to be computer literate, so that when they go to the working world they know what to do and implement what they have learnt from our school" and another one concurred when stating that the school's vision is "in a developmental process" and he continued, "I can't say it's a clear vision we have but we are trying to get there."

*Lack of infrastructure*

The summary data from the initial Likert scale revealed that 50% of the participants thought that infrastructure and resources were lacking in their school, while the other 50% were unsure (See Table 1), and that they desired more computers and Internet connection. Examples of interview responses are, *"We need Computers, they are not enough even for learners. We have one computer lab for the whole school. It poses a challenge when you need to practice because computer giants are always using them. Then computer illiterate people are in disadvantage. We do not even have Internet that is another challenge"* and, *"The lab has to be set up. Some of the infrastructures produces have been addressed but a few are still outstanding."* The need for more computers is reflected in the statement, *"As we have big numbers in our classes, learners need more computers so that*

*[each] one can have his/her own computer so as to speed up in period."* The need for technical support was also articulated: *"The other thing that I think is the problem is the maintenance of the computers. Sometimes the computers are less [due to the fact that some are not working] and when you go to the computer room you'll find out some of them are not working. There are 20 computers and maybe 5 are not working and 15 of them are working*."

*Lack of support from the Department of Education*

Eighty three percent of the teachers indicated in the questionnaire that leadership, support and training related to computers were lacking (See Table 1). Interview data supported this claim and six interviewees categorically stated that support from the Department of Education (DOE) was non-existent. One participant mentioned that there were "*some promises",* but that this had not materialized. Another teacher mentioned that their assistance came from a NGO, not the DOE. In the open ended responses on the questionnaire regarding DOE support a number of the participants confirmed that they had been assisted by NGO's but not the DOE, and that the DOE was *"full of promises"* and not helpful, as evidenced by responses such as, *"Past experience has taught one that NGOs are the people who develop schools"*; *"Eastern Cape Department is dead as compared to other provinces."*

*Need for ongoing support and hands on training*

Table 1 reveals that the teachers feel that support is vital, an aspect that was evident during interviews. One teacher stated that support is required all the time; another concurred and added that it has to be ongoing, stating *"You need to not disappear. You need to guide us, constant observation. Look what we are doing because [Name of NGO omitted] made the mistake of giving the computers and then see for yourself what you can do. I say those who organize the training need to be hands on. There is no way you can leave the school."*

*Need to improve existing participation and sharing of experiences during the implementation process*

Thirty three percent of the participants indicated that they disagreed that there was enough participation and consultation regarding implementation efforts and 60% were uncertain (See Table 1). A deeper analysis of their specific responses revealed that the majority were either uncertain or disagreed with statements such as whether there were opportunities to share their computer classroom experiences – positive aspects as well as challenges, whether there were regular staff development sessions regarding the computer implementation process and development sessions. Interview data indicated that they acknowledged that there had been some form of consultation and discussion in their schools. One teacher mentioned that they often discuss equipment problems and problems that the learners experience in the computer room. However, this was almost always done in an informal way among staff members. A principal of one of the participating schools stated that they discussed as a group *"how effective computer makes us to our schools and the shortcomings that people encounter when they make use of computers."* He also noted that they looked at *"How can we budget to keep the programme sustainable and of course some costs are looked at by the entire school."* A teacher noted that as all staff members are not all at the same computer skills level, this made discussions difficult; *"basically you know as a committee we are not at the same level with one another when it comes to computers. We are more or less focusing on developing our own skills and secondly we look at the challenges that we face at the computers."* He also noted that teachers did discuss *"what content we want to teach."* Another teacher stated that at their school they have meetings, but that the meetings were more like informal discussion groups than formal gatherings. Table 1 also reveals that 97% of the participants highlighted the importance of group participation related to the implementation process.

*Need to improve the computer skills of colleagues in the school*

The overall summary of the Likert scale questionnaire revealed that 40% of the respondents indicated that teachers in their schools lacked computer skills, while 57% were uncertain whether those who can use computers had adequate computer skills (Table 1). When the raw data were examined in more depth, it was found that only 7% considered the staff members in their schools to be computer literate, 63% of the participants were uncertain and 30% indicated that they were not computer literate. Only 20% of the participants stated that their principals were computer literate, while 47% indicated that this is not the case. Junior staff members were seen to be more computer literate than senior staff members, but overall perceptions of literacy was low (17% of the junior staff members and only 7% of the senior staff member). The importance of more training is also indicated in Table 2, as 93% of the participants stated that there is a need for teachers to be trained regarding computer skills and computer integration.

Table 2: First order- or extrinsic barriers (individual items) *

| Summary of items | n | Mean | SD | Low 1,3 1<=x<=3 | | Avg 3,5 3<x<=5 | | High 5,7 5<x<=7 | |
|---|---|---|---|---|---|---|---|---|---|
| The importance of training for computer skills and computer integration | 30 | 6.73 | 1.14 | 1 | 3% | 1 | 3% | 28 | 93% |
| Existing time tabling provision for computers | 30 | 3.67 | 2.14 | 11 | 37% | 13 | 43% | 6 | 20% |
| Enough access to computer room | 30 | 3.83 | 2.72 | 11 | 37% | 10 | 33% | 9 | 30% |
| The importance of rewards and incentives | 30 | 6.03 | 1.90 | 3 | 10% | 3 | 10% | 24 | 80% |
| I will learn more about computers if I am rewarded for it. | 30 | 1.73 | 1.62 | 25 | 83% | 3 | 10% | 2 | 7% |
| Funding available for training | 30 | 2.0 | 1.51 | 21 | 70% | 8 | 27% | 1 | 3% |

* No Cronbach alpha calculated, as only one item was used referring to this aspect or item

Interview data confirmed the quantitative data. During interviews two teachers from different schools stated that principals were *"somewhat computer literate."* Another teacher stated, *"If I can rate the on the level of 1; 2; 3; 4. The majority of them I would say are in level 2, meaning that they have the basic skills. Opening, typing and saving the document."* One teacher said that *"I think the principal is computer literate; he is at [name of the university] so I think he must be computer literate and because he had a computer in his office, a laptop and a computer at his house."* Personal school visits also indicated that the principals did have computers in their offices, but that this does not necessarily indicate that they could use them effectively. This observation was supported by a principal who noted during an interview, *"What spoils us as principals is that you have a secretary and when it comes to do some typing you just ask the secretary to quickly do it for you."* The teachers interviewed also felt that junior staff members were more computer literate than older teachers. One teacher mentioned that this was because *"they are younger and more up to date with technology."* Another teacher also said, *"They are quite computer literate, because they are freshly out of tertiary institutions so they actually know what to do."*

*Need to address time issues*

The data from Table 2 suggests that there are time related aspects that have to be addressed. Only 20% of the participants indicated that their school timetable provided adequate scheduled periods (See Table 2), 43% indicated that they were uncertain and 37% indicated that this was not the case at all. Two primary schools teachers stated very strongly that the timetable did not provide adequate periods for computer room visits by their learners, as there was not enough time. This has to be seen within the following context, as the majority of township schools have more than 800 learners per school. The participating high schools have between 1100 and 1400 learners from grade 8 to 12. During an interview a teacher concurred that time was a problem when he stated, *"I wouldn't say that learners have enough time because there is only one room in the computer lab and we have an enrolment of 1300. At this school there is a ten-day cycle and each learner has one opportunity to use the computer laboratory every ten days."* Other teachers confirmed that at this point in time, large numbers in their schools constrained contact opportunities and that this aspect of promoting ICT in their schools was very challenging, hence highlighting the infrastructure problems referred to previously, i.e. the need for more computers.

*Rewards, incentives and training prospects*

The importance of rewards and incentives were highlighted by 80% the participants who felt that rewards and incentives were of great importance in terms of motivating teachers to acquire computer skills. At the same time,

83% of the participating teachers felt that there was no reward system in place which would influence other teachers to undergo computer training. In addition, 70% of the respondents highlighted the fact that funding for training was lacking.

***Second order barriers***

*Lack of computer skills*

Computer skills are not only an external barrier, but can also be seen as an intrinsic barrier as they may influence how teachers respond to implementation opportunities. The data suggests mixed views on their computer skills. Only 30% agreed that they had the necessary skills, 37% were uncertain whether they have the skills and 33% stated that they saw themselves as not well computer skilled (See Table 3).

Table 3: Second order- or intrinsic barriers

| Summary of items | n | □ | Mean | SD | Low 1,3 1<=x<=3 | | Avg 3,5 3<x<=5 | | High 5,7 5<x<=7 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Necessary computer skills for implementation | 30 | 0.94 | 4.13 | 2.00 | 10 | 33% | 11 | 37% | 9 | 30% |
| Confidence, knowledge and skills to use the computer as a teaching tool | 30 | 0.91 | 3.95 | 1.43 | 11 | 37% | 12 | 40% | 7 | 30% |
| Positive attitude towards the use of computers as a teaching tool | 30 | 0.49 | 6.26 | 1.07 | 1 | 3% | 4 | 13% | 25 | 83% |

Interview data affirmed these perceptions; “We do need training very much because myself I am not well trained. I did short courses more than 3 times and I like to know more. I’m keen to do everything. We will appreciate training”. The teacher in charge of the computer room at one school stated that one problem is; “I would say a lack of interest”, and added that skill levels are also problematic; “Many could be encouraged and inspired to use the computer lab number one, secondly they need training. And then we can sit down and say we have the computers available this is a school where it is a learning area and just work together as a team. They need to be encouraged and they need training.” He continued “Basic computer literacy, to know how to operate a computer, perhaps that is what will motivate them. Perhaps they have a fear of not knowing how to use a computer.”

*Confidence related to learning computer skills*

Although the participants did not feel confident initially, the majority (60%) indicated that they felt confident that they were able to learn computer skills. The rest, except one, were uncertain or neutral (See Table 4), probably because of the ‘newness’ of ICT to them and because they might have been uncertain what the training would hold in.

Table 4: Second order- or intrinsic barriers (individual items)*

| Summary of items | n | Mean | SD | Low 1,3 1<=x<=3 | | Avg 3,5 3<x<=5 | | High 5,7 5<x<=7 | |
|---|---|---|---|---|---|---|---|---|---|
| I feel confident that I will be able to learn computer skills | 30 | 5.63 | 1.56 | 1 | 3% | 11 | 37% | 18 | 60% |
| I feel a bit hesitant to participate in the training of the integration of computers for teaching and learning. | 30 | 2.52 | 1.72 | 16 | 55% | 12 | 41% | 1 | 3% |

*No Cronbach alpha calculated as only one item was used referring to this aspect or item

The majority of teachers (55%) indicated that they were not hesitant to participate in the project, but 41% were uncertain (See Table 4). Those who were uncertain mentioned that they did not know what to expect from the training - as one mentioned during an interview, *"I would say I never received any training before; it was something that was new to me."*

*Confident that the necessary skills will be acquired*

The responses indicated that the participants' confidence in terms of understanding how to use the computer in their classrooms, teaching subject matter, and having the necessary management and ICT skills, was very low (See Table 3) as only 30% stated that they were confident). One teacher mentioned that she perceived the computer as "a rhino", implying that she was in fear of it. Subsequent statements in the Likert scale indicated that, although their current confidence and knowledge related to computer integration were low, a majority (83%) indicated that they needed training on how to manage teaching and learning within the ICT classroom (See Table 3). It is important to note that despite not feeling confident at that present moment, the participants were extremely positive towards using the computer as a teaching tool. Eighty-three percent of the participating teachers were 'very positive' towards using computers as a teaching tool, in spite of their lack of confidence. Ninety-three percent indicated that they would like to be trained to use the computer for teaching and learning, 70% said that they found the use of computers to be practical for their learners, and 83% indicated that they thought that computers should be a necessary part of teaching and learning.

## DISCUSSION AND RECOMMENDATIONS

This study reveals the many first- and second order barriers to ICT integration that the participating teachers experience, even after having had some access to ICT resources over two years. These barriers include limited resources, time constraints as a result of large class sizes, limited ICT related vision, lack of support from the Department of Education, not enough computer skilled teachers as well as a lack of rewards and incentives.

The schools all appeared to be at Level 1 or Phase 1 of implementation at the beginning of the project, and there is little reason to believe that this is not the case for a majority of township schools. After two years of participation, the data reported above, and discussions with school principals and teachers, suggest that after the two years of ICT training sessions and provision of a limited number of computers (20), the following is in place:

- A basic school ICT policy
- A vision that requires revisiting
- An internet school usage policy
- Time tabling that makes provision for classes to visit the computer classroom

It is also evident that the following aspects are still in need of attention on an on-going basis:

- Training sessions
- School support visits
- Exposure to different ICT strategies
- Providing a web repository with ready-made ICT resources and lesson plans
- Helping teachers to obtain laptops and internet connections to be used at home in order to prepare for classroom implementation
- Securing data projectors
- Securing netbooks that can be used in any classroom
- Providing opportunities for teachers to share their experiences, positive as well as negative (challenges)

As such, it can be said that by the end of the second year of the intervention process the schools had only reached Level 2 of implementation (see 'Phases of integration' section for a description of the levels). This finding challenges the South African Department of Education's stated aim that ICT and technology integration within the South African context should *'jump'* the initial phases of adoption (Department of Education, 2004), and suggests that within the current context of limited support, this aim is highly unlikely.

Our experiences suggest that the majority of South African disadvantaged township schools have similar needs to those described above, and that it is likely that the majority disadvantaged schools experience similar barriers. Nevertheless, the findings of this study can also help juxtapose the context within which these schools operate against the more general findings in the literature, and motivate the following suggested heuristic regarding the implementation of ICT within such schools.

A major aspect that is considered in the heuristic is the plea that integration should be tackled by a multi-faceted approach taking into account a socio-cultural view to ICT integration (Hung & Koh, 2004). This view suggests that focusing on first and second order barriers alone will not have the desired integration effect. Rather integration should focus on inter-related enablers, namely school structures, classroom dynamics, teacher beliefs and student behaviours (Hung & Koh, 2004). The heuristic in figure 1 is offered as a response to their plea, and takes into account the findings of the researchers noted in this paper and the data generated in this study. The heuristic and stepwise process that is described below is aimed at those (for example NGOs and Departments of Education) who wish to drive an ICT implementation strategy, and who have at least some access to the structures/resources that make it possible to implement:

- Step 1: Create of a passionate ICT support Team which is made up of people who want to make a difference, people that will walk the extra mile, and who believe in the potential of ICTs.

- Step 2: Conduct a SWOT analysis that focuses on school structures, classroom dynamics, teacher beliefs and student (learner) behaviors; i.e. the possibilities that ICT integration offers, the possible threats of zones of discomfort that ICT integration might bring, and exploration of how to address these issues.

- Step 3: Survey the schools needs by means of quantitative and qualitative data which provides detailed personal insights. These include ICT skills analysis in order to determine teacher and learner needs.

- Step 4: Plan an adaptable workable strategy related to the implementation process based on the teachers' and schools' needs, which includes a shared vision, goal setting, time lines as well as the envisaged teaching styles/strategies that could be followed to serve the envisioned needs.

- Step 5: Select 5 to 10 volunteers per school. Keep in mind the possible support capability/capacity that the support team can offer, i.e. be realistic. Equally important, start with those teachers who are committed and want to participate. Do not force the process on all teachers.

- Step 6: Provide teacher training related to using computers in context. Start with basic computer literacy where necessary. Allow teachers to see the administrative value, online resource usage and teaching planning possibilities that ICTs offer. Allow the participants to experience as much success as possible in order to raise self-efficacy.

- Step 7: Reward participating teachers with the necessary equipment such as laptops and internet connectivity that can also be used at home where possible by soliciting, or helping them to solicit, support from all potential sources.

- Step 8: Provide ongoing training and school based onsite support as well as onsite classroom visits to support participants implement their strategy. Monitor and managed the process on a weekly basis.

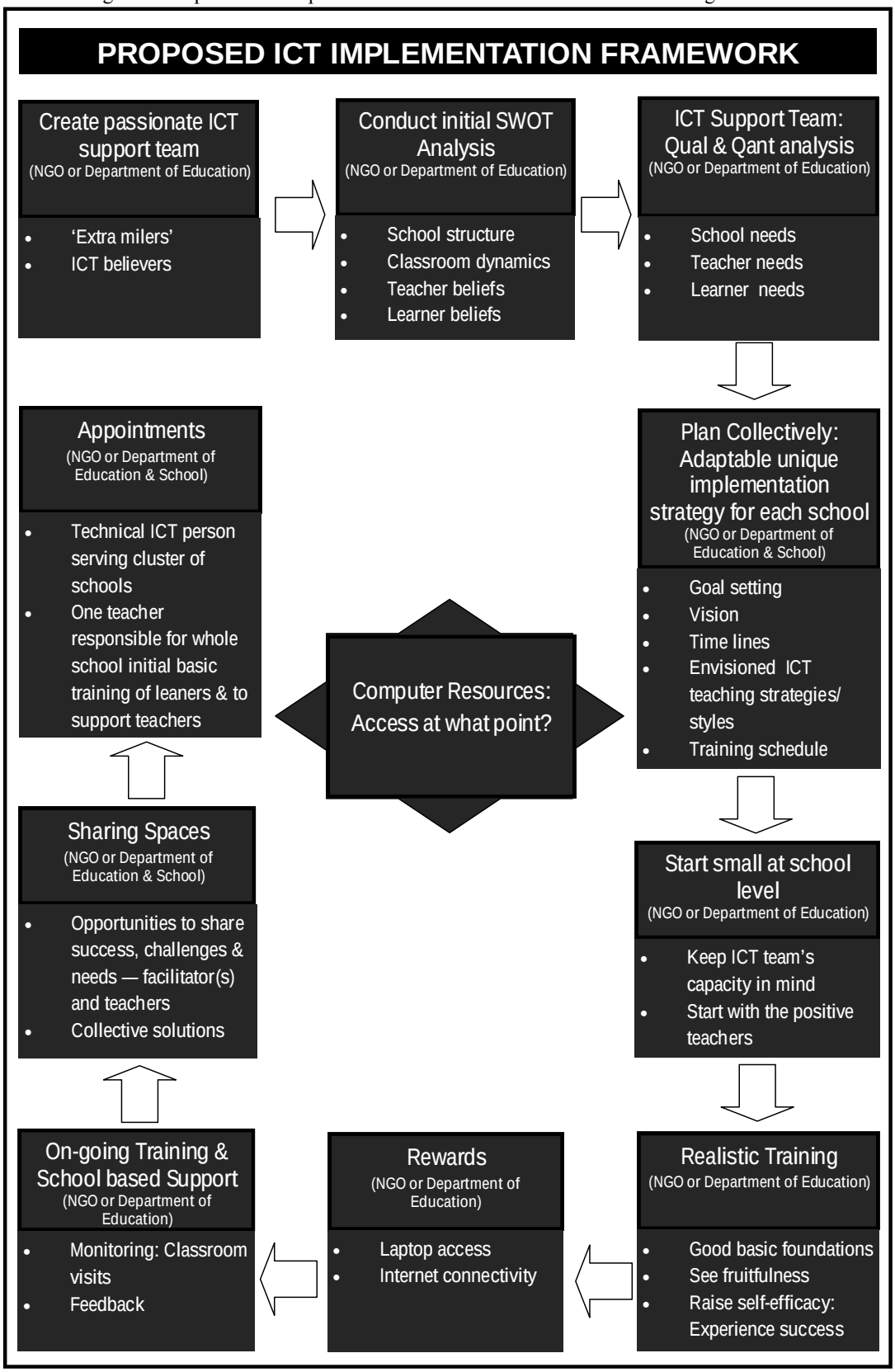
- Step 9: If in a resource provision mode, allow access to the computers for teaching only after the vision, goal setting and time tabling is in place, and only after the participating teachers had be well trained.

- Step 10: Provide opportunities for participating teachers to share – within the school and among neighbouring institutions – success stories as well as the challenges they experience. Enable participating teachers and the ICT support team to discuss, brainstorm and model strategies or practices that can be tried out in order to address their particular challenges.

- Step 11: Appoint a technical persons who is responsible for servicing the school's ICT infrastructure who can also train interested teachers with trouble shooting and basic ICT trouble shooting skills. Appoint one teacher leader responsible for initial basic learner ICT training and teacher assistance for the whole school.

The stepwise procedure above suggests that much will have to take place before the envisioned integration appears to materialize, and experience suggests that the integration process is something that will probably not happen within a calendar year. It will take, in the words of Leggett and Persichitte (1998) in their article titled, 'Blood, Sweat and Tears!'

Figure 1: Proposed ICT implementation heuristic for schools in disadvantaged contexts



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