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TO WHOM IT MAY CONCERN

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Qualitative case studies of context sensitive ICT pedagogical practices of teachers in the North-West Province

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Abstract

The *White Paper on e-Education* encourages schools and teachers to increasingly make use of Information Communication Technologies (ICTs) for effective teaching and learning. Although the publication of this policy on e-Education represents a major step into the new information era, it is unclear what is happening at ground level. The *Second Information Technology in Education Study* (SITES 2006) was a large scale international survey on the ICT practices of schools in twenty two countries and education systems. This study investigated the ICT practices of Grade 8 mathematics and science teachers, principals and ICT coordinators through three questionnaires. Due to the quantitative nature of the study, SITES 2006 did not focus on the unique human experiences and practices of teachers regarding ICTs on a contextual qualitative level. Therefore, the aim of our investigation was to obtain an in-depth context sensitive understanding of ICT pedagogical practices and experiences of Grade 8 Mathematics and Science teachers at eight different types of schools in the North-West Province. We visited the schools and conducted interviews with teachers. We then used the computer assisted data analysis program Atlas.ti™ to analyse the interview data and constructed an integrated data set which identified four main categories of data related to the ICT pedagogical practices and experiences of Grade 8 Mathematics and Science teachers: (i) Context Barriers, (ii) Context Enablers, (ii) ICT Barriers, and (iv) ICT Enablers. We explore these categories through observations, photographs and quotations from the interviews.

Keywords: Information Communication Technology (ICT), Pedagogical Practices, Grade 8, Mathematics, Natural Science

1. Background and problem identification

In response to the progressive realities of the information age today's teachers increasingly use computers and other forms of ICTs across all learning areas. The South African Government committed itself to the integration and use of ICTs in education for equal access to learning opportunities, economic growth and social development (Republic of South Africa, 2004: 10). Since 2004, the *White Paper on e-*

Education (Republic of South Africa, 2004) acts as the official governing policy on e-Education in South Africa. This policy "... supports larger systematic, pedagogical, curricular and assessment reforms that will facilitate improved education and improved use of educational resources such as ICT" (Republic of South Africa, 2004: 14). The strategic goal of the policy is that "every South African manager, teacher and learner in the general and further education and training bands, will be ICT capable (that is, use ICTs confidently and creatively to help develop the skills and knowledge they need as lifelong learners to achieve personal goals and to be full participants in the global community) by the year 2013" (Republic of South Africa, 2004: 17). Teachers are encouraged not only to make use of ICTs for effective teaching and learning, but also to access ICT resources to support curriculum delivery, build capacity through collaboration and co-operation, and to make management and administration more cost and time effective. Teachers and students can easily connect through ICT infrastructure that recognises individual person-centred learning and progress. According to the White Paper on e-Education (Republic of South Africa, 2004: 39-41), the implementation of these comprehensive strategic policy goals requires a multi-year implementation strategy executed in three phases:

- Phase 1: Enhance system-wide and institutional readiness to use ICTs for learning, teaching and administration
- Phase 2: System-wide integration of ICTs into teaching and learning
- Phase 3: Integration of ICTs at all levels of the education system, including management, teaching and learning, and administration.

Consequently, the pedagogical use of ICTs in classrooms has become a major research focus to help realise the Government's vision of equal educational opportunities through the integration and use of ICTs. Although many schools have not yet integrated ICTs in their teaching and learning practices, the total number of computers available in schools for pedagogical purposes increased substantially from 18% in 1998 to 38% in 2006 (Pelgrum, 2008: 75). Technology, on its own, contains neither pedagogical, nor content bias. Computers can be used for teaching both traditional instructional packages, as well as for promoting modern teaching approaches. However, in many schools the integration of computer-based technologies is not explored, as teachers do not have access to computers for their daily teaching purposes and lack basic ICT competencies (Blignaut, 2002: 109-125). For the *White Paper on e-Education* to reach its objectives, large scale ICT implementation and training is required. It became necessary for teachers to become competent in using computer technology as part of their repertoire of teaching and learning strategies (Spiceland & Hawkins, 2002), and consequently to e-empower their learners. Stable, reliable and regular access to ICTs propels the effectiveness of ICTs, as well as the extent to which students, teachers, managers, and administrators can access the infrastructure and build inclusive competencies. ICTs also require extensive staff development and support, as well as professional development of practising teachers. The revised *Norms and Standards for Educators* and the review of in-service training policies and programmes should ensure that teachers understand and use ICTs competently (Department of Education, 2006).

Although the publication of a policy document on e-Education represents a major step into the new information era, no one knows to what extent these policies make a

difference in practise. South Africa has a long history of assessing how well it performs in the arena of using computers in schools. Besides various small case studies describing various implementation strategies, South Africa under the auspice of the *International Association for the Evaluation of Educational Achievement* (IEA) took part in the Second International Technology in Education Study (SITES) (Law, Pelgrum, & Plomp, 2008). SITES is a large scale international comparative survey that aimed to uncover how ICTs influence teaching and learning processes in schools. To the present, three international SITES modules contribute to this understanding. The first module was a school-based survey, while the second module comprised a comprehensive study on how teachers use ICTs and included comparative case studies of innovative pedagogical practices supported by ICTs. SITES 2006 (module 3) involved an international comparative longitudinal large-scale survey on the use of ICTs in schools. It investigated how school and education system factors influence teachers' pedagogical adoption of ICTs (Pelgrum & Law, 2008: 1-11). The SITES 2006 survey of schools and teachers compared the pedagogical practices adopted in 22 participating educational systems and their ICT use. SITES 2006 administered three questionnaires for: (i) school principals, (ii) technology coordinators, and (iii) Mathematics and Science teachers. The South African sample in the SITES 2006 module comprised of 504 schools, 622 Grade 8 Science teachers and 666 Grade 8 Mathematics teachers.

The SITES 2006 data analysis indicated that about 38% of South African schools had access to computers for Grade 8 learners in 2006. This number has doubled from SITES Module 1 conducted in 1998 that indicated a number less than 20%. This figure remains dismally low when compared to other education systems in developing contexts such as Estonia, Chile, and Israel. These educational systems indicated almost a 100% access to computers for their learners. South Africa reported only 17% ICT equipment available in schools, compared to 47% ICT equipment available in Chilli, 70% in Israel, 72% in Lithuania, 98% in Singapore, 92% in Slovenia and 66% in Estonia (Pelgrum, 2008: 81). To achieve education goals such as fostering collaborative skills and teamwork and preparing students for responsible Internet behaviour in the 21st century, Internet connectivity becomes increasingly important. Again, SITES 2006 indicated that South Africa lag behind in Internet access, compared to other developing contexts such as Chile (92% access), Israel (98% access), Lithuania (100% access) and Estonia (100% access). South Africa's availability of more modern ICT equipment such as interactive smart-boards, mobile devices, digital resources, modelling software, multimedia production tools, and electronic laboratory equipment was even lower. SITES 2006 provides baseline information almost halfway into the lifespan of the e-Education policy. Nevertheless, SITES 2006 was a large scale survey that did not investigate the in-depth context sensitive practices and experiences of teachers at ground level.

2. Aim

The aim of this study was to investigate the context sensitive real-life ICT pedagogical practices and experiences of Grade 8 Mathematics and Science teachers in the North-West Province. Through this in-depth investigation we intend to reveal the unique experiences, practices, barriers, enablers, fears and expectations of these teachers in relation to the objectives and expectations of the e-Education policy.

3. Research design and methodology

3.1. Design

In order to obtain an in-depth understanding of the ICT pedagogical practices and experiences of practicing teachers in the North-West Province, we used three qualitative data collection strategies: (i) semi-structured interviews, (ii) observations, and (iii) photographs. Using the SITES 2006 questionnaires as guideline, we composed a semi-structured interview schedule with the objective to obtain in-depth information on the ICT practices and experiences of teachers in different school contexts. We also composed a paper-based observation schedule which recorded contextual information regarding the unique school context, including demographics, general infrastructure and facilities, security and organisation. We furthermore decided to collect artefact data in the form of photographs to visually record the unique contexts of each school.

3.2. Training of fieldworkers

With the help of an expert in interview procedures, we trained three final year BEd students at the Faculty of Education Sciences of the North-West University to assist in all three data collection components, i.e. interviews, observations and photographs. This provided a valuable opportunity for these student-research assistants to obtained research skills and fieldwork experience.

3.3. Sample

The Higher Education Management Information System (HEMIS) database identified twelve South African schools with Grade 8 learners according to a purposefully selection grid (Table 1), based on two selection criteria: (i) type of school, and (ii) number of computers with or without Internet for pedagogical use.

Table 1: Purposefully Selection Grid

	Computers Available (with and without Internet)						
	1-2 Computer without Internet	3-5 Computer without Internet	6-5 Computer without Internet	16+ Computer without Internet	2-5 Computer with Internet	6-15 Computer with Internet	16+ Computer with Internet
Types of Schools							
Farm School	**A**						
Semi-Rural School	**B**	C				D	
Urban School				**E**	F		**G**
Former Model-C School				**H**			**I**
Private School			**J**				**K**
International SA School							L

With the submission of this paper, the data of eight schools were available as indicated in bold on the selection grid (Table 1). We interviewed one Grade 8 Mathematics and one Grade 8 Science teacher at each of the eight schools.

3.4. Ethical considerations

Before commencement of this research, we obtained formal permission from the North-West Department of Education to visit schools throughout the province. We also applied and obtained ethical clearance from the North-West University's Ethical Committee. We contacted the principals of the purposefully selected schools and provided them with a letter explaining the purpose and nature of the study. The schools were asked to participate voluntarily and formal consent was obtained from all participating principals and teachers with the understanding that they had the right to withdraw at any stage of the research process. All participants were treated with respect.

3.5. Procedures

Our research team visited eight schools according to the data collection grid (Table 1) to collect data. We shared the responsibility to conduct interviews, to complete the observation schedule, and to take photographs. We took the school time table into consideration and conducted the interviews during school brakes and open periods in which teachers were available. We obtained permission to take photographs as part of our research data set. All interviews were recorded using data recorders. Back at the North-West University, we transcribed the interview data and member-checked the transcription of the individual interviews. We use ATLAS.ti™, a computer-assisted qualitative data analysis software to analysis the integrated data set.

4. Findings

In ATLAS.ti™, we constructed an integrated data set which identified four main categories of data related to the ICT pedagogical practices and experiences of Grade 8 Mathematics and Science teachers: (i) Context Barriers, (ii) Context Enablers, (iii) ICT Barriers, and (iv) ICT Enablers. In the text, we provide examples of photographs and quotations throughout to illustrate aspects of barriers and enablers for each category.

4.1. School Demographics

Table 2: School Demographics

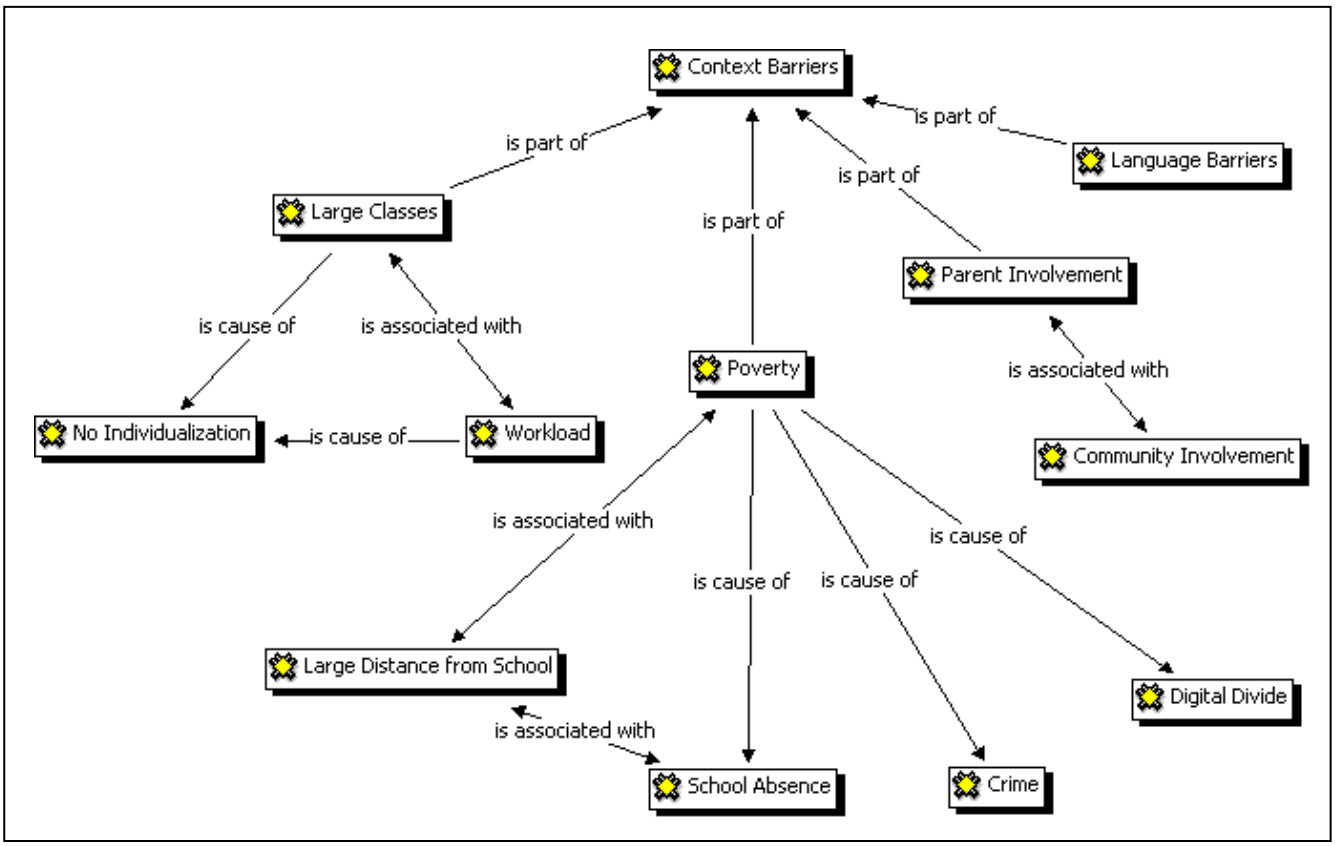
Grid Selection	Region	District	Nearest Town	Number of Learners	Computer Labs	Computers Available	Internet Access
A	Bojanala	Rustenburg	Rustenburg	180	0	2	No
B	Southern	Potchefstroom	Potchefstroom	1063	0	21	No
E	Southern	Matlosane	Klerksdorp	1300	1	25	No
G	Bojanala	Rustenburg	Rustenburg	987	3	120	Yes
H	Central	Kgetleng River	Koster	520	2	22	No
I	Central	Zeerust	Zeerust	573	2	40	Yes
J	Southern	Matlosane	Klerksdorp	64	1	10	Yes
K	Bojanala	Rustenburg	Rustenburg	255	2	43	Yes

Table 2 provides the major demographics of the eight schools that were purposefully selected by the selection grid (Table 1). The identities of these schools are not reported to protect the identity and integrity of the teachers who participated.

4.2. Context barriers

Figure 1 shows the major Context Barriers that were identified via the integrated data set, including large classes, poverty, low parent involvement and language. It is worth noting that the length of this paper only allows us to provide a few illustrative examples, however, for most categories we tagged between 20 and 100 quotations in our data set.

Figure 1: Context Barriers



The majority of the schools reported large classes of more than 30 learners per class, with School B with 50 learners per Grade 8 Mathematics class. Large classes result in a high workload, many teaching responsibilities, fatigue, work-related stress and restricted individual attention, as some of the teachers explain:

- Presently, we are overstaffed... It is very stressful, very stressful.
- Even if we take work home, and when you go home you are tired from school. You still have work to do and you are still tired. And then you end up not doing the correct thing, because you can't do all these classes and give proper attention... I can't divide myself.
- Yes, it is very difficult because we can't do individual attention.

Poverty seems to be a very important Context Barrier, as expressed by the Grade 8 Mathematics teacher at School B:

- ...the conditions from which these children are coming from... they are walking from far to school, most of the time without eating anything. It is difficult for them to stay under such pressure for the whole day with nothing to eat. That is what is influencing them to go back home... Perhaps if the Department of Education in the future provides these learners with food, at least it will keep them around.

Poverty seems to be associated with large distances that learners travel by foot to

school, and also seems be to a source of school absence:

- No they are from far. Some of them walk as far as... 10 km a day. Some do come with some lifts and so on, but the distance from where they are staying to where they get there lifts are also a distant as well.
- So they travel from very far, walking in fact those distances, without any food in their stomach, and then you expect them to deliver. They are coming in the morning, but normally they do not return after 12h00. It is a big problem.

Photograph 1: Farm Children Receive Pap and Gravy at School A; some of these children walk up to 15 km to school to receive their first meal for the day

During our visit to School A (Photograph 1), the Grade 8 Mathematics teacher told us that since the school started to provide a basic meal per school day, more learners attend school because it is the first, and sometimes only meal they receive for the day. Poverty is the major factor leading to the digital divide (discussed below), and also seems to be associated with crime:

- .. there are still a lot of unemployment, whereby we are the target school in terms of burglars. The other day they came here and burgled the place where the computers were. They took out the corrugated iron and they went through that particular place in the roof, and they went in through the ceiling.

Computers and other ICT equipment are a major focus for crime because they have a good street value. Many children are drive to crime by their poor circumstances:

- We got a serious problem with cell phones, you know to such a extend that we sometimes tell them not to bring their cell phones to school, because some of them steal them, you know, in an effort perhaps to sell them for food.

All the schools we visited have security in the form of wired fences and security doors, while some had alarm systems and private security response unites protecting the

school. As evident from Photograph 2, high burglaries, crime and drug abuse forced some of the schools to appoint full time security officers to guard the school premises. The principal of School E even asked the South African Police Services to open a police station next to the school in the near future.

Photograph 2: Constant Security at School E Against Crime and Drugs Abuse

Photograph 3: North-West Department of Education's "Let's Stop Crime in Our Schools" Campaign at School B

As can be seen in Photograph 3, the North-West Department of Education launched anti-crime campaigns in an effort to reduce crime in schools.

Another context barrier identified by most of the schools is poor parent involvement:

- School means nothing to them because most of them [the parents] did not go to school. They grew up on the farms. They do not actually understand the meaning of school. For them it is only to relieve themselves - they will say go to school.
- Then we say ok, we are going to discuss the children's progress tonight. Then, not even 10% of the parents come. This is a problem we always have.

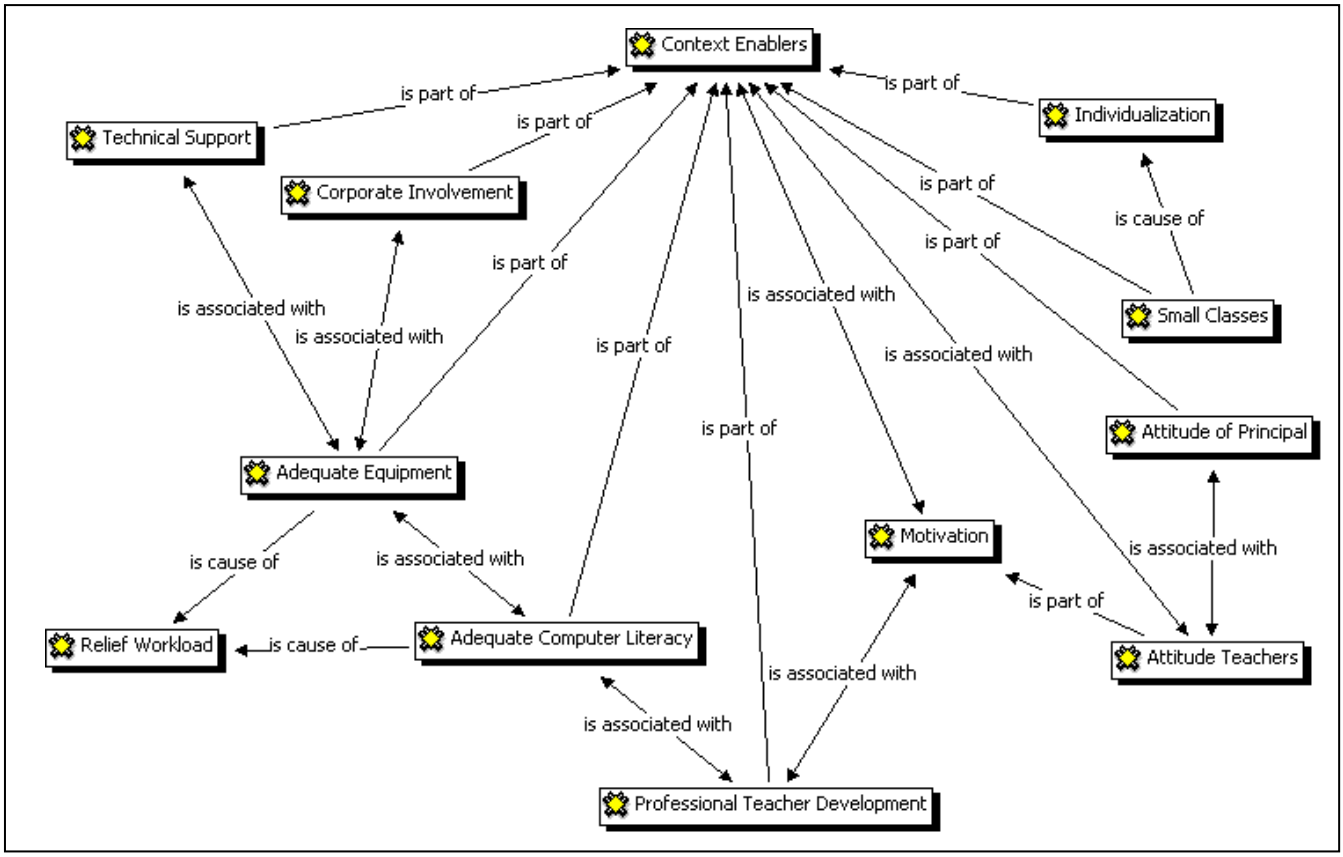
Poor parent involvement is also associated with poor community involvement:

- No, there is totally no support from the community.

4.3. Context enablers

Figure 2 indicates the context enablers that were identified from the integrated data set. The most important enablers seem to be technical support, corporate involvement, adequate equipment, motivation, the attitude of the principal, small classes and individual attention.

Figure 2: Context Enablers



Many teachers argue that adequate equipment and technical support were important context enablers (Section 4.5). In general, the more equipment available at a school, the more computer literate teachers and learners seem to be (Photographs 4 and 5).

Photograph 4: Adequate Computer Facilities with Technical Support at School G

Photograph 5: Evidence of Adequate Computer Literacy Amongst Teachers at School B

Most teachers indicated that computers and other ICTs already relief their workload, or will relief their workload when they get the opportunity to use them in the future:

- I think it [ICT] is a good thing; it makes the teacher's work much easier
- And it [technology] saves a lot of time in terms that we are still using the old ways of teaching using textbook methods and chalkboard methods. If they were introduced and we were using them, these ICTs materials or equipments, I think we could save a lot of time. They will really impact very positively.

Besides the two Private Schools J and K, all other schools are dependent from the Government to provide adequate equipment. In one case, a Life Sciences teacher took the initiative to write a letter to a corporate mine group and received a donation consisting of a laptop and data projector for her pedagogical practices:

- About two years ago I wrote a letter to Anglo Platinum. For a long time I heard nothing, then they phoned and told me they received stock and that I can get it within a week. And they delivered and installed it, it made a huge difference in my teaching.

Private School J only have 64 learners in the entire school. When we visited the school, the principal told us that the mission of the school is to provide individual attention to learners with learning difficulties. Consequently, the school has an average of six learners per grade. The principal provided us with evidence in the form of learner reports which indicate that small classes have a positive effect on academic and skills performance. The school has one computer available for every 6 learners in the school. This ratio is very high compared to most other schools, for example School E has one

computer for every 52 learners in the school.

Motivation also seems to be a Context Enabler:

- "one must make a plan to get it for it is very expensive. It is good to broaden one's framework of mind to bring renewal, because the children needed it. You know, in the past we had an overhead projector that was not very clear. I promised myself that the day will come when it will be brighter. And the day arrived.

Motivation, in turn seems to be associated with professional teacher development and the general attitude of teachers, as explained by a teacher who received a laptop and data projector:

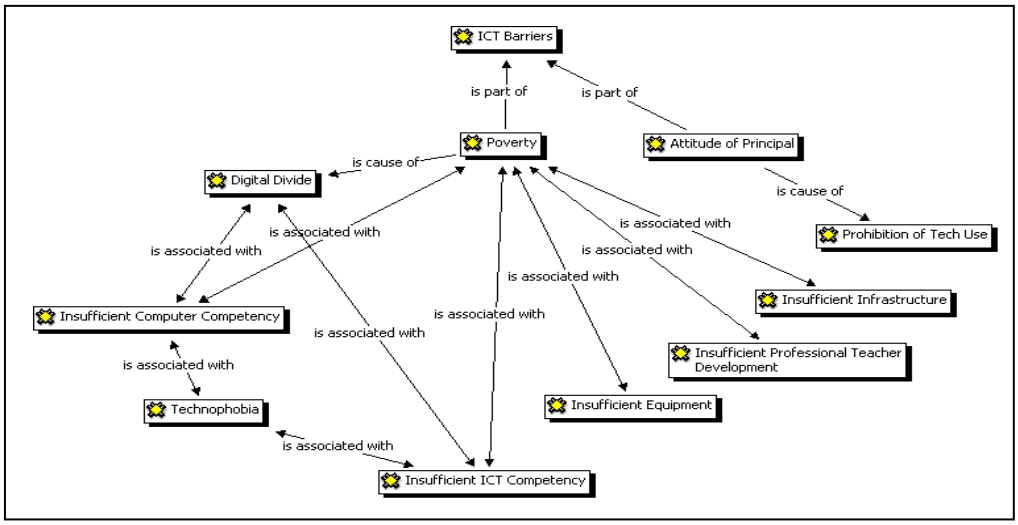
- ...it was during a time in which my worked became exceptionally stagnant. I just continued and continued, and I had many files full of transparencies, but it there was no challenge any more. Therefore, it was the right thing at the right time for me.

The positive attitude of teachers is also associated with the positive attitude of principals:

4.4. ICT Barriers

Figure 3 indicates the major ICT Barriers identified from the integrated data set, i.e. poverty, the digital divide, insufficient equipment, insufficient computer literacy, technophpobia, insufficient professional teacher development and negative attitudes from principals.

Figure 3: ICT Barriers



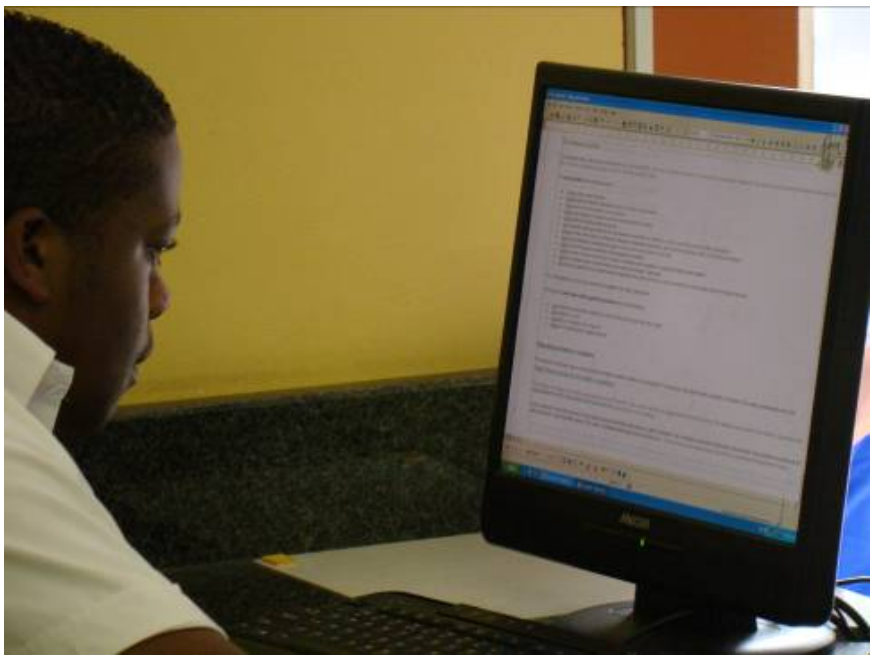
As already pointed out under Context Barriers, poverty is a major barrier for equal ICT access and opportunities. Poverty is the root of the digital divide that exists among learners from different socio-economic and social backgrounds. Many children do not have access to computers at home, and in most schools we visited up to 50% of

learners do not own their own calculators:

- Well, we use some calculators, but you will find that out of 30, only ten have calculators. It is a problem... because the very same guys [Grade 8's] who have calculators have to share the very same calculators with the Grade 9's
- It's difficult for them to buy those things, because the parents send them to school because they are under the impression that they are getting free education, and free education that means everything - they must also get the calculators from school, and all those things. So it is a problem to buy all those things.

The digital divide is clearly visible between Schools A and G, both in the same District (Photograph 6 and 7).

Photographs 6 and 7: The Hard Reality of the Digital Divide Between Learners of Schools A and G



While all schools have computers, some of the schools like School A, does not allow learners to use computers, and in other schools, for example School E, computer facilities are exclusively available to learners studying Technical Drawings.

Insufficient equipment also relates to insufficient computer literacy among teachers, which in turn, results in high workload for administrative staff:

- No, we handwrite it [tests and exam papers] and we give it to the clerk at the office. The clerk has to type it. It is taking her long time as well, because she got to type the whole bunch of question papers for all the teachers.
- Here are actually people [teachers] who do not know how to print, or what a memory stick is

Technophobia is another ICT barrier which is connected to feelings of being incompetent:

- I feel stupid... You know that fear that I don't know if I should try it or not, because I know how I give class and I trust my own instincts and that sort of thing. It is that bridge a person should come over.

Misuse of technology such as Mxit and mobile phones used to send pornographic material around, may result in Technophobia, which in turn, often produce negative feelings towards any new forms of technology:

- We have a very strict rule, if your phone is visible we confiscate it. It is locked away in a safe for a month, and they must pay a R100 fine, and receives 50 retention points.

Very few of the schools enrolled their teachers in basic computer literacy courses for their professional teacher development. The principal's fear and protective attitude towards technology may even prevent teachers from using them, as reported by one teacher:

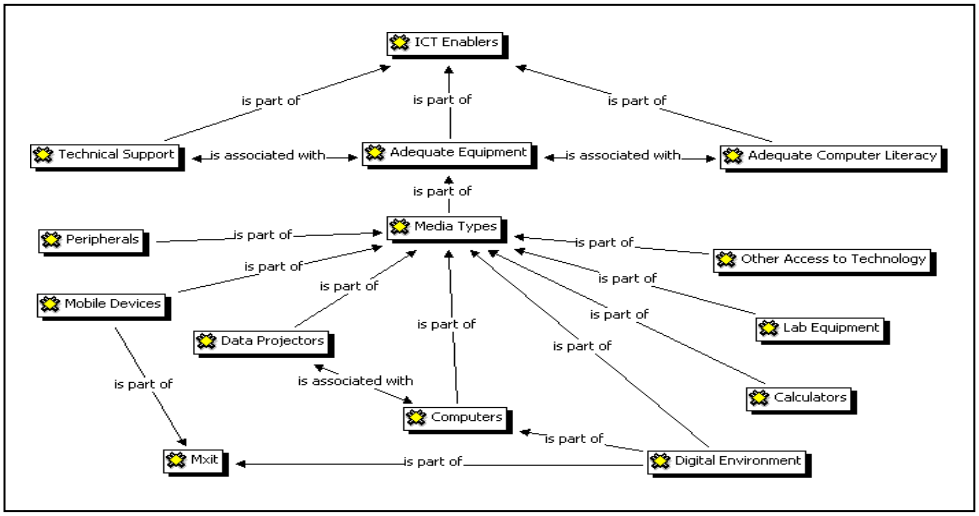
- … at first we had some barriers, the principal was not free to offer the computers, but now that changed, we can use some of them, but not all, just some. At first he possessed them, although it is school property, but that has changed now. Even the photocopy machine, nobody was allowed to touch this photocopy machine.

4.5. ICT Enablers

Figure 4 indicates the major ICT Enablers identified from the integrated data set, i.e. adequate equipment, adequate computer literacy and adequate technical support. The schools reported different types of ICT media used, including computers, data projectors, overhead projectors, calculators, laboratory equipment and Interactive Smart-Boards. In some cases ICT is integrally used for pedagogical purposes, for example:

- for my own preparation I use technology all the time because I have a projector in my class, I work from my calculator, on my laptop, and then we have programs such as Geosketchpad and AutoGraph, Cami Maths and Mathematics ... and then our children also do investigations in cases where we give them open questions.

Figure 4: ICT Enablers



Photograph 8 shows adequate laboratory equipment at School K, while Photograph 9 shows evidence of sufficient computer literacy amongst learners of School I.

Photograph 8: Adequate Laboratory Equipment at School K

Photograph 9: Evidence of Computer Literacy Amongst Learners of School I

Good ICT integration is reflected by Internet connection for pedagogical practices, the use of computers and software such as PowerPoint to prepare lessons, and other encouragement to make use of ICTs for teaching and learning. At School H, learners use their mobile phones to take photographs of specimens through telescopes in the Life Sciences. They then make printouts of these slides at home and include it in their assignments, and even get the chance to present their findings in front of the class using PowerPoint presentations via a laptop and data projector (Photographs 10 and 11).

Photographs 10 and 11: Learners at School H Use Their Mobile Phones to Take Photographs of Specimens through Microscopes in the Life Sciences and Present their Findings to the Class via a Laptop and Data Projector

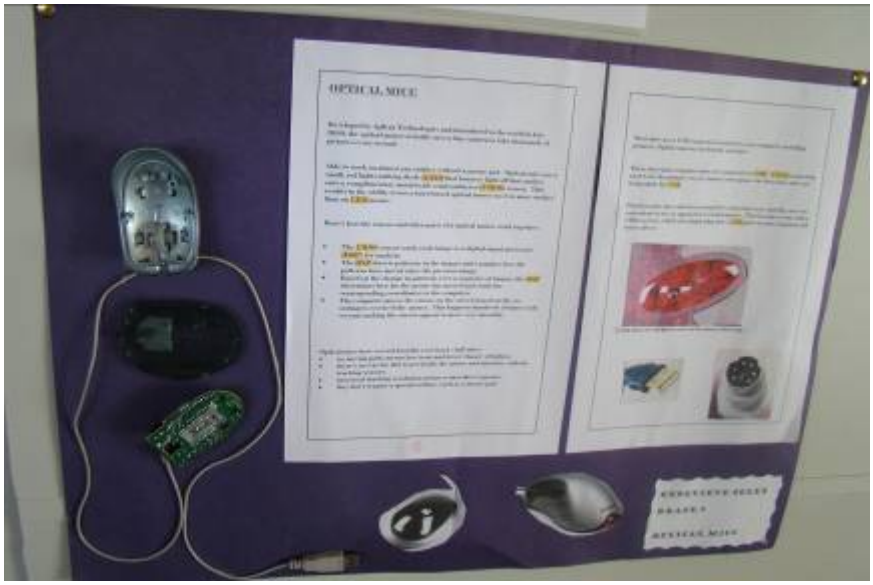
- when they [the learners] do microscope work, they put the camera where you usually put your eye...then you can take a very beautiful picture.
- ...when the children have projects they present it in this way... They come with their memory sticks or a CD and do their presentations in this way. In a protective environment they can exceed themselves. I am very excited
- The same class also regularly connect to the Internet and project their searches through the data projector to make the Internet search as interactive as possible:
- There is this cute video clip that we found the other day [on the Internet] about a mine in Sierra Leone. Die attentions has shifted from blood diamonds, they started to mine raw ore to form titanium. It is very cute, and with such a short video clip the children can see for themselves how the mine looks like, and also a small part of the country.

Various online encyclopaedias are used to find information on different subjects:

- We really use Wikipedia a lot, and Buglopedia is good for insects

The importance of ICT is recognized by some schools, such as School J, who share technical ICT knowledge and skills with their learners to help prepare them for the demands of the Information Age (Photograph 12).

Photograph 12: The Sharing of Technical ICT Knowledge and Skills at School J



Most schools reported that at least 30 to 50% of their learners have mobile phones as well as the competency to use them. m-Learning is increasingly becoming a resource

for technology based learning in developing context such as South Africa (Photograph 13).

Photograph 13: A Finnish Research Team Testing an U-Fractions Mobile Game at School B

Photograph 14: The Use of Interactive Smart-Boards at School K for Teaching and Learning

School K had the best ICT resources and infrastructure of all eight schools (Photograph 14). This private school receives financial support from the Bafokeng Royal Family and is well equip with computer laboratories, speech and reading therapy facilities, laptops for all teachers, educational DVDs, Interactive Smart-Boards, scientific calculators, top-of-the-range laboratory equipment, data projectors, Internet access, IT technical support, etc.

5. Conclusions and Recommendations

The integrated data set reveals interesting Context sensitive barriers and enablers of computer and other ICT use for pedagogical purposes. Although schools are increasingly making use of ICTs, poverty, insufficient equipment and computer literacy seems to be some of the greatest barriers against the objectives of the White Paper on e-Education, i.e. to ensure that every learner and teacher are computer competent by the year 2013. As can be seen from Photograph 15, some of the schools such as School A and School B, received computers from the Department of Education or as donations from the commercial sector, but are not utilizing these computers because of insufficient computer literacy amongst teachers and learners, no technical support for hardware and software problems, and due to insufficient infrastructure (room space).

Photograph 15: Unutilised Computers at School A Due to Insufficient Computer Literacy and Technical Support

We recommend that more energy should be invested in the professional development of computer and other ICT competence among teachers. Principals should be motivated to promote the implementation and integration of various ICT resources at their schools, and in turn through a positive attitude, motivate their teachers to undergo professional development. Currently, many schools are only using their computers for subjects such as Technical Drawing. It is furthermore recommended that schools invest in promoting

other computer-based pedagogical practices with the resources they already have. Only through self-empowerment will teachers be able to empower their learners with ICT competency and skill, in order to become active role players in the global information age and sustainable economy.

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