Master of Science Project Proposal

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1   Details of the Research Proposal

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Provisional Project Title:	Models of Internet connectivity and networking in secondary schools in the Eastern Cape, with a view to ICT integration in the curriculum.
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2   Field of Research

Computer Science and Education - Information and Communication Technologies in Schools.

3   Provisional Title

Models of Internet connectivity and networking in rural secondary schools in the Eastern Cape, with a view to Information Communication and Technology integration in the curriculum.

4   Research Context

With recent advances in technology, computers are increasingly considered as valuable tools in education, not only for the purpose of administration but also for teaching and learning. Computers can aid pupils in projects, both in the research and the actual project creation itself, through the use of software such as word processors for report production, or slide show applications for producing presentations of their work. For the teacher, computers can aid in their administrative work as well as in lesson preparation. They can make use of software such as word processors or graphical editors to create, for example, worksheets and handouts, as well as making use of databases and spreadsheets in order to keep track of the marks and performance of their classes. "It is felt that [computers] can increase not only the effectiveness of the educational process but also its overall efficiency, whether in terms of classroom

activities or administration. The possibilities they offer have the potential to transform the organization and structure of schooling and may promote the development of higher cognitive processes." [1].

In a survey published in 2000, entitled "Computers in Schools: A national survey of Information Communication Technology in South African schools", conducted by the Education Policy Unit of the University of the Western Cape and the International Development Research Centre, a review of literature and studies pertinent to the survey was undertaken. The review, undertaken in order to explore the use and impact of Information and Communication Technologies (ICTs) in developed and developing countries, showed that "the effective use of ICTs in a country impacts strongly on the competitiveness of that economy within the global marketplace as well as the ability of governments to deliver on their social goals. The development of ICTs in education are seen as an important priority by most countries." [2, p2] The survey also found that, no matter what the country's stage of development, factors which accompany successful implementation of ICTs in schools include networks of connectivity and structured and continuous programs that work to educate and train teachers to make effective use of the technology for teaching and administrative purposes [2]. Networking and specifically connectivity to the Internet open up a world of information. In the schooling environment this means that not only are computers tools for producing reports and making presentations, but computers also facilitate research and building knowledge banks for teachers and pupils. The Internet has the ability to put a world of information within the grasp of those that have access to it.

In 1996, Gill Summerly [3] investigated the then current use of the Internet in South African schools. The survey was entitled "1996 SA School Connectivity Review" and looked at school connectivity to the Internet from a technical and infrastructural point of view. The research questions that were posed were:

- how many schools have Internet access?

- what sort of access do they have?

- who are the providers of school Internet access are?

- what school-related networking infrastructure is in place?

All nine provinces were included in the survey. A table of the connectivity of each province was drawn up and has been included as an appendix to this proposal [4]. According to Summerly's findings at the time, Internet access was heavily concentrated in four of the nine provinces, namely the Western Cape, Gauteng, the Eastern Cape and Kwa-Zulu Natal. Only a very small percentage of South African schools had Internet connectivity of some kind, approximately 1%, of which the Western Cape accounted for 53%, Gauteng 20%, the Eastern Cape 18% and Kwa-Zulu Natal 8%. The remaining 1% was divided up amongst the remaining five provinces. The reasons for these disparities across the provinces were due to activities of school networking organisations in the regions; the distribution of tertiary institutions, which provided backbone connections to the schools as well as technical support; and existing non-technical disparities, e.g. the relative affluence of schools in the area. She further found that, of the schools that were connected to the Internet, most had relatively poor connectivity, in that they could not provide all members of the school with e-mail facilities or access to the World Wide Web (WWW) [4].

In the survey published in 2000, the following comments were made about South African schools: schools in the Western Cape and Gauteng provinces have on average a better ICT infrastructure than schools in the other nine provinces. Schools in the Free State, Kwa-Zulu Natal, Mpumalanga and the North West Province had an intermediate position in terms of ICT resources, while schools in the Eastern Cape, Northern Cape and the Northern Province were the worst off of all [2]. The connectivity to the Internet, of the schools in the provinces, tends to mirror the ICT infrastructure that is found in those provinces. The survey also showed that e-mail facilities were being used extensively in many schools as a management and administrative resource, as well as a teaching resource. Use of the Internet, i.e. the WWW, was

widespread across a spectrum of schools in all the nine provinces of the country, with Gauteng and the Western Cape having the greatest access [2].

The number of schools in the country with at least one computer, according to the survey, was 2311. Of this number, 212 schools were within the Eastern Cape, that is 9.2% of the total. There were 5880 schools in the Eastern Cape, meaning that 3.6% of the Eastern Cape schools had at least one computer [5]. If we compare the figures from the 1996 survey with those of the 2000 survey, we note that there has apparently been a decrease in the number of computers in schools in the Eastern Cape - a decrease of almost a half. This could be for a number of reasons such as theft, breakage, or lack of funding to support their earlier initiatives, etc.

The 2000 survey also indicated that schools with ICT resources are primarily in urban areas and that there is a stark inequality betwen urban and rural schools [5]. Urban schools tend to be more advantaged than those found in the rural areas. They also tend to have better access to facilities and opportunities than rural schools. In the Eastern Cape the majority of schools tend to be rural and as such experience difficulty in obtaining ICT infrastructure and Internet connectivity. Research and experimentation here will hopefully produce new and innovative methods of connecting rural schools and overcoming geographical limitations.

The focus of this research project will be to model Internet connectivity to schools, looking to find the best possible solutions for schools in the Eastern Cape. Further, it includes looking at the networking and ICT infrastructure within the schools, because while having just a single computer with a connection to the Internet is better than nothing, it is extrmely limiting and far from ideal. There is not much published on similar work done in this area, especially regarding this country or any other third world country. There is some documentation on the work that has been done in first world countries [6, 7]. The work that has been done in those countries will be carefully studied so as to avoid making the mistakes that those countries have already made. It is, realised, however, that what can and does happen in first world countries is not necessarily appropriate or even possible in a third world country. It is hoped that the results of this project will have implications not only in the Eastern Cape but also for the rest of South Africa. The work of this project will be contributing to a bigger research question and project: "What stategic issues need to be addressed to ensure that Secondary Schools in the Makana District can successfully integrate ICT into the curriculum?" This research is being conducted by Dr Cheryl Hodgkinson of the Rhodes University Education Department.

The Makana District appears to be an ideal region in which to conduct research of this nature, due to the wide spectrum of schools that are available for study there (this is discussed further in sections 6.2 Research Aims and section 7 Research Design and Framework). Both the Education Department and the Computer Science Department - through the auspices of the Centre of Excellence (CoE) - of Rhodes University have good relations with the majority of the schools in the Makana District. Through the help of the CoE it will be easier to obtain networking technologies and be able to experiment with them in some of the schools. It is also hoped to include some of the schools in the Alice and King Williamstown Districts because they tend to be more rural and disadvantaged than those of the Makana District. As mentioned previously it is the disadvantaged schools in the rural areas that have the most difficulty in obtaining and integrating ICT infrastructure and Internet connectivity. Internet connectivity to some of the more remote and rural areas, within the third world contexts, will be an interesting problem to solve and one that has not been thoroughly studied and will be a difficult, though interesting, problem to solve.

5   Limitations

According to chapter 5 of the 2000 Computers in Schools survey, schools in the Eastern Cape and the Northern Province are the worst off in terms of infrastructure such as condition of buildings, libraries, laboratories, water supply, electricity supply, ablution facilities and telephones [5]. I recognise that there

will be schools in the Eastern Cape where it is simply impossible to deploy computer networks and connectivity, for example schools without electricity, or insufficient buildings. Such schools have far more pressing issues than a lack of ICT infrastructure and should probably be concentrating on those before they attempt to integrate ICT into their schools.

6 Research Goals

6.1 Research Questions

The main research question is:

What models of networked computertechnologies can support secondary schools in the Eastern Cape in implementing their vision or need for integrating ICT in the curriculum?

Subsidiary questions arising out of the main question are:

- What ICT infrastructure and computer networking technologies already exist in the schools?

- What are the infrastructural issues that the school, principal, teachers, pupils, parents and government face in introducing ICT and Internet connectivity into schools?

- How can these infrastructural and connectivity issues be overcome?

- What appropriate software is available that will help educators manage and troubleshoot their networks?

- How cost effective can the infrastructure and connectivity be?

6.2 Research Aims

This research aims to establish the most cost effective and organisationally sound means of networking computer facilities of schools in the Makana (and possibly the Alice and King Williamstown) districts in the Eastern Cape, with a view to creating a set of generic templates that can be applied to other schools to produce the best outcomes for them, based on their current situation and their needs. It is assumed that schools across the country and indeed the Eastern Cape will fall into a number of categories of similar needs and situations, for example, ex-Model C, DET and House of Representatives schools and private schools. Further, it will be assumed that schools of similar backgrounds will have similar needs and thus I will be able to produce a set of generic models or plans, meaning that there will be at least one model that can be recommended to a school.

I will be visiting schools in the districts mentioned above in order to assess what their current situations are and what they require in order to successfully integrate ICT into the curriculum as well as use it as an administrative tool for the staff. I will also research and experiment with different networking models and technologies, thus gaining a broad understanding of networking and connectivity that may be applied to producing suitable models for secondary schools in the Eastern Cape. Few of these schools have integrated ICT into their curricula or schools, or if they do have ICT infrastructure, are not making use of it due to limitations of some kind. Thus this project will hopefully provide the schools with useful models of connectivity such that any school will have a feasible plan for obtaining ICT infrastructure and Internet connectivity. The work will also contribute to the broader aim of integrating ICT into the curriculum, thus allowing teachers and administrative staff to do administrative work and plan lessons, and provide a means for schools to obtain such technology affordably.

7 Research Design and Framework

This research aims to bring together two disciplines, namely the Sciences and Social Sciences, in order to solve the problem of how to provide connectivity to schools, as well as contributing to the integrating of ICT into schools. For this reason, the Positivist approach is not appropriate. The positivist paradigm is dominated by reasoning, rationality and scientific thinking. The positivistic approach is interested in patterns of phenomena and in being able to develop generalisations about the results of the research. Variables can be identified, isolated and controlled, and it is possible to express generalised relationships between those variables. Positivism is associated with mathematical precision - those variables can be expressed exactly and measured, hence positivism is often associated with quantitative methods[8]. The positivist believes in empiricism: that the idea that observation and measurement was the core of the scientific endeavor [9].

When considering research that involves only machines or calculations in a laboratory the positivistic approach has merit; however, when research involves groups of people and their interactions with each other or inanimate objects, the positivistic approach has been criticised. These criticisms point out that people are not plants or chemicals and as such variables can often not be identified nor isolated, controlled or measured (variables such as emotions and thoughts). Humans are also not generalisable, and one can not ignore their individuality. Critics also question positivism's firm stance on being able to be completely objective - the positivist researcher believes that he has no influence on the research at all, he is nothing more than an observer. This position is strongly criticised, saying that it is impossible to be completely objective [8].

From the criticism of positivism, it is clear that it would not be a suitable paradigm for me to choose for this project, however, a pure interpretivist approach would not be appropriate either, because of the experimental work that will be done with networking. For this reason I have chosen a post-positivistic approach.

Post-positivism assumes that scientific and common sense reasoning are essentially the same thing [9]. Post-positivists will accept that researchers can not be completely objective at all times and that their subjectivities will be found in our work, but will endeavour to limit the subjectivity present in their work. Post-positivists also accept that people can not be held to the strict measurements of the positivistic approach and that the information provided by the individual is important and can not necessarily be generalised to others.

A common form of post-postivism is critical realism. A critical realist believes that there is a reality independent of our thinking about it that science can study. Post-Positivist critical realists thus recognise that all observation is fallible and that theories can be revised (this is largely different from the positivist approach, where definite facts are non-refutable). Thus a critical realist is critical of our ability to know reality with certainty [9].

Thus this project will be conducted from a post-positivistic critical realist paradigm, bridging the sciences and the social sciences; being aware that our results are fallible and not necessarily generalisable. W. M. Trochim says it succinctly: "where the positivist believed that the goal of science was to uncover the truth, the post-positivist critical realist believes that the goal of science is to hold steadfastly to the goal of getting it right about reality, even though we can never achieve that goal! [9, para 6]"

7.1 Research Sites and Participants

The data collection procedure will include visiting schools in the districts that we will be covering. In the Makana District there are 13 secondary schools, ranging from private schools to the former DET schools. Of the 13 schools in the Makana District, 3 are private schools, 3 are previously Model C schools and

the remaining 8 are former DET and House of Representatives Schools, providing a microcosm of the country's schooling systems. At each of these schools we will evaluate their current infrastructure, as well as conduct interviews with teachers, principals and pupils. These interviews will provide an idea of what the schools need in terms of computer facilities and how to set up networks for maximum benefit from the new technology. I will also need to read as much as possible of the available documentation on similar projects that have been done in this country and others. For example, the Western Cape Education Department has a successful ICT program in their schools and I would like to read about how they achieved this, what problems they faced and how they were overcome. There are research papers available from similar projects that have taken place in the United States and Great Britain [6] [7]. It is important to note that projects done in first world countries may not necessarily always be applicable, however the work that has been done in those countries will provide a basis from which to begin. First world research will provide information of what has already been done and also what failed there, thus this project will hopefully not repeat failures and build upon successes, while remaining within the third world context.

7.2 Research Methods

All 13 secondary schools in the Makana district will be invited to participate in a survey. This will be done by sending out a questionnaire with a covering letter explaining the work that will be done in this project. It will be addressed to the principal of the school and the teacher in charge of IT in the school. This questionnaire will be a collaborative effort by myself, Nikiwe Sotashe and Nombeko Mbane (two research team members from the Education Department). While Nikiwe and Nombeko will focus on the integration of ICT into schools and how this affects the teachers and the pupils, I will be looking at what exactly the schools have in terms of infrastructure; how to set up the networks at each school so that integration is possible; what limitations, geographical and others, need to be overcome or worked around in order to make networking to and within the school possible. Conducting surveys is one of a number of methods of data collection. Surveys are most effective when the aim is to reach a large proportion of a population. They tend to be used to extrapolate and generalise from a typically small sample of a population to the whole population [10]. We will be using a survey in order to gain a basic understanding of how ICT is being integrated and to what extent, so that by the time we arrive at the school we will already have a basic knowledge about that school and we can use the visit to enrich our data.

Once confirmation has been obtained from the schools that we wish to include in the research project, arrangements will be made to visit to the schools in person. Our visit will allow us to conduct the necessary interviews and to observe the schools. Nikiwe will be interviewing and observing the teachers at the schools, Nombeko, the pupils, and I will be dealing with the technical aspects and meeting with the IT teacher. "Interviewing is a two-person conversation initiated by the interviewer for the specific purpose of obtaining research-relevant information, and focussed by him on content specified by research objectives of systematic description, prediction or explanation." [11, p1]. The interviews will hopefully provide data that is richer than that of the questionnaire and it will also allow for better focussed questioning or to clarify answers/responses from the questionnaire.

Another method of data collection that will be used is that of observation. Observation is about describing or representing a setting [12]. We will be using our observations to accompany and hopefully support (very possibly refute) data from the questionnaires and interviews.

Extensive reading and experimentation with different networking options will fulfill the other half of this project. In order that I may recommend network technologies to and within schools I will need to have an extensive knowledge of networking in general and have experimented with new, different and innovative network technologies. The aim is to provide the template ICT and Internet connectivity models for effective integration thereof into schools. In order for this to happen, an extensive investigation of all types of networking options will need to be undertaken. Some examples of network technologies

that will be investigated and experimented with are dial-up, Digital Subscriber Line (DSL), wireless and satellite communications. Apart from reading the work that others have done, test networks will need to be constructed, allowing for experimentation. Experiments will include, amongst others, investigating speed of data transfer, reliabilty of data transfer, quality of the data transfer, cost and feasibility. It is further hoped that some of those test networks will then be deployed in certain schools where they will be appropriate.

The types of networks previously mentioned provide a wide range of different choices, some of the options being slightly older networking options while others are relatively new. Since South Africa is a third world country, it makes sense to consider all the options, from the older to the newer technology, because the infrastructure for the older technology is more likely to be available than that of the newer technology, and the newer technology will tend to be more expensive than the older technology. For this reason I feel that it is important to consider all our options. The older technology, such as dial-up, will also provide a basis to compare all the other options against.

7.3   Research tools

The research tools that will be made use of in this project include questionnaires - to assess the basic infrastructure of the schools; interviews - to gain a deeper understanding of the infrastructure mentioned as well as the school's approach to integrating ICT into the school; an observation checklist - to either confirm or refute the responses to the questionnaires and interviews, as well as to provide a deeper understanding still of the issues that the school faces with regards to integrating ICT into the school and the curriculum; and lastly, reading as much as possible of the works that have been published on similar projects that have been undertaken in this country and in others, as well as experimenting with different types of networks.

The particular details of each school's ICT infrastructure, i.e. hardware, software, networking and Internet access, as well as the details pertaining to their organisational issues, like location of computers, maintenance, security (in terms of physical security and not virus security, etc), insurance, staff technical skills and computer literacy will be gathered through questionnaires that are presented to the teachers and principals.

There will also be semi-structured interviews with the teachers and principals of each school. These interviews will hopefully create a deeper understanding for myself as to what the needs of each school are and what the problems are that they are facing. For each interview there will be an interview schedule of questions that I would like to cover. These questions will be based on the responses that the Principal or IT teacher provided in the questionnaire that will have been sent out beforehand.

Through the questionnaires and semi-structured interviews I will be able to compare schools with each other as well produce statistics about school infrastructures, which will hopefully produce some insights as well as highlight trends that we may find in the schools. These trends will either be confirmed or denied by the observation of the schools. In observing each school, a checklist will be made of all that is found in the school (infrastructure and equipment) as well as the limitations faced by each school.

As mentioned in the previous section there are a number of networking options that will be investigated. Investigating the reliability of a network involves regularly checking the network and recording statistics of the network, an example of such a system is Big Brother which is used at Rhodes University to monitor the campus network. Another means of testing the network reliabilty would be to send large volumes of data and note how many of the packets were dropped by the network. Measuring speed of data transfer would involve measuring the time that it takes to transfer data on the network, a program such as tcpblast would do this. Alternatively something as simple as ping would measure the round trip latency. The quality of the network and data transfer is based on the assessment of the speed, reliability and latency. There are many programs that can be used to measure all these variables on a network and produce useful statistics and graphs. The cost of certain types of networking will be found through reading price lists and careful

costing on all the necessary equipment that would be required would need to be done. The feasibility of a connectivity model will then depend on all these factors: whether the network performs satisfactorily, whether it is a reasonabily cost effective option and lastly whether it is a practicle solution in terms of the requirements and limitations of the school.

7.4 Research Activities

The first step will be to obtain permission from the schools in order to include them in the project. We will send out letters to each school, accompanied by a questionnaire, to request permission to include the school in the project and conduct interviews with the school principal, relevant teachers and pupils. We will also need permission to visit the school so that we can examine their current infrastructure and assess what is already present.

Once we have obtained permission from the school, we can then set up times to visit the school, conduct the interviews and view their facilities. All the necessary information will be collected so that a report can be produced on each of the schools, which will contain information from the questionnaire, interviews and what was seen at the school. A copy of these reports will be sent to the school in question for verification. Any interview transcripts will also be sent to the relevant person in order that we may confirm that the information that we obtained from the interviewee is an accurate record of the interview.

From these reports we will hopefully be able to identify problem areas that need addressing and common trends which will contribute to the template plans (models) of Internet connectivity and provide insight to what ICT infrastructure they will be requiring. Schools will be able to assess what they need in terms of computer facilities for their schools and what Internet connectivity model will best meet their needs.

In conjunction with this work, I will need to investigate alternative networking options for schools, assessing the pros and cons of each network technology, evaluating costs, productivity, reliability, etc. I will begin by looking for similar work that has been done by others, so that my work will build new information and not repeat other people's work, achievements and mistakes. From their work I will also be able to gain a sound grounding in what has been done, where their work worked and where it did not work and from there hopefully find new and innovative ways of networking schools, in such a way that the networks are optimal for each and every school.

From this we will deploy some networks in a few selected schools. For the obvious reasons of monetary constraints, we will not be able to deploy computers and networking in all the schools. This project will also produce a report on what we have found, what worked and what did not work, as well as the template models or plans that we will have created, so that other schools will be able to apply these models to their own situations.

8 Ethical Issues

Semi-structured interviews and participant observations require a large amount of trust between the researcher and the participants, and a good understanding of what it is that the researcher wishes to do with the research. For these reasons, participants must be clearly briefed on what the research is and what it will amount to - by this I mean that we will be very careful not to create false hope or imply promises that we will not or can not keep. Particular attention should be paid to the fact that we are not promising to bring free technology to the schools with a working solution - obviously we hope that this would be the case, but there are no guarantees that our research will succeed as we would hope.

All transcripts from interviews and observations will also need to be sent to the schools and interviewees so that they may verify our findings and that we may ensure that we are not misrepresenting them in any way.

It will be made clear to all participants that they may withdraw from the research at any time or stage should they no longer wish to be a part of the research. They will be under no obligations to take part in the research from the beginning and as such may decide to discontinue their participation in it later on.

9   Provisional Contents

Chapter 1: Background and Overview

Chapter 2: Literature Review

Chapter 3: Research design

Chapter 4: Models of Internet Connectivity

- Section: Report on questionnaires and Interviews {interviews}, etc {remove etc}

- Section: Report on the different types of networks

Chapter 5: Findings and Discussions

Chapter 6: Summary and Recommendations

10   Project Outcomes

The potential outcomes of this project are to produce a practical plan that can be applied to all schools, tailoring a solution based on their situation. It is hoped that it will result in schools having the best (or most appropriate) Internet connectivity and networking as well as computer facilities for their particular situation and that the maximum potential will be obtained from these facilities. This work will hopefully have broad implications for education in general, across the country, and complement the work being done by the MEd students who are studying methods of successful integration of ICT into the curriculum.

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A Connectivity summary by province

Province / Domains	Non-ISP Providers	Non-ISP Dialup UUCP (e-mail)	Non-ISP Dialup PPP (WWW)	Dialup ISP accounts (single-user WWW and e-mail)	Leased-line <= 28.8 kbps [x] = # of sites with ISP connection	Leased-line >= 64kbps [x] = # of sites with ISP connection	Total schools online	% of total
Western Cape wcape.school.za	WCSN [130] (via Uninet at UCT)	123	90	0?	8 [1]	0	131	53%
Gauteng pta.school.za, jhb.school.za	PretNet (via UP), CSIR, GSN (via Uninet at Wits and RAU)	24	0	17	0	9 [2]	50	20%
Eastern Cape ecape.school.za	RU (via Uninet), ECSN (via PETech)	38	0	?	7	0	45	18%
Kwazulu-Natal dbn.school.za, pmb.school.za, kzsn.school.za	UNP, Uninet (UND)	6	0	11	2	2	21	8%
Free State	(Uninet)	0	0	?	0	0	0?	<1%
Northern Cape ncape.school.za	WCSN	1	0	1	0	0	2?	<1%
Mpumalanga		0	0	1	0	0	1?	<1%
Northern Province		0	0	?	0	0	0?	<1%
North West		0	0	?	0	0	0?	<1%
TOTAL		192	90	30	16	11	249	