CHAPTER 7

ICT USE CONFERENCE FINDINGS

This chapter presents the ICT use conference findings as obtained for purposes of deliberation, verification and legitimisation. Section 7.1 presents an introduction to the Chapter. Findings as negotiated during the ICT conference are presented in Section 7.2 before the conclusion in Section 7.3.

7.1 Introduction

This section presents findings on the ICT use conference findings, the aim of which was to '*legitimise'* the findings of this study. The conference design, instruments development, population and sample, and the analysis applied of the ICT use conference were presented in Chapter 4. As explained earlier, the ICT use conference invited representatives of key stakeholders to discuss the findings from the perspectives of 'do they recognise the findings as being indeed reflecting the context of the rural Namibian schools'?, and to discuss at the ICT use conference on the basis of two exercises what would be appropriate measures or actions to be taken by stakeholders such as the Ministry of Education and regional education authorities and/or at school level to address problems and issues that have been identified through this research.

The notion behind the ICT use conference methodology was to share information with stakeholders, again with the aim of legitimising the findings (Mulder, 1994). The documents shared with the stakeholders contained the main issues to be clarified during the conference, the description of the context of ICT implementation in rural areas, and the preliminary findings of this study as presented in Chapters five and six respectively. The presentation at the beginning of the conference covered the introduction to the study, aims and objectives, context, research questions, conceptual framework and preliminary findings. The presentation highlighted the dependent and independent variables so that when the participants performed exercise two, they would reflect on them. The exercises were presented before the preliminary findings for research questions one and two

respectively. Exercise 1 comprised the questionnaire on preliminary findings, asking the participants to tick the most appropriate answer. Exercise 2 requested the participants to draw pictures illustrating the relationships that exist between the factors (*Appendix N*). Finally, the participants were given a chance to deliberate on how to improve ICT implementation in the rural schools. The deliberations were recorded in order to capture the consensus reached or the interactions in case of different opinions. Before the conference, the researcher developed rules to determine the final decisions. The decision was based on the mode of the highest frequency count for all statements per construct (see Section 4.4). The mode would determine the decision. The background information of the school principals, science teachers and ICT technicians are presented below.

The ICT use conference was attended by the representatives from the key stakeholders in ICT in Education in Namibia, such as the National ICT Coordinator who acted as a presenter for the outcomes of the exercises to verify the findings; the principals, science teachers and the ICT technicians from three schools, and the researcher who acted as the facilitator of the workshop and the presenter of the preliminary findings of this study, to verify and legitimise the findings. The principals, science teachers and the ICT technicians were drawn from schools in areas within at least a 100 kilometres of the conference venue which was held at UNAM Oshakati campus. These schools had scored high in the survey, indicating that they had ICT and that they had been implementing ICT for at least two years. The characteristics of the respondents are described in Table 7.1 below.

Table 7. 1: Characteristics of the school principals, science teachers and ICT technicians

	School P	School Q	School R
Principals			
Age	45	50	34
Training	Bed	BA, PGDE	BEd.
No of years as principal at that school	10	5	4
Science teachers			
Age	25	32	32
Training	BETD	BEd	Bed
No of years as teachers	5	3	7
ICT technician			
Age	30	25	42
Training	BETD	No formal training	Bed
No of years as ICT technician	7	3	10
Teaching subjects	Biology	Computer studies	Computer studies

Table 7.1 above shows that the principals' age ranged between 34 and 50. Two had Bachelors of Education (Bed) degrees and one had a post graduate qualification in education, (PDGE), with more than four years of experience as principals of their respective schools. The science teachers' age ranged between 25 and 32, with two having a BEd and one a BETD teaching qualifications. The science teachers had more than three years of teaching experience. The ICT technicians' ages ranged between 25 and 42, with two having teaching qualifications, BETD and BEd and one being an 'unqualified teachers', that is, without a teaching qualification. The number of years of teaching ranged between three (for with the unqualified teacher) and seven and ten (for the other two teachers). Two of the ICT technicians taught Computer Studies whilst the third ICT technician taught Biology. In addition, the National ICT Coordinator had years of experience in that position and was a professional IT technician. This information is presented to provide a better insight into the findings of the ICT use conference.

This section presents findings from the ICT use conference. The results are presented in two parts. Section 7.2.1 presents findings on description of ICT implementation in science classroom and rural schools. Section 7.2.2 presents findings on affecting ICT implementation. The findings of the ICT use conference are presented in a descriptive mode. Finally, a summary of the negotiated findings are presented in Section 7.2.3.

7.2. Conference participants' perceptions' of ICT implementation in rural schools

This sub-section presents the legitimate findings for research question two on how ICT is being implemented in science classrooms. The participants were asked to reply to the statement about their own schools. An additional column was added to show the stance of the participants. However, where the participants differed on statements for their school, it is indicated in the scores as well as the discussions. Each statement is presented with a conclusion. The responses are reported in the tables below.

ICT infrastructure

The participants were asked to indicate if they agreed with the statements asking them about the extent of supply and maintenance of ICT infrastructure in rural schools.

Table 7. 2: ICT conference findings on ICT infrastructure

Statements	N	Strongly agree (n)	Agree (n)	Disagree (n)	Strongly disagree (n)	Conclusion for construct (n)
There is sufficient number of computers available.	10	0	2	5	3	**Disagree**
Computers at our schools are well maintained.	10	0	2	5	3	**Disagree**
My school has bought additional computers	10	0	1	6	3	**Disagree**
Total	**30**	**0**	**5**	**16**	**9**	

The table suggests that the participants disagreed that there were sufficient computers and that they were well maintained in all the junior secondary schools in the three educational regions.

Digital learning materials

The participants were asked to comment on whether the rural schools invested money in buying digital learning materials and whether the materials made available to them were relevant. In addition, the respondents were asked to indicate if they possessed skills that would enable them to use the said digital learning materials. The findings were as follows:

Table 7. 3: ICT conference findings on Digital learning materials

Statement	N	Very sufficient (n)	Rather sufficient (n)	Somewhat sufficient (n)	Not sufficient at all (n)	Conclusion on construct
Our school has invested into buying software for teaching	10	0	2	3	5	**Somewhat sufficient**
Statements	**N**	**Very relevant (n)**	**Rather relevant (n)**	**Somewhat relevant (n)**	**Not relevant at all (n)**	**Somewhat relevant**
The digital materials we have at our school are relevant for teaching science.	10	1	2	7	0	
Statement	**N**	**Strongly agree (n)**	**Agree (n)**	**Disagree (n)**	**Strongly disagree (n)**	**Disagree**
I possess skills that will enable me to use the digital learning material available at my school.	10	1	2	7	0	
Total	**30**	**2**	**6**	**17**	**5**	**0**

The results on digital learning materials suggest that some schools invested in buying software and that the software was somewhat relevant. Science teachers also disagreed that they possess some skills that would enable them to teach using the software.

Expertise

The participants were asked to rate the extent to which the teachers, principals and ICT technicians had relevant expertise and portray a positive attitude towards ICT use. The response was as follows:

Table 7. 4: ICT conference findings on Expertise

Statements	N	Very relevant (n)	Rather relevant (n)	Somewhat relevant (n)	Not relevant at all (n)	Decision on construct
I have relevant knowledge in ICT	10	2	0	8	0	**Somewhat relevant**
I have relevant skills in ICT to teach/assist colleagues.	10	2	4	4	0	**Rather relevant**
		Strongly agree (n)	**Agree (n)**	**Disagree (n)**	**Strongly disagree (n)**	
Science teachers at my school possess the right attitude to use ICT.	10	2	4	3	1	**Agree**
Total	**30**	**6**	**8**	**15**	**1**	

The responses on digital learning materials suggest that the knowledge of ICT of principals, science teachers and ICT technicians was somewhat relevant. The participants also suggested that they had rather relevant skills to integrate ICT or to assist other colleagues. The participants also agreed that the science teachers at their school possess the right attitude to ICT use.

Vision and leadership

The participants were asked to indicate whether their schools had a vision statement that reflected and encouraged ICT-related activities in the schools. The responses were as follows:

Table 7. 5: ICT conference findings on vision and leadership

Statements	N	Strongly agree (n)	Agree (n)	Disagree (n)	Strongly disagree (n)	Conclusion
Our school has a vision statement with regard to ICT.	10	2	3	5	0	**Agree**
Our school leadership is very active in all ICT related matters.	10	2	5	3	0	**Agree**

Statements	N	Very much encouraging	Rather Encouraging	Somewhat encouraging	Not at all encouraging	
Our school's vision encourages the use of ICT in class.	10	3	4	3	0	**Rather encouraging**
Our school's vision encourages teachers to use ICT.	10	3	5	2	0	**Rather encouraging**
Total	**40**	**10**	**17**	**13**	**0**	

The results on vision and leadership suggest that half of the schools had vision statements. The school leadership was also very active in all ICT-related matters, and the participants indicated that their schools' vision rather encouraged ICT use

in class. Both scales expressed agreement on a 4-point scale and can be seen as similar. The survey had a small number of participants and the findings are used in an indicative way and not generalised to the population. The same reason is applicable to tables with a similar phenomenon.

Collaboration and support

The participants were asked to rate the statements describing the collaboration on ICT between schools and at circuit level and to rate the level of support made available to teachers. The responses were as follows:

Table 7. 6: ICT conference findings on Collaboration and support

Collaboration	Statements	N	Strongly agree	Agree	Disagree	Strongly disagree	Decision on construct
	Our school collaborates with other schools on ICT related matters	10	0	4	6	0	**Disagree**
	I collaborate with other teachers in my circuit on ICT related matters	10	0	4	6	0	**Disagree**
	I belong to a teachers' online forum.	10	0	0	6	4	**Disagree**
Total		**30**	**0**	**8**	**18**	**4**	

Support	Statements	N	Very much	A little	Somewhat	Not at all	Decision
	I receive/render necessary technical support on time.	10	0	2	6	2	**Somewhat**
	I receive/render the necessary pedagogical support on time.	10	0	3	5	2	**Somewhat**
Total		**20**	**0**	**5**	**11**	**4**	

The results with regard to collaboration suggest that there was none between schools within the same circuit or online forum for teachers on ICT-related matters. The technical and pedagogical support that the science teachers received was somewhat sufficient.

Professional development

The participants were asked to rate the extent to which professional development was offered with regard to skills acquisition and also on integration of ICT. The responses were as follows:

Table 7. 7: ICT conference findings on professional development

Statements	N	Strongly agree (n)	Agree (n)	Disagree (n)	Strongly disagree (n)	Conclusion on construct
I have been trained in ICT.	10	0	7	0	3	**Disagree**
I have been trained in ICT integration.	10	0	2	5	0	**Disagree**

Statements	N	Strongly agree (n)	Agree (n)	Disagree (n)	Strongly disagree (n)	Conclusion on construct
The training I received was relevant for teaching science.	10	0	2	4	4	**Disagree**
Total	**30**	**0**	**11**	**9**	**10**	

The respondents disagree that professional development was provided, particularly with regard to integration and also the relevance of ICT.

7.3 Conference participants' views about factors affecting ICT implementation

This section presents the negotiated findings on factors affecting ICT implementation in rural schools. The negotiated findings are presented in two parts: 1) list of factors in order of importance, the how factors link to each others, and 2) the suggestions.

The participants were asked to rate the order of importance of the constructs illustrated in the conceptual framework (Chapter 3) of this study. The respondents were reminded to think of the factors they thought would be dependent and independent and link these accordingly. Space was also provided in the questionnaire in case the participants had more factors that did not appear in the list provided. The results were as follows:

Table 7. 8: Findings on factors affecting ICT implementation

Factors	N	Very important	Rather important	Somewhat important	Not important	Conclusion
Vision and leadership	10	10	0	0	0	**Very important**
Collaboration	10	5	5	0	0	**Rather important**
Pedagogical Support	10	8	2	0	0	**Very important**
Technical support	10	8	2	0	0	**Very important**
ICT infrastructure	10	10	0	0	0	**Very important**
Professional development	10	10	0	0	0	**Very important**
Digital learning materials	10	8	2	0	0	**Very important**
Knowledge, attitude and skills	10	8	2	0	0	**Very important**
Pedagogical use of ICT	10	5	5	0	0	**Rather important**
ICT use in general	10	10	0	0	0	**Very important**
Total	**100**	**82**	**18**	**0**	**0**	

The results in the table above suggest that most of the factors listed in the conceptual framework of this study were rated by the participants as very important. However, half expressed that collaboration and pedagogical use of ICT were rather important. The participants deliberate on the importance of the two constructs based on the effort and the acquisition of the basic needs for the schools. Some schools indicated that they were very much challenged by the sustainability of pedagogical use of ICT, given that they had less infrastructure, less time to finish the syllabus and few skilled science teachers. With regard to collaboration, half the participants said that collaboration was also rather important

for science teachers to share knowledge and skills on ICT use, but that they would have liked more ICT training to be conducted so that more science teachers would be skilled before collaborative activities were taken on by the Ministry of Education. Overall, the finding suggests that the factors are very important. The respondents did not come up with any new factors.

Linking of factors

After the participants listed the factors accordingly, they were asked to link them in a way they saw as affect ICT implementation. In this exercise, two groups were formed each consisting of five participants. Group 1 consisted of one Principal, one ICT technician, the National ICT Coordinator and two science teachers. Group 2 consisted of two principals, two ICT technicians and one science teacher. The groups provided different answers as presented below:
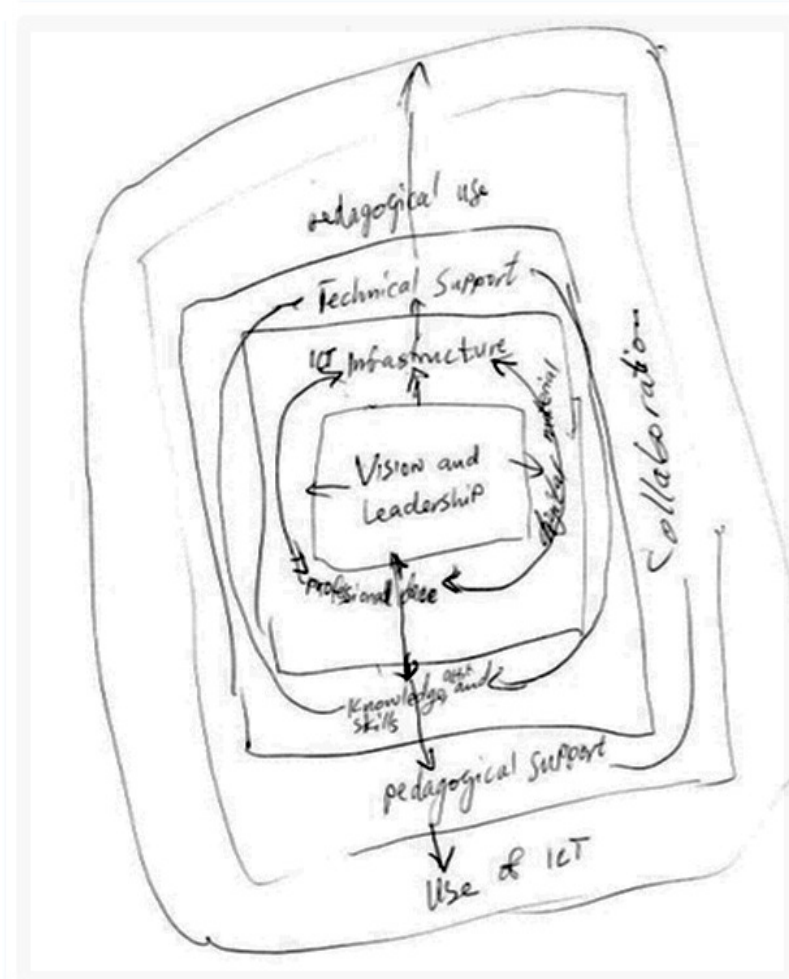
Figure 7. 1: Link of factors by group 1
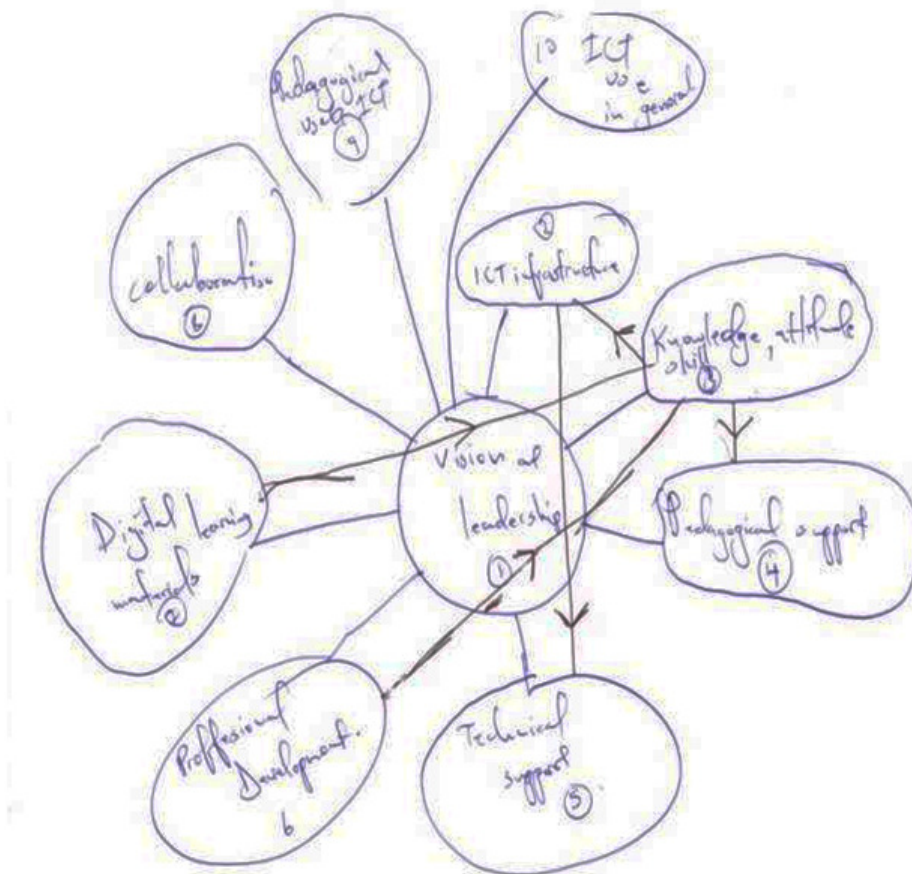
Figure 7. 2: Linking of factors by Group 2

Both figures 1 and 2 (above) show that the vision and leadership is seen as core to the implementation of ICT and may influence other actors positively or negatively. These figures suggest that all other factors are dependent on the vision and leadership of the school. Group 2 numbered the factors in terms of importance and how they linked to each other.

Suggestions from the participants

As the final activity of the curriculum conference, the participants were asked to provide suggestions they think should be considered in the effort to improve the implementation of ICT in rural schools. The suggestions were provided per construct as follows:

Leadership

When asked to make suggestions about the vision and leadership, the participants made the following comments:

> *'The leadership should remain strong. The principals are eager to have the ICDL Computer programme introduced to their schools. The leadership would like to have their learners and teachers become ICT literate by 2030. The leadership must therefore encourage the teachers and learners to use ICT' (Principal R, 02 July 2010).*

> *'On a national level, I think the whole issue of ICT should be reviewed. I find it to be very understaffed at national level as a result, the regions are becoming increasingly frustrated because they feel that there is no constant and continued flow of information… so improved relation between the head office and regional offices is needed' (ICT National Coordinator, 02 July 2010).*

> *'Are schools at liberty to develop their own ICT policy that will guide their operations? Should the schools have guidelines, they will be able to generate their own income for as long as it is properly managed' (ICT National Coordinator, 02 July 2010).*

This statement raised an argument as Principal 'C' does not know whether it is allowed to generate income for the school that will be used towards ICT activities. Principal C comments furiously:

> *'I am not so sure if schools are allowed to generate their own income by letting the community members use their facilities...sometimes we are being told that it is not allowed ...things are just not clear for us…' (Principal R, 02 July 2010).*

In an attempt to reach a consensus, Principal 'A' comments:

'Schools can have internal policies and with that, one can be protected...' (Principal, P, 02 July 2010).

From the data, it appears that the participants are of the opinion that the school leadership is responsible for taking the lead in the implementation of ICT. The conference participating schools have shown willingness to take part in the ICT project and the school leadership encourages teachers and learners to use ICT effectively. However, there were a number of ambiguities within the National ICT policy as well as other policies that may affect the implementation of ICT in schools. The participants referred to ambiguities such as inconsistency within the different education-related policies with regard to generating income for the school, and the mandate of the school leadership. The ICT National Coordinator is therefore calling for a review of the National ICT policy.

Collaboration

The participants also commented on the issue of collaboration within and between schools circuit as well as the region in general. The participants had the following comments:

'The fact that collaboration is not there, is due to the fact not all schools have the ICT infrastructure. Let us say, in a circuit of 30 schools for example, and only one school has computers. With whom are you going to collaborate? However, principals must do their level best to collaborate with other schools regardless of their schools being in the same circuit or same region so that the flow of skills can be increased from one school to the other' (Principal, R, 02 July 2010).

'Schools must find sister schools which are well established and link up, that is, schools with well established ICT and partner with them. There are still schools that do not have guidelines on how to use computers...but with a partner school, guidelines could be developed

on how to come up with guidelines, how to best use computers labs, and how to best share the limited resources available. Say for example, the other party comes to another school on a Tuesday afternoon to show teachers how certain activities are performed. It is practical and it does not cost you money...' (ICT National Coordinator, 02 July 2010).

In addition, Technician Q stated:

'There is need to enhance ICT use within our school. Very few teachers possess knowledge and skills in ICT….they need to be encouraged to transfer skills to more teachers' (ICT technician Q, 02 July 2010).

From the data, two suggestions have been made, namely to foster strong links within and between schools in the same circuit, intra-regional and inter-regional collaboration in order to share resources and ensure skills transfer from one school to the next.

Pedagogical support

In terms of pedagogical support, one suggestion was made.

'For effective use of ICT in teaching, why can't we have advisory teachers for ICT at the regional level?' (Science teacher Q, 02 July 2010).

It appears that the participants are not exposed to advanced ICT skills and knowledge in order for them to make demands that are reasonable.

Technical support

In terms of technical support, the participants made remarks such as:

'It will not work with only one technician per region. I think technicians must be appointed to each and every school so that technical support is provided on time should any faults occur...it is not good to hear that the technician is somewhere else every time you need him. It will delay the use of ICT' Teacher A, 02 July 2010).

> *'If appointing technicians per school is too much...Maybe technicians should be appointed per circuit'* (Principal R, 02 July 2010).

> *'Finance will always be an issue. We can't even appoint teachers at all our schools...so appointing technicians may not be possible but it will be a matter of training the ICT focal person at each school and that should be rolled out from the head office level. Thus, maybe increasing capacity at circuit level...'* (ICT National Coordinator, 02 July 2010).

> *'In terms of technical support, I think the government should look into recruiting volunteers from other countries in order for them to come assist...' (*Principal Q, 02 July 2010).

The participants suggest that ICT technicians be appointed at circuit level to ensure that the schools receive professional service on time. Appointment of technicians may take a long time before being considered since the Ministry of Education is struggling even to appoint teachers. Another suggestion to appoint volunteers from other countries to render technical support might also work.

Professional development

The participants made suggestions on improving professional development as follows:

'I think teachers should be trained at colleges because at schools, teachers hardly have time' (Principal P, 02 July 2010).

'The colleges must have a computer course that is compulsory for all...but also the government must make sure that it supplies schools with infrastructure' (Science teacher P, 02 July 2010*).*

'Right now at UNAM, computer is compulsory but it is not sufficient. It can also not be sufficient because [as a student] you have other subjects but then more training on integration of ICT needs to be taught' (Science teacher R, 02 July 201).

The conference recommended that both principals and teachers be trained in ICT. The teachers must be trained at the teacher training institutions to ensure that upon appointment, they have the necessary skills to perform duties using ICT. In addition, the principals must also be trained in ICT to ensure effective supervision and guidance with regard to ICT implementation in schools.

Expertise

Suggestions with respect to knowledge, attitude and skills, the comments were as follows:

'You find that at times the teachers had knowledge in ICT but because he or she was placed at a school without ICT, she forgets' (Science teacher P, 02 July 2010).

'The school leadership should encourage the teachers' attitude to change in a more positive way...to integrate ICT in their daily lessons...and to use internet more' (Principal R, 02 July 2010).

The participants did not have concrete suggestions about knowledge, attitude and skills, rather, the comments were more general towards encouraging ICT use and subsequently changing the attitude of the teachers. However, the level of

expertise amongst the science teachers may increase with the increase in professional development. The outcome of such training and the provision of ICT to schools may influence the science teachers' attitude more positively.

Digital learning materials

The participants' suggestions on digital learning materials were as follows:

> *'We need money to buy the materials' (*Science teacher P, 02 July 2010).

> *'We are not aware that Namcol is training teachers to develop software for use in teaching subjects'* (Principal R, 02 July 2010).

> *'It is important that the teachers are supported with educational software that align to the curriculum goals....and more so, the curriculum should be clear on how certain topics are to be taught using ICT'* (Science teacher Q, 02 July 2010).

From the data, the schools must be given more money to buy their own software, though the types and use were not specified. It may be interpreted from this that the knowledge about software is limited and they do not know what is available in the market. In addition, the participants were not informed about the development being pursued about content development courses at Namcol. The acquisition of digital learning software must be in line with science curriculum goals.

ICT infrastructure

With regard to ICT infrastructure, the participants suggested that the principals must make sure that the schools were equipped with ICT. In order to do so, the principals must be trained on a course that raises awareness about the importance and use of ICT. For example:

'*Principals in rural areas have been trained in those years and did their work without computers and they do not even care whether the schools have computers or not. Thus, principals need to be made aware of the importance of ICT and how to get their staff use ICT*' (Principal P, 02 July 2010).

Processes on how to acquire ICT were not discussed as it is taken for granted that the government should provide ICT. There was no plan to replace the obsolete computers.

7.4 Summary of the negotiated findings for the study

This section presents the summary of the negotiated findings sought from the ICT use conference. The ICT use conference was aimed at legitimising the findings, phrase conclusions and suggest recommendations. The findings from the ICT use conference are summarised per construct below:

1. Schools have vision statements and the school leadership is active in ICT-related matters. Through the vision, science teachers are encouraged to use ICT. It is envisioned that schools should develop their own ICT policy to guide them on ICT-related matters for the school. Some participants claimed that they did not know what was expected from them and also how to go about raising funds in order to sustain and maintain the ICT. It is recommended that the National ICT Policy be reviewed.

2. Collaboration between teachers in the same school or with other school in the same circuit or region is lacking as is collaboration between schools and the communities in term of ICT support. It is recommended that the notion of establishing sister schools be introduced thus, schools with more or better ICT resources would assist those without. Also, collaboration within and between schools and communities should be encouraged by the school leadership.

3. There is insufficient pedagogical or technical support being offered to the science teachers who are rather encouraged to use ICT. In addition, it was observed that the National ICT Office was understaffed and there was lack of flow of information from head office to rural schools. It is recommended that advisory teachers and ICT technicians be appointed at regional level in order to ensure pedagogical and technical support respectively in rural schools.

4. There was lack of professional development in rural schools. Principals, science teachers as well as ICT technicians had not been trained in basic computer use or pedagogical use of ICT. It is recommended that they attend extensive training in basic computers and also in pedagogical use of ICT. Compulsory ICT training should be done during pre-service so that teachers become skilled before resuming teaching duties.

5. With regard to expertise, the participants indicated that the knowledge they possess is somewhat relevant and they also have rather relevant ICT skills. As a result, the science teachers from the participating schools, use ICT, they have indicated that they have a positive attitude towards ICT. However, skilled science teachers may be placed to work in schools without ICT, which may result in the science teachers forgetting most skills. It is therefore recommended that in order to increase ICT use and transfer of skills, ICT skilled science teachers be placed in schools with the necessary infrastructure.

6. Digital learning materials are somewhat not available. A few schools buy digital learning materials and they claimed that the software is relevant. However, science teachers and ICT technicians had not been trained on how the software operates. It is recommended that rural schools be supplied with relevant software that is aligned to science curriculum goals.

7. There is a lack of ICT infrastructure in schools. The government has provided the basic ICT to rural schools irrespective of the number of learners and teachers in those schools. The criteria for ICT deployment are not consistent with all schools. Some schools have acquired more ICT

depending on the availability of funds in their school development fund. It is recommended that the principals attend an awareness campaign on the importance of ICT in schools.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

This chapter presents a summary of the research project and of its key findings, as well as reflecting on methodology and conceptual framework and making recommendations and drawing conclusions. The findings, recommendations and conclusions drawn from this study provide strategies to improve and implement ICT in rural junior secondary schools, particularly in the science classroom, and the overall education system in Namibia. The results provide a general overview of translating policy into practice in the rural schools in developing countries, but the findings and conclusions are only applicable to the population of this study. Further research questions are also proposed.

8.1 Summary of the research

This thesis has evaluated the implementation of Namibia's Policy on ICT in rural junior secondary schools, particularly in science classrooms. It is argued that new technologies require teachers to include new pedagogical approaches that apply innovative ways of using ICT. Some authors have noted little understanding of the way in which ICT is used in schools and classroom around the world (Ainley et al., 2008; Boateng, 2007). However, it is important for the national policy to state what ICT should be used for in school and at classroom level. To date, no study has been conducted in Namibia to evaluate how ICTs have been used by the teachers since the introduction of ICT Policy (2005) in the country's schools. What schools are doing with ICT in accordance with the policy requirements have not been investigated (Matengu, 2006). It is in this light that the thesis was conducted to explore ways ICT is being implemented in rural schools and to identify factors that affect the implementation process, in particular how science teachers integrate ICT in the science classrooms and contribute to the knowledge of it in rural schools in developing countries.

The main research question was as follows:

- How and to what extent has ICT been implemented in Namibian rural junior secondary schools?

The sub-research questions were:

- *How are ICT being implemented in the science classrooms?*
- *What factors affect ICT implementation in the rural schools?*

Findings for these research questions were presented in Chapters 5 and 6 respectively.

The study has used a mixed methods approach (as argued in Chapter four): a baseline survey to describe the status of ICT and to explore factors and a case study approach (interviews and classroom observation), to deepen the understanding of factors that affect ICT implementation in junior secondary schools in Namibia. The survey consisted of three questionnaires for principals, science teachers and ICT coordinators, respectively. A total of 136 out of 163 schools were drawn from the population of secondary schools in the Northern educational regions. Data was analysed using the SPSS to explore and identify predicting factors that affect ICT implementation. Interviews were conducted with nine interviewees from three purposively sampled schools (three principals, three science teachers, and three ICT coordinators) Data was analysed manually. Further, an ICT use conference was conducted with the following participants: the National ICT Coordinator and the principals, science teachers and ICT coordinators from three purposively selected schools, viz schools that appeared to use ICT relatively intensively, based on the survey findings, and not included in the case studies. Data was collected using self-designed questionnaires and focus group discussions in the ICT use conference, and was analysed using frequency counts to determine the findings for purposes of verification of the preliminary findings.

The findings of this study should be placed in the perspective of supporting the Four-in-

Balance Model (2002) (Figure 3.2). This model was useful in advancing the theoretical understanding and has been used as the conceptual framework for analysing ICT use in rural schools (Sections 5.3, 5.4 and 5.5 and Sections 6.4, 6.5 and 6.6 respectively). The model is also used to identify the variables that emerged from a review of the literature (Chapter 3) as possibly affecting pedagogical use of ICT in rural schools. As illustrated in the previous chapters, it has been tested for consistency with data collected and suitability for answering the research questions. The findings illustrate that the model and other factors derived from relevant research and models fit the data on implementation of ICT in rural science classrooms.

8.2 Summary of the research findings

This section presents the key research findings that were established from the previous chapters. They are presented in line with the research questions with literature findings also discussed to enhance the quality of the discussion. The research findings of this study are summarised according to each research question in the following sections:

8.2.1 Pedagogical use of ICT in science classrooms

In general the use of ICT by science teachers is in Phase 1 of the National ICT Implementation Plan for ICT in Education (2006) (see Chapter 2). Phase 1 requires the deployment of ICT to educational institution, development of curriculum and content, training of teachers and learners in ICT skills and the development of a sustainable support mechanism. According to the National ICT Policy, it was anticipated that by the year 2009 all activities in Phase 1 of the ICT implementation Programme (2006) would have been complete. The findings of this study in comparison to the statements in the policy are presented. For a better understanding of scores as low, medium and high, the computation has been shown in Appendix O to explain the level of ICT implementation

ICT use

The use of ICT in Namibian rural schools is in its initial stage of implementation. The Namibian ICT in Education Implementation Plan Guide (2006) states developmental levels with targets for implementation. Five levels are outlined from level 1, describing schools and institutions with very basic ICT usage to level 5 being the schools and institutions at exceptionally advanced stages of ICT usage. The levels ensure access and usage of ICT. At level 1 it is expected that the school would have one room with ICTs, audiovisual facilities, at least one to two teachers with intermediate level ICT Literary Certificate, and learners who are introduced to ICT through one class period per month in order to meet the requirements of Level 1. At this level the Internet is not a requirement.

This study found that the rural schools only partially met the requirements of Level 1, as none of the science teachers had indicated that they possessed the Intermediate Level ICT Literacy Certificate. However, science teachers in Namibia use computers almost every day for lesson preparation, study notes, lesson activities and for assessment. On average, science teachers spent between 2 to 6 hours on ICT use per week (Figure 5.3) on ICT.

From the literature, Kennisnet (2008) found that secondary school teachers in The Netherlands use ICT on average 5 hours a week, whilst the managers use ICT about 13-18 hours a week. In Finland, science teachers use ICT only once a week, amounting to 28% of the teaching time during a particular period of the year, this being due to lack of time, too few digital learning materials, and a lack of ICT resources after school (Kankaanranta, 2009). Finnish teachers have developed a negative attitude towards ICT use at school despite the rapid increase of access to ICT in all schools, and they do not make use of its full potential. Generally, in England, science teachers use ICT for exploring simulations of scientific phenomena, modelling scientific process, capturing and analysing data automatically and being able to access and communicate scientific information (Webb, 2008).

Pedagogical use of ICT

Pedagogical use of ICT in Namibian rural schools is in its initial stage. Policy states that ICT integration for educators addresses the use of ICT across all subject areas, as ways in which ICT can be utilised as pedagogical tools. The science teachers are expected to use ICT in their lessons in various subjects to enhance learning opportunities beyond what is possible with currently available resources. As discussed above, the use of ICT has not yet reached an advanced stage in which one would expect rural science teachers to perform above Level 1 of the developmental stage.

The findings of this study show that science teachers performed the most basic tasks when teaching using ICT (see Table 5.4). For example, during observation they taught scientific themes in which they asked the learners to explore Encarta and developed notes using an overhead projector. No advance skills were evident during observations. In addition, a few science teachers indicated that their personal computers were connected to the Internet and that they used them for teaching-related activities (Figure 5.4).

The Finnish science teachers lacked pedagogical skills, which resulted in their developing a negative attitude towards ICT use (Kankaanranta, 2009).

Professional development

At present, professional development courses in Namibia are inadequate to prepare science teachers for pedagogical use of ICT. The aspect of professional development in the National ICT Policy for Education has been omitted and made synonymous with training. Under the section 'schools with secondary grades', it was only mentioned that by the year 2009, 5,500 teachers would have been trained in at least the Foundation Level ICT Literacy Certificate and completed the ICT Integration for Educators module. The policy did not mention how the pre-service teachers would be trained. The involvement of the University of Namibia in the teachers' training programme with regard to ICT is non-existing.

This study found through document analysis (see Chapter 2) that the Integrated Media in Technology Education (IMTE) course offered to pre-service teacher trainees was only revised in 2006 to include ICT, and a few science teachers have undertaken this course at the Colleges of Education. The professional development in ICT follows the ICDL Programme or ICT Literacy programmes with no strategies to integrate ICT in the science lessons. No professional development courses were made available for principals and ICT technicians in the Namibian rural schools.

Literature relates how the Danish professional development programme started with a pedagogical IT driver's license in 1994 and gradually integrated ICT in the main stream programme of the in-service teacher training programme. Subject-specific courses were developed as follow-ups for ICT licensed teachers (Larson, 2009). Chile has invested in professional development to train teachers in ICT use (Sánchez & Salinas, 2008) whereby the Ministry of Education had partnered 24 universities to provide technical and pedagogical support to each school in the country **(**Hinostroza, Hepp, Laval, 2000). Also, Trinidad and Tobago University has developed a model on professional development where teachers receive incentives for having completed a course in ICT (Gaible, 2008). Universities and other institutions are working to develop models for ICT integration into specific curriculum subject matters such as science and mathematics. The models include technology, teaching methodology, learning objectives, teaching resources and tools for student learning assessment (Sánchez & Salinas, 2008)**.**

ICT infrastructure

ICT infrastructure in the Namibian rural schools is poor (Table 5.4) in terms of availability, decision making about acquisition, and maintenance. The Namibian government has provided the minimum basic ICT to rural schools. Each school under the TechNa project (see Chapter 1), is to have the basic necessary ICT infrastructure.

This study found that the Namibian government has provided 20 computers to each participating school, but how these computers were maintained and sustained was not

very clear. Obsolete computers from the SchoolNet project were stored in one corner of the computer laboratories or classrooms, taking up space for more equipment (Section 6.5). During observation in School C (Section 5.4) the electricity went off three times within a period of 45 minutes. The criteria for deploying computers and Internet connectivity to rural schools were not consistent. Some schools received computers without the Internet and others received both. As a result, some schools had acquired Internet devices for which the schools paid N$ 300-500.00 per month (Tables 6. 21, 6.22).

Some authors in other developing countries, such as Macambique (Cossa & Cronje); Uganda, (Kenny, 2001; 2002); and Chile (Hinostroza, Hepp & Cox, 2009; Hinostroza, Labbe & Claro, 2005), noted with concern that the ICT infrastructural deployment was limited and not provided to all educational institutions in the amounts needed. However, in South Africa, there were cases of low density of Internet connectivity (Howie, in press), and high costs of ICT provision in comparison to the costs of other equipment. Thus, provision of infrastructure is in competition with the provision of other basic needs such as textbooks, basic furniture, teacher training, and nutritional supplements and more (Brandt et al. 2008; Cawthera, 2002). A study conducted in Europe including many countries, concluded that schools with good ICT resources achieve better results than those that are poorly resourced (Balanskat, Blamire & Kefala, 2006).

Vision on ICT in education

Rural schools have a rudimentary and implicit, rather than explicit vision on ICT in education. *This study found that the Namibian schools participating in the case studies have vision statements written on the wall at the entrance of the schools but that these do not include a phrase on ICT. However, the data from the larger sample of this study showed that the vision as perceived by the science teachers was high (Table 5.4) and forms basis of the implementation of ICT (Figures 8.1, 8.2).*

The vision of the National ICT Policy for Education should reflect any or all of the three paradigms: technological literacy, which puts emphasis on computer or information literacy as a subject; knowledge deepening, which emphasises on improving effectiveness of learning in different subjects by using ICT; and knowledge creation, which emphasises ICT as an agent of curriculum and pedagogical change to foster students' development of 21st century skills (UNESCO, 2008a). In addition, the policies need to state developmental strategy that articulates the vision on how the goals are to be achieved (Cecchini & Scott, 2003; Kozma, 2008; Law, 2009), requiring the introduction of school-level policy to engage the school leadership more in an effort to strive for quality in schools.

Leadership

Leadership at school level is medium (Table 5.8). In accordance with the National ICT Policy for Education requirements, the principal is expected to manage finance, human, and physical resources in an efficient and effective manner.

In this study, principals indicated that leadership was the basis on which all other constructs were built (Figures 8.1, 8.2). Principals were not exposed to any training courses to guide them on decision-making regarding ICT-related issues, but rather they continued encouraging science teachers to use ICT in their lessons.

In Namibia, Katulo (2010) found that principals need transformational leadership skills in order to ensure ICT integration in schools located in the Caprivi region. In Mozambique, the principals of schools were trained to allow them to understand and support the project activities (Cossa & Cronje, 2004). Contrary to the idea of training, principals in Finland have developed a negative attitude towards ICT use at school, despite the rapid increase to ICT access in all schools (Kankaanranta, 2009).

Collaboration

The level of collaboration and support was high on the surface value and low in practical terms. The National Policy of ICT states that the best option to develop collaboration and support systems is to establish a National Education Technology Service and Support Centre (NETSS). This centre would provide maintenance and technical support to schools and also acts as a distribution hub for ICT in terms of hardware.

This study found that the element of collaboration between science teachers at the same school or between schools is missing. The principals however indicated that they encourage teachers to collaborate by sharing skills and resources within the same school (see Section 5.4). From observation, an administrator was at School B to make copies for schools within the surrounding area that did not have ICT facilities. There is lack of teachers' networks or organizations with regard to teaching and learning activities. In addition, the schools have indicated that they do not allow community members to use their ICT facilities (see Section 5.4).

From the literature, the involvement of teacher forums for purposes of collaboration appeared to be necessary for sharing teaching materials and experiences (Delphi project, 2004). In addition, the involvement of the local community in ICT implementation is a crucial element in the ICT use in rural schools and not necessarily considered in the developed world. For parents to allow their children to learn what computers are and to work with them after school, for example, the parents must have a fair understanding of computers and so may contribute to the investment in computers. An important finding from research in Mozambique and South Africa is that ICT projects need support if they are to become sustainable or else they are likely to fail (Cossa & Cronje, 2006; Thomas, 2006).

Support

Pedagogical as well as technical support towards science teachers is also low (see Table 6.24). The Ministry of Education in Namibia has established a NETSS Centre to

provide support services to the schools partly via telephone and by employing one ICT technician per educational region.

In this study, the science teachers have indicated that the kind of support the teachers receive from the principals is administrative. The principals know very little about pedagogical and/or technical aspects of ICT use to guide or support the science teachers accordingly. Technically, the science teachers also receive support from ICT technicians, who have no professional technical skills.

The quality of technical support might be compromised and the telephonic instructions through the call centre at NETSS seem not to be effective. In order to receive quality technical service, some schools paid out of the school development fund. From the literature, Boateng (2007) found that in Ghana, although computers were available at the school teachers were not using them. This was attributed to lack of support from the local communities. Bringing technology into the schools systems in developing countries was unsuccessful due to lack of planning and support to secure the support of key participants (Tiene, 2002).

Expertise

Science teachers' expertise in pedagogical use of ICT is in its infancy, although statistically the findings show that it was medium (see Table 5.4). The National ICT Policy for Education states that the ICT Literacy Certification is designed to serve as the basis for computer literacy standard and curricula in the country.

This study found that the knowledge that the science teachers had about ICT was acquired informally and over a long period of time, sometimes as far back as typing lessons in high school (see Section 5.4)). As observed, the innovative science teachers used basic ICT in their lessons. Platforms to learn about the newest development were not made available in rural schools.

Katulo (2010) revealed that there was a lack of personnel to cascade training in the Caprivi region, Namibia. Anderson and Plomp 2009 revealed gaps in countries that took part in the SITES2006 study. Most of the education systems that took part in the study indicated that they did not have specific policies on ICT requirements for teachers, with approximately 50% not having formal requirements for key types of teacher development, nor having a system-wide programme geared towards stimulating new pedagogies.

Attitude

Findings of this study suggest that the attitude of the science teachers towards pedagogical use of ICT was negative. Contrary to this finding, science teachers who participated in the case studies portrayed the right attitude to implement ICT. These science teachers prepared their lesson plans using ICT and had managed to let their school acquire more software for timetabling, mathematical software and many more uses to ensure effectiveness in their work. From the literature, a study in Turkey revealed that science teachers had a positive attitude towards ICT, although the results did not differ regarding gender, only age, ownership of computers at home and computer experience (Cavas et.al., 2009).

Digital learning materials

Digital learning materials were inadequate in number and also in quality (see Table 5.4). The National ICT Policy for Education Implementation Plan states that a number of content packages are available in schools, which include *DireqLearn, Learn Things, Learn Online, Encarta* and local content developed by Namibians.

This study found only one (Encarta) out of the five content packages available in rural schools. Depending on the money available in the school fund and need, some schools bought software for timetabling and preparing report cards. The acquisition of educational software was not matched to subject specific curriculum goals. No science teachers or the ICT technicians were trained in using pre-installed software. The

science teachers indicated that Microsoft Word was the mostly used software for lesson preparation and report writing by the principals, teachers and learners. Generally, there was lack of knowledge about the types of software science teachers may need in their teaching. The costs of development of digital learning materials are great and effective demand is not likely to be large while those with purchasing power are already served by good conventional schools (Dede, 2000; MacFarlane & Sakellariou, 2002; Wagner, 2004). In order to ensure access to all schools, many governments have taken it upon themselves to take on the task of e-content distribution, either through a portal or any Learning Management Systems. The development of these materials and their quality is a concern (Cawthera, 2002; Cecchini & Scott, 2003).

In summary, the findings showed that pedagogical use of ICT, technical support, attitude of science teachers and ICT infrastructure were low. Science curriculum goals, collaboration, professional development, digital learning material, expertise were medium. Leadership and vision were high.

8.2.2 Factors affecting ICT implementation in rural schools:

This section presents findings on research question 3, what factors affect ICT implementation in rural schools. Findings on factor analysis are presented. Exploratory correlation analysis as well as regression findings are summarised.

The factor analyses revealed the following factors per construct:

Table 8.1: Summary of factor analyses per construct

Construct	Factors yielded:
Vision on ICT in education	Learner preparation for the ICT world
	Learner assessment on curriculum content
Leadership on implementing ICT	Teacher mentoring
	Innovations
	Creating schedule for collaboration and technical support
Use of ICT in school	Use in school subjects
	ICT integration in a school subject
	ICT use of applications
	ICT integration and challenges.
Digital learning material	Software availability
	Digital resources
	Software application
	Science projects
	Instructional learning
	Investigation of scientific principles
	Data analysis
Collaboration	Collaborative activities
	Learner mentoring
Science curriculum goals	Learner skills preparation
	Technological challenges
Pedagogical use of ICT	Use of ICT for assessment
	Collaborative activities
	Classroom management
	Giving feedback to learners
	Assessment
	ICT use for collaboration

The exploratory correlation analysis revealed that the leadership of principals had a strong positive relationship between curriculum goals and the vision of the principal respectively. The vision of the principal had a strong relationship with the science teachers' views on collaboration and also with science curriculum goals. ICT use and the vision of the principals were strongly correlated. Pedagogical support and vision of the principals were strongly correlated. Science teachers' attitude, expertise and professional development were strongly correlated. This means that principals and the science teachers were likely to agree on matter regarding the identified relationships.

Given the results, more relationships have been identified. For example, the inputs from the science teachers' characteristics, the location, and the demands by the National ICT Policy, have been a direct effect on school quality. This suggests that while there could be relationships established through school quality, the science teachers' characteristics could be very influential, given that only highly motivated science teachers would teach using ICT in the adverse exceptional circumstances. In turn, the school quality has a relationship with the leadership style adopted by the school leadership. Thus, the data on the type of leadership applied in the rural school could generate more relationships between factors. This challenging situation may only be experienced in the developing world.

The regression analysis showed that the following constructs were retained in the regression model, with Pedagogical use of ICT as a dependent variable. The independent constructs of interest were professional development, vision, obstacles, digital learning materials, support, collaboration, expertise, general use, leadership and ICT infrastructure, curriculum goals and attitude as perceived by the science teachers. In addition, expertise, vision, effort, leadership, collaboration, ICT infrastructure, pedagogical support and obstacles as perceived by the principals were included. The model of factors affecting ICT implementation in rural schools that include all these constructs can explain 85% of the variance in the model (see Section 6.5.2). The model parameters indicate that the only constructs found to be significant in the model were leadership of the principals, expertise of the science teachers as well as general use of ICT by science teachers (Section 6.6). As a result, there is an increase in pedagogical use of ICT about 0.353 for every unit increase in the leadership. The pedagogical use of ICT increases by 0.267 and 0.877 per unit increase in both the expertise as well as in general use respectively. This finding suggests that the regression model conforms to a higher degree (85%) of the Kennisnet model (2009).

In conclusion, the results seem to be robust and have to some extent validated what other researchers have reported from countries in the developing world, such as Ghana (Boateng, 2007), in South Africa (Howie et al., 2005), in Mozambique (Cossa, 2006), in

Sudan (Ali, 2010) and in Chile; as well as the developed world, such as in Finland (Kankaarata (2009), and Lithuania (Markauskaite, 2009). This study revealed that ICT implementation in Namibia is still in its initial stage, where at times ICT has to compete with the acquisition of the most basic need in rural schools. In cases where that is a problem, ICT becomes secondary. Professional development and expertise are geared towards acquiring the most basic ICT skills. The Namibian government provided schools with the most basic digital learning materials, which may not be aligned to the curriculum goals. Schools with more financial resources acquire more digital learning materials to enhance effective teaching and administration activities. There was minimal collaboration amongst teachers of the same school but it does not go beyond. No support is evident, be it technical or pedagogical, for the science teachers. The relationships between factors were determined and the significant constructs in the model were identified as leadership by principal, general use of ICT and expertise of the science teachers.

8.3 Reflections

This section presents some issues arising from the study and possibly some lessons that can be learnt: firstly, methodological issues addressing the extent to which the approach influenced the findings of this study; secondly, a reflection on the analyses and the conceptual framework applied in this study.

8.3.1 Methodology

This subsection presents reflections on baseline survey, in-depth case studies and ICT conference accordingly:

Baseline survey
Three main reflections are discussed, namely research conducted in the developing world, sampling and ICT coordinator. There is a deficit of research conducted in ICT implementation in the developing world, making it difficult to identify the most important

variables to be considered in rural schools. The sample for the survey was considered sufficient in order to yield significant statistical conclusions about how ICT is being implemented in Namibian rural schools. Most schools in the Namibian rural areas are similar in nature and therefore conclusions could apply to other rural schools not included in the sample. Most schools lacked ICT technicians, which affected this study in terms of collecting some important data from most schools.

In-depth case studies

The sample used in the case studies was small and therefore not intended to represent all rural schools in Namibia. The schools were chosen based on them being case-success stories, using ICT extensively. More schools could have participated, but due to a natural disaster that occurred during the data collection period this was not possible. Data collected from the case studies was used to deepen the understanding of what was happening in rural schools with regard to ICT implementation.

ICT use conference

This method was particularly a challenge due to it being the first time it was being applied in the Southern African region. The questionnaires were designed to include statements that would lead to finalising the findings. It is important that a four-point Likert scale be considered to avoid bias responses.

In addition, the following should be considered during the analyses:

After conducting the baseline survey, it was discovered that the categorical responses used in the questionnaires did not match the analysis. The categorical responses were revised and narrowed to reflect the indices that would enable the schools to score in the range of minimum and maximum values in order to determine the extent of implementation of the National ICT Policy. The research should build the indices already into the responses when designing the questionnaires.

In order to run a regression analysis, data was reduced to include only schools that had both the principals and the science teachers responding to the questionnaires. The aim was to match the principals' responses to those of the science teachers. Where the school had two science teachers responding to the questionnaire, an average response was calculated. The ICT technicians' data was excluded in the exploratory factor analysis because of the low number of responses. However, during the pilot study, all questionnaires, including those of ICT technicians were returned and it was anticipated that the ICT technicians would respond to the survey in large numbers. In hindsight, the researcher perhaps should have adopted a more rigorous approach, such as explaining the portfolio of the ICT at workshops and meetings where the target group meets occasionally.

A number of relationships could not be determined using Pearson's correlations, due to either the quality of the data or the fact that the respondents could not identify some of the variables under the constructs. This does not necessary mean that the relationship does not exit, but could be attributed to this study having adapted the SITES instruments used internationally, and that are flexible for adoption and adaptation in the participating countries. This study experienced difficulty in using some of the ICT terminologies that may pose challenges to the respondents. These terminologies were adapted from the variables. More research needs to be conducted in order to develop more appropriate variables for Namibia.

Despite the limitation highlighted above, the data collected for this study was mined extensively to enhance the quality of this research design and generate findings for the extent to which ICT is being implemented, as well as identifying factors that affect ICT implementation in rural school. This study yielded some interesting findings that will be reflected upon in the conceptual framework below.

The limitation in the dataset may not necessarily be the weakness in the conceptual framework, but it is limited to rural areas in the developing country when attempting to explain ICT Policy implementation. The variance in the data could also be a result of the

respondents' limited knowledge on ICT-related activities, but that could improve with ICT development in rural schools. This may explain much of the variance in the developing countries in contrast to the developing world, where the resources and teaching experiences may be different.

8.3.2 Conceptual framework

The conceptual framework of this study was influenced by the Kennisnet model (2009), which was placed within the Howie model (2002) in order to demonstrate the systems level (see Chapter 3). A few options have been added to the Kennisnet model (2009) as well as the Howie model (2002) to illustrate the situation of ICT implementation in Namibia and possibly other developing countries. This study should not be interpreted as a test for the Kennisnet model as presented in Chapter 3. Based on the results and reflection on the initial conceptual model, this study yielded some interesting conclusions that required modification of the initial conceptual framework for this study.

The original model of the Kennisnet (2009) had the leadership directly influencing the four constructs at school level: vision; expertise and attitude; ICT infrastructure; and digital learning materials. In addition, the Kennisnet model (2009) suggests that collaboration and support have an influence on the same four constructs. Findings from this study suggest that at school level, 'science curriculum goals' also influence the four constructs (see Figure 9.1). This in turn influences the general use of ICT and, consequently, the pedagogical us of ICT. The attitude of the science teachers may also influence the pedagogical use of ICT.

The Howie Model (2002) has been adapted for this study to provide the structure within which the Four-in-Balance Model was placed for purposes of distinguishing the systems level from the school level. Some parts of the Howie Model (2002) have been changed to suit the conceptual framework of this study. The three levels have been adopted from how they appeared in the Howie Model (2002) (see Figure 3.3). These are input, process and output and the elements thereof have been adapted as follows:

Input

In the input level, describing the National Policy issues,the economic, physical and human resources influenced the quality of the schools in the Howie model (2002). In this study, those variables have been replaced by the provision of ICT to schools, professional development and the vision of the Nation a ICT Policy for Education resulting in the quality of the school (see Figure 9.1 below).

Process

In the process level, the adapted Kennisnet model (2002) was placed with additions to the number of constructs. In line with the findings of the regression analysis, entrepreneurial leadership style, expertise and the general use of ICT have been added. Entrepreneurial leadership style refers to principals who are very skilful 'partnership builders' in an effort to source the necessary ICT resources for the school (Yee, 2000). In addition, the case studies suggested the constructs on entrepreneurial vision of the science teachers and the science curriculum goals.

Outcome

To the Howie model (2002), the construct on attitude construct has been retained to show the effect of science teachers' attitude to pedagogical use of ICT. The outcome of this study suggests that in order to increase ICT use in rural schools, the science teachers need to be motivated constantly. This is not thought through in the Kennisnet model (2009) as teachers in the developed world have good infrastructure, digital learning materials, knowledge and skills in ICT. However, the attitude of teachers is said to be moderate but yet the implementation of ICT is advanced compared to Namibia or some other developing countries such as Sudan and South Africa. Science teachers in rural areas tolerate many unrealistic demands from the Ministry of Education when they have insufficient infrastructure, no digital learning materials, no knowledge and skills in ICT, and almost no support. However, some science teachers were committed to ICT

use and therefore they need encouragement from the school leadership to continue using ICT in their teaching.

Figure 8.1 Factors affecting ICT policy
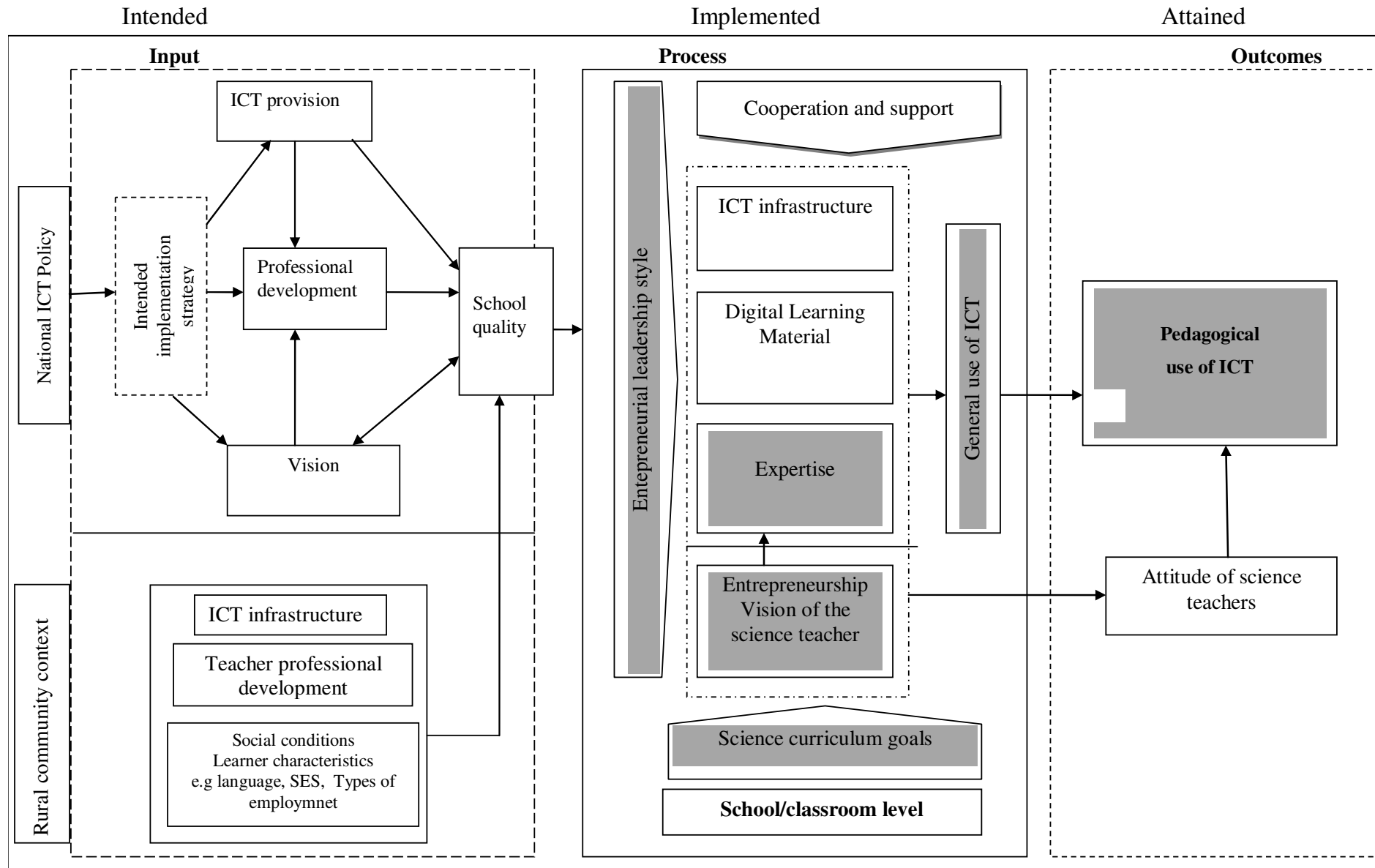
8.4 Conclusions and Recommendations regarding ICT implementation in rural areas

This section presents the main conclusions of the study based on the findings presented in Chapter 6 to 8 and in Section 8.2. These are informed by the conceptual framework for the study. Key recommendations are made for Namibia and other developing countries if applicable. In addition, the study suggests future research directions. The main conclusions of this study are:

1. **The Namibian rural schools implement ICT at a low level of Phase 1 of the Implementation Programme**.

ICT implementation is not yet widespread and where it is being implemented it is not yet fully utilised. The data shows that ICT use is in the medium category (Table 6. 8). The medium category entails basic use of ICT for pedagogical and administrative use. However, findings from case studies suggest that ICT use in rural schools is low (Section 6.6). It can therefore be concluded that ICT implementation in rural schools is not yet widespread or effective nationally. The science teachers make very little use of ICT if at all in most schools. ICT is used mainly for basic administrative duties such as report writing by the principals (Table 6.2) and lesson preparation by science teachers (Section 5.4). This finding could be attributed to many principals and science teachers lacking the necessary skills and knowledge to use ICT in an advanced way. In addition, schools have still not yet acquired the basic needs such as chairs, desks, running water and storage facilities for the schools (Table 6.7), making it difficult to move up to the next phase of implementation. The obstacles to ICT use that were identified were: *lack of knowledge to identify the appropriate equipment*; *learners' lack of skills* and *lack of confidence and time* to teach using ICT by science teachers (*see Appendix F*, item 24). Obstacles were found to be a significant predictor of pedagogical use of ICT. This finding is evidenced in Matengu (2006) that ICT use in some parts of Namibia was low but as a consequence claimed that the need for ICT use in schools appeared at national and regional levels of educational leadership but did not exist in schools. This was

typical of developing countries such as Chile (Hinostroza, Hepp & Cox, 2009), the Philippines (Ogena & Browner, 2009) and Trinidad and Tobago (Gaible, 2008) before 2005 and 2006 respectively. These countries have been identified internationally as examples of good practice for ICT. Namibia has the potential to advance its level of ICT implementation.

Recommendation: *There is need to revise the National ICT in Education Implementation Plan (2006), to make it more realistic in terms of what if achievable in a particular period. As the Implementation Plan is now, it is very ambitious. Many activities should have been completed already by 2009, but this has not been the case. The review should consider fewer goals, extended timelines, and an increase in the number of personnel as well as professional development programmes. In addition, schools must be encouraged to develop explicit ICT policy goals and specific implementation plans for the specific school year.*

There is a need to develop a strategy on increased ICT use in rural schools. The strategy must identify the appropriate equipment, attempt to enhance learners' ICT skills by increasing the number of ICT lessons, and in addition to general teachers training in using ICT pedagogically instil confidence in the science teachers with regard to ICT use.

Further research: *There is a need to investigate the perceptions' of principals, science teachers and ICT technicians towards ICT implementation in rural schools more broadly.*

Research is needed in other educational regions to complete the view of ICT implementation in Namibian schools. More research is needed to compare Namibia to other African and other developing states concerning the national ICT policies, problems, challenges and issues experienced by local schools in comparison to the ICT implementation strategies. The comparative studies are needed for countries to learn from each other, both in policy and in the implementation strategies.

In addition, this thesis calls for comparative studies between Namibia, Chile and Trinidad and Tobago and/or the Philippines in search of good practices for rural areas.

2. Rural schools have a rudimentary and implicit vision of ICT.

The data shows that the vision of rural schools is medium (Table 6.8). The vision is limited and rudimentary. The school leadership lacks the basic knowledge that will enable them to advise and make informed decisions about ICT. Currently, the vision is geared towards: *preparing learners for the ICT world* and is also perceived as a tool to *assessing learner's content knowledge* (Section 6.4). The vision of the principal is strongly related to the science teachers' views on collaboration, pedagogical support and ICT use. Thus, this finding suggests that where there are strong leadership qualities, there are likely to be strong views on collaboration, pedagogical support and ICT use and vice versa. The ICT use conference findings show that the vision of the principals is very important in the planning of ICT implementation (Figures 7.1 and 7.2). This finding is supported by Anderson and Plomp (2009) and Katulo (2010) who found that leadership at school level makes a great difference in terms of pedagogical improvements in teaching.

Recommendation: There is a need to educate principals and other staff, including all teachers about ICT. The course or awareness campaign should cover the importance of ICT in general and in education.

Further research: *There is need for research on the role of principals in implementing ICT policy at the school level.*

3. There is lack of necessary infrastructure to enable ICT implementation in rural schools.

The data suggests that ICT infrastructure is medium (Table 6.8). The infrastructure provided to schools is basic and limited to computers and a printer. Schools receive 20

computers from the Government of Namibia, irrespective of the total number of learners. This number of computers is perceived by the principals, science teachers and ICT technicians as insufficient, from the case studies (Section 5.4 and Section 6.6) and from the ICT use conference participants (Table 7.2). A few schools sourced additional computers and Internet connectivity and digital learning materials on their own. The schools that acquired additional infrastructure were those that showed entrepreneurial leadership style. However, the digital learning materials were said to be somewhat relevant (Table 7.3) but not aligned to the science curriculum goals. In addition, there is a correlation between ICT infrastructure, leadership and support (Table 6.27). However, ICT infrastructure was not a predictor for ICT pedagogical use, but yet it is a necessary condition for use. However, it is not the number of computers that will ensure effective use but the quality of use. For example, Chile deployed ten computers to schools, which is less than the number received by rural schools in Namibia, but the quality of support in Chile contributed to the effective use of computers (Hinostroza, Hepp & Cox, 2009). Since the adoption of the National ICT Policy (2006), this is the first study that provides a comprehensive view of ICT implementation, including the infrastructure provided to rural schools. From the international literature, Anderson and Plomp (2009) found through the SITES 2006 that in all participating countries except South Africa, most highly developed countries, had almost 100% of schools with computer and Internet access for pedagogical use.

Recommendations: *A 'needs assessment plan' for rural schools with regard to ICT must be developed. Future plans should consider a systematic approach with regard to ICT infrastructure and ICT implementation. Also, planning must consider appropriate storage space, and development of deployment and the maintenance plan in order to avoid provision of computers to schools that lack the basic needs such as desks and chairs.*

The teachers currently acting as ICT technicians should be trained so that they will acquire troubleshooting skills that will enable them to repair and maintain the computers in the absence of available technicians.

Also, there is need to strengthen the link between the school's overall educational approach and its use of digital learning material. Not only should teachers use digital learning materials for small-scale projects but when purchasing them their relevance should be considered and the use should be extended to include conceptual approaches.

Further research: *An investigation is needed into the quality of the locally produced e-content and its relevance to the Namibian context. This effort is commendable but the level of knowledge of the teachers producing should be on par with the latest technology worldwide and/or internationally.*

4. There are an inadequate number of science teachers trained in pedagogical use of ICT.

Generally, pedagogical use of ICT shows that it is in the medium category (Table 5. 4). A few science teachers' who were observed using ICT for pedagogical purposes, demonstrated very basic skills. This suggests that teachers have been trained. The medium category is attributed to the fact that training in ICDL was carried out. The data shows that country-wide only 408 teachers started the training and out of these 352 obtained ICDL certificates between 2007 and 2009 (Section 2.4.2). Perhaps, as a result, only about half (47%) of the science teachers in the three educational regions of interest had allocated between two and four hours a week to ICT use (Table 5.3). There is no evidence that training in pedagogical use of ICT was conducted. Instead, only training in computer literacy was conducted. Six different factors emerged as important towards support of pedagogical use of ICT, namely: *use of ICT for assessment*, *collaborative activities*, *classroom management*, *giving feedback to learners*, *assessment*, and *ICT use for collaboration* (*see Appendix F*, item 16, 17, and 18).

A small percentage of science teachers benefited from the Integrated Media and Technology Education (IMTE) course offered in the BETD pre-service professional development after 2006 when the curriculum was reviewed to include ICT (Iipinge,

2010). On the one hand, Matengu (2006) found that there was no school capacity to deal with ICT integration. On the other hand, Kapenda (2009) suggests that ICT use be enhanced in the teaching of science. Other studies have provided evidence that there is a lack of understanding about what ICT integration in the subject areas means (Boateng, 2007, Sutherland & Sutch, 2009).

Recommendations: *There is need to develop extensive teaching and teacher training programmes that cover content on ICT integration, considering the classrooms sizes and insufficient resources made available to schools by the Namibian Government. In addition, the principals need to be trained in ICT courses that cover basic ICT as well as entrepreneurial skills defined as the innovativeness and capability to source more ICT infrastructure for the purpose of increasing access and enhancing teaching efficiency.*

In addition, policy-makers need to follow this debate about emerging pedagogical paradigms that focus on ICT knowledge application skills, self-management skills, thinking skills and creativity so that the teachers comply with the required skills of the 21st century. The review of the science curriculum should be conducted accordingly and more aligned to the National ICT Policy. The policy-makers should come up with clearer defined tasks that science teachers should understand and be able to practice.

Further research: *There is need to investigate the teaching strategies using ICT that rural science teachers employ in their classrooms, given large class sizes and limited resources.*

There is need to investigate gender and age issues in relation to ICT use in the rural science classrooms. This information may help to attune teacher training to the needs and characteristics of the target group, but also implementation strategies may take into account differences on these variables.

5. There is a lack of support for science teachers, both pedagogical and technical.

The data suggests that support towards science teachers is low (see Table 5.4). There is very little evidence of pedagogical or technical support of science teachers. The case studies show that science teachers received very limited support from other experienced science teachers (Section 5.4). There is only one ICT technician per educational region, making it difficult for him/her to reach all schools on time. As a result, some teachers with knowledge about trouble-shooting have volunteered to act in this position. A number of obsolete computers obtained through the School Net project were dumped in one corner of the computer laboratory of at least two of the participating schools (Section 6.6). Two factors emerged as important for support, namely: *pedagogical support towards students* and *pedagogical support towards teachers and administrative staff* (*see Appendix E*, item 23 and 24). Technical support for science teachers strongly relates to ICT infrastructure (Table 6.27). Thus, technical support was applicable in schools where ICT infrastructure was also available and vice versa.

This finding is consistent with SITES M1 that there is lack of computer literacy amongst teachers and lack of training amongst the computer integration into different learning areas. Also, this finding was confirmed in Namibia by Matengu (2006), stating that there is a need for both technical staff and pedagogical support with increased training and personalized access to enhance ICT use in teaching.

Recommendation: *There is a need for a strategy to be put in place that will coordinate pedagogical and technical support initiatives for rural schools.*

Also, there is need to develop support strategies that will consider support centres for science teachers at regional level.

In addition, there is needed to appoint more ICT technicians that will attend to technical problems within a reasonable time. Science teachers need to establish a collaboration forum where they can share resources and experiences.

Further research: *Research should be done to develop optimal scenarios for pedagogical and technical support to science teachers.*

6. Where a high level of ICT use for pedagogical purposes was found generally within schools, an entrepreneurial leadership style was present.

Case studies (Section 5.4) data suggests that schools with higher level of ICT use have science teachers with expertise resulting in entrepreneurial vision and consequently entrepreneurial school leadership (Section 6.6). In Namibia, there is a lack of studies on ICT implementation by principals. However, Yee (2000) emphasises training of principals, including skills in entrepreneurial skills development. In the majority of schools in the Potchefstroom district in South Africa, Mentz and Mentz (2003) found that where computers were used for teaching, principals were of the opinion that they were used effectively for pedagogical purposes.

Recommendations:

Principals also need to be trained in basic computing courses, content development and pedagogical use of ICT in order for them to provide the necessary support. Training should be provided by certified trainers. The courses should be appropriate and should meet the needs of the schools.

This study suggests that principals be exposed to entrepreneurial development approaches in order to encourage widespread and more intensive use of ICT in education. The training must cover alternative ways of raising school funds in order to keep up with these technological challenges. In addition, the school leadership should undergo ICT skills development courses to enable them to make informed decisions about ICT-related matters.

Further research: There is need to investigate the types of entrepreneurial leadership styles that exist within the different school leadership and try to identify the most appropriate for enhancing ICT-related activities in the rural schools.

7. Where a high level of ICT use for pedagogical purposes was found within specific classrooms, an entrepreneurial vision of the science teachers was present.

Data from the case studies suggest that higher level of ICT use for pedagogical purposes was mostly attributed to the entrepreneurial vision of the science teachers. From observations, science teachers expressed willingness in ICT use despite the difficult situations in which the lessons are conducted. For example, during a classroom observation in a case study school, the electricity went off three times within a period of 45 minutes. In addition, two learners were observed sharing a chair as they worked on one computer. Despite these difficult conditions, the science teachers in the case studies portrayed willingness and enthusiasm to teach using ICT. These were the same teachers that influenced the vision of the school leadership in terms of increasing access to ICT use as well as buying more computers and subscribing to Internet services (Sections 5.3 and 5.6). Hamunyela (2009) observed a lack of electricity and modern equipment in rural Namibia (2008). Brandt et al. (2006) report on a survey undertaken by the Education Policy Unit of the University of the Western Cape and the International Development Research Centre which found that South Africa has an alarmingly low teledensity in some rural areas, sometimes less than 5% in certain rural areas.

Recommendation: Science teachers with entrepreneurial ideas and attitudes that influence their vision need to be supported and encouraged continuously in order to them to enhance ICT use for pedagogical purposes.

Further research: There is need to further investigate the motivating factors that enable continuous use of ICT for pedagogical purposes despite the difficult rural environment the science teachers are working under.

There is also need to investigate the optimal scenarios that exist within the entrepreneurial vision of the science teachers.