CHAPTER 5

ICT IMPLEMENTATION IN SCIENCE CLASSROOMS

This chapter presents the research findings for research question two of this study and also serves as a basis for presenting the quantitative part in Chapter 6 of this study. The introduction is presented in Section 5.1. The background information of the science teachers is discussed in Section 5.2. The description of findings with regard to ICT use in science classrooms is presented in Section 5.3. The case study findings per school are presented in Section 5.4 and the case cross analysis in Section 5.5. Finally, the conclusions are drawn in Section 5.6.

5.1 Introduction

This section presents the introduction to the chapter that aims to present findings for research question two, *how is ICT being implemented in science classrooms?* For a better understanding it is important to present the background of respondents. This information will provide the context within which ICT is being implemented, followed by a description of ICT integration and implementation in science classrooms located in rural areas. For the purpose of this chapter only descriptive data for the constructs is provided.

As explained in Chapter 3, the findings of all constructs are presented at classroom level, containing only the science teachers' data on variables that appear in the middle component of the conceptual framework (see Chapter 3), marked 'implemented' as well as those in the last component of the conceptual framework marked as 'output'. The variables are leadership, collaboration, vision, support, expertise, digital learning materials, and ICT infrastructure and pedagogical use of ICT, and these in turn may have an influence on the science teachers' attitudes and aspirations towards education and ICT.

The analyses of the data covered the indices scores of the science teachers. In order to have a substantive meaning of the constructs, an index table is provided

showing the computation of the indices per construct (*Appendix H*). The findings are presented at classroom level because the scores on the constructs provide insight into the science classrooms for the aspects represented in the constructs. In some schools, however, more than one science teacher responded to the questionnaire, but since the findings are reported at classroom level this has no effect on the findings.

The data was collected from science teachers and therefore it became necessary to present the background information (Section 5.2). Description of ICT use is presented in Section 5.3 and the Conclusion in Section 5.4.

5.2 Biographical information of the science teachers

This section presents the background information of science teachers with regard to period of teaching experience, age groups, gender and ICT use.

Teaching experience

The science teachers were asked to indicate their number of years of teaching experience, with responses as follows:

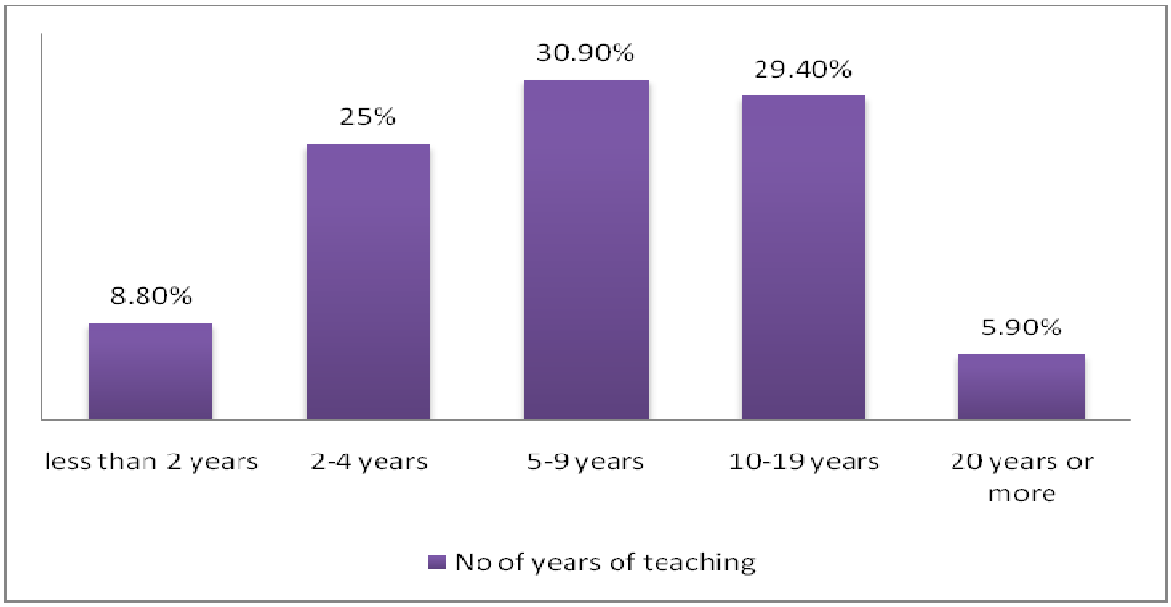

Figure 5. 1: Years of teaching experience of science teachers (N=137)

Figure 5.1 (above) shows that more than half (31%+29%) of the science teachers had between 5 and 19 years of teaching experience. This does not imply that they have been teaching science since the beginning of their teaching career. It should be noted that there was a shortage of science teachers and it is probable that these teachers upgraded themselves through courses such as MASTEP, one that most teachers at junior secondary school level followed in order for them to become science teachers (Clegg, 2004).

Qualifications of science teachers

The science teachers were asked to indicate what qualifications they held, and the responses showed their qualifications ranged from secondary school leaving certificate to a Bachelor's degree, as in figure 5.2:

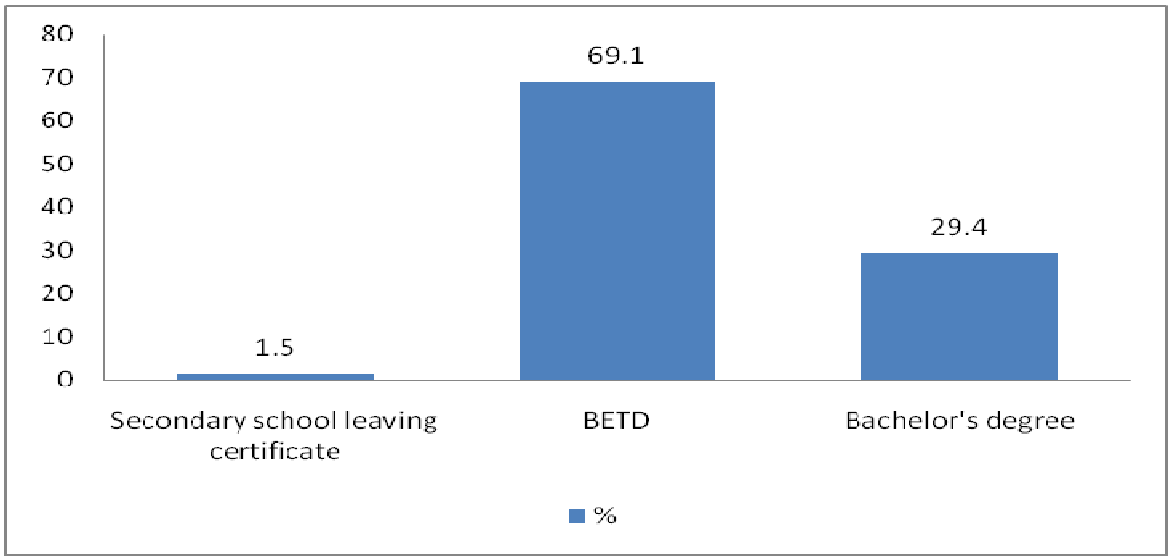

Figure 5. 2: Science teacher's qualifications (N=137)

Figure 5.2 (above) shows that most science teachers (69.1%) have a Basic Education Teaching Diploma (BETD), and only 29% have a Bachelor's degree. Very few (2%) of the responding science teachers were unqualified.

Age of science teachers

The science teachers were asked to indicate their age category, and the age distribution is presented below:

Table 5. 1: Age distribution of science teachers (N=137)

Age group	Percentages (%)
below 25	7 (2.2)
25-29	33 (4.0)
30-39	38 (4.2)
40-49	16 (3.2)
50-59	5 (1.9)
Total	**100**

The highest age group distribution was between 30-39 years of age (38%) followed by 25-29 (33%) of the total number of science teachers. Most science teachers (38% + 33% + 7%) were about the category '39 years of age or below', a finding that suggests that there is a new generation of science teachers in rural schools. This could be because following Namibia's independence in 1990, emphasis was placed on science education of which these science teachers were likely to be products (Clegg, 2004).

Gender of science teachers

The science teachers were asked to indicate their gender, with response as follows:

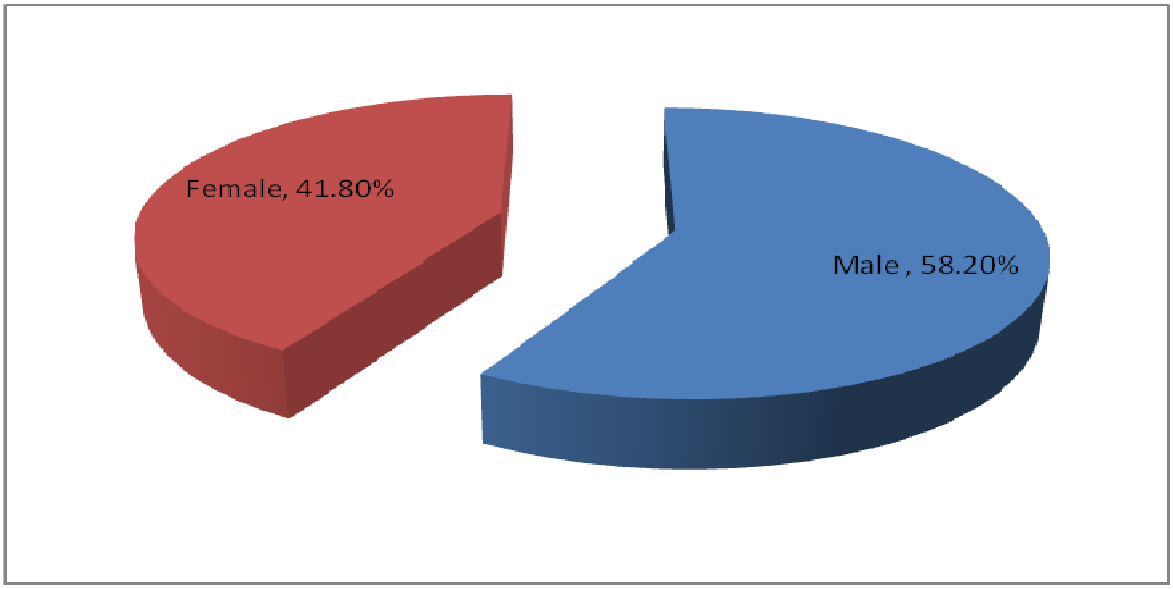

Figure 5. 3: Gender of science teachers (N=134)

The pie chart (Figure 5.3, above) shows that more than half (58%) of the science teachers were male, not surprisingly since for many years this profession has been occupied by men. Gradually, with the advocacy of female children in science and other projects supporting women in science, in an attempt to get girls to study science at secondary schools level, this profession is becoming slightly less male-dominated.

Access to computers at home

Asked whether they had a computer at home, the responses of the science teachers were as follows:

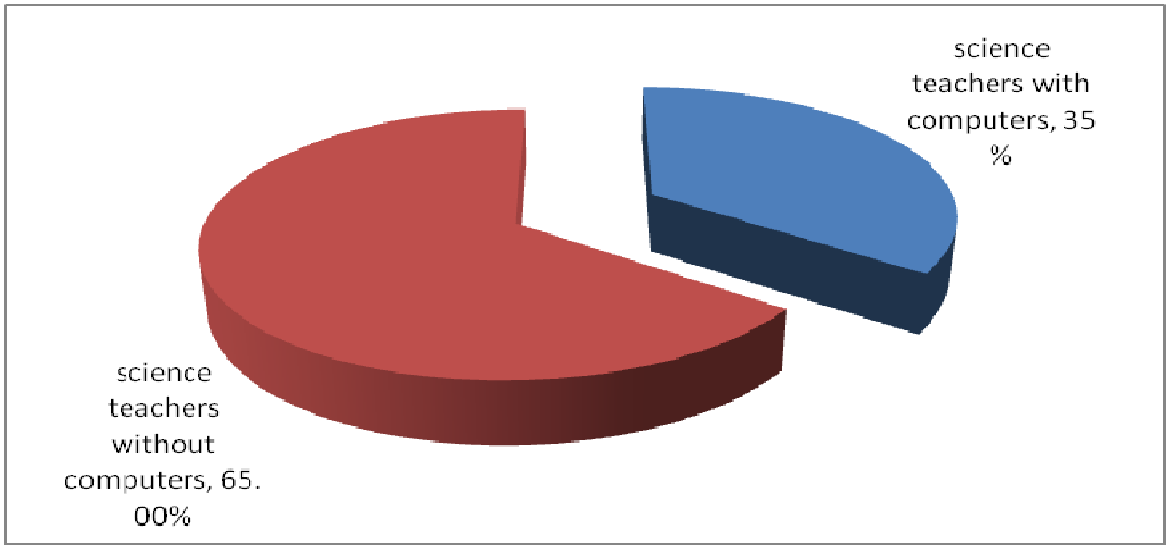

Figure 5. 4: Access to computers at home (N=137)

Figure 5.4 (above) shows that a third of the science teachers owned computers and used them for school related activities, an indication that some did posses computers and used them after hours for school-related activities.

Connection to internet

The science teachers were asked to indicate if their computers at home were connected to the internet, eliciting responses as follows:

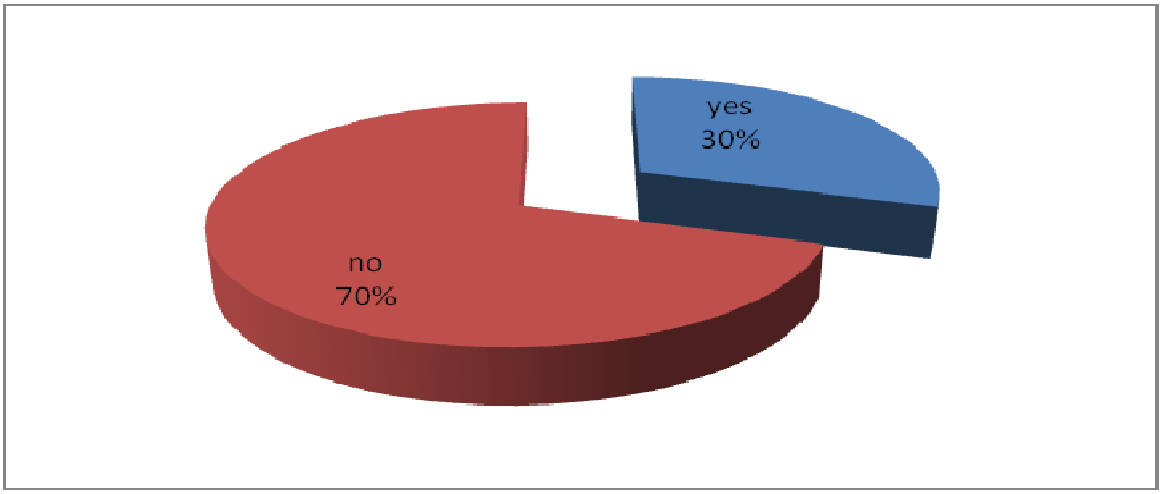

Figure 5. 5: Computers' connectivity to internet (N=137)

Figure 5.5 (above) shows that about a third of the science teachers' computers were connected to the Internet. This does not imply that science teachers who indicated that they did own computers were necessarily the same who indicated that their computers were connected to the Internet. It was probable that some science teachers did have access to the Internet through other devices, as indicated by Figure 5.4.

Learners' ICT skills operations

The science teachers were asked to indicate the level of ICT skills for learners, with the response rate as follows:

Table 5. 2: Learners' ICT skills operations (N=137)

Operation software		nearly none		some students		majority of students		nearly all students		don't know	
	N	n	%	n	%	n	%	n	%	n	%
Word processing	129	72	56	20	16	10	8	3	2	24	19
Database software	130	89	69	11	9	3	2	1	1	26	20
Spreadsheet	126	86	68	12	10	2	2	0	0	26	20
Presentation software	127	86	68	11	9	2	2	0	0	28	22
Application of multimedia	127	77	61	18	14	3	2	0	0	29	22
Email	126	77	61	15	12	8	6	0	0	26	21
Internet	127	77	61	17	13	9	7	0	0	24	19
Graphic calculator	127	77	61	19	15	10	8	2	2	19	15
Data-logging tools	127	93	73	5	4	2	2	1	1	26	21

Table 5.2 (above) shows that the majority (between 93% and 72%) of the science teachers indicated that almost none of the learners knew about the operation software. However, some science teachers indicated that a few learners did

possess ICT skills to operate some software. The non-response rate was high as many teachers did not integrate ICT in their science lessons.

Classroom information

Science teachers were asked to indicate the time they allocated to ICT use per week, with the response as follows:

Table 5. 3: Average ICT class time allocation per week (N=137)

Time	% /SD
less than 2 hours	17 (3.2)
2-4 hours	47 (4.3)
5-6 hours	14 (3)
7-8 hours	13 (2.9)
more than 8 hours	10 (2.5)
Total	**100**

Table 5.3 (above) shows that about half (47%) of the science teachers had allocated between 2 and 4 hours a week to ICT use. A few schools (22.6%) allocated 7 hours or more per week to ICT, a finding that suggests ICT use is higher than the number of hours spent by the Finnish teachers (Section 3.5). This could be attributed to a number of factors that are presented in the next sections.

5.3 Description of ICT use in science classrooms

This sub-section presents findings on the ICT use in Namibian rural science classrooms. For better understanding the definitions are presented before the findings.

Definitions of variables:

Vision refers to the schools' view of what constitutes a good teaching approach and how the school aims to achieve its objectives considering the role of the teachers and learners, the teaching, and the materials being used to teach. The

vision of the principals and teachers determine the policy of the school and the design and organisation of its teaching.

Expertise refers to teachers and learners need to have sufficient knowledge and skills in order to utilise ICT to achieve educational objectives. This requires skills beyond basic ICT skills to operate a computer. Pedagogical ICT skills are also necessary to help structure and organise learning processes.

Digital learning materials refer to all digital learning educational content, whether formal or informal. This includes educational computer programmes.

ICT infrastructure refers to the availability and quality of computers, networks, and Internet connections. ICT constitutes infrastructure facilities. In addition, electronic learning environments and the management and maintenance of the school's ICT facilities are also considered as ICT infrastructure.

Collaboration: the encouragement by the school leadership to use ICT and the initiatives to create partnership within the school and between schools in the same region or outside region.

ICT use: refers to the general use of ICT.

Pedagogical use: refers to the use of ICT for purposes of teaching science.

Having presented the definition for better understanding, a brief discussion on the computation of the indices and the descriptive findings on ICT use are presented respectively.

This section presents findings on ICT implementation in science classrooms. The original responses by the science teachers were converted to indices to allow for computation of the constructs into scales. The scales comprise three categories of low, medium and high. For further explanation on how the scales were computed, see Chapter 4. The findings show the outcome of indices calculated in maximum and minimum scores as well as the mean scores (see Table 5.4 below):

Table 5. 4: Description of findings on the use of ICT in the science classroom

Construct	*Data source*	*N*	*Mean*	*Minimum*	*Maximum*	*SD*
Pedagogical use of ICT	Science teachers	137	24.99	.00	91.00	17.11
Leadership	Science teachers	137	80.17	0.00	100.00	19.96
Vision	Science teachers	137	66.18	0.00	100.00	39.60
Science curriculum goals on ICT	Science teachers	137	53.94	0.00	71.79	12.01
Collaboration	Science teachers	137	55.20	0.00	75.00	15.87
Technical support	Science teachers	137	24.57	0.00	100.00	25.17
Professional development	Science teachers	137	52.14	0.00	92.86	12.26
Digital learning materials	Science teachers	137	62.91	0.00	100.00	27.72
Expertise (ICT related)	Science teachers	137	41.95	0.00	76.56	13.85
Confidence in ICT use[i]	Science teachers	137	12.14	0.00	53.00	15.08
Confidence in Pedagogical use of ICT	Science teachers	137	14.94	6.00	59.00	14.57
ICT infrastructure	Science teachers	137	17.35	0.00	66.67	16.73
Obstacle	Science teachers	137	48.72	0.00	100.00	30.06

Pedagogical use of ICT by science teachers

The science teachers were asked to comment on statements on the pedagogical use of ICT and also to indicate the impact thereof. The responses range from 00.00 % to 91.00%, with a mean score of 43.76% (SD=17.11). This finding suggests that the mean score is medium. However, some school have scored high on the scale, suggesting that those schools that scored highly make more use of ICT for pedagogical purposes than for others.

Leadership

The respondent science teachers were asked if the statements about leadership applied to them in their respective schools. Table 5.4 (above) shows that the science teachers responses on questions about leadership ranged between 0.00% and 100.00% (SD=19.96, and a mean of 80.17 %). The indices scores show a mean score at a high level. It can be interpreted from this that the school leadership was performing its duties in relation to the vision of the National ICT policy. Some schools as per the views of the science teachers suggest that the leadership is more emphasized than in other schools.

Vision

The respondent science teachers were asked if the statements about vision applied to them in their respective schools. Table 5.4 (above) shows that the science teachers' responses range between 0.00% and 100.00, with a mean score of 66.18 (SD= 39.60), suggesting that the vision of the science teachers lie in the high category of ICT implementation.

Science curriculum goals

The responding science teachers were asked to indicate within this school year (2010) how important it was for them to achieve the curriculum goals. The response ranged from 0.00% and 71.79% with a mean score of 53.94% (SD=12.01). The mean score was medium (53.94%) and it could mean that the science curriculum goals with regard to ICT were implemented halfway in line with the goals of the National ICT Policy for Education.

Collaboration

The science teachers were asked to state whether they agreed or disagreed that the school leaderships encouraged teachers to engage in cooperation that allowed them to work in groups, sharing knowledge and solving problems; and also on whether the leadership encouraged teachers to use different assessments. The science teachers showed a response range between 00.00 and

75.00%, with a mean score of 55.20% (SD=15.75). The findings could mean that some schools were not at all supportive of ICT related activities. This should also be noted that the principals scored themselves high on this construct, implying that they performed their duties very well, and therefore the high means score.

Technical support

Asked to comment on the technical support offered to them, the science teachers' mean score was slightly above the low range (Mean = 24.57%, SD= 25.17). However, some schools have high level (Max=100.00%) of technical support while other schools have no technical support at all (0.00%). From this it can be interpreted that the level of support offered to science teachers was low.

Professional Development

Commenting on statements that pertain to professional development, in particular whether they had participated in any professional development course and if not, whether they would liked to attend any, the science teachers' responses ranged from 0.00 % to 92.86%, with a mean score of 52.14% (SD=12.26). This finding suggests that they were being trained, although from the minimum and maximum values it can be stated that some schools were offering training of science teachers more (max=92.86%) than others (min 0.00%). The likelihood exist that some schools created opportunities to train more of their science teachers.

Digital Learning materials

The science teachers were asked to state how often the target class performs certain activities and also to state whether ICT was being used for such activities. The table shows that the mean score on digital learning materials was low (Mean=18.47%, SD=18.47), reflecting a lack of them in science classrooms.

Expertise

The science teachers were asked to state how often they conducted the ICT-related activities and also to state if they did use ICT to conduct the activities. The

table shows that the knowledge skills and attitude of the science teachers was the medium range (Mean=41.95%). However some schools did not conduct ICT-related activities at all (Minimum value=0%) and some conducted ICT related activities using ICT (Maximum value=76.56%). It is likely that the schools that conducted ICT related activities in the science classrooms were also those that were being encouraged to do so by the school leaderships.

ICT infrastructure

Asked to indicate the frequency of use of ICT software the table shows that the frequency of ICT use by science teachers was low (Mean=17.35%, SD=16.72). It can be said that the ICT infrastructure in schools was insufficient in terms of acquisition and availability, and poor with regard to decision-making about acquisition and maintenance.

Attitude

In response to being asked to indicate whether they were confident in the general use of ICT and also in pedagogical use of ICT, the figures show that confidence in the general use of ICT ranged from 0.00% to 53.00% with a mean score of 12.14% (SD= 15.08), whilst in pedagogical use of ICT, the responses ranged from 6.00% to 59.00% with a mean score of 14.94 (SD= 14.57). These findings suggest that the attitude of the science teachers was very low hence the low level of ICT implementation explained above. The low category in this instance could be interpreted to mean that the attitude was negative.

Obstacles

Finally, the science teachers were asked to comment on the extent to which they were affected by a number of obstacles. The findings show a range of 0.00% and 100.00% with a mean value of 48.72% (SD=30.06), suggesting that the obstacles are medium, meaning that the teachers were not completely affected by the various obstacles.

Summary of ICT use in science classrooms

Findings on indices have been presented per construct that appear in the conceptual framework of this study. The origin of the categories of low, medium and high have been referred to in Chapter 4 and for more information is attached (Appendix, O). The findings showed that pedagogical use of ICT, technical support, attitude of science teachers and ICT infrastructure, fell in the low range. Science curriculum goals, collaboration, professional development, digital learning material, expertise and obstacles have mean scores that fall in the medium range. Leadership and vision had high mean scores, however, the use of ICT and pedagogical use of ICT was low. Interestingly, the obstacles had a mean score which was in the low range. This raises questions as to why the mean score for the obstacles was low, given that ICT use was also in the low range. In order to understand this apparent anomaly, qualitative findings are presented.

5.4 Case studies' findings on ICT use in science classrooms

This section presents findings of schools A, B, and C., presented per construct. The three case studies participating schools are all rural based, one in each of the three educational regions. As explained in Chapter 2, these educational regions were war zones before the years 1990. In terms of resources, none of the schools is said to be better equipped than the others. All the three schools depended on the Namibian Government to provide them with basic resources. Given the fact that the case studies participating schools are homogenous in nature, the findings are similar in many respects. It can be said in generally that the findings for all schools are in agreement with one another.

Table 5. 5: Characteristics of science teachers

Science teachers	School A	School B	School C
Age	25	32	32
Training	BETD	BEd	BEd
No of years as teachers	2	5	5

Table 5.5 (above) shows that the science teachers are both young between the ages of 25 and 32. Two of the three teachers have Bachelor's degrees with five years of teaching experience, and one has a BETD Diploma with two years of teaching experience. This background information is important as it might have influenced the responses of the science teachers. The responses are presented per school below:

School A

This section presents the views of the respondents at School A on factors that may affect their ICT implementation. The views are presented per construct then summarized.

ICT use

Computers are largely used for administrative duties. For example, Science teachers also stated that they use computers for preparing lesson plans and typing notes for use in class. This is evidenced by:

> *'I use computers to plan my lesson, type the notes for the learners and to make copies to give to my learners if there is a photocopier machine'* (Science teacher A, 13 April 2010).

The science teacher stated that ICT was used almost every day for lesson preparation. In addition, during observations, he was also observed teaching using ICT, which appeared to be the type he needed to deliver the lesson.

Pedagogical use of ICT

The theme being taught determines the ICT to be used. Science teachers use ICT such as an overhead projector, a screen, a radio or a video when teaching. The science teacher mentioned:

> *'… depending on the theme being taught determines the ICT to be use, sometimes I use an overhead projector, a screen, a radio or a video to project on the wall for all the learners to participate'* (Science teacher, A, 13 April, 2010).

Leadership

The school leadership is encouraging ICT use in the science classrooms and also gives advice. Some members of the school leadership lacked knowledge about ICT and therefore were not able to give informed advise on ICT-related matters. This is evidenced by:

> *'The school leadership monitors teachers especially when they are in the computer room. E.g. they come to give ideas though not all of them know how to use computers very well' (Science teacher, A, 13 April, 2010).*

Collaboration

The science teacher receives assistance from the ICT technician, indicating some collaboration between the two. During observation, a staff member from the circuit office was seen typing question papers for schools that did not have computers. A science teacher stated:

> *'I get assistance from our instructor here and our principal is not that good at ICT and if you go there and ask him question he will only refer you to the instructor and even the Head of Department for Science'* Science teacher, A, 13 April, 2010).

Pedagogical support

Pedagogical support towards science teachers is minimal as not many teachers use ICT in their class. For example:

> *'Support from other teachers is good but not all of them are ICT-orientated'* (Science teacher, A, 13 April, 2010).

Technical support

The ICT technician has developed rules to guide the teachers through the use of ICT and teach the school administrative assistant to take over some responsibilities. The science teacher stated:

> *'Technical support is not a problem, we have a teacher who is teaching ICT'* (Science teacher, A, 13 April, 2010).

Vision

The science teacher seemed to know what the vision of the school was towards ICT use:

> '...all our teaching should make use of ICT' (Science teacher, A, 13 April, 2010).

ICT infrastructure

The researcher observed that the Ministry of Education had provided this school with 20 computers, and though it did not have access to the Internet the principal knew that he would have to pay N$150.00 for Internet services once installed. The

electricity supply was not continuous as power failures had been experienced whilst teaching. During observation, a number of obsolete computers were seen to be stowed away in one corner of the computer laboratory. There was a shortage of desks and chairs, with two learners sharing a chair and a computer:

> *...the negative impact can be also while you are in the motion of teaching the power failure occurs and teaching is disturbed.'* (Science teacher, A, 13 April, 2010).

Expertise

The science teacher has had training for a short period on basic ICT skills. The training happened when he was a student at the College of Education. The Ministry of Education provided a computer software package without necessary training to teachers:

> *'I have been trained but not in Encarta… I was trained by … Dr Ella for two weeks'* (Science teacher, A, 13 April, 2010).

Digital learning materials

Encarta software was pre-installed in the computers provided to schools. In addition, the school bought extra software, such as one for teaching mathematics. *Encarta* is seen as relevant to teaching science. The science teacher stated:

> *'The ministry came to install the computer, they also put in Encarta... it is relevant... it makes learners come to school. Encarta is mostly used... relevant but there are more software with more details'* (Science teacher, A, 13 April, 2010).

The science teacher uses ICT almost every day for lesson preparation, and was observed teaching using ICT. The teacher was well prepared and appeared to know the appropriate ICT to use for that particular lesson. The lesson plan was also made using computers, although in the interviews he mentioned that he used

different types of ICT such as radio, television and computers. The science teacher had undergone a two-week training course in basic computers. The school leadership was supportive of ICT-related activities, although some members lacked knowledge about ICT. Collaborative activities between science teachers and other teachers were minimal due to many teachers not having been trained in ICT and therefore unable to offer the required support.

School B

This section presents the views of the respondents at School B on factors that may affect ICT implementation in their school. The views are presented per construct and summarised.

ICT use

The science teacher stated:

> *'With computers it's easy for me to prepare my lesson activities using a computer, printout, make copies and it is easy for learners to answer questions. Learners pay much attention when they do activities with computer in class rather than me coming without any activities* (Science teacher B, 13 April 2010).

Pedagogical use of ICT

The science teachers use ICT more to teach and search for information in preparation of the lesson. However, the challenge is that, when using ICT, the science teacher does not get to finish the syllabus:

> *'I use ICT to explain the content what is being taught, I project the information on the screen so that learners can see what is being taught... to produce handouts with some information, print and give to the learners. Also, I can search for information on the Internet. However, you don't complete the syllabus on time*

> *because you end up going slower. Sometime you have to tell every learner to stop using the computer and sometimes you have to go show them how'* (Science teacher B, 13 April 2010).

Leadership

The science teacher stated that the function of the school leadership was to acquire computers and to ensure that Internet was accessible. However, it was up to the teacher to choose the appropriate ICT for a particular lesson. The science teacher stated:

> '*The school leadership makes sure that computers are there and functioning also that the Internet is working'* (Science teacher B, 13 April 2010).

Collaboration

There is some evidence of collaboration between the ICT teachers as they assist each other. The type of collaboration is in a form of support and is not explicit. The community members are not allowed to use the schools' ICT facilities.
The science teacher stated:

> *'Teachers who have better skills in ICT always help whenever I am stuck '(*Science teacher B, 13 April 2010).

Pedagogical support

The science teacher claims that the support system is weak. A number of teachers have knowledge about ICT and therefore help in times of need. The more people are shown how to fix the problem, the better for the school in terms of increasing the number of people who will be able to attend to recurring problems.

Technical support

The science teacher claims that technical support offered to them is weak. A few teachers have skills in troubleshooting and they assist others:

> *'The support system is weak. There are those teachers that got special training in computer and when you are stuck with something on the computer they assist in fixing the problem'* (Science teacher B, 13 April 2010).

Vision

The science teachers related that a vision was not stated in any school document but concurred with the one expressed by the principal and the ICT technician. During classroom observation, the researcher noted that the school had a vision statement posted on the wall at the entrance of the school, but that it made no mention of ICT. The teacher said:

> *'I cannot tell that much because we don't have anything on paper, I haven't seen anything on paper. I'm the chairperson of the timetable committee I can see clearly that the school is aiming at having all learners at least acquire computer skills'* (Science teacher B, 13 April 2010).

ICT infrastructure

During classroom observation, the researcher observed that the school was provided with 20 computers by the Ministry of Education. In addition, it had purchased a few more computers out of the school development fund. The Internet connection fee was N$ 300.00 per month, accessed through a 3g device. About 7 computers were placed in the staffroom for teachers, one in the principal's office and two at the reception. The computers were protected against dust with the intention of increasing duration of functionality.

Expertise

The science teacher had undergone basic training in ICT during post-school training. The school had been supplied with pre-installed *Encarta* but no training had been provided to the users. Pre-knowledge acquired in the teacher training programme became necessary. Training in ICDL was about to start at the time of data collection. During classroom observation, the science teacher portrayed confidence in ICT integration. He was able to teach a class of 40 learners with 20 computers and still accomplished the objectives of the lessons:

> *'I was trained in using the timetable software by the service provider. When I was at UNAM we had a course called Communication Technology, I did a bit of that for a volunteer from America who came to train us'* (Science teacher B, 13 April 2010).

Digital learning materials

The school had been supplied with pre-installed *Encarta*. In addition, the school could buy the timetable and report card software. This software was said to be very relevant for pedagogical use, with *Microsoft Word* the mostly used and easy to operate:

> *'Timetable, report cards is mostly used. Operating these software is quite easy and relevant at our school'* (Science teacher B, 13 April 2010).

The science teacher B uses ICT to prepare lessons and give activities to learners. The ICT technician confirmed that the science teacher used computers at least twice a week. The science teacher was observed teaching using ICT. The teacher was well prepared and appeared to know the appropriate ICT to use for that particular lesson. The lesson plan was also drawn up using computers.

School C

This section presents the findings from the case study, School C. The findings are presented in a logical format of schools A and B respectively, before they are summarised.

ICT use

The science teacher stated that he used computers for administrative purposes and also for browsing the Internet:

> *'I use ICT to type documents and to search for information on the Internet'* (Science teacher C, 16 April 2010).

Pedagogical use of ICT

The science teacher used ICT for lesson preparation and for assessment. In addition, the science teachers used ICT for the Internet. The science teacher felt that the reason some teachers, including the science teachers, were not using ICT in their lessons was that it was not stated in the curriculum. Science teacher C stated:

> *'I use it for lesson preparation and for assessment. I would like the science curriculum to indicate when to use ICT like it is done in Mathematics. Some teachers do not make an effort to use ICT because it is not stated'* (Science teacher C, 16 April 2010).

During observation, the science teacher did not use the Internet to teach.

Leadership

The school leadership encourages science teachers to use ICT in lesson presentation, with examples from simulations. In addition, the school leadership ensures that teachers conduct lessons on ICT and also advises on what software

to buy, based on the need. However, the decision about ICT-related matters are made by the school leadership and not by school board. Science teacher C:

> *'The management makes sure that each teacher is teaching ...and bring the learners to the lab so that we show them how to use computers'* (Science teacher C, 16 April 2010).

Collaboration

There is evidence of collaboration where more knowledgeable teachers in ICT support those who are less knowledgeable in teaching using ICT. During a lesson observation, the science teacher was being assisted by the ICT technician, showing learners where to click if they failed to follow instructions. Science teacher C stated:

> *'I get assistance from my fellow teachers who have knowledge in ICT'* (Science teacher C, 16 April 2010).

Pedagogical Support

Pedagogical support was lacking. Science teacher B seemed very well vested in ICT skills and showed other teachers how to prepare report cards using computers. For example:

> *'We are not very much supported in that. I help all of them regardless of whether they are science teachers or not. Like now, I just gave them a lesson on how to do the report cards' (*Science teacher C, 16 April 2010).

Technical support

Technical support is weak. The principals only made sure that they released the funds for computers to be repaired. In this case, the science teacher was also acting as an ICT technician and sometimes taught fellow teachers on how to use

the report card development software. However, this support was only given during free time or when absolutely necessary, as it may have required the ICT technician to leave her class. For example:

> *'We the management only make sure that computers are repaired as soon as possible technical support is not good, sometimes you sit for the whole week or whole month with computers and you do not know what to do or who to contact'* (Science teacher C, 16 April 2010).

Vision

The vision for the school was for all teachers and learners to use ICT in preparation for the tertiary education. The vision of the school was written at the entrance of the school, but no words about ICT feature. Science teacher C stated:

> *'…the vision of the school is to produce learners who know how to use computers'* (Science teacher C, 16 April 2010).

ICT infrastructure

The school has been supplied with 20 computers by the Ministry of Education. In addition, the school bought about six computers:

> *'Since I started in 2007, the computers that I found here…were not compatible with the CD that I am using. But now with the acquisition of these new computers which we bought, it is possible to use ICT'* (Science teacher C, 16 April 2010).

Expertise

The principal had received training on ICT whilst in high school. The science teacher acquired ICT skills through an Engineering programme with UNAM. Science teacher C stated:

> *'Firstly, in my first year, I was doing Engineering and I could not continue due to financial problems. I did Computer Engineering at UNAM I know more of… data processing, GPS…'* (Science teacher C, 16 April 2010).

Digital learning materials

Computers given to the school had pre-installed *Encarta* software. In addition, some additional software for mathematics, timetabling and report card development software. The science teachers stated that *Encarta* was mostly used and that the software are relevant. Science teacher C stated:

> *'Encarta is mostly used... and relevant. We bought Equation 3.0, a timetabling software and report card making software'* (Science teacher C, 16 April 2010).

School C showed a low level of ICT implementation based on the fact that the principal uses computers for letter writing and record keeping. The Science teacher used ICT for lesson preparation, searching information on the Internet. However, very few teachers used ICT because of lack of expertise. The science teacher had acquired ICT skills informally through a course at UNAM, the principal also mentioned that he acquired ICT in high school. The principal encouraged teachers to use ICT and as a result the school had bought additional software to enhance their teaching and administrative tasks, such as report writing. During observation, the electricity went off three times within a period of 45 minutes. Inconsistent supply of electricity has an effect on pedagogical use of ICT in the science classrooms.

5.5 Cross case analysis

The findings of cross case studies with the three science teachers and classroom observations are presented. In order to understand how the cases have been crossed, see *Appendix I*. The findings from the interviews and classroom

observations are presented to draw common findings per construct. Findings from other studies are elucidated to elicit what is already known about the topic.

ICT use

On the question relating to what ICT the science teachers used with confidence, their responses ranged from *Encarta* to *Microsoft Word*, *Spreadsheet*, *Word pad* and *PowerPoint*:

> *'I teach in class in prefer to use Encarta the most..In fact Microsoft I can use it when for example I prepare activity as class work or test for the learners...'* (Science teacher B, 13 April 2010).

Also, Science Teacher A used other software such as the

> *'... spreadsheet, mh… and also aahh… word pad and mmmm….. PowerPoint presentation' (Science teacher A, 13 April 2010).*

From the data, on average science teachers used *Encarta* more than all the other software on the computers in school. In addition, Science Teacher A listed many more skills than all the other teachers. It is not convincing that Science Teacher A was much more advanced in using the software as he listed numerous skills. From the observation notes, the science teachers used *MS Word* and *Encarta* in all of the observations. The science teachers stated reasons for the choice of *Encarta*, such as getting an additional definition to a concept and providing a picture which was well labelled. Science teacher A responded:

> *'... It [Encarta] contains everything that you are requesting and they can give additional definition to a certain term mhhh…. term terminology and again they can provide a photo there and everything is well labelled...'*

During observations, the teachers used *Encarta* in almost all the lessons observed. The learners did some activities in class, including the search for definition and read more in order to obtain more information about a concept being taught at the time. In addition, the science teachers demonstrated classroom management skills by going around the class to check if learners were actually doing the task or activity given to them during class time. The teacher continued walking around to check whether they understood the activity and be available for help.

Baylor and Ritchie (2002) argue that teachers' willingness to integrate technology into the classroom is closely tied to external factors such as professional development and a supportive climate. The supportive climate, in this study referred to as 'support', consists of technical support and pedagogical support. The extent to which teachers use ICT can be a measure of their interest and corresponding skills in using ICT (Baylor & Ritchie, 2002). At lower secondary level it is most satisfying to retrieve information and presentations in more specific domains of the curriculum, such as science (Howie et al., 2005). In addition, other authors place emphasis on the provision of schools with ICT to enable the teachers to practice and gain confidence in its use.

Curriculum goals

The science teachers commented on how they would implement ICT in the curriculum and also their role with regard to ICT implementation in their classroom.

The responses of two science teachers are alike in that they tried to match what was in the syllabus with the ICT to be used. Science teacher B responded as follows:

> *'... when I prepare I have to get what topics to teach and try to look for different ICT that I can get in the school or maybe which I can make myself I try to look for them and see which ICT is appropriate to use in a lesson... I can't tell much but like in Mathematics I remember there are topics that have to refer to*

> *ICT things e.g. the use of the calculator the curriculum stipulates that one should refer to the calculator'* (Science Teacher B, 13 April 2010).

Science teacher C referred to a CD that demonstrated how ICT was to be integrated into the curriculum:

> *'We have a CD that shows us the approach on how to teach and that is normally the one I refer to'* (Science teacher C, 16 April 2010).

From the data, it appears that the science teachers understood the link between the curriculum and ICT, and they had implemented it well in Mathematics for Science teacher B for example. It was not very clear whether Science teacher C understood the concept well since he did not elaborate on what the CD detailed.

With the regard to the teachers' roles, science teachers understood them to be very important as they had to prepare lessons that involved learners, make presentations about a topic in class and engage in classroom management. Science teacher B summarised his role as:

> *'Actually my role is a very important one because I have to apply ICT in my teaching when I prepare my lesson and I really have to make sure I include ICT because it is believed that ICT enhance the learning process. So, my role is to make sure that during the teaching learning process ICT is applied in the lesson just for the learners to catch up with the content'* (Science Teacher B, 13 April 2010).

In addition, Science teacher C was thinking about classroom management:

> *I keep on walking up and down. I go table by table... ensure that learners are busy with the task given to them* (Science teacher C, 16 April 2010).

From the data, the science teachers understood their roles well, however, they did not mention the aspect of monitoring students' progress using ICT. Howie et al. (2005) found that many schools do not use ICT to monitor students' progress. The fact that the science teachers did not mention it is not conclusive evidence that they do not use it. Meanwhile, in the literature, Fullan (1993, 2001) emphasizes the moral purpose of education to improve the livelihood of all learners, irrespective of their background in order to live and work productively in an increasingly dynamic complex society. Learners need to be prepared for the 21st century (Doornekamp, 2002; Valentine & Holloway, 2001). Specifically, Kapenda (2008) emphasises that the science curriculum in Namibian schools needs to encourage the use of ICT in the classroom. The more people are ICT literate the broader the spectrum of achieving the Millennium Development Goal (MDG) of becoming a knowledge-based economy.

Leadership

The science teachers expressed their views on the leadership and vision of their respective schools, in particular on the vision of their school and the level of involvement of the school leadership. When asked about the role of the school management with regard to ICT implementation, their responses listed monitoring, facilitation and administrative roles, increasing access and infrastructure:

> *'facilitation is done very well because they use to monitor, mhhh… they use to monitor teachers especially when they are in the computer room for example they use to be there too giving mhhh… ideas though not all of them know how use them [ICT] very well. But those of them that know and are at the top of the school [leadership] they are actually helping.'* (Science teacher A, 13 April 2010).

> *'I think they make sure that the instructor of computer studies is present and that computers are there and functioning. Sometimes the internet is working because I understand that it is paid for so they make sure they*

have these things... I think that their intention to have ICT working well in the school ' (Science teacher B, 13 April 2010).

'The leadership… I think they are doing well in that. This year in the timetable, there is a new programme allowing each student to have two ICT lessons per cycle. The management makes sure that the teacher teaching that class does teach' (Science teacher C, 16 April 2010).

The science teachers indicated that they understood the scope within which the school leadership should operate in order to enhance the teaching and learning using ICT. It is very important that the school leadership shares its view with teachers in order to empower them. It was likely that the science teachers were implementing the ICT policy within the perceptive of how the management should facilitate ICT related activities. The functions of the school leadership appeared to be the same across all the schools.

When asked whether the school leadership prescribed to the science teachers what ICT to use, they responded that:

'It is upon the teacher to decide' (Science teacher A, 13 April 2010).

This is an indication that the school leadership was not becoming involved in day-to-day issues of the teachers, but rather it was acting within the scope of ensuring that the teacher did his/her work, irrespective of whether ICT was used or not.

ICT infrastructure

The science teachers also stated that they had experienced some negative impact from the electricity failure and completion of the syllabus from time to time:

'... it can be also be while you are in the motion of teaching the power fails and everything is now disturbed and it can be that it is gone maybe for a day...' (Science teacher A, 13 April 2010).

It was also observed that electricity had failed three times before the end of the day for School C. These problems, if perpetual, would be a de-motivation to teachers using ICT in their lessons, for fear that a power failure might occur at any time.

In terms of ICT availability, there were substantial differences noted in quality and functioning of ICT equipment between schools, as well as access to the Internet for instructional purposes. As a result, learners were observed rushing into class in order to access a computer hoping to share a chair with a learner of the same sex. From the literature, governments internationally are aware of potential unequal access to technologies (Howie et al., 2005).

Vision

The science teachers expressed their views on the vision of their respective schools, in particular on the vision of their school:

> *'The vision of my school, I cannot tell that much because we don't have anything on paper...I can see clearly that the school is aiming at having all learners at least [ahhh] acquiring computer skills.'* (Science Teacher B, 13 April 2010).

> *'…the vision of the school is to produce learners who know how to use computers and how to type, how to create a document and just the basics…'* (Science teacher C, 16 April 2010).

The findings indicate that the science teachers shared the values as expressed in the ICT policy. It can therefore be argued that the ICT policy did reflect to a larger extent what was happening in the classrooms.

Digital Learning Material

The science teachers were asked to indicate the different types of digital materials, if any, available at their school, and the relevance thereof. They responded in the affirmative, specifying *Encarta* and *MS* package, the timetable software and report card software. The *Encarta* and *MS* package was common to

all participating schools. Teacher B and C mentioned additional software that the school had purchased, but one of the two science teachers could give the name of the two software packages for report cards and for the timetable. In addition, Science teacher C mentioned mathematical software called *Equations,* which he normally used in the Mathematics lessons.

When asked about the relevance of the available software, the science teachers agreed that the *Encarta* software was of great importance:

> *'... the good thing is all disciplines are there, the topic that I that I am teaching now they are also there'* (Science teacher A, 13 April 2010).

From the observation notes, science teachers at all participating schools in the interview made use of this software to teach different topics in science. Mostly, it contained definitions of concepts and simulations about them. The learners were observed searching for meanings of words and also definitions of concepts, no longer carrying dictionaries for the same purposes.
Teacher C had additional reasons for using ICT:

> *'I started with this timetable a long time ago when we were not having these software but it was very much hectic and I have to spend some days and some nights trying to come up with timetable but now is easy you just go to the computer with little bit of information and you just enter and then you generate data and the timetable is ready. So now is quite easy...'* (Science teacher B, 13 April 2010).

The National ICT Policy Implementation Plan (2006) stipulates that no complete, standardised digital content package is currently available. Materials are adopted in an *ad hoc* manner but the Namibia E-Learning Centre will coordinate the development of locally produced content. Where quality content is unavailable, content will be licensed or 'borrowed' from both proprietary and non-proprietary sources.

This is in line with findings by Howie et al. (2005), that at lower secondary school level the most satisfying experiences with technology appear to be information retrieval and presentation. However, Ten Brummelhuis, de Heer and Plomp (2008) argue that no accurate information concerning the educational software and its content actually used by teachers and students is presently available in the Netherlands. Teachers wish to have ready-to-use software for unknown reasons, but they speculate that it may be due to lack of awareness in schools of the programmes and content available, and inability to find software that meets the needs of the schools, and/or a mismatch between supply and demand.

The participating schools indicated that they had purchased additional software, but details of the cost linked to the digital learning materials were not explored in this study. This study therefore cannot discuss the investment made towards acquisition of digital learning materials and whether they were of good quality or relevance. The interviews concentrated on the means of the schools.

Kennisnet (2008) argues that the importance of coordinating digital learning materials should be one of a school's overall goals, if not there is a high risk that investment in ICT will produce little or no benefit. According to Kennisnet (2008), only a few schools have managed to consider the ideas of teaching and learning as a basis for acquiring digital learning materials to support those pedagogical ideas. Given the socio-economic conditions of the rural schools in Namibia, it is improbable that the schools will acquire digital learning material that suit the pedagogical principles of the respective schools. As a result, rural schools stand a chance of meeting "low costs of digital learning materials" (Kennisnet, 2008), but not necessarily making choices based on quality.

Collaboration

From the case studies, very little collaboration was noted between science teachers of the same school or from other schools in the same educational region or beyond. This could be because most teachers lacked ICT skills and knowledge, and therefore they were not in a better position to form collaborative activities:

> *'I get assistance from fellow teachers who have knowledge in ICT'* (Science teacher C, 16 April 2010).

In addition, none of the schools had stated that they did allow community members to use their facilities. This practice was said to have ended in the past due to lack of time. However, it could generate money for the schools to use for items that are costly, such as buying toner for printers and paying for maintenance of the ICT, should the regional technician not turn up on time to do the repairs. The fundraising appeared to be justifiable, in the absence of ways the MoE could find to supply the school with toner, and also due to the schools having to pay some fees for the Internet per month, and in other cases buy electricity. This study did not dwell on how best schools could raise money to sustain these expenditures.

Pedagogical support

The science teachers were asked to comment on the pedagogical support at their schools:

> *'there are those teachers that are better that got maybe special training in computer and whether you are stuck with something on the computer and you call them for assistance they can help… they can sometimes help you'* (Science teacher C, 15 April, 2010).

From the responses, all principals and teachers agreed that there was pedagogical support amongst teachers, and those that were more skilled in ICT assisted others. However, the scope of knowledge appeared to be limited. The low level of pedagogical support could be attributed to lack of understanding of the concept of ICT integration (Iipinge, 2010; Matengu, 2006; Sutherland & Sutch, 2009). This ambiguity may result in the lack of support as the principals and the ICT technicians may not have known the kind of support needed or how to support the science teachers. From the interviews, science teachers indicated that they received support from fellow teachers who had some experience in ICT. In

addition, the skills that the teachers at the school possessed were limited to allow for more exploration of innovative ways of teaching using ICT.

The role of the University of Namibia with regard to ICT implementation in schools is not pronounced. Rather, all students, including the science teachers' training programme, take a computer literacy course in the first year. It is assumed that the skills acquired during a six-month course are sufficient to teach science using ICT after graduation.

From the literature, South Africa has the same challenges explained above. In order to improve the situation, the Thutong Portal was established to support the needs of the teachers. This portal is supplied with quality educational information reviewed by a panel of educational specialists. As at 2007, about 23,635 had subscribed to this portal, of whom 11,565 were educators who shared resources and experiences on this portal.

Technical support

The science teachers were asked to answer questions about the technical support that is rendered to them and the school at large. Generally, the science teachers said that the technical support was weak:

> *'Technical support system, I think is weak. You do not get much of the assistance on that even from the region. I think is really weak. We are not very much supported in that. If something gets broken and I happen to fix it, it is by try an error'* (Science teacher C, 16 April 2010).

From the data, it can be concluded that the support system in general was not in place. The principals relied on the little expertise of the technicians to repair the computers. The science teachers, being also computer literate, appeared to attend to the problems themselves, through trial and error. In addition, the technicians were also making an effort to ensure that an effective system was in place, for example by trying to teach the school administrative assistant how to troubleshoot. Providing science teachers with technical knowledge alone is not

sufficient (Hakkarainen, et al. 2001), but it is not clear from the literature as to how much of technical knowledge the science teachers should have.

Attitude

The survey finding suggests that the attitude of the science teachers was negative. Contrary to this finding, the case studies showed a positive attitude of science teachers enjoying teaching using ICT. They had confidence in the subject content as well as ICT integration; however the class sizes were large, with learners fighting to enter the classroom for chairs. There was one chair for every two learners, yet the teachers delivered their lessons as planned. The fact that the case studies participating science teachers were able to teach using ICT in such an environment, it is evidence enough that a few science teachers had a positive attitude. However, a larger number of science teachers showed a negative attitude towards ICT use.

Baylor and Ritchie (2002) argue that teachers' willingness to integrate technology into the classroom is closely tied to external factors, such as professional development and a supportive climate. In the absence of a strategy that describes how ICT is to be integrated in the curriculum, there is little hope that a considerable number of teachers' attitudes would change significantly.

Expertise

The component of knowledge, attitude and skills covered response from the science teachers as to whether they had been trained, and if so when and what software they preferred to use.

Asked if they have been trained in any of the software supplied to them, all teachers indicated that they had not. However, some felt confident in using *Encarta* as they claimed it was easy. Teacher C felt very confident using *Encarta* because of his past experiences with computers:

> *'Yes at UNAM level. Firstly, in my first year, I was doing Engineering and my brother told me that I could not*

> *continue due to financial problems. I did Computer Engineering, which involved all those stuff of ICT. Also, at UNAM there is a core module on ICT which everybody has to do. I can say that I know most of the computer things…data processing, GPS…'* (Science teacher C, 16 April 2010).

The skills that the science teachers had were acquired through various training programmes, apparently over a short period of between two weeks to a few months. From the data, it also appears that they also received training from their suppliers of software. Science teacher B said she had acquired ICT skills from a Canadian lecturer:

> *'Yes, the service Provider... When I was at UNAM we had a course called Communication Technology, I did a bit of that although that time you couldn't catch up very well. At school there came particular volunteer from America, she came to train us a bit'* (Science teacher B, 13 April 2010).

In the absence of formal in-service training on ICT for science teachers, it becomes difficult to determine teachers' ICT skills. However, from observations at all the participating schools, science teachers demonstrated a good knowledge of ICT required to conduct a lesson and also they displayed a good grasp of what equipment to use for ICT when teaching. The science teachers were asked to indicate which of the software they used frequently. Contrary to what the ICT technicians observed, the science teachers stated that they preferred to use *Encarta,* complemented by *MS Word*:

> *'When I teach in class I prefer to use Encarta the most... In fact Microsoft I can use it when for example I prepare activity as class work or test for the learners...' (Science teacher B, 13 April 2010).*

> *'... spreadsheet, mh… and also aahh… word pad and mmmm….. PowerPoint presentation'* (Science teacher A, 13 April 2010).

From the data, on average science teachers use *Encarta* more than all the other software on the computers in school. In addition, Science Teacher A listed much more than all the other teachers. It could be interpreted that Science Teacher A is much more advanced in using the software he listed, although it is doubtful whether he would use them all in one day.

When asked whether the science teachers felt the impact the introduction of ICT brought to their schools, they acknowledged it was positive for their teaching.

> *'I think the introduction of computers has a positive impact on my teaching …' (Science teacher B, 13 April 2010).*

The science teachers stated reasons such as getting an additional definition to a concept and providing a picture which is well labelled, as stated by Science teacher A:

> *'... they can contain everything that you are requesting and they can give additional definition to a certain term, mhh... term terminology, and again they can provide a photo and everything is well labelled...'* (Science teacher A, 13 April 2010).

During observations, the teachers used *Encarta* in almost all the lessons observed. The learners did some activities in class, including the search for definitions, read more and obtained more information relevant to the topic being taught at the time.

> *'...it can be also be while you are in the motion of teaching the power fails and everything is now disturbed and gone maybe for a day...'* (Science teacher A, 13 April 2010).

If the electricity repeatedly goes off, it de-motivates teachers to use ICT in their lesson for fear it may happen again at any moment. In addition, Science Teacher C stated that she was affected negatively by the test, as she was not able to use computers.

> *'…you don't complete the syllabus on time because you end up going slower because learners sometime need help. You have to tell them to stop using the computer and sometimes you have to go show them how to search information and all that'* (Science teacher B, 13 April 2010).

During the observation, the teachers walked around the class to check upon learners on whether they were actually doing the task or activity given to them during class time.

A number of studies revealed that although teachers have had training in ICT, some were not comfortable with using it. Most of the teachers had received theoretical training at colleges of education as part of their pre-service training, and some as part of the in-service training courses, yet not all have the confidence to use ICT in their classrooms (Boateng, 2007). Some teachers attributed their failure to use computers for teaching to the inadequate training in effective use and integration of computer technology in a school curriculum, as well as socio-economic factors related to living in rural areas (Boateng, 2007; Unwin, 2004). Some teachers however took the initiative to gain ICT skills elsewhere, although they still struggled with how to integrate ICT into the curriculum.

In another study in Lithuania, teacher training covers technical, information-related, social, pedagogical, and management competencies (Markauskaite, 2009). The standard for teacher training is based on the basic modules of the European Computer Driving License, plus additional modules specifically related to the use of ICT in schools (Markauskaite, 2009). This approach is criticised in that it is not sufficient to train teachers in ICDL, as it does not enable teachers to integrate ICT in the subjects they teach, rather it equips them with basic computer skills only.

In Namibia, a study by Iipinge (2010) revealed that these Colleges of Education and the University from which these teachers graduated are struggling to implement ICT due to lack of equipment, time and supportive system. There is a high likelihood that whilst there, these teachers were deprived of the opportunity to learn quality ICT.

In summary, across the cases, science teachers use computers every day for lesson plans, study notes, activities and for assessment. Appropriate ICT is chosen, depending on the theme or topic being taught. However, the science teachers are worried about the effect of ICT on completion of the syllabus. The school leadership ensures that the science teachers conduct their lessons using ICT, and provide some advice on ICT related matters. Their knowledge about ICT is very limited and much of it is evident on issues of procurement. There is collaboration between teachers of the same school. Most science teachers have not been trained in ICT therefore they are unable to offer professional pedagogical support to fellow science teachers. The science teachers are familiar with their school's vision towards ICT although it is not anywhere stated in the school documents.

There is lack of basic equipment such as desks and chairs. At least two learners have to share a computer per class of 40 learners, and there is an inconsistent supply of electricity, making it difficult for the science teachers to teach using computers and also Internet. There is also an insufficient supply of digital learning materials. Depending on the understanding of the school leadership and the funds available in the school development fund, two of the three schools were able purchase additional software, however it was very basic and followed a pragmatic approach (Kennisnet, 2008), as explained in Chapter 3 of this study**.**

5.6 Conclusion

This chapter has presented descriptive findings on a classroom level. In order to give insight into the rural areas, the background of the respondents and the profiles of the rural schools were presented. Further, the descriptive findings on indices were all discussed to show how ICT is being implemented in rural science

classrooms. The findings showed that pedagogical use of ICT, technical support, attitude of science teachers and ICT infrastructure, fell in the low range. Science curriculum goals, collaboration, professional development, digital learning material, expertise and obstacles have mean scores that fell in the medium range. Leadership and vision had high mean scores. However, the use of ICT and pedagogical use of ICT was low. The case studies findings show an insufficient number of computers. Most schools have received a total of 20 computers each. There is lack of technical and pedagogical support towards science teachers. Science teachers lack formal training in ICT skills or integration in ICT. These findings were tested for reliability and validity of the constructs in the proposed model in Chapter 6.