CHAPTER 6

FACTORS AFFECTING ICT IMPLEMENTATION IN RURAL SCHOOLS

This chapter reports on the findings of research question three of this study which aims at exploring factors that affect ICT implementation in rural schools. Section 6.1 presents the introduction to the Chapter. Section 6.2 presents the background information of the respondent. Section 6.3 describes the profile of the rural schools and ICT use at school level. Section 6.4 discusses findings on factor analysis. Section 6.5 presents factors that predict ICT implementation. Section 6.6 discusses the context information of case studies findings at school level. Section 6.7 presents the conclusion.

6.1 Introduction

This part of the study is exploratory and designed to address research question three, '*what factors affect ICT implementation in rural schools?'*. The aim of the exploration is to identify the significant factors that affect ICT implementation in rural schools and also to determine the validity of the constructs provided in the conceptual framework of the study. For a better understanding of the context, it is important to provide the background in formation of the respondents at school level (Section 6.2) as well as the profile of rural schools and ICT use (Section 6.3). An exploratory factor analysis (Section 6.4) was employed to describe the covariant relationships amongst the constructs per respondent. In addition, Pearson's correlation was conducted to determine the strength of the relationship between the respective constructs before the regression analysis (Section 6.5) used to determine factors for the best line of fit. The outcome of the regression analysis suggests factors that should be included in the model. In addition, findings on case studies are presented (Section 6.6). The case studies comprise of interviews of principals and ICT technicians at school level. It is important to note that cross-case analysis has been presented in Chapter 5 but at classroom level. The purpose of case studies was to obtain a better understanding of what makes or hampers the implementation of the National ICT Policy. Finally, the conclusion to the Chapter is presented (Section 6.7).

6.2 Background of respondents

This section presents the background information of the principals and the ICT technicians as respondents in the survey, that of the science teachers having been presented in Chapter 5. This chapter covers the principals' years of experience, age and gender, as well as their activities over the previous few years, whether they owned computers and, if so, if they have access to Internet.

6.2.1 Background information of the principals

This section presents the principals' experiences, age, gender and computer use. Information about the principals' qualification for this job was not included in the survey as the general requirement for a principal's position in Namibia is three years of teaching experience and no extra or specific skills are needed.

Years of experience as principal

This subsection presents the working experiences of the principals in their current position.

Table 6. 1: Years of occupation of principal position (N=105)

Duration	Principal of any school (%) (SD)	Principal of the current school (%) (SD)	Working in any other profession (%) (SD)
less than 3 years	34 (4.6)	32 (4.6)	25 (4.2)
3-5 years	23 (4.1)	27 (3.8)	11 (3.0)
6-10 years	27 (4.3)	28 (3.9)	25 (4.2)
11-20 years	11 (3.0)	9 (2.5)	25 (4.2)
21 years and more	6 (2.3)	5 (1.9)	14 (3.3)
Total			**100%**

Table 6.1 (above) shows that a third (34%) of the principals held the same position at another school for less than 3 years. About a third also indicated that they had been principals of the current school for less than three years. Three sets of 25% of the principals had been working in other profession before becoming principals for less than three years, 6-10 years and 11-20 years respectively. The possibility exists that the teaching profession was very attractive after the review of the teaching structure. This explains why a third of the principals are relatively new in this position. It is also possible that the predecessors used the principalship as a steppingstone to other professions, as there is currently a trend in Namibia for principals to be promoted to the position of Education Officer at the Regional Education Offices.

Age of principals

Asked to indicate their age category, the principals provided the data for Figure 6.1:

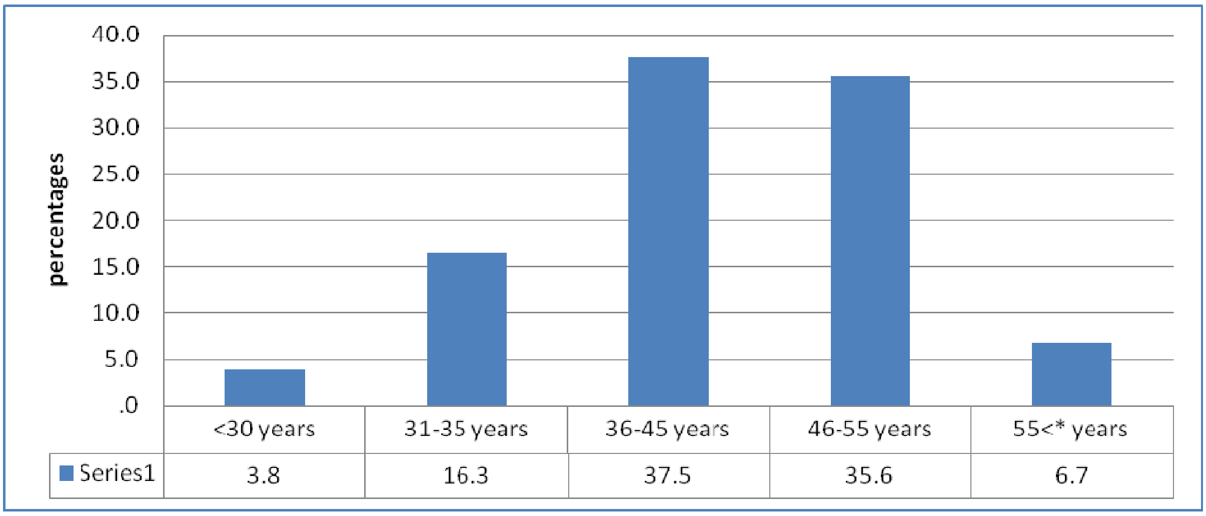

Figure 6. 1: Age distribution of principals (N=105)

Figure 6.1 (above) shows that 38% of principals who took part in the survey ranged between 36 and 45 years of age, followed by an age category of 46-55 years of age (36%). As explained above (Table 5.1), it is likely that the old principals were promoted to the positions of Education Officers or had possibly moved to other jobs. This explains why about 40% were less than 45 years old. Also, more than third of the principals were about to retire and less than 10% had reached retirement age. Retirement in Namibia starts at the age of 55.

Gender of principals

The principals were asked to indicate their gender:

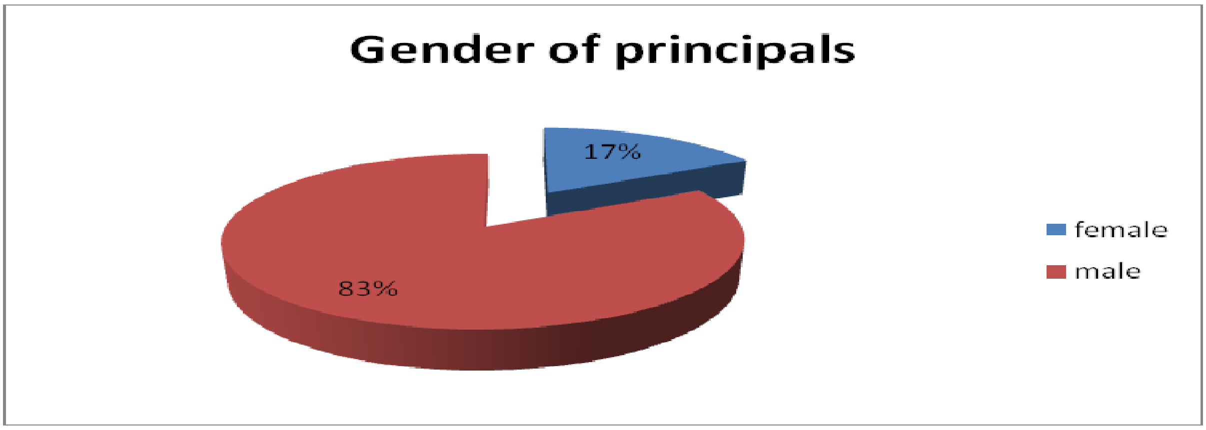

Figure 6. 2: Gender of principals (N=105)

The figure above shows that only 17% of principals were female, reflecting a common and longstanding trait that positions of principals are occupied by males.

Computer use

The principals were asked to indicate their computer use:

Table 6. 2: Activities for ICT use by principals

Activities	No	Yes (in %) (S.D)
Writing documents and letters	101	89 (3.0)
Budgeting, monitoring or controlling expenses	100	39 (4.8)
Planning purposes	101	54 (4.9)
Communicating with teachers	101	45 (4.9)
Communicating with parents	101	34 (4.6)
Teaching/instruction	100	38 (4.7)
Timetabling	101	64 (4.7)
Searching for information	101	79 (4.0)
Developing and making presentations	100	46 (4.9)
Own professional development	101	82 (3.7)

The majority of the principals reported that they used ICT to write documents and letters (89%) and search for information (79%). Much of computer use also was attributed to their own professional development (82%), which indicates that they used them to type their assignments and present work required by the institution offering the course of study, as well as for their private work. More than half of the principals used computer for timetabling (64%), and about a half for planning purposes (54%). This data shows that principals used computers for various reasons.

Ownership of computers

The principals were asked to indicate whether they owned and whether they used their personal computers for school-related activities:

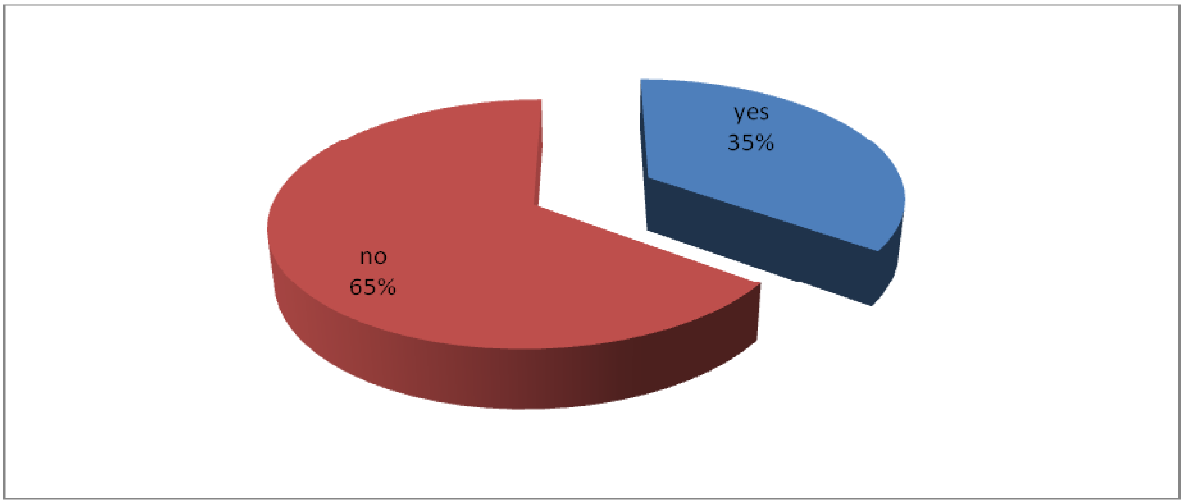

Figure 6. 3: Use of principal owned computers for school-related activities

Figure 6.3 show that about a third (35%) of the principals indicated that they use their private computers for school related activities. This can be interpreted to mean that about a third of the principals owned computers and used them for school related activities.

Access to Internet

The principals were asked to indicate whether their personal computers were connected to Internet. The response was as follows:

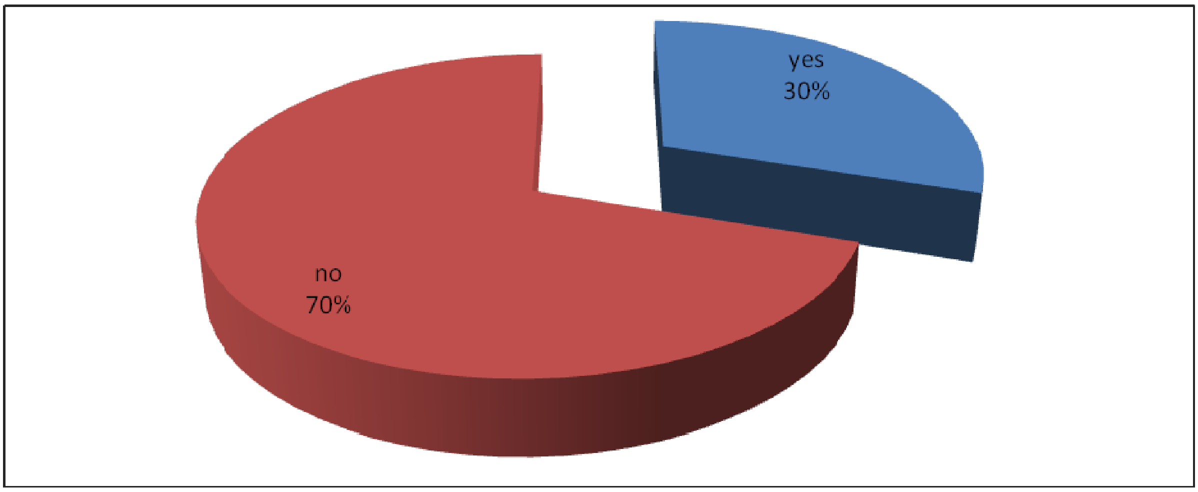

Figure 6. 4: Percentage of principals' owned personal computers connected to the internet (N=105)

Figure 6.4 (above) shows that about a third (30%) of the principals' personally owned computers were connected to the Internet. This done not mean that all the principals' in Figure 6.3 who own computers were necessarily those who had indicated that their computers were connected to Internet. Some principals could have access to Internet through alternative devices such as cellular telephones. As a result, the percentage of principals with Internet connectivity was almost the same as that of the principals who owned computers.

6.2.2 Background information of the ICT technicians

This sub-section presents the background information of the ICT technicians in terms of the positions they held and their duties. There is no designated position for ICT technicians in Namibian schools, so the number of respondents was lower than that of principals and science teachers (see Chapter 5). In addition, data on qualifications for ICT technicians was not included as it was assumed that the ICT technicians were most likely one of the teaching staff with a minimum of three years qualification.

Positions held by ICT technicians

The ICT technicians were asked to indicate the positions they hold at their schools:

Table 6. 3: Other position in school held by ICT technicians

Position	No	Percentage (in %)
Head of Departments	70	77
Principal	70	19
Teacher	68	4
Total		**100**

There was no designated position for ICT technicians. Most (77%) heads of departments acted as ICT technicians. About 20% of the principals and fewer than 5% of the science teachers also acted as ICT technicians. There was a non-response rate of 2% in the teachers' data due to ignorance.

Duties of the technicians as perceived by themselves

The ICT technicians were asked to indicate if they agreed with statements that described their duties:

Table 6. 4: Duties of ICT technicians (N=70)

Duties	No	Yes (in %)
I teach ICT courses to students.	67	40
I teach ICT courses to teachers and other school staff.	63	38
I teach Mathematics and/or Science.	62	55
I teach other subjects.	63	81
I formally serve as ICT technician.	64	25
I informally serve as ICT technician.	64	61

Table 6.4 (above) shows that most (81%) ICT technicians also taught other subjects, about a third (40%) of the ICT technicians taught either Mathematics and/or Science.

About 60% of technicians served in this position informally and about a quarter (25%) indicated that they formally served as ICT technicians. This could be because they have been issued with letters from the principal appointing them to serve in that position. Less than a quarter of the ICT technicians taught others teachers and other school staff in the schools. This finding suggests that teachers, including the science teachers, were preoccupied with what they were appointed to do. Serving as an ICT technician was voluntary.

Access to computers at home

The ICT technicians were asked to indicate if they owned computers at home:

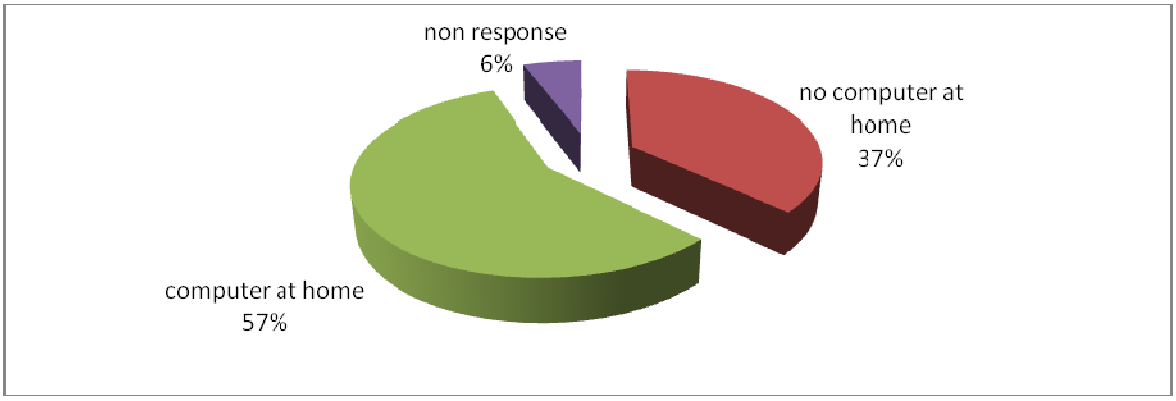

Figure 6. 5: Access to computers at home for ICT technicians (N=70)

Figure 6.5 (above) shows that 57% of the ICT technicians have their own computers at home. 6% of the ICT technicians did not respond to this question. This finding shows that more than half of the ICT technicians did own computers. This could be interpreted to mean that these teachers or school staff had an interest in computers and therefore they made an effort to own computers.

Connection to Internet

The ICT technicians were also asked if their computers were connected to Internet:

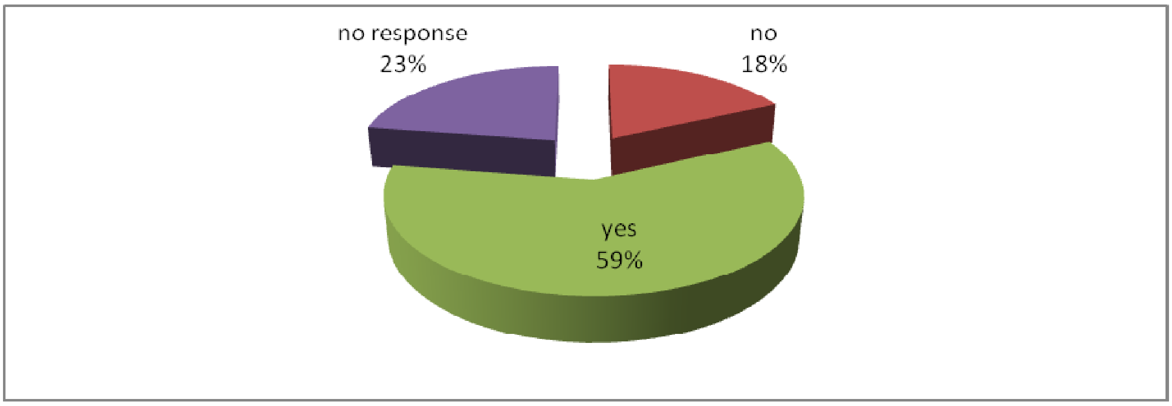

Figure 6. 6: Access to internet at home for ICT technicians (N=70)

Figure 6.6 shows that 59% of the ICT technicians had Internet connection at home and the non-response rate was 23%. More ICT technicians had Internet at home than there are technicians with their own computer at home (see Figure 6.5). This is possible, as the technicians could also access Internet through other devices or locations. This finding shows that more than half of the ICT technicians had Internet access, indicating a high probability that they used these computers to download teaching materials.

6.3 Profile of rural schools and ICT use

This section presents findings about ICT implementation in rural schools, defined in Chapter 3. For better understanding of the rural schools, background information about them is presented. This includes the average number of people living in the village, the average number of boys and girls in schools, the effort spent on upgrading the schools, classroom information, time allocated to ICT use in class per week and the level of skills of the learners in the rural schools. This information provides descriptive information about the villages in rural Namibia for a better understanding of factors that affect ICT implementation in rural schools.

People in the villages

The principals were asked to indicate the approximate number of people in the villages where the schools were located:

Table 6. 5: People in the villages (N=105)

People	Percent (%)
≤ 3 000	60.0
3001-15000	39.0
Total	**99.0**

Table 6.6 (above) shows that more than half (60%) of the principals indicated there were less than or equal to 3,000 people in the villages where the schools were located. Some principals do participate in community projects and therefore they know the number of people that live in the villages. It should be noted that the Namibian population was less than 2 million people, and although about 60% lived in the Northern regions, the areas were still sparsely populated (see Chapter 2).

Learner absenteeism

The principals were asked to indicate the percentage of student absenteeism per week:

Table 6. 6: Percentage of learner absenteeism (N=105)

absentees	Percent
<5%	75
5-10%	23
11-20%	1
>20%	1
Total	**100**

Table 6.6 (above) shows that most (75%) of the principals indicated that less than 5% of the learners were absent per week. Given the vastness of the regions, learners sometimes had to walk long distances but nevertheless attended school regularly.

Most important principals' activities during the past few years

The principals were asked to indicate the activities on which they had spent much of their energy in the previous five years. The principals' responses are illustrated in percentages and standard errors as follows:

Table 6. 7: Most important principals' activities during the past few years (N=105)

Activities	No	Yes (in %)/S.D
Making changes to pedagogical practices	95	73 (4.4)
Adopting new assessment practices	98	85 (3.5)
Installing electricity	104	68 (4.5)
Installing running water	102	81(3.8)
Setting up a storeroom	104	68 (4.5)
Acquiring a telephone line	105	72 (4.4)
Acquiring a photo copier	105	91(2.7)
Acquiring sufficient desks	104	66 (4.6)
Acquiring sufficient chairs	104	71 (4.4)

Table 6.7 (above) shows that the majority (91%, 85%, 81%) of the principals spent much of their time on acquiring photocopiers, adopting new assessment practices and on activities related to getting running water at their schools. Most (73%, 72%, 71%) of the principals spent time on making changes to pedagogical practices, on acquiring a telephone line and acquiring sufficient chairs. In addition, the principals spent more than half (68%, 66.3%) of their time on activities related to installation of electricity and acquiring desks.

The principals indicated that as a matter of priority they had been working towards changing their pedagogical and assessment practices. There were still a number of basic needs to be achieved before acquiring ICT. Some schools were working toward acquiring sufficient chairs and desks, and installing running water and electricity, and more schools felt that these topics should remain on top of the agenda. This problem was attributed to geography as developing countries are challenged to provide satisfactory level of technology and technological competence to school in remote areas which are often sparsely populated rural areas (Brandt et.al. 2008).

ICT use in rural schools

This section presents findings on ICT implementation in rural schools, with original responses by principals and ICT technicians converted to indices to allow for computation of the constructs into scales, comprising categories of low, medium and high (*see Appendix H*):

Table 6. 8: Description of independent variables

Construct	***Data source***	***N***	***Mean***	***Mini-mum***	***Maxi-mum***	***SD***
General use of ICT	Principals	105	43.76	.00	83	24.49
Leadership	Principals	105	49.03	16.00	68.00	13.34
Vision	Principals	105	42.95	0.00	50.00	11.62
Collaboration	Principals	105	83.10	0.00	100.00	19.46
Support on assessment	Principals	105	89.76	0.00	100.00	18.65
Pedagogical support	Principals	105	17.58	0.00	61.00	15.57
Technical support	ICT technicians	70	35.90	4.35	91.30	22.87
Professional development	ICT technicians	70	60.67	0.00	100.00	18.88
Digital Learning Materials	ICT technicians	70	14.71	0.00	90.00	18.16
Expertise (ICT related)	Principals	105	43.89	0.00	80.60	20.22
ICT infrastructure	Technicians	70	31.80	0.00	63.16	15.43
	Principals	105	42.99	0.00	86.36	23.15
Obstacles	ICT technicians	70	30.06	0.00	64.44	20.56
	Principals	105	24.92	0.00	64.10	14.95

The discussions on findings in Table 6.8 are presented per construct below:

ICT use by principals

The principals were asked to comment on the importance of ICT use in the target group, with responses ranging between 00.00% and 83.00%, with a mean score of

43.76 (SD=24.49). This finding suggests that the use of ICT by principals is medium. However, some principals make use of ICT more than others.

Leadership

The principals were asked if statements about leadership applied to them in their respective schools. The indices scores for the principals show a mean score at a medium level. This can be interpreted to mean that the school leadership was performing its duties as prescribed in the National ICT policy.

Vision

The respondent principals were asked if the statements about vision applied to them in their respective schools. The principals responses on the question about vision ranged between 0.00% and 50.00%, with a mean score of 42.95 (SD= 11.62). This finding suggests that the vision of the principals with regard to ICT implementation is medium.

Collaboration

The principals were asked to state whether they agreed or disagreed that the school leaderships encouraged teachers to work cooperatively in groups to share knowledge and problems, and whether the leadership encouraged teachers to use different assessments. From the table, the principals showed a range of responses between 0.00% and 100.00%, with a mean score of 19.46%. The findings could mean that some schools were not at all supportive of ICT related activities. It is also noted that the principals scored themselves high on this construct, implying that they performed their duties quite effectively, hence the high mean score.

Pedagogical support

The principals were asked to comment on the frequency of providing pedagogical support to science teachers when performing some activities using ICT. The table 6.8 shows that the average mean score for pedagogical support was about 25% (SD=14.95), indicating that the pedagogical support provided to science teachers was low. However, in some schools, science teachers were not supported at all (minimum value 0%) and in others schools the support was offered moderately (Mean=64.10%). It can be concluded that there was lack of pedagogical support in rural schools.

Technical support

The ICT technicians were asked to comment on the position they hold at their school and the duties they had besides offering technical support. In addition, the technicians were asked to state the frequency of technical support to students and fellow teachers. The table 6.8 shows that the mean score was medium (Mean = 35.90%, SD= 22.87). However, some schools had high level (Max=91.30%) of technical support while others had very little (4.35%). This can be interpreted as being that the level of support offered to science teachers was in the medium range.

Professional Development

The ICT technicians were asked to comment on statements that pertain to professional development. Particularly, the ICT technicians were asked to state whether science teachers in their respective schools had acquired knowledge and skills in ICT for teaching and learning. The technicians were also asked to indicate whether the courses on ICT were available at the school and could be offered at school or by an external organization. Table 6.9 shows that the mean score (60.67%, SD 18.88) was in the medium range. This finding suggests that science teachers were being trained, and it was probable that some schools created opportunities to train more of their science teachers.

Digital Learning materials

The technicians were asked to indicate the types of digital learning materials available in their school, and whether they needed them. The responses ranged between 0.00% and 90.00%. The table 6.8 shows that the mean score on digital learning materials was low (Mean=14.71%, SD= 18.16). The use of digital learning material was low because there was lack of it in rural schools. However, the ICT technicians showed that some or few schools had digital learning materials available. It is possible that these schools had bought them out of their school fund.

Expertise

The principals were asked to state if they encouraged knowledge and skills acquisition. The principals indicated that they did encourage science teachers to use ICT. The level of encouragement offered ranged between 0.00% and 80.60% with a mean score of 43.89%. It is probable that the schools that conduct ICT-related activities in the science classrooms were also those that were being encouraged by the school leaderships.

ICT infrastructure

The technicians indicated that the availability of ICT in the schools ranged between 0.00% and 63.16% with Mean=31.80% (SD=15.43). The principals indicated that the decision-making powers on ICT-related matters ranged between 0.00% and 86.36%, with a Mean=42.99% (SD=23.15). On average, it can be said that the ICT infrastructure in schools was medium in terms of acquisition and availability, but poor with regard to decision-making about acquisition and maintenance.

Obstacles

The ICT technicians were asked to comment on the extent to which the schools were affected by a number of obstacles. Contrary to that, the principals were asked to state the extent to which the school’s capacity was able to overcome those obstacles. The mean (30.06%, SD=20.56) showed that the obstacles were in the low range. The principals indicated that the efforts they applied to minimise the obstacles were in the low range (Mean=24.92%, SD=14.95). There is a possibility that the ICT technicians and the principals were not well versed in ICT-related matters and therefore the demands on the Namibian Government or the expectation by the school leadership were unknown. The school leadership may not be in a position to offer the unknown.

Summary on indices

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 has been referred to in Chapter 4 (*also see Appendix H*). The findings showed that, generally, the use of ICT, digital learning materials, ICT infrastructure, and obstacles were in the low range. Leadership, vision, and expertise had mean scores that were in the medium range. Collaboration and support on assessment had high mean scores. However, the use of ICT was low. Interestingly, the principals rated themselves high on matters related to collaboration and support on assessment, implying that they did offer the necessary support.

Conclusion

In conclusion, the profile of rural schools has been presented, describing the population in the village, learner absenteeism and efforts by the principals to make the school ICT-ready. The findings of constructs show that the most villages had a population of about 3,000, and learner absenteeism was very low. The principals spent most of their time acquiring the basic needs for the schools. Analysis of factors related to ICT implementation in rural schools show low rate of use of ICT due to other relevant variables also being low, such as digital learning materials and ICT infrastructure, with additional obstacles. Collaboration and support had a high score because the principals rated themselves very high. Further, relational analysis was conducted to identify factors that affect ICT implementation.

6.4 Interpretation of factors related to ICT implementation

An exploratory factor analysis is used in the description of the covariance relationships among the many variables in terms of a few underlying but unobservable, random quantities known as ‘factors’. Factor analysis is a special case of the principal component method in which the approximations are more elaborate. In the context of factor analysis, various methods can be used in the selection of variables that are contributing to the dependent variable of interest. The two most popular methods of parameter estimations are the principal component, its

related principal factor method and the maximum likelihood method. As Richard and Dean (2002) pointed out, the solution from these two methods can be rotated in order to simplify the interpretation of the factors. The two approaches are discussed.
The principal component solution of the factor component: In this case two methods can be used to determine the factor analysis solution, which is the number of factors that are significantly explaining suitable proportion of the total variance in the sample. These are mainly the eigenvalue tabulations and the scree plots. In particular, the eigenvalues (λ) are real numbers representing the variation accounted for by each component (factor) and that satisfy the equation $|A-\lambda|x=0$, where A is a correlation matrix calculated from the observations to be classified and x a non - zero solution vector. On the other hand a scree plot is a plot of all eigenvalues in their decreasing order. Hence as a rule of thumb, the number of factors are then given by those factors with $\lambda \geq 1$ which are equivalent to the substantial elbow in the scree plot. These two methods can be used to supplement each other (concurrently), however we have only presented the results of the eigenvalue tabulation as those of the scree plot at times are difficult to determine exactly the position of the elbow in the plot.

On the other hand, the maximum likelihood estimates of the factor loadings and specific variance can be used when the factors (common and specific) are assumed to be normally distributed. It is also important to point out here that both of these methods were calculated based either on a sample covariance or a correlation matrix of the sample data. The maximum likelihood is more common in the estimation of the rotating factor loadings from a principal component analysis through the varimax procedure by Kaiser (1958), and will be used as such in this study.

In this study, several variables under various constructs are considered. These constructs are as follows: Principal and its relevant constructs, science teachers (see Chapter 5) and its relevant construct, and the ICT Technicians and their relevant constructs. The findings on the constructs are discussed below:

Principal

Findings on relational statistics about constructs in the principals' data set are discussed. Specifically, constructs on effort, vision, and leadership have been discussed in detail. From of consideration of space in the thesis, the rest of the constructs are merely summarised. The constructs are broken down into various factors as indicated for reference in the principals' questionnaire (Appendix E).

Effort

The resulting outcome of the principal component (PC) analysis in Table 6.9 (below) shows that the first six factors have eigenvalues ranging from 4.058 to 1.032, as a result had been retained by the PC criterion. These six factors accounts for a cumulative percentage of about 68.7% of the total (standardized) variation in the sample data. In addition the communalities and the rotated factors loadings (through the varimax procedure) for the first six factors are shown in Table 6.10. It is therefore clear from this figure that the variable of installing electricity, installing running water, acquiring a telephone line, and acquiring a photocopier, define factor 1 (high loadings on factor 1 and small or negligible loadings on other factors) while the variable of flushing toilet, setting up a science laboratory, setting up a school library and acquiring a fax machine define factor 2. A variables on connecting to the Internet and installing computer laboratory define factor 3; the variable of acquiring sufficient desks and chairs define factor 4; a variable of making changes to pedagogical practices, adopting new pedagogical practices and setting up a store room define factor 5; and a variable of adopting buildings to suit ICT approaches and setting up computers in classrooms makes up factor 6 respectively.

One might therefore label factor 1 as *basic needs for rural schools*; factor 2 as *laboratory needs*, factor 3 as *ICT readiness*, factor 4 as *classroom furniture*, factor 5 as *classroom changes* as well as factor 6 as *setting up of computer laboratories*.

Table 6. 9: Effort Total variance explained

		Initial Eigenvalues	
Component	Total	% of Variance	Cumulative %
1	4.058	23.871	
2	2.000	11.763	
3	1.684	9.903	
4	1.573	9.255	
5	1.330	7.821	
6	1.032	6.069	
7	0.883	5.194	73.876
8	0.819	4.818	78.693
9	0.764	4.496	83.190
10	0.674	3.967	87.156
11	0.528	3.106	90.262
12	0.453	2.663	92.925
13	0.402	2.362	95.287
14	0.322	1.893	97.180
15	0.226	1.329	98.510
16	0.167	0.981	99.491
17	0.087	0.509	100.000

Extraction Method: Principal Component Analysis

Table 6. 10: Effort Rotated component Matrix

Variables	Component 1	2	3	4	5	6
Making changes to pedagogical practices					0.866	
Adopting new assessment practices					0.740	
Connecting to the Internet			0.785			
Adapting buildings to suit the school's pedagogical approaches						0.495
Setting up computers in classrooms						0.789
Installing computer laboratories			0.831			
Installing electricity	0.828					
Installing running water	0.827					
Installing flushing toilets		0.532				
Setting up a science laboratory		0.693				
Setting up a school library		0.830				
Setting up a storeroom					0.560	
Acquiring a telephone line	0.720					
Acquiring a fax machine		0.515				-0.413
Acquiring a photo copier	0.482					
Acquiring sufficient desks				0.941		
Acquiring sufficient chairs				0.945		

Vision

For constructs about vision, the PC analysis retains two factors with eigenvalues of $\lambda_1 = 6.093$ and $\lambda_{2_2} = 1.064$. These two factors accounts for a cumulative percentage of about 71.6% of the total variation in the sample (Table 6.11, below). In addition, the results of the communalities and the varimax rotated factor loadings are made up of variable fostering students' ability and readiness, providing activities which incorporate real world examples, providing learners with opportunities to learn, fostering face-to-face communication skills, and preparing students for responsible Internet for factor 1. Factor 2 constitutes variable cover of prescribed curriculum content, promoting learners' performance on assessment, individualising learners' learning experiences, increasing learning motivation and fostering collaboration. It is also important to point out here that the loadings for both variables on individualised learners' learning experiences and fostering learners' ability and readiness are very close to that of factor 1 (in the case of variable on individualised learners' learning experiences) and factor 2 (in the case of variable on fostering learners' ability and readiness) respectively, thus they can be equally allocated to any of the two factors. However in this case, the respective variables have been allocated to that factor for which it has the highest loading of belonging, irrespective of how close they are (Table 6.12). Therefore, one can refer to factor 1 as *learner preparation for ICT world* and factor 2 as *learner assessment on curriculum content*.

Table 6. 11: Vision: Total Variance explained

		Initial Eigenvalues	
Component	Total	% of Variance	Cumulative %
1	6.093	60.934	
2	1.064	10.644	
3	0.603	6.028	77.606
4	0.552	5.522	83.128
5	0.429	4.294	87.422
6	0.360	3.598	91.020
7	0.305	3.045	94.065
8	0.229	2.291	96.356
9	0.213	2.127	98.483
10	0.152	1.517	100.00

Table 6. 12: Vision: Rotated component Matrix

Variable	Component 1	Component 2
To cover the prescribed Curriculum		0.891
To improve students' performance on assessments/examinations		0.914
To individualize student learning experiences in order to address different learning needs	0.525	0.527
To increase learning motivation and make learning more interesting	0.504	0.601
To foster students' ability and readiness to set own learning goals and to plan, monitor and evaluate own progress	0.593	0.575
To foster collaborative and organizational skills when working in teams	0.494	0.649
To provide activities which incorporate real-world examples/settings/applications for student learning	0.665	0.580
To provide opportunities for students to learn from experts and peers from other schools/organizations/countries	0.793	
To foster communication skills in face-to-face and/or on-line situations	0.837	
To prepare students for responsible Internet behavior (e.g., not to commit mail-bombing, such as spam, etc.) and/or to cope with cybercrime (e.g., Internet fraud, illegal access to secure information, etc	0.796	

Leadership

With respect to leadership, the result of the PC analysis in Table 6.13 (below) shows that three factors with eigenvalues between $\lambda_1 = 4.730$ and $\lambda_{3_2} = 1.050$ will be returned by the PC criterion. These factors explain about 66.5% of the cumulative total variation in the sample data. Furthermore, according to the communalities and the varimax rotated factor loadings in Table 6.14, factor 1 is made up of variable meetings with teacher to review the pedagogical approaches, monitoring and evaluating the implementation approach, establishing new teacher teams encouraging teacher collaboration and featuring new instructional methods. Factor 2 constitutes organising workshops to demonstrate ICT use, changing class schedules for innovation implementations, implementing incentive schemes and involving parents in ICT related activities. Factor 3 comprised variables on re-allocating workload to allow for collaboration and re-allocating workload to allow for the provision of technical support. Therefore, one can refer to these factors as *Teacher mentoring* (factor 1), *Innovations* (factor 2) and *creating schedule for collaboration and technical support* (factor 3) respectively.

Table 6. 13: Leadership: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	4.730	42.996	
2	1.531	13.919	
3	1.050	9.545	
4	0.879	7.991	74.451
5	0.606	5.505	79.957
6	0.546	4.963	84.920
7	0.476	4.328	89.248
8	0.379	3.448	92.696
9	0.336	3.054	95.751
10	0.244	2.217	97.968
11	0.224	2.032	100.000

Table 6. 14: Leadership: Rotated Component Matrix

Variable	Component 1	2	3
Re-allocating workload to allow for collaborative planning for innovations in the classrooms			0.899
Re-allocating workload to allow for the provision of technical support for innovations		0.416	0.753
Organizing workshops to demonstrate the use of ICT-supported teaching and learning		0.788	
Meeting with teachers to review their pedagogical approach	0.776		
Monitoring and evaluating the implementation of pedagogical changes	0.885		
Establishing new teacher teams to coordinate the implementation of innovations in teachers' teaching and learning	0.758		
Changing class schedules to facilitate the implementation of innovations		0.572	
Implementing incentive schemes to encourage teachers to integrate ICT in their lessons		0.804	
Encouraging teachers collaborate with external experts to improve their teaching and learning practices	0.687		
Featuring new instructional methods in the school newspaper and/or other media (e.g., the school website)	0.460		
Involving parents in ICT related activities		0.720	

Overall, in similar ways, findings for construct Leadership, Collaboration, Support towards assessment, ICT infrastructure, Importance of ICT use, Expertise, General use of ICT, Pedagogical support, and Obstacles are summarized below:

Collaboration

With respect to collaboration, the result of the PC analysis shows that one factor with eigenvalues of $\lambda_1 = 2.160$ will be returned by the PC criterion. These factors explain about 54.0% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield the factor as *teachers' collaborative activities* (*see Appendix E*, item 11).

Support towards assessment

With respect to support towards assessment, the result of the PC analysis shows that two factors with eigenvalues between $\lambda_1 = 4.526$ and $\lambda_1 = 1.169$ will be returned by the PC criterion. These factors explain about 71.2% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *encouragement to use different modes of assessments* and factor 2 as *encouragement towards use of written tasks* (*see Appendix E*, item 12).

ICT infrastructure

With respect to ICT infrastructure, the result of the PC analysis shows that 3 factors with eigenvalues between $\lambda_1 = 5.272$ and $\lambda_1 = 1.040$ will be retained by the PC criterion. These factors explain about 61.4% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *access to computers*, factor 2 as *decision related to use of ICT* and factor 3 as *use of handheld devices* (*see Appendix E*, item 13 and 14).

Importance of ICT use

With respect to importance of ICT use, the result of the PC analysis shows that two factors with eigenvalues between $\lambda_1 = 9.722$ and $\lambda_1 = 2.701$ will be retained by the PC criterion. These factors explain about 64.8% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *learner orientation* and factor 2 as *teachers' encouragement* (*see Appendix E*, item 15 and 16).

Expertise

With respect to expertise, the result of the PC analysis shows that four factors with eigenvalues between $\lambda_1 = 8.404$ and $\lambda_1 = 1.192$ will be retained by the PC criterion. These factors are explaining about 72.3% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *pedagogical use of ICT*, factor 2 as *priority with regard to ICT use*, factor 3 as *managing collaborative activities*, and factor 4 as *pedagogical use of ICT* (*see Appendix E*, item 17 and 18).

General use of ICT

With respect to general use of ICT, the result of the PC analysis shows that three factors with eigenvalues between $\lambda_1 = 5.978$ and $\lambda_1 = 1.078$ will be retained by the PC criterion. These factors explain about 63.4% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *use of computers for various activities*, factor 2 as *information search* and factor 3 as *communication* (*see Appendix E*, item 19).

Pedagogical support

With respect to pedagogical support, the result of the PC analysis shows that two factors with eigenvalues between $\lambda_1 = 6.323$ and $\lambda_1 = 2.770$ will be retained by the PC criterion. These factors are explaining about 72.3% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *pedagogical support towards students* and factor 2 as *pedagogical support towards teachers and administrative staff* (*see Appendix E*, items 23 and 24).

Obstacles

With respect to obstacles, the result of the PC analysis shows that two factors with eigenvalues between $\lambda_1 = 9.351$ and $\lambda_1 = 1.710$ will be retained by the PC criterion. These factors are explaining about 72.3% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *hindrance due to lack of necessary equipment* and factor 2 as *hindrance due to pedagogical related issues* (*see Appendix E*, item 25).

ICT TECHNICIANS

This section presents relational findings on the description of ICT implementation in rural schools from the point of view of the ICT technicians. The constructs discussed in detail are ICT in school and Digital Learning Materials. For the sake of space, other constructs are presented in summary. Reference to the factors the variables form is made in the ICT technicians' questionnaire (*see Appendix G*).

ICT in school

It is observed from Table 6.15 that the resulting analysis of PC retains four factors with eigenvalues ranging between $\lambda_1 = 4.428$ and $\lambda_1 = 1.138$. These factors cumulatively explain about 71.5% of the total variation in the sample data. The communalities and the varimax rotated factors loadings as presented in Table 6.16 shows that variable on time used in Mathematics, time used in Natural Science, time used in Social sciences, time used in mother tongue, and time used in foreign language define factor 1; with variables on the level of ICT integration, use of ICT in teaching and learning and the time use in a separate subject defining factor 2; and variable on the number of years the school used ICT and the known ICT application types useful for school defining factor 3 whereas factor 4 is only made up of variable on the degree of ICT integration and the constraints outweighs ICT at school. As a result, we can now safely refer to factor 1 as *ICT use in school subjects;* factor 2 as *ICT integration in a school subject*; factor 3 as *ICT use of applications;* and factor 4 as ICT *integration and challenges.*

Table 6. 15: ICT use in School: Total Variance Explained

	Initial Eigenvalues		
Component	**Total**	**% of Variance**	**Cumulative %**
1	4.428	36.900	
2	1.693	14.106	
3	1.318	10.980	
4	1.138	9.486	
5	0.860	7.167	78.639
6	0.593	4.938	83.578
7	0.526	4.387	87.964
8	0.501	4.177	92.142
9	0.398	3.315	95.456
10	2.80	2.330	97.786
11	0.181	1.511	99.297
12	0.084	0.703	100.000

Table 6. 16: ICT use in school: Rotated Component Matrix

	Component			
Variables	1	2	3	4
No of years of using ICT			0.520	
ICT is considered relevant in our school			0.491	0.577
Our school has integrated ICT in most of our teaching and learning practices		0.812		
We have started to use ICT in the teaching and learning of school subjects		0.662		
We still do not know which ICT applications are useful for our school			-0.878	
Constraints rule out the use of ICT in our school				0.888
Mathematics	0.764			
Natural Sciences	0.707	0.450		
Social Sciences	0.679	0.419		
Language of instruction (mother tongue)	0.775			
Foreign languages	0.767			
ICT as separate subject	0.787			

Digital Learning Materials

However, with respect to Digital Learning Materials, the PC analysis retains three factors with eigenvalues in the range of $\lambda_1 = 3.329$ and altogether they are accounting for about 61.2% of the total variation in the sample (Table 6.17). In addition, the results of the communalities and the varimax rotated factor loadings (Table 6.18) shows that factor 1 comprises variable: availability of equipment and hands-on material, availability of simulation software, availability of communication software, availability of mail accounts for teachers and availability of mail account for learners, factor 2 has a variable of availability of multi-media production tools, availability of digital resources and availability of mobile services, and with variable availability of office suite and availability of mail account for learners making up factor 3. These factors can therefore be referred to as *software availability* (factor 1) *Digital resources* (factor 2) and also *software application* (for factor 3).

Table 6. 17: Digital Learning Material: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	3.329	33.291	
2	1.478	14.783	
3	1.314	13.141	
4	0.988	9.877	71.092
5	0.915	9.146	80.237
6	0.605	6.046	86.284
7	0.510	5.103	91.387
8	0.428	4.280	95.667
9	0.265	2.647	98.314
10	0.169	1.686	100.000

Table 6. 18: Digital Learning Material: Rotated Component Matrix

	Component		
Variables	1	2	3
Equipment and hands-on materials (e.g., laboratory equipment, overhead projectors, slide projectors, graphic calculators)	0.742		
General office suite (e.g., word-processing, database, spreadsheet, presentation software)			0.707
Multimedia production tools (e.g., media capture and editing equipment, drawing programs, webpage/multimedia production tools)		0.769	
Simulations/modeling software/digital learning games	0.595	0.402	
Communication software (e.g., e-mail, chat, discussion forum)	0.723		
Digital resources (e.g., portal, dictionaries, encyclopedia)		0.547	
Mobile devices (e.g. Personal Digital Assistant (PDA), cell phone)		0.767	
Smart board/interactive whiteboard			-0.726
Mail accounts for teachers	0.883		
Mail accounts for learners	0.627		

As in part one, the results for Professional development, Support, and Obstacles are presented in the same way and are summarized below:

Professional development

With respect to professional development, the result of the PC analysis shows that five factors with eigenvalues between $\lambda_1 = 5.533$ and $\lambda_1 = 1.122$ will be retained by the PC criterion. These factors explain about 72.8% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *knowledge acquisition*, factor 2 as *mode of training*, factor 3 as *ways of knowledge transfer*, factor 4 as *knowledge acquired through print media*, and factor 5 as *impact of news letters on ICT* (*see Appendix G*, item 11 and 12).

Support (technical)

With respect to technical support, the result of the PC analysis shows that 4 factors with eigenvalues between $\lambda_1 = 4.428$ and $\lambda_1 = 1.138$ will be retained by the PC criterion. These factors are explaining about 71.5% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *availability of technical support in general*, factor 2 as *level of ICT integration*, factor 3 as *frequency of ICT use* and factor 4 as *constraints experienced* (*see Appendix G*, item 13, 14, and 16).

Obstacles

With respect to obstacles, the result of the PC analysis shows that three factors with eigenvalues between $\lambda_1 = 6.757$ and $\lambda_1 = 1.215$ will be retained by the PC criterion. These factors are explaining about 72.3% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *lack of the necessary resources*, factor 2 as *lack of teaching resources*, and factor 3 as *curriculum related issues* (*see Appendix G*, item 17).

ICT infrastructure

The results for ICT infrastructure show that there are fewer than two cases, of which one of the variables has zero variance. There is only one variable in the analysis, and therefore the coefficients could not be calculated.

Science teachers

This section presents findings on constructs that appear in the science teachers' data. The constructs discussed in detail are ICT in school and Digital Learning Materials. For the sake of space, other constructs are presented in summary only. Reference to the factors the variables form is made in the ICT technicians' questionnaire (*see Appendix F)*.

Technical support

In the case of Technical support, the result of the PC analysis is presented in Table 6.19. From the table, it can be observed that the analysis retains one factor (eigenvalue = 2.093) which is explains about 69.8% of the total variation in the sample data. It is therefore important to point out here that the communalities and the varimax rotated factor loadings do not exist as only one factor is retained. As such Table 6.20 shows that all the variables were retained in the factor.

Table 6. 19: Technical support: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	2.093	69.760	
2	0.668	22.263	92.023
3	0.239	7.977	100.000

Table 6. 20: Technical support: Rotated Component Matrix

	Component
Variables	1
Evidence of technical support received from the technician	0.705
Evidence of access to computers	0.876
Evidence of administrative work	0.910

Digital Learning Materials

However, with respect to Digital Learning Materials, the result of the PC analysis shows that four factors with eigenvalues ranging between $\lambda_1 = 5.543$ and $\lambda_{4_2} = 1.023$ accounting for a cumulative percentage of about 67.1% of the total variation in the sample (Table 6.21) were retained. The respective communalities and the varimax rotated factor loadings (Table 6.22) show that factor 1 comprises variables on extended projects (2 weeks or longer), short-task projects, product creation, self-accessed courses and/or learning activities, and scientific investigations. Factor 2 comprises variable exercises to practice skills and procedures, laboratory experiments with clear instructions and well-defined outcomes, discovering science principles and concepts, studying natural phenomena through simulations, and looking up ideas and information. Factor 3 takes on variables in field study activities and teachers' lectures and processing and analyzing data making up factor 4 respectively. As a consequence one can therefore refer to these factors as *Science projects* (factor 1) *Instructional learning* (factor 2) *Investigation of scientific principles* (factor 3) as well as *Data analysis* (factor 4).

Table 6. 21: Digital Learning Material: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	5.543	39.595	
2	1.498	10.701	
3	1.330	9.499	
4	1.023	7.305	
5	0.834	5.957	73.057
6	0.687	4.907	77.964
7	0.589	4.208	82.172
8	0.560	3.998	86.169
9	0.511	3.648	89.818
10	0.393	2.809	92.626
11	0.344	2.459	95.086
12	0.262	1.872	96.958
13	0.223	1.594	98.552
14	0.203	1.448	100.00

Extraction Method: Principal Component Analysis

Table 6. 22: Digital Learning Material: Rotated Component Matrix

	Component			
Variables	1	2	3	4
Extended projects (2 weeks or longer)	0.797			
Short-task projects	0.710			
Product creation (e.g., making a model or a report)	0.750			
Self-accessed courses and/or learning activities	0.671	0.455		
Scientific investigations (open-ended)	0.816			
Field study activities			0.871	
Teacher's lectures			0.649	
Exercises to practice skills and procedures		0.661		
Laboratory experiments with clear instructions and well-defined outcomes	0.528	0.619		
Discovering science principles and concepts		0.813		
Studying natural phenomena through simulations		0.732		
Looking up ideas and information		0.611		
Processing and analyzing data				0.967

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalisation

Expertise

Similarly, the outcome of the PC analysis for Expertise from Table 6.23 retains only two factors with the corresponding eigenvalues of $\lambda_1 = 6.439$ and $\lambda_{2_2} = 1.117$. The cumulative total variation in the sample data that is explained by the two factors is about 63.0%, while the communalities and the varimax rotated factor loadings as presented in Table 6.24, shows that variables making up factor 1 are to:

- present information/demonstrations and/or give class instructions
- provide remedial or enrichment instruction to individual students and/or small groups of students
- help/advise students in exploratory and inquiry activities

- organize, observe or monitor student-led whole-class discussions, demonstrations, and presentations
- assess students' learning through tests/quizzes,
- provide feedback to individuals and/or small groups of students,
- use classroom management to ensure an orderly, attentive classroom
- organize, monitor and support team-building and collaboration among students

Factor 2 mainly comprises variables on

- organising and/or mediating communication between learners and experts/external mentors
- liaising with collaborators (within or outside school) for learners' collaborative activities
- providing counselling to individual students
- collaborating with parents, guardians and caretakers in supporting and monitoring students' learning
- providing counselling

Therefore, one can refer to these factors as *Collaborative activities* (factor 1) and *Learner mentoring* (factor 2) respectively.

Table 6. 23: Expertise: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	6.439	53.658	
2	1.117	9.308	
3	0.960	8.002	70.968
4	0.683	5.689	76.656
5	0.511	4.255	80.912
6	0.478	3.982	84.893
7	0.438	3.646	88.539
8	0.366	3.047	91.586
9	0.312	2.601	94.186
10	0.277	2.307	96.494
11	0.227	1.892	98.386
12	0.194	1.614	100.000

Extraction Method: Principal Component Analysis

Table 6. 24: Expertise: Rotated Component Matrix

Variables	Component 1	Component 2
Present information/demonstrations and/or give class instructions	0.768	
Provide remedial or enrichment instruction to individual students and/or small groups of students	0.554	0.460
Help/advise students in exploratory and inquiry activities	0.727	
Organize, observe or monitor student-led whole-class discussions, demonstrations, presentations	0.676	0.423
Assess students' learning through tests/quizzes	0.778	
Provide feedback to individuals and/or small groups of students	0.771	
Use classroom management to ensure an orderly, attentive classroom	0.832	
Organize, monitor and support team-building and collaboration among students	0.584	0493
Organize and/or mediate communication between students and experts/external mentors		0.770
Liaise with collaborators (within or outside school) for student collaborative activities		0.768
Provide counselling to individual students		0.722
Collaborate with parents/guardians/ caretakers in supporting/monitoring students' learning and/or in providing counseling		0.701

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalisation

Science curriculum goals

The outcome of the PC analysis for Science curriculum goals from Table 6.25 retains two factors ($\lambda_1 = 5.939$ and $\lambda_{2_2} = 1.900$), explaining about 60.3% of the total variation in the sample data. Furthermore, the communalities and the varimax rotated factor loadings in Table 6.26 indicates that variables for factor 1

- to prepare students for the world of work, to prepare them for upper secondary education and beyond,
- to provide activities which incorporate real-world examples, settings and applications for student learning,

- to improve students' performance in assessments/examinations, to increase learning motivation and make learning more interesting,
- to individualize student learning experiences in order to address different learning needs,
- to foster students' ability and readiness to set their own learning goals and to plan, monitor and evaluate their own progress,
- to foster students' collaborative and organizational skills for working in teams, and
- to satisfy parents' and the community's expectations made up factor 1.

Factor 2 comprises the following variables:

- to provide opportunities for students to learn from experts and peers from other schools/countries,
- to foster students' communication skills in face-to-face and/or online situations, to prepare students for competent ICT use and to prepare students for responsible Internet behaviour.

These factors can be referred to as *learner skills preparation* (factor 1), *technological challenges* (factor 2) respectively.

Table 6. 25: Science curriculum goals: Total Variance Explained

	Initial Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	5.939	45.685	
2	1.900	14.614	
3	0.822	6.324	66.623
4	0.746	5.738	72.362
5	0.696	5.352	77.713
6	0.597	4.596	82.309
7	0.525	4.037	86.346
8	0.472	3.634	89.979
9	0.387	2.976	92.956
10	0.344	2.648	95.604
11	0.252	1.939	97.543
12	0.168	1.292	98.835
13	0.151	1.165	100.000

Extraction Method: Principal Component Analysis

Table 6. 26: Science curriculum goals: Rotated Component Matrix

	Component	
Variables	1	2
To prepare students for the world of work	0.483	0.461
To prepare students for upper secondary education and beyond	0.715	
To provide opportunities for students to learn from experts and peers from other schools/countries		0.579
To provide activities which incorporate real-world examples/settings/applications for student learning	0.777	
To improve students' performance in assessments/examinations	0.812	
To increase learning motivation and make learning more interesting	0.852	
To individualize student learning experiences in order to address different learning needs	0.624	
To foster students' ability and readiness to set their own learning goals and to plan, monitor and evaluate their own progress	0.729	
To foster students' collaborative and organizational skills for working in teams	0.765	
To foster students' communication skills in face-to-face and/or online situations	0.445	0.535
To satisfy parents' and the community's expectations	0.557	
To prepare students for competent ICT use		0.918
To prepare students for responsible Internet behavior (e.g., not to commit mail-bombing, etc.) and/or to cope with cybercrime (e.g., Internet fraud, illegal access to secure information, etc.)		0.903

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalisation

Overall, the rest of the results for Instruction, ICT infrastructure, Confidence on Pedagogical use of ICT, Obstacles, Professional development and Pedagogical use of ICT are summarised below:

ICT infrastructure

With respect to ICT infrastructure, the result of the PC analysis in Table 6.31 shows that one factor with eigenvalue of $\lambda_1 = 5.621$ will be retained by the PC criterion. These factors explain about 70.3% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *insufficient infrastructure* (*see Appendix F*, item 19).

Attitude

With respect to science teachers' attitudes, the result of the PC analysis in Table 6.31 shows that one factor with eigenvalue of $\lambda_1 = 5.779$ will be retained by the PC criterion. These factors explain about 72.2% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *confidence in ICT use* (*see Appendix F*, item 20).

Obstacles

With respect to obstacles, the result of the PC analysis in Table 6.31 shows that three factors with eigenvalues between $\lambda_1 = 4.000$ and $\lambda_1 = 1.486$ will be returned by the PC criterion. These factors explain about 62.1% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *lack of knowledge to identify the appropriate equipment*, factor 2 as *learners' lack of skills* and factor 3 as *lack of confidence and time* (*see Appendix F*, item 24).

Professional development

With respect to professional development, the result of the PC analysis in Table 6.31 shows that three factors with eigenvalues between $\lambda_1 = 2.588$ and $\lambda_1 = 1.026$ will be retained by the PC criterion. These factors are explaining about 69.2% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *participation in technical and media operations courses*, factor 2 as *participation in Internet courses*, factor 3 as *participation in pedagogy related courses* (*see Appendix F*, item 25).

Pedagogical use of ICT

With respect to pedagogical use of ICT, the result of the PC analysis in Table 6.31 shows that 6 factors with eigenvalues between $\lambda_1 = 8.799$ and $\lambda_1 = 1.092$ will be retained by the PC criterion. These factors explain about 26.7% of the cumulative total variation in the sample data. The communalities and the varimax rotated factor loadings yield factor 1 as *use of ICT for assessment*, factor 2 as *collaborative activities*, factor 3 as *classroom management*, factor 4 as *giving feedback to learners*, and factor 5 as *assessment*, and factor 6 as *ICT use for collaboration* (*see Appendix F*, item 16, 17, and 18).

Vision

Factor analysis was also performed for construct on vision. It was therefore evident from the table that the PC analysis retained a single factor with an eigenvalue of 2.123 and account for about 70.8% of the total variation in the sample. The communalities and the varimax rotated factor loadings yield factor 1 as *development of school's vision*.

Collaboration

Similarly, with respect to the collaboration, the PC analysis shows that only one factor accounting for only 45.9% of the total variation in the sample data is retained (eigenvalue = 1.835). Therefore as in the vision construct, all the variables were retained in this factor, as *evidence of collaboration within and between schools*.

Summary of the factor analyses

In order to determine factors that affect ICT implementation in rural schools, exploratory factor analyses were conducted on the principals, science teachers and the ICT technicians' data respectively. An exploratory factor analysis is used in the description of the covariance relationships among the many variables called factors. The total variance in the samples was calculated. The findings for each construct are shown in terms of the number of variables or factors grouped per theme that they explain. ICT infrastructure as perceived by the ICT technician only had one variance and therefore could not be calculated further.

Having presented the variances between factors, the factors predicting ICT implementation in rural areas are presented below:

6.5 Factors predicting ICT implementation in rural areas

This section presents findings on factors that predict ICT implementation in rural areas. The findings of this study are presented at school level, although a distinction is made about principals' and the science teachers' factors respectively. It is important to point out that the responses of the principals and the science teachers were combined at school level. In the case of the school having two science teachers respond to the questionnaire, the responses were averaged to elevate the scores at school level. The Pearson's correlation analysis (see Chapter 4) is presented in Table 6.32 only for factors with values above ±0.30 as moderate fit for explanation (Cohen, Manion & Morrison, 2007). The rest of the correlation table is in Appendix P. In addition, the regression analysis is presented to determine the best fit using the dependent variable as pedagogical use of ICT by the science teachers. This section presents the correlation analysis in Section 6.5.1 and regression analysis in Section 6.5.2 respectively.

6.5 1 Correlation analysis

The findings on Pearson's correlation analysis are presented in the Table 6.32 (below), and suggest pedagogical use of ICT has relationships with a considerable number of constructs, such as attitudes, expertise, ICT infrastructure and professional development of the science teachers. The other constructs had fewer relationships between them.

Table 6. 27: Correlations of the principals and the science teachers

Variables	Pearson's Correlation	Variables			
Pedagogical use of ICT		Science teacher's attitude	Expertise of science teacher	ICT infrastructure	Professional development
	Correlation	0.307	0.387	0.421	0.339
	Significance level	0.003	0.000	0.000	0.001
	N	91	91	91	91
Support by principal		Collaboration by principal			
	Correlation	0.457			
	Significance level	0.000			
	N	91			
Leadership of principal		Curriculum goals	Vision of principal		
	Correlation	0.421	0.469		
	Significance level	0.000	0.000		
	N	91	91		

Vision of principal		Curriculum goals by science teachers	Collaboration principals
	Correlation	0.470	0.317
	Significance level	0.000	0.002
	N	91	91
Leadership by science teachers		ICT infrastructure by science teachers	
	Correlation	0.334	
	Significance level	0.001	
	N	90	
Support for science teachers		ICT infrastructure by science teachers	
	Correlation	0.368	
	Significance level	0.000	
	N	91	

ICT use by principals		Vision of principal	
	Correlation	0.476	
	Significance level	0.000	
	N	90	
Pedagogical support by principals		Vision	Leadership by principals
	Correlation	0.446	0.434
	Significance level	0.000	0.000
	N	91	91

The findings show that there is a significant relationship at $p \leq 0.01$ between the factor pedagogical use of ICT with attitude (p=0.307), expertise (p=.387), ICT infrastructure (p=0.421), and professional development (p=0.339) of the science teachers. This means that principals and the science teachers are likely to agree on matters regarding science teachers' attitude, expertise and professional development. They are also likely to agree on statements about ICT infrastructure as perceived by the science teachers.

The leadership of the principals has a strong positive relationship between curriculum goals (p=0.421) and vision of the principal (p=0.469) respectively. This finding suggest that both the principal and the science teachers are likely to agree on statements that reflect views on curriculum goals of the science subject as expressed by the science teachers and the vision of the principals in relation to the leadership style.

The vision of the principal has a strong relationship with the science teachers' views on collaboration (p=0.317) and also with science curriculum goals (p=0.470). This finding suggests that both the principals and the science teachers are likely to agree on issues of collaboration as perceived by the science teachers, as well as issues about science curriculum goals in relation to the vision of the principals.

There is a strong relationship between ICT use and the vision of the principals (p=0.476). This finding suggests that the principals and the science teachers are likely to agree on statements about the vision of the principal with regard to ICT use.

There is a strong relationship between pedagogical support and vision of the principals (p=0.446). This finding suggests that the principals and the science teachers are likely to agree on matters related to the vision of the principal in relation to pedagogical support towards the science teachers.

6.5.2 Regression analysis

This section presents findings based on the regression analysis of the principals and the science teachers' data. The calculation of scores was conducted whereby the responses in all the questionnaires were converted into indices to allow for regression analyses. Arguments for computation and the processes followed are presented in Chapter 4 (also see Appendix O). Variable selection or regressions procedure calls for consideration of all possible subsets of the pool of potential independent variables (factors) and identifying some for detailed examination of a few or good subsets according to selection criteria. The dependent variable of interest is pedagogical use of ICT by the science teachers. This study will therefore undertake model building for the dependent variable.

In order to assess the magnitude of the contribution of various constructs to the pedagogical use o ICT by science teachers, a simple regression model was fitted. The independent constructs of interest in the model include: professional development, vision, obstacles, digital learning materials, support, collaboration, expertise, general use of ICT, leadership, curriculum goals, infrastructure, and attitude of the science teachers, while the principals mentioned the support, expertise, vision, effort, leadership, collaboration, ICT use, infrastructure, pedagogical support and obstacles. The proportionate reduction in the variability of the pedagogical use of ICT when all the above constructs were included in the regression model is about 85.2%, while the outcome of the analysis of variance (ANOVA) for the fitted model presented in Table 6.33 shows that at 5% level there is a significant difference in the contribution of the constructs toward pedagogical use of ICT by science teachers.

Table 6. 28: ANOVA result

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	73416.349	22	3337.107	17.493	.000[a]
	Residual	12781.748	67	190.772		
	Total	86198.097	89			

The individual coefficient of the model parameters indicates that the only constructs that were found to be significant in the model at the 5% level of significance were leadership by principals (0.022), expertise (0.041) and general use by science teachers (0.000). As a result, for every activity added to leadership, the pedagogical use of ICT increases on average by 0.022. An increase in expertise, that is, adding knowledge and skills-related activities, pedagogical use of ICT increases on average by 0.267. Similarly, for every activity added to the general use of ICT, the pedagogical use of ICT increases on average by 0.877. This finding suggests that the model can be applied to rural schools in the same situation. In addition to the quantitative findings, the case studies are presented below to dig deep into the actual events as they happen in the natural environment.

6.6 Findings of school level case studies

This section presents three case studies of three schools (School A, B and C), discussed in Chapter 5 of this study. Case studies were analysed in order to deepen understanding of the findings from the survey. To obtain a full picture of factors that affect ICT implementation in rural schools, the cases were cross-analysed by combining findings from the respondents occupying the same profiles at the respective schools per factor.

Context information of the cases

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 available, 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. Over time, the principals had realised that they needed to source for additional teaching materials if their schools were to perform better at Grade 10 level. As a result, at least two of the three schools demonstrated innovative ideas on how to acquire more resources, without the assistance of the Namibian Government. The innovative ideas also perhaps depended on the characteristics of the school leadership or the principals. The background information of the school principals, science teachers and ICT technicians are presented below:

Table 6. 29: Characteristics of the school principals, science teachers and ICT technicians

Principals	**School A**	**School B**	**School C**
Age	50	55	32
Training	MA	BA, PGDE	BEd.
No of years as principal at that school	5	20	1
Science teachers	**School A**	**School B**	**School C**
Age	25	32	32
Training	BETD	BEd	BEd
No of years as teachers	2	5	5
ICT technician	**School A**	**School B**	**School C**
Age	27	23	40
Training	BETD	No formal training	BEd
No of years as ICT technician	5	3	8
Teaching subjects	Geography	Computer studies	Entrepreneurship

The background information of the principals, science teachers and ICT technicians show that the level of qualification for two of the principals is a bachelor's degree and for School A, is a master's degree. Two of the principals are between 50 and 55, with principal C by far the younger. The years of occupation as principal vary between 1 and 20. Principal B is the most experienced with 20 years of experience, followed by Principal A with 10 years and Principal C with about a year of experience in their respective schools. The science teachers are all young, between the ages of 25 to 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.

The ICT technicians' ages range between 27 to 40 years. Two had formal qualifications and one did not. The number of years of teaching experience varied between 3 and 8, with the oldest ICT technician having the greatest teaching experience. In addition, to serve as an ICT technician these had other teaching subjects allocated to them.

This background information is important as it might have influenced the responses of the principals, science teachers and ICT technicians. The responses are presented in the matrices below:

Cross case analyses

This section presents the cross case analyses findings of principals, science teachers and ICT technicians. The aim of crossing the cases was to understand innovative pedagogical ICT uses, how these changed in what science teachers do, the support systems made available to them and how these practices are associated with contextual conditions. The data was analysed manually, based on statements made in the case report.

Vision

The principals as well as the ICT technicians were asked to answer questions about the vision they held, whether the school board and/or the school leadership was involved in the implementation of ICT in their schools, and also what the role of the school leadership was. All the principals and technicians had the same vision towards ICT implementation, articulated by principals as follows:

> *'The point is for everyone in the school to be able to use ICT or computers* (Principal C, 15 April, 2010)
>
> *'…because in the 21st century there will be no one who will call oneself a better teacher or best teacher unless you are able to use technology in the classroom'* (Principal A, 12 April 2010).

In order to realise this dream, Principal C had expanded the schedule so that '*all the learners are exposed to at least to 2 to 3 periods per cycle to ICT'* (Principal C, 15 April, 2010). This effort explains why the vision is in the medium category (42.92%). Schools have vision statements posted on the walls, being the first thing the researcher observed at the entrance of the schools. However, the statements did not reflect any technology. The ICT implementation component appears to be secondary on the priority list of the school activities. The level of ICT implementation is still low and, as observed, is still at the provision level of ICT.

From the literature, the vision statements of the interviewee as stated during the interview have elements of social rationale as well as vocational rationale (see Section 3.3). In the spectrum of the social rationale, ICT is being implemented with the hope that both the teachers and learners will get ready for the challenges of the 21st century. All children in all societies therefore need to be prepared for an ICT and communication society (Doornekamp, 2002; Valentine & Holloway, 2001). Complementary to that view, the emphasis of the vision is on skills acquisition for both the teachers and the learners, with the hope that ICT skills would be required in the world of work and subsequently make a contribution to the MDGs. It can be interpreted that this hope will result in Namibia becoming an industrialised country (Vision 2030).

Leadership

Asked who was responsible for the implementation process, some interviewees, particularly the principals, responded that it was the school board. The principals said the following:

Hmmm… the school board because the school board members most of them obviously would like all of us to use ICT at school and that all computers be kept safe… And they don't want the ICT to be used for personal reasons since they are for the school unless the person who want to make use of it gets permission from them, otherwise …we may experience breakage among the computers and nobody will be responsible for that. Therefore they are always informed or instructed to get permission before they make use of the computer… at parents' meetings …. (Principal B, 13 April 2010).

They attend to lessons for ICT and teachers must make sure that all the twenty computers that we have in the lab are working and more learners are exposed to ICT. Rather than having about three or four computers only working. We, the management only make sure that whenever there is a computer that is not functioning, we make sure that it is repaired as soon as possible and we encourage learners to make sure that they attend the lessons. All in all, they do enjoy it and they do go. (Principal C, 15 April, 2010).

From the data it is noted that all principals knew more or less what the roles of the school leadership were, hence the medium score (Mean=49.03%). The school board ensured effective use of ICT by both teachers and learners by way of encouraging more teachers to use ICT. Faults detected with the operations of ICT were to be reported to the school board.

The school boards did not necessarily prescribe what ICT the science teachers should use in their classes (Principal A and C). However, Principal B indicated the need to inform the school management about how teachers used ICT. Contrary to this answer, the technicians think that the school leadership is responsible. Technician A responded:

'the leadership supports ICT a lot. They try and….and maintain the computers. They make sure that there is also electricity at school which is a bit of a challenge to our school. Most of the…most of the

> *leaders try to encourage learners to make use of these facilities.* (Technician A, 13 April 2010).

It is interesting that divergent views emerged on this question. The principals report to the school board and in their meetings they are obliged by the structure of the Ministry of Education to report on issues of progress towards ICT implementation, breakage and possibly new projects that are being initiated in the areas of ICT. However, at the level below the school management, technicians think that the school leadership is responsible for the implementation of ICT. It is sensible for the ICT technicians to respond that way, since they may not be part of the school management, and it is possible that they would not know what is discussed in school board meetings. The technicians and the science teachers report their complaints to the school management, who in turn report to the school board for any decision to be made.

From the data, it is noted that all interviewees knew more or less what the roles of the school leadership were. The school board ensures effective use of ICT by both teachers and learners, by way of encouraging more teachers to use ICT:

> *"Where possible, teachers are also encouraged to learn ICT on their own" (Principal A, 12 April 2010).*

However, from the answer about the exclusion of the school board it can be interpreted that the involvement of the school board is somehow limited. The school board is composed of the school management, heads of department, and the community members, of whom many will be immediate parents of learners attending a particular school. These parents are from the nearby village and, given their socio-economic status, have little knowledge of ICT.

Howie et al. (2005) argue that the extent to which school principals promote the use of ICT in their schools depends largely on how useful they consider these technologies to be. In a different study, principals see their role as catalysts and facilitators of ICT integration in the classroom (Tondeur et al., 2008). Assuming that most principals see their role as such, about 50% of the schools that participated in SITES M2 have developed policies concerning ICT use in line with their vision and also towards establishing positive attitudes. Many were found to be implementing at least half of the policy objectives (Howie et al., 2005). This is confirmed by a study by Tondeur et al. (2008) which revealed that school policies were often underdeveloped and underutilised due to lack of various types of resources.

Digital Learning Material

In order to establish the different types of educational software available at school and to determine whether that provided to the schools was relevant, the interviewees' views were sought. The Ministry provided the schools with computers in which the *Encarta* and MS Office programme were pre-installed. Some school acquired more software to enhance the effectiveness of their work.

Regarding the software provision, all interviewees appeared to know what was available in their respective schools. The technicians answered:

> *' We have only a mathematical one …oh not only a mathematical one ..but also Encarta.'* (Technician C, 13 April 2010).
>
> *'Yes we have… Microsoft, and Encarta.'* (Technician B, 13 April 2010).

Regarding the data, *Encarta* and *MS* package was common to all participating schools. In addition to the pre-installed software by the Ministry of Education, School B and C bought extra software, such as that used to do timetabling and the other for producing report cards for learners. This is a sign of commitment towards ICT integration and working fruitfully towards the vision of their school. The acquisition of extra software is dependent on the vision of the principals and the affordability of software by the schools. 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, with a long tradition of ICT in schools. However, teachers wish to be ready to use software for unknown reasons, but they speculate that it may be due to lack of awareness of the programmes and content available, an inability to find software that meets the needs of the schools, and/or mismatch between supply and demand.

On the relevance of the software, the interviewees mentioned that the introduction of ICT and particularly the introduction of certain software caused excitement at the schools. The interviewees shared the sentiment that the work was done faster and more easily with regard to creating report cards for the learners. Principal B commented as follows:

> *'They are very much relevant and they make teachers work easier, more especially when it comes to compiling their schedules, teachers do not need to scratch their heads and used a lot of their energy. They seems to enter the marks on the computer, the computer do everything for them… and when it comes to writing report cards , the time you enter the marks on the computer is the time when the computer is writing down the report on the card'* (Principal B, 13 April, 2010).

From the data, all interviewees agreed that the software was relevant for administrative and for pedagogical purposes. The details of the cost linked to the digital learning materials were not explored in this study, making it difficult to describe the investment towards acquisition of material which could be of good quality and relevance. The interviews concentrated within the means of the schools. Kennisnet (2008) argues that the importance of coordinating digital learning materials should be done with the school's overall goals. In cases when this is not done there is a high risk that investment in ICT will produce hardly any benefit. According to Kennisnet (2008), only a few schools have managed to consider the ideas of teaching and learning as basis for acquiring digital learning materials to support those pedagogical ideas. Given the socio-economic conditions of the rural schools, it is improbable that digital learning material that suits the pedagogical principles of the respective schools will be acquired. Rural schools therefore stand a chance of acquiring digital learning materials at lower costs (Kennisnet, 2008).

With regard to the most used digital learning materials, the technician mentioned that *Microsoft Word* was the software most used by the teachers and learners. The responses were also limited because the school did not have a wide variety of software available to it. Within their limit, the technicians indicated that *MS Word* was used the most, 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. The technician's response was "*Microsoft word.'* (Technician B, 13 April 2010). The technicians further indicated that *MS Word* was being used for lesson preparation and complimented by information obtained through a search on the Internet:

> *'I think is an important programme on the computer cause most people are using computer to type and on top of that Encarta is also important cause they are using it to search their information.'* (Technician B, 13 April 2010).

Most computers have MS packages, and from observation most if not all the supplied by *School-net* are obsolete. Thus, *School-net Namibia* is almost non-functional in the participating schools. Teachers will not be able to use the free software through the *Linux* system, thus limiting them to access of more digital learning materials.

On the question of whether the ICT technicians had been trained on how to use the digital learning materials available at their schools, some indicated that they had not been trained:

> *'Not really, it is a matter of getting used to the software and getting to know how they work but I was not given a formal on how they work'* (Technician A, 13 April 2010).

> *'Yes, I have been trained to use the Linux but this Microsoft from the Ministry, they did not give us any but they are planning to come here from the holiday the 26th May to train us ICDL. [Encarta] No, I just learn it myself'* (Technician B, 13 April 2010).

From the data, neither the technicians nor the science teachers had been trained in using any of the software made available to the schools. Each possessed ICT skills acquired through a different platform. The technician conversant with *Linux* had been trained some years previously, when schools were provided with computers by *School-net Namibia*. It is assumed by the ICT National Coordinator at the MoE that learning how to operate software is something that can be self-taught, and therefore teachers did so without assistance. However, at the time of conducting this study, training in ICDL was about to start within a month.

Expertise

The interviewees were asked to answer questions on the knowledge, skills and attitude with regard to ICT implementation. The knowledge possessed by each interviewee varied considerably between technical and software engineering, and was informally acquired by self-teaching through trial and error, from a brother who was a technician and through volunteers at the respective schools. This could be the case with many principals and ICT technicians, contributing to the placing of expertise in the medium category. However, some principals had received little or no training while holding the office of principal. Only one, principal A, had been trained in *MS Word*. Principal B was self taught whilst Principal C had acquired skills at school as a learner and during pre-service. Asked whether the interviewees were trained during their reign of principal position, Principals A and B responded:

> *'Ya, I had some elementary training some years back, 2004 but it was not intensive. I really wanted to do Excel and PowerPoint but unfortunately it was just limited to Microsoft Word and document writing and staff… I would really like to be trained…. it was just Microsoft Word, on how to write letters and design and how to open and create folders. I really wanted to be trained in PowerPoint. These days when you go to a conference and you are asked to present, one uses PowerPoint'* (Principal A, 12 April 2010).

'Myself, hmmm I was not…. I simply started typing with the manual typing machine and then I decided no, no, no… I should also try the computers. In most cases I used to call the computer teacher just to show me what to do' (Principal B, 13 April, 2010).

'Yes, I was when I was in high school I did Computer practice from Grade 8-10. From there I learnt on my own. In fact that is where I acquired a lot, especially in how to use Microsoft package. I am not very skilled in using the other one, Linux. Microsoft is easier to me. Microsoft Word, Excel...then searching through Internet and whatever…' (Principal C, 15 April 2010).

The data shows that the principals had not been adequately trained in ICT. They did have some knowledge about ICT, especially in the *MS* package. Principal C seemed more knowledgeable about ICT issues because of his school background. Similarly, the technicians had the following to say:

'I acquired this knowledge through my brother who is an ICT technician. He has been working with computers and most times he was teaching at some institutions and he also tried to attend classes. I did not get any formal training in ICT and therefore no formal qualification in it' (Technician A, 13 April 2010).

'I got my training at School-net Namibia on how to give basic computers to learner.' (Technician B, 13 April 2010).

'I was trained by the institution where I studied.' (Technician C, 16 April 2010).

From the data it is evident that none of the interviewees was trained in ICT suited for his or her employment. The knowledge about ICT is acquired through different means and served different purposes, yet, it is expected from the MoE that these individuals perform their duties effectively. The general observation made about the participants of the case studies is that the interviewee in the teaching positions are relatively middle aged and have undergone training during their in-service training programme at the University or colleges.

On the questions of what skills the interviewee possessed, the responses ranged from *MS Word, Excel, PowerPoint,* the Internet, operations of *Encarta*, *Equation 3.0*; to timetable software and report card development software. The responses were:

> '*They are quite a lot. From the technical aspect, PC Engineering, I know quite a lot. From the software, I learnt quite a number of them, how to use the different type of software. The basic software that we use, like Microsoft word, Excel, Publisher,… and this one for the database, and Internet.'* (Technician A, 13 April 2010).

> *'We got practical and theory but just the basic. How to use Microsoft Word, spreadsheet presentation and how to use Internet and we also learn how to troubleshoot the computer, the little technical signs.'* (Technician B, 13 April 2010).

Given these responses, it becomes questionable as to what is expected from these technicians. They have minimal skills, and what qualifies a technician in this context is unclear. It is also apparent that the repairs by the technician could be based on trial and error, and thus the ICT durability would not be guaranteed. In the midst of this process, Technicians A and B have acquired some technical skills in PC Engineering. From the data, it is evident that the technicians are better skilled in software applications than they are in hardware operations. This situation makes the technicians use trial and error to repair the computers and other ICT, as they may not possess the necessary skills to do a good job.

The technicians were also asked to describe the strategy used in their respective schools to increase ICT use by fellow science teachers. Two of the three wished that all teachers had time so that they could attend ICT training that they have initiated. It is also anticipated that the teachers would be encouraged to attend the ICDL training planned by the Ministry of Education, which was to give a laptop to the school as an incentive, should a teacher complete all seven modules. Technician B commented by saying:

> *'...most of them are eager to learn. It is only that they don't have time but if that ICDL thing they have to come cause they are going to get something at the end and everybody want them to be trained…Yes and they will be a laptop to be awarded to a person to complete all the modules.* (Technician B, 13 April 2010)*.*

The finding confirmed the quantitative results that science teachers were being trained. From the qualitative data the technicians were not clear on what specific strategy they were proposing in order to increase ICT use in their schools, but rather they depended on the wider Ministry of Education project to introduce ICDL Modules to the schools. However, the focus was going to be on basic ICT skills acquisition. It still remains questionable if all the hardware operations skills by teachers would be achieved in the school so that technical problems would be solved within a reasonable time. In addition, it was unclear whether the teachers acting as technicians would be able to detect the technical problems confidently to a level at which they would be given instructions telephonically that they could easily perform.

Attitude

The interviewees were also asked to answer questions about whether the attitudes of science teachers had changed since the introduction of computers to their respective schools. On average, the responses were positive, reading from these comments:

> *'I think embracing of ICT is low in the sense that I do not know what is wrong with our people. They just do not have the interest. I think they still need some motivation for them to participate. I heard some of them say… no we are old and stuff… one is never too old to learn. Like the workshop we had recently with the new Minister of Education, he said, nowadays in the 20th century, there is no way that you can become a good teacher if you are not given access to computers'* (Principal A, 12 April 2010).

> *'It had a positive impact on the teaching although it depends on teacher to teacher and the skill they have and how they can apply ICT'* (Technician A, 13 April 2010).

> *'Some use ICT and others not because they ask other people to do things for them. For those that use ICT often, they normally come to the laboratory and check things on the Internet, print out and give the printout to the kids'* (Technician C, 16 April 2010).

From the quantitative data it could be concluded that the attitude towards ICT use was low. Through the interview responses a negative attitude was also detected in Principal A's response. The low use of ICT could be attributed to the negative attitude of some science teachers. For some who were confident in using ICT, the attitude had changed. For those who did not know how to use ICT, they repeatedly asked for assistance from their fellow colleagues. Currently, their attitude is said to be negative.

ICT infrastructure

The interviewees were asked to state the number of computers available in their schools, including those the schools had bought and those donated. The principals also related the procedure for maintenance and the procedure to be followed to get their schools connected to the Internet:

Table 6. 30: Response of principals to the number of computers per school

Principal	No of computers available at the school
A	27
B	26
C	26

The supply of computers to schools from the Ministry of Education seemed consistent across all schools. Every school had been provided with 20 computers, irrespective of the number of students per school. The quantitative findings suggest that ICT infrastructure is in the medium range, because some schools managed to acquire more computers by purchasing some, or offered as a donation from *School-net Namibia*. However, during the time of the data collection, most computers from *School-net Namibia* were 'dumped' on the floor and appeared not to be in use. Some schools bought a number of computers, according to the principals' response:

> *'We have six (6) computers which we acquired in 2004 from School-net and their system is different. They use Linux* (Principal A, 12 April 2010)*.*

> *Mmm, the ones that are in the computer lab, were donated to us by the ministry whereas the ones that we have in the offices, we bought out of the school development fund. The ones in the staff room were donated to us by School-net* (Principal B, 13 April, 2010).

The principals' responses to the way in which the computers were acquired can be interpreted to mean that the principals kept good records of their acquisition. From the observation notes, each computer was placed on its desk with a chair. In all the schools observed, the learners would rush to the computer laboratory for a lesson in order to try and choose a fellow learner of the same sex with whom to share a chair. Thus, two learners were forced to share a chair, creating discomfort in the learning environment for some learners, an also inconvenience when trying to write down notes. In addition, the boys dominated the girls and tried to do all the activities given to them in class.

The computers acquired through donations from School-net Namibia had a Linux operating system built in. The condition was that no proprietary software is to be used on those computers. Thus, excluding MS programme to be installed onto the same computers. All software on these machine are said to be free of charge. After the acquisition it is imperative that the computers be maintained. The principals explained the procedure followed to maintain them should breakage occur. The computers acquired from the Ministry of Education follow a maintenance procedure different from the one for self-acquired computers. The principals comments were:

> *'When it comes to the ones that we bought ourselves, we are maintaining them. And the ones that were donated by School-net, when they break...[we] take to their branch in Ondangwa for their technician to repair them. Fortunately this one from the ministry up to now did not have any breakage… We consult the people from where we bought them. We take them to those people and they repair them when they have breakage and they install a software if there is a need to install and then we pay for the service'* (Principal B, 13 April, 2010).

> *'The computer practice teachers are the ones to always attend to the computers. If the problem is beyond their knowledge, then we call in someone from outside…Yes, someone that we pay but there is also a gentleman from the Ministry's side but more often you call him and he does not help you much because he also does not know… He does not come a lot. It is very difficult for him to come. For example,*

> *this year, we tried to call him but he did not come'* (Principal C, 15 April, 2010).

On the same question about how the computers should be maintained, Technicians A and B had set up basic rules to which the users had to adhere:

> *'Mhh…we have basic rules that guide us through the use of computers. We make sure that they are all well looked after by al the users…everyone who uses them. The rules are just there to just basically to encourage people to use the computers in a good way'* .(Technician A, 13 April 2010).

> *'We make sure that they are in a good …[laugh]…condition. They are clean. We keep them away from dust'* (Technician B, 13 April 2010).

Technician C somehow felt that the regional technician should do the maintenance for his school:

> '*Mh..We do not have a technician. I understand we have a [regional] technician in Ondangwa but he does not come here. It is only this girl who is a volunteer who try to fix some of them'* (Technician C, 16 April 2010).

From the data, it is evident that in addition to what the Ministry of Education does to maintain the computers deployed to schools, two of the three had taken the initiative to do the basic maintenance. As stated by all the principals, the regional technicians did not respond punctually to technical problems, making it difficult for the teachers to teach using ICT.

From the observation notes, some of the computers, especially those donated by *School-net,* were put on the floor as they could not be repaired and occupied large space in the computer laboratories. Other ICT, such as the television, were kept in the library and the DSTV donated by *Multichoice Namibia* was said to be not working, as the reception was weak during certain sometimes of the day.

From the findings, it was evident that the maintenance of computers was fragmented. The Ministry of Education had put in place the structure for maintenance at regional level, which was not efficient. Despite several calls from the schools, the technician did not come, probably for reasons suggested by Principal C:

> *'…overloaded because he is the only one in the whole region. You call him and he is always telling you that he is at another school. It is difficult to see him'* (Principal C, 15 April, 2010).

It also appears that the technician did not have a designated car allocated to him for these functions. Again Principal C said:

> '*He will always cite problems such as transport'*
> (Principal C, 15 April, 2010).

The computers purchased by the school were serviced by the supplier for a fee, implying that only schools with a good financial standing of the school development fund could use them. Schools that were unable to generate income for their school development fund may not be able to maintain their computers. This is prevalent in cases where the computers are donated and the agreement between the donor and the school does not include a servicing plan. These projects are doomed to fail (Thomas, 2007). Matengu (2006) noted that computers donated by *School-net Namibia* were broken and had not been repaired in some schools, specifically Katima Mulilo and Windhoek areas. Matengu (2006) noticed that out of 25 computers from *School-net* only two were working for a period of six months. Matengu (2006) therefore had doubts that these would be repaired. The breakage was also mentioned but how long the technician would take to repair them was not pursued.

This study also argues that the idea of using computer teachers to do the troubleshooting was short-lived. One questions their troubleshooting skills and the time it takes to detect and repair the computers. In the event that the computer teachers are used, it is likely that they may also aggravate the problem and cause more damage. Again, technicians from outside companies are used to repair at a fee should teachers fail. Schools with low income in the school development fund will still not manage. Kennisnet (2008) advocates that the obsolete computers be replaced, something that is unlikely to happen in the near future in Namibia, given the National ICT Project Budget and the extent to which the implementation process is moving.

In the effort to enhance teaching and learning, the Ministry of Education has provided Internet connection to some schools. The findings of this study show that only one of the schools has Internet through the Ministry of Education ICT project. Principal B had acquired a 3G device for which the school paid N$ 500.

> *'Those ones we bought a 3G but it's not always in use, we just bought it to update our Anti-virus. And if the teacher wants to use Internet then they just use the 3G but not always.'* (Technician B, 13 April 2010).

> *'Yes we have [Internet]. Yes, it is cheap. It is a flat rate of N$ 500.00 per month. It is within the school's affordability.'* (Principal C, 15 April, 2010).

From the data it is evident that only a few schools are connected to the Internet. For example, Principal A responded to one of the questions by saying they had had computers since 2004, from *School-net*, though it was not clear why the school did not have the Internet up to that time. Principal C had also had computers for a considerable time, but already the school was connected to the Internet. The question arises as to what parameters determine connectivity to the Internet. According to Howie et al. (2005), governments internationally are aware of potential unequal access to technologies. There were substantial differences noted in quality and functioning of ICT equipment between schools.

With regard to Internet connectivity, only two schools were connected, Schools B and School C, the former having acquired it through a 3G connection that the school was paying for. School C had acquired Internet connectivity through the Ministry of Education ICT project. School A had not been connected. From the data, School B had taken an initiative to be connected to the Internet to upload anti-virus for protection of their computers. Protection against viruses will increase the durability of the computers and allow teachers and students to use them for a longer time. As with School A, it can be assumed that School B was ready to access the Internet via the Ministry of Education project, although it was not known how far they were in the queue.

Use of ICT

The frequency of ICT use was sought to determine if indeed teachers used it to enhance their teaching and learning of science. The principals used ICT mainly for administrative work. All principals used ICT to write reports of principals; trimester; dropout and financial. In addition, the principals wrote letters to parents. When asked what principals used ICT for, Principal C responded:

> *'Like now, we are approaching towards the end of the term. I have to compile the reports: the principal report, the trimester report, dropouts report, and the financial report. I have to make use of the computer to prepare report being required by the inspector of education or maybe by the region. Then I also use to write letters to the parents where I inform them as how much they should pay for the examination, how much for the next term, hostel fees, school development fund, hostel development fund they need all those information'* (Principal B, 13 April, 2010).

From the quantitative data, it is evident that ICT use by principals was low. This contradicts the quantitative finding which suggests that ICT use by principals was medium. It appeared that the principals use *MS Word* most of the time to write reports. The principals hardly used other *MS* programmes, although they mentioned reports such as hostel fees and a hostel development fund that may require the use of *Excel*. The Kennisnet (2008) reported that the most highly used software was practice programmes, followed by *MS Word*, and finding information on the Internet.

A study by Kennisnet (2008) found that the managers in Dutch secondary schools use ICT about 13-18 hours a week. Of South African schools that participated in SITES M2, about 4/5 (80%) were found to be using them increasingly for monitoring and school administration, providing routine work for school administrations. The South African principals worried more about how their schools could gain maximum benefit from using computers and less about preparation time (Howie, et al. 2005; Thomas, 2006). Instead, the principals wanted to be shown how to encourage teachers in order to increase participation in the use ICT, and how they, their pedagogy and students' learning could benefit from computer use.

Collaboration

The principals and technicians commented on whether they allowed community members to use their ICT facilities, and also on the gains generated from them. Both the principals and the technicians responded that they did not allow community members to make use of their facilities. They cited reasons such as lack of time and the non-promotion of the idea to allow community members to use the facilities at the expense of learners and teachers. The principal and the ICT technician comments were:

> *'We wanted to and also make a little bit of money there… but the problem is the time. It is clashing with our timetable. There are so many teachers who want to use the computers and our learners are also keen to learn. So for the time being, they are out now'* (Principal A, 12 April 2010).

> *'… normally we do but now we are no more doing it because I'm also studying and I don't have time to train them. They only used to come and get training… Yes they used to pay a N$100.00 per month'* (Technician B, 13 April 2010).

From the data, it is evident that collaboration with the community is possible, depending on the availability of the technician and also pending the decision of the school board. However, from the quantitative data, the principals indicated that collaboration was high. This type of collaboration refers to that of teachers within the schools. In addition, collaboration with the communities seemed possible, To cover training in basic computer at a fee which will be used to pay for other expenses, such as maintenance of computers and purchase of toner for the printers, and also to pay for the Internet, as stated by the two technicians:

> *'The benefit would be that the school can make some income for them even though it is not allowed. The school can use this money for maintenance, even to buy toner.' (Technician A, 13 April 2010).*

> *'It goes to the school fund; I don't know but they normally we used to pay N$300.00 for internet' (Technician B, 13 April 2010).*

From the data, the availability of ICT at schools could generate money for the schools, to be used for items that are costly, such as buying toner and paying for the maintenance of the ICT, should the regional technician not turn up on time to do the repairs. The fund-raising sounded justifiable in the absence of ways the Ministry of education would supply the school with toner, and also because the schools had to pay some fees for the Internet per month. This study did not examine how schools could best raise money to sustain these expenditures.

As to who decides on issues of collaboration with the community, the principals mentioned the school board:

> *'The school-board comes in because we have to inform them, they are our supervisor otherwise if something happens to our computers by the community members and we don't inform them then they may say 'no but we the community people are not using the computers'. Therefore we make it a point that we inform them so that they know about the community people using our computers' (Principal B, 13 April, 2010).*

> *'The school management. These are day to day issues, so the school board does not really get involved' (Principal C, 15 April, 2010).*

From the data it is clear that the school board decided on issues of collaboration. The school management was responsible for the day-to-day ICT implementation. The structure and rationale for reporting were explained in the subsection of Vision and Leadership, and the collaboration between schools has been observed. During the observation period at School A, the secretary from a nearby school was observed typing question papers for examinations at their school. However, collaboration between science teachers through ICT was, non-existent possibly due to lack of resources to create online communities and also because the schools had limited time within which to use ICT.

Technical support

The principals were asked about the technical support rendered to them and the school at large. Two principals expressed their satisfaction with the technical support established at their school. Principal C stated that:

> *'It is not good, sometimes you sit for the whole week or whole month without computers and you do not know what to do and you do not know who to contact. Some of the computers are pre-programmed in Windhoek and also all the people who did it are in Windhoek. Sometimes it is not the same as having a person on site. I still feel a lot needs to be done… We do not have a technician per se, only teachers who are teaching the subject help where they can. If they can't, we call a gentleman from the region, Ondangwa and sometimes we call the head office. What they do is give instructions over the phone if there is something that can be done' (Principal C, 15 April, 2010).*

From the data it can be concluded that the support system in general is not in place. This finding confirms the quantitative finding on low technical support. The principals rely on the little expertise of the technicians to fix the computers. Since the technicians are also full time teachers, they have only limited time within which to do troubleshooting or software-related supports. The technicians are also making an effort to ensure that an effective system is in place, for example, by trying to teach the school secretary how to trouble shoot, as related by Technician A:

> *'I normally try and teach the school secretary so that when I am not available at least he can do the job. I normally teach him most of the basic trouble shooting. I am also just available during break or when I am off. I can just help anytime' (Technician A, 13 April 2010).*

Sometimes these problems intensify to an extent that the technicians have to leave their class to attend to a problem considered urgent. Technician C explained:

> *'They normally call me. There's a time table for the subject I teach and I also have to attend to my lessons. So, I can only help them when I am free. But if anything urgent comes up then, I have to leave my class… After hours, I also help them when I am free. Like the secretary calls me to help her but if it is something urgent then that means I have to leave my class and help her out' (Technician C, 16 April 2010).*

From the data it appears that the technical support at both schools is complicated because the technicians who attend to technically related problems are also full-time teachers. It is expected that they prioritise their duties before embarking on their voluntary activities. Should the technical fault occur in the middle of a lesson by a science teacher, it is only dependant on the technician to judge whether to continue teaching his lesson or go to help out with the crisis. The idea of training the administrative assistant would be ideal, depending on whether he was also not too busy for him to do extra jobs outside his job description. A problem would arise if the administrative assistant or the teacher broke the devices beyond repair, begging the question of who was to blame or hold liable for the damage caused, when both parties were not formally assigned to do troubleshooting. Beyond that, schools are depended on the technicians assigned to their respective educational regions, who are not responsive on time. Principal C though much needed to be done in order to get a timely response during a crisis.

Pedagogical support

Principals were asked to comment on the pedagogical support at their schools. When asked about pedagogical support that is taking place at their respective school, Principal C said:

> *'You find that teachers who are more knowledgeable about computers help others by showing them all that needs to be done' (Principal C, 15 April, 2010).*

From the responses, all principals agreed that there was pedagogical support amongst teachers. The more skilled in ICT do assist others. This response is only applicable to a small sample of case participating schools. However, this contradicts the quantitative response on the same issue. The majority of the respondents through the survey indicated that pedagogical support was low. It can be interpreted that the assistance is more of a technical nature than it is pedagogical, for example, entering marks and preparation of report cards. As argued above, understanding the concept of integration is nonexistent; it therefore becomes difficult to render pedagogical support to other teachers.

6.7 Conclusion

In conclusion of this chapter, the quantitative as well as the qualitative findings are presented in Sections 6.2 and 6.3 respectively. The qualitative findings are presented in Section 6.4. Findings from Pearson's correlation suggest that there was a strong relationship between support and collaboration by the principals and digital learning materials. There is a strong relationship between leadership and the vision of the principals as well as curriculum goals as perceived by the science teachers. There is also a strong relationship between the vision of the principal and collaboration and curriculum goals as perceived by the science teachers. These findings have been interpreted that both the principals and the science teachers are likely to agree on the statements made about those constructs. The regression analysis suggests that constructs that were found to be significant in the model were leadership of the principals, expertise as well as general use of ICT by the science teachers. The regression findings suggest that for every increase in the significant construct, the pedagogical use of ICT also increases. From the case studies, science teachers use ICT for administrative purposes. The science teachers have indicated that they use ICT for lesson preparation, to write documents, and to develop timetables. In the interviews, some science teachers indicated that their work was made easy with the introduction of ICT in their respective schools. These findings were validated by participants in the ICT use conference presented in Chapter 7.