An evaluation of the implementation of the National ICT Policy for Education in Namibian rural science classrooms

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Abstract

Information Communication Technology (ICT) implementation in Namibian schools is still in its infancy in rural science classrooms at junior secondary school level. The research reported in this paper adapted the Four-in-Balance model that reflects the pillars of the use of ICT in classrooms. In order to explore the extent of the implementation in rural science classrooms of the government ICT Policy for Education, a survey was used to collect science teachers' level data. Three levels of ICT implementation, viz low, medium and high, were identified. The results show that for management aspects of the ICT Policy the implementation level is high to medium, which contrasts with the low levels of implementation of subject specific ICT resources for pedagogical use, and also with teachers' negative attitude to the use of ICT. The results might influence policies on ICT use and how ICT is to be used in the future at classrooms level.

Keywords: ICT Policy, Namibia, pedagogical use of ICT, science education, rural schools

Introduction

In Namibia, a National ICT Policy for Education was first introduced in 1999. A review of this policy took place in 2005 resulting in a new National ICT Policy for Education (Ministry of Education, 2005) and the National ICT Policy Implementation Plan (Ministry of Education, 2006). The new policy stipulates that pre-service and in-service teacher education institutions would be priority areas for ICT deployment, followed by schools with secondary grades (Ministry of Education, 2005). The Namibian Ministry of Education reserved funds for ICT in education in the National Budget from 2006/2007 onwards. In addition, stakeholders such as the Global e-School Initiative (GeSCI), SchoolNet Namibia, Namibia Education Training Academy (NETA) and Computer Education Community Service (CECS) have been supporting ICT development by donating ICT resources to schools mostly located in the rural areas. These non-governmental organisations (NGOs) also provide teacher training to rural schools.

However, the effects of the policy on ICT implementation in the Namibian education system are unknown, since no evaluation has taken place. A few studies conducted in Namibia have focused on ICT deployment and technical maintenance (Clicherty & Tjivikua, 2005; Matengu, 2006) and teacher training (Iipinge, 2010). However, ICT deployment does not guarantee use and integration in the school curriculum. There is a need to evaluate the implementation of ICT Policy at national, school and classroom level for purposes of enhancing teaching and learning of science, as poor implementation may result in difficulties of reaching sound and reliable conclusions about effectiveness of the policy on ICT in education (Rossi, Lipsey & Freeman, 2004). Currently in Namibia, there is insufficient data-based evidence about how the

ICT Policy is being implemented in classrooms, especially at junior secondary schools in rural areas whilst these schools are a priority in the national policy. Thus, this article addresses the research question:

'To what extent is ICT being implemented in the Namibian rural science classrooms?'

Evaluation of the ICT Policy implementation plan is critical for informing further planning and decision-making of pedagogical use of ICT in rural classrooms. This article is based on a study (Ngololo, 2011) that represents one of the first attempts in Namibia to evaluate the ICT Policy implementation in rural classrooms.

Review of literature and conceptual framework

This section summarises some literature on ICT use in education in a number of developing countries, with an emphasis on its use in rural schools. The effectiveness and challenges of policies for integrating ICT into schools in developing countries are discussed with reference to Chile (Hinostroza, Hepp & Cox, 2009), and countries in the Sub-Saharan African Region (Adomi & Kpangban, 2010; Tilya, 2008), which include Ghana (Boateng, 2007) and South Africa (Howie, 2009).Chile has been included as an illustrative example of developments outside of Africa.This is followed by a discussion of the conceptual framework for the research.

Chile

Access to ICT in Chilean schools is relatively good. By 2005, more than 90% of the student population had access to ICT in their schools and more than 80% of the teachers had received training in the administrative and pedagogical uses of ICT. These were achieved through the *Enlaces* programme, a government initiative (Hinostroza *et al*., 2009). The majority of computers in primary and secondary schools are located in the computer laboratories as prescribed by the ICT in Education Policy in Chile. By 2007, a total of 9, 970 (90%) primary and secondary schools had received computers connected to Internet for free and educational software (p.160).The maintenance and renovation of hardware and software of ICT infrastructure is a responsibility of the schools.

The study by Hinostroza *et al.* (2009) shows similarities with the Namibian ICT programme in terms of its attempt to achieve the national goals by addressing issues of equity in remote areas where the majority of the schools are located. Particular attention was given to ICT access to rural schools, improved teacher quality and provision of better resources. Chile has managed a very successful ICT implementation programme in schools and universities. Universities and other higher education institutions are working towards developing models for the use of technology in classrooms, teaching methodology, learning objectives, teaching resources and student assessment tools to be used in the integration of ICT into specific curriculum subjects, such as Science and Mathematics (Sánchez & Salinas, 2008).These claims are confirmed by Howie (2010) who concludes that the implementation plan in Chile has been implemented quickly and effectively, by adopting a combined top-down and bottom-up approach strategy which is results-oriented. Chilean schools wishing to integrate ICT had to submit a detailed proposal as to what and why they needed the ICT, which is not the case in Namibia.

Ghana

A study in Ghana revealed that there is a concentration of ICT use in urban schools while rural schools lag behind (Boateng, 2007). Particularly, Boateng's study examined how one rural school used computers and related technologies in its curriculum in compliance with the national policy on ICT in view of increasing ICT use in the pre-tertiary school curriculum. The study used the critical social theory framework to examine the use of computers in a rural-based school. Particularly, the study addressed issues of use and non-use of computers and related technology to determine the underlying social, economic, and political factors that affected technology use at school.

Boateng (2007) found that although computers were available at the school, teachers were not using them. Computer lessons were taught in isolation without a focus on the curriculum due to inadequate training of teachers in the use and integration of computer technology in their classes. The same observation was made in another West African country, viz Nigeria, where survey results of 176 respondents in Nigerian secondary schools noted a lack of or inadequate IT facilities (61%), poor perception of ICT amongst teachers and administrators (40%), and inadequate educational software (35%) amongst other factors (Adomi & Kpangban, 2010).

South Africa

The national goals for integrating ICT in South African schools are summarised by Howie, Muller and Patterson (2005) and Howie and Blignaut (2009). In 2007, a baseline survey was conducted (Farrell & Isaacs, 2007) for the Department of Education (DoE) to determine the ICT available in schools in order to make informed decisions in terms of resource allocation. Like other developing countries, South Africa relies on donor funding for the provision of computer laboratories to schools. In order to ensure accessibility and equitable quality education, the Thutong Portal (Setswana word meaning 'a place for learning') was developed to support the needs of students, teachers, parents, administrators, managers and researchers in search of educational information. Specifically, this portal was supplied with quality educational content reviewed by a panel of educational specialists. As of 2007, about 23,000 people had subscribed to it, half of whom were educators.

Howie et al. (2005) stated that the South African strategy of ICT development in schools has not systematically involved universities in teacher professional development. Every university in South Africa provides ICT training in the way it sees fit. Howie (2010) concluded that a lot can be learnt from the Chilean strategy where universities are given a specific role by the government to train teachers in ICT. In comparison with other countries in Sub-Saharan Africa, South Africa is ahead and leading in ICT Policy implementation. In the typical Sub-Saharan country, schools are equipped with second-hand computers, have insufficient computer rooms, and unreliable provision of electricity, and a shortage of trained teachers especially in the use of educational software (Tilya, 2008).

The literature above provides a general overview of the current status of ICT Policy implementation in some developing countries. Despite the various challenges, the developing countries still see ICT as a 'powerful catalyst for change' (Tiene, 2002, p. 216) to help them leapfrog into the industrialised world (Adomi & Kpangban, 2010; Tilya, 2008). It is therefore important to monitor the developments in schools for which we use a conceptual framework capturing all relevant components of ICT implementation.

Conceptual framework

To evaluate the implementation of ICT in Namibian rural schools, use has been made of the Four-in-Balance-Model (Kennisnet, 2009). Figure 1 reflects the four pillars of the use of ICT in classrooms. The model - developed in The Netherlands to conceptualise the factors that may influence the use of ICT in Dutch schools and classrooms - expresses that for successful use of ICT, a balanced deployment of a number of basic elements is needed. The model provides the theoretical and conceptual basis for the analysis of the data. The model has been adapted for the Namibian situation with a focus on pedagogical use of ICT in Namibian rural science classrooms.

Many developments in education took place after teachers received their initial training, such as the introduction of ICT in education and the emphasis on student centred pedagogy. This underlines the importance of 'maintaining' the expertise of teachers. Teachers, themselves, wish to keep up with these developments related to education and to participate in regular professional development (Albirini, 2006; Cavas, Cavas, Karaoglan & Kisla, 2009). Therefore, the Four-in-Balance-Model (see Figure 1) has been expanded with two components, as identified in the review of the literature, i.e. 'Professional development' and 'Attitude'.

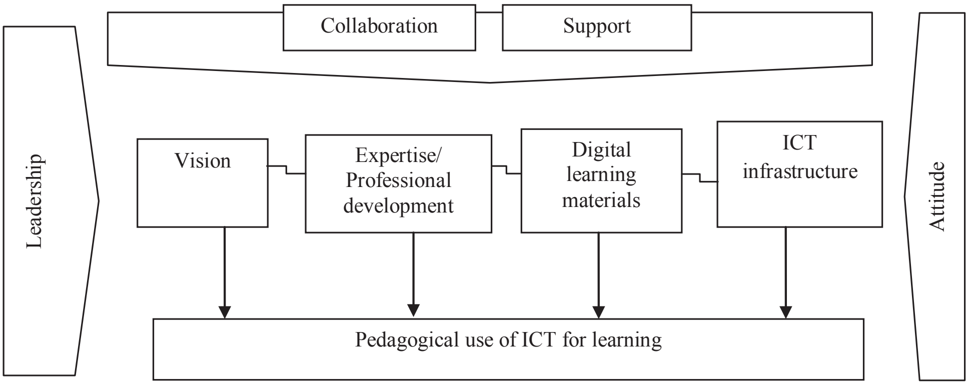

Figure 1: The Four-in-Balance Model (adapted from Kennisnet, 2009)

Pedagogical use of ICT refers to possible uses of ICT for teaching, learning and assessment activities. This is the main outcome measure in this study.

Leadership at school level is based on a vision of education and refers to the role of the school in organising the complete teaching and learning process such as the allocation of workloads, technical support, organising professional development workshops, establishing teacher teams, implementing incentive schemes to allow for collaboration and general ICT use.

Vision refers to the science teachers' view on education and the possible role of ICT, the school's vision statement, motivation and expectations on how the school may intend to achieve its objectives including the role and use of ICT therein.

Expertise refers to science teachers' knowledge and skills to utilise ICT to achieve educational objectives. This requires skills beyond basic ICT skills to operate a computer. Pedagogical ICT skills are also necessary to help structure and organise learning processes.

Digital learning materials refer to all digital educational content available in the schools whether formal or informal. This includes educational computer programmes and also materials available through WWWeb for those schools that have access to the web.

ICT infrastructure refers to the availability and quality of computers, networks, and Internet connections. Electronic learning environments and the management and maintenance of the school's ICT facilities are also considered part of the ICT infrastructure.

Collaboration refers to collaboration between science teachers and other staff within the same school sharing knowledge in a team and the ability to consult teachers from other schools. Teachers in Namibia may co-teach, discuss experiences related to ICT and to collaborate with international schools.

Support refers to supporting science teachers with the use of ICT, i.e. *technical* and *pedagogical* support for teachers to encourage them to use ICT-based materials, such as written tests, written tasks, demonstrations, simulations and project report.

Attitude refers to the science teachers' attitude towards structure, leadership, organising lessons and teaching with the use of ICT.

The model illustrates that the successful introduction of pedagogical use of ICT is more than just the acquisition of hardware and educational software (Plomp, 2006). Effective pedagogical use of ICT is also influenced by the resources and efforts put in the vision statement, expertise, digital learning materials and ICT infrastructure at each school.

Methodology

To address the research question, descriptive information is needed for all the constructs in the conceptual framework. The survey method has been used to obtain descriptive information of how science teachers implement ICT in their classrooms. A pilot study was conducted to assure validity of the instrument and the reliability coefficients of the indicators were calculated (see Appendix B). The Cronbach alpha coefficients are satisfactorily high, indicating a good reliability of the data.

Population and sample

In each selected region, a population survey was conducted to include 235 science teachers from schools with electricity and functioning ICT as identified from the Educational Management Information Systems (EMIS) database (MoE, 2010). A total of 137 science teachers (response rate of 58.3%) answered the questionnaire by giving a description of, and their perceptions about, ICT implementation.

The instrument

All relevant concepts and issues presented in the conceptual framework (Figure 1) were included in the Second International Technology in Education Study (SITES) (Law, Pelgrum & Plomp, 2008). SITES consisted of a survey of pedagogical use of ICT in schools and was conducted under the auspices of the International Association for the Evaluation of Educational Achievement (IEA) in 2006. Use could be made of the instruments of the SITES 2006 study with approval of the IEA. Specifically, the SITES instrument allowed data collection for all of the components of the Four-in-Balance model including the additional constructs 'Professional development' and 'Attitude'. The SITES questionnaires were adapted to the Namibian situation (see Ngololo, 2011).

The questionnaires asked for information about science education and policy matters in the school related to pedagogical practices and ICT (see Appendix A). Items on the 'Impact of ICT Use' were deleted from the original questionnaire as ICT was recently introduced to schools in Namibia and so would not yet warrant an impact study. The questionnaire was piloted in 20 schools within the reach of the main researcher. A total of 18 science teachers responded to the questionnaire. No changes were suggested to enhance the quality of indicators for the constructs reported in Appendix B. All the science teachers who were involved in piloting of the instrument were included in the main data collection.

Data collection

Data collection occurred during the first term of the 2010 school year (January to March). The self-administered questionnaire was posted to schools through the Ministry of Education Internal Mail Services, and responses were collected through the School Inspectors Offices in the respective regions.

Data was entered in version 18 of Statistical Package for Social Sciences (SPSS). Data cleaning and validation was done using SPSS. Variables in the database were defined using data set codes.

Data analysis

Each statement was allocated a score resulting in a total score for each of the key constructs in the Four-in-Balance model. The actual score of each science teacher was calculated per construct. Together, the score give a comprehensive overview of the status of ICT implementation in rural science classrooms.

The analysis entailed converting the original responses by the science teachers to indices to allow for computation of the constructs into scales (The Economic Commission for Africa, 2004). The scales comprise three categories of low, medium and high. The interpretation of the scores is as follows: 'low' if the mean score is 33.3% or below, meaning that few teachers agree with the statement in the constructs, 'medium' if the mean score is between 33.3% and 66.6%, meaning that an average number of the science teachers agree with the statements in the constructs, and 'high' if the mean score is 66.6% or higher, meaning that the majority of the science teachers agree with the statements in the constructs. The findings show the outcome of indices calculated in maximum and minimum scores as well as the mean scores (see Table 1).

Findings on ICT implementation in rural science classrooms

The descriptive findings are presented per construct in Table 1. A score of 0 denotes that the respondents did not respond either due to ignorance or they could not understand or disagreed with the questions. For each construct, the number of teachers scoring at the various scales is provided in Appendix B.

Table 1: Descriptive statistics of science teachers' responses (N=137)

Construct	Minimum (%)	Maximum (%)	Mean of scores	StdDev	Interpretation
Pedagogical use of ICT	0	91.0	25.0	17.1	low
Leadership	0	100.0	80.2	20.0	high
Vision	0	100.0	66.2	39.6	medium
Collaboration	0	75.0	55.2	15.9	medium
Support	0	100.0	24.6	25.2	low
Digital learning materials	0	40.0	18.5	8.6	low
Expertise (ICT related)	0	76.6	42.0	13.9	medium
ICT infrastructure	0	66.7	17.4	16.7	low
Professional development	0	92.9	52.1	12.3	medium
Attitude	0	59.0	14.9	14.6	low

Pedagogical use of ICT by science teachers

This is the main outcome measure in this study. The science teachers were asked to comment on statements on the pedagogical use of ICT. The response scores per teacher range from 00.0 % to 91.0%, with a mean score of 25.0% (SD=17.1). This finding suggests that the mean score is low. Many science teachers (97; 71.0%) have scored low on the scale, suggesting that their schools make limited use of ICT for pedagogy. However, some science teachers (31; 22.6%) scored high showing that they make considerable use of ICT for pedagogical purposes.

Leadership

The science teachers were asked to judge statements about leadership in their respective schools. Their response scores on questions about leadership ranged between 0.0% and 100.0% with a mean of 80.2% (SD=20.0).Many science teachers (85; 62.0%) indicated that they participated in the development of the overall view in the school of how to use ICT, operationalising school development and inspiring goals.

Vision

The science teachers were asked if they discussed what they want to achieve in their lessons, critically assess their own teaching practices, and what they think about the vision of their classrooms. The science teachers' response scores ranged between 0.0% and 100.0%, with a mean score of 66.2% (SD= 39.6), suggesting that the level of achievement of discussions, teaching practices and the vision of ICT in the respective schools was rated medium. The high standard deviation suggests a range of scores with about half of the science teachers (69; 50.4%) indicating that the formulation of their vision on the use of ICT is based on their intent to improve lesson outcomes and their teaching practice.

Collaboration

The science teachers were asked to state whether they agreed or disagreed that the school leadership encouraged teachers to engage in cooperation that allowed them to work in groups, sharing knowledge and solving problems on ICT related problems. The response scores ranged between 00.0 and 75.0%, with a mean score of 55.2% (SD=15.7). The findings show that the level of collaboration of the majority of science teachers (95, 69.3%) on ICT related activities was in the medium category. This means that to some extent the science teachers collaborate amongst themselves and with other teachers in the same school, share knowledge and have the ability to consult teachers from other schools.

Support

The science teachers responded to questions about the availability and quality of technical and pedagogical support offered to them. The response scores ranged between 0.0% and 100.0%, with a mean score of 24.6% (SD = 25.1). The mean score is low, meaning that the majority of science teachers (107, 78.1%) are of the opinion that they neither receive much and adequate technical nor pedagogical support. Only very few science teachers (8; 5.8%) have indicated that they are provided with good, sufficient and timely technical and pedagogical support.

Digital Learning materials

The science teachers were asked to state whether they had digital learning materials available for teaching and learning activities. The science teachers response scores ranged between 0.0% and 40.0%, with a low mean score of 18.5.0% (SD=8.6). This finding shows that the majority of the science teachers (134; 97.8 %) did not have digital learning materials in their classrooms, although a few (3; 2.1%) science teachers had.

Expertise

The science teachers were asked to state if they felt they had ICT expertise, and whether they integrate ICT in the science subject. The response scores ranged between 0.0% and 76.6%, with a mean of 42.0% (SD=13.8). The results show that the science teachers' expertise is in the medium range. Many science teachers (98; 71.5%) have indicated that they do have some expertise to use ICT. Only a few science teachers (15, 11.0%) have indicated that they believe to have a high level of ICT expertise and integrate ICT in the science subject.

ICT infrastructure

The science teachers were asked to indicate the availability of ICT. The response scores ranged between 0.0% and 66.7%, with a mean 17.4% (SD=16.72). The finding shows that the availability of infrastructure as indicated by science teachers was low. Many of the science teachers (114; 83.2%) have indicated that ICT infrastructure in schools was insufficient in terms of acquisition, availability, and maintenance.

Professional Development

The science teachers were asked to judge statements that pertain to professional development, in particular whether they had participated in any ICT related professional development course and if not, whether they would like to attend any. The science teachers' response scores ranged from 0.0 % to 92.9%, with a mean score of 52.1% (SD=12.3), indicating a medium level. This finding suggests that a meaningful number of science teachers (120; 87.6%) have been trained to some extent in ICT skills and ICT integration in the science subjects.

Attitude

The science teachers were asked if they possessed the necessary ICT skills needed to structure and organize the learning processes - this reflected their attitude towards ICT use. The figures demonstrate that science teachers attitude towards ICT ranged from 0.0% to 59.0% with a mean score of 12.1% (SD= 14.6). This finding suggests that the attitude of the science teachers towards using ICT was low. The majority of the science teachers (97; 70.8%) have indicated a negative attitude towards general use of ICT. Only a few science teachers (31; 22.6%) have indicated a positive attitude towards pedagogical use of ICT.

Conclusion and recommendations

This paper evaluates the implementation of Namibia's Policy on ICT in, particularly the rural science classrooms. The study has used a quantitative approach (i.e. a survey) to describe the status of ICT implementation in science classrooms. It is acknowledged that the validity of the findings may be affected by the fact that the data were self-reported by the science teachers on how they practiced or perceived ICT Policy implementation in their classrooms. Even with this caveat, several conclusions can be drawn when comparing the findings of this study with the statements in the Namibian Policy on ICT.

In general, the data show that the pedagogical use of ICT in rural science classrooms is low. The few science teachers, who use ICT in their classrooms, do so with very minimal technical support. These findings are in line with findings by Matengu (2006) who concluded that ICT use in some parts of Namibia was low and as a consequence claimed that the awareness of the need for ICT use in schools does exist among policy makers and educational leadership at national and regional levels but apparently not in schools. In Ghana, Boateng (2007) found that although computers were available at the school, teachers were not using them in their teaching, a situation contrary to what was found in Nigerian rural communities where a good infrastructure is lacking but yet teachers used ICT (Agyeman, 2007).

The data show that the low level ICT use is not due, primarily, to lack of the management aspects. Constructs such as school leadership for the use of ICT, vision of the science teachers with regard to ICT usage, collaboration between them or their expertise in ICT usage are all reported as being present at high or medium levels. Referring to the Four-in-Balance model, these management aspects represent the left-hand side of the model (see Figure 1). In contrast, the constructs of the right-hand side of the model are identified as potential reasons for the low ICT use in rural science classrooms. These constructs include teachers' negative attitude to the use of ICT in their classes, and the reported lack of resources including the poor availability of ICT infrastructure, lack of technical and pedagogical support, and the shortage of digital learning materials. The data show particular low levels for these four constructs. These findings suggest that both the government and the management of the schools have to provide leadership, direction and actions to change this situation. This implies the need of teacher development in ICT in education so that teachers acquire the right attitude and competences for integrating ICT in their teaching. Besides, there is a need for investing in classroom related ICT provision, i.e. specific software for science subject teaching, practicals, assessment tools; mounting of a portal with specific web-based science activities. In addition, development of teacher skills for browsing the web for identifying high-quality learning resources; teacher training for IT-based PCK, not general IT pedagogics, but science related pedagogics at junior secondary school level.

The fact that availability of professional development for ICT is rated as 'medium' suggests an opportunity for the development of teacher training programmes that address topics like ICT integration - considering the classroom sizes - and basic trouble shooting skills. Although science teachers may believe that the use of IC enhances science education, the data show that about half of the teachers lacked a clear vision on ICT implementation in their science classrooms. This lack of vision suggests that there is also a need to include in these teacher training programmes an emphasis on the potential and relevance of ICT for classroom teaching, i.e. its pedagogical use.

The provision and availability of ICT infrastructure is low, meaning that the infrastructure provided to schools is basic and limited. Also, the majority of the science teachers have a negative attitude towards the general use of ICT. Thus, within a minimal availability of ICT, only a few science teachers use ICT in their classrooms. Many SITES 2006 participating countries have computers and internet provision for all schools except for South Africa as it relies on donor funding for provision of computer laboratories (Howie, 2009). In addition, Boateng (2007) found that even when computers were made available at the schools, teachers were not using them to integrate ICT in the curriculum implementation, but used them for isolated activities.There is a 'needs assessment plan' in Namibia to identify rural schools that meet the requirements of ICT deployment before computers are availed to schools. As part of this needs assessment plan, science teachers willing to implement ICT in their classrooms should be identified as a condition for the supply of computers and digital learning materials. In Chile, schools that wanted to implement ICT had to submit a detailed proposal as to why they needed the ICT minimizing the risk of low use of ICT for pedagogical purposes (Hinostroza et al*.,* 2009). Asking Namibian rural schools to develop similar proposals would articulate what the needs and priorities of those schools are in terms of technical, pedagogical support systems; and the types of digital learning material to be adopted by the particular schools. However, schools should be supported in preparing such proposals.

Collaboration, professional development, and expertise have mean scores in the medium range. There are some collaborative activities with other teachers in the same school or other schools. Many science teachers have some training in ICT skills and ICT integration in science subject teaching. On the other hand, after attending a professional development course on ICT, some science teachers still do not have the expertise to implement ICT in their classrooms. In Chile, universities and other educational institutions have developed successful models for ICT integration into specific curriculum subject matter in Science and Mathematics (Sánchez & Salinas, 2008). The South African strategy of ICT development in schools has not involved universities at all in the professional development (Howie et al., 2005). Given the good example of Chile, it is recommended that the Ministry of Education establishes effective learning communities and involves the University of Namibia and other educational institutions to develop teacher training programmes focusing on ICT implementation in science classrooms and a change in the science teachers' attitudes to the pedagogic use of ICT. In particular, there is a need for developing classroom related ICT resources, i.e. specific software for science subject teaching, practical tasks, assessment tools, and mounting a portal with specific web-based science activities. In addition, development of teacher skills for browsing the web for identifying high-quality learning resources; teacher training for IT-based PCK, not general IT pedagogics, but science related pedagogics at junior secondary school level.

There is a lack of relevant digital learning materials and of technical and pedagogical support for science teachers. The Namibian secondary curriculum is UK based, but the large number of resources available to schools (such as digital content) are not necessarily suitable for rural Namibian contexts. In particular, there is a need for developing classroom related ICT resources, i.e. specific software for science subject teaching, practical tasks, assessment tools, and mounting a portal with specific web-based science activities.

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Appendix A: Examples of questions asked in the survey

In your teaching of the target class in this school year, how important is it for you to achieve the following goals?

Please mark only one choice in each row.

		Not at all	A little	Somewhat	Very much
A	To prepare students for the world of work	☐	☐	☐	☐
B	To prepare students for upper secondary education and beyond	☐	☐	☐	☐
C	To provide opportunities for students to learn from experts and peers from other schools/countries	☐	☐	☐	☐

In your teaching of the target class in this school year,

(a) How often is the scheduled learning time of the class used for the following activities?

(b) Has ICT been used when these activities took place?

Please mark only one choice for each of the two parts in each row.

		(a) How often is the scheduled learning time used for the following activities?				(b) ICT used?	
		Never	Sometimes	Often	Nearly always	No	Yes
A	Extended projects (2 weeks or longer) ..	☐	☐	☐	☐	☐	☐
B	Short-task projects	☐	☐	☐	☐	☐	☐
C	Product creation (e.g., making a model or a report)	☐	☐	☐	☐	☐	☐

In your teaching of the target class in this school year:

(a) How often do you conduct the following? (b) Do you use ICT for these activities?

Please mark onlyone choice for each of the two parts in each row.

		(a) How often do you conduct the following?				(b) ICT used?	
		Never	Sometimes	Often	Nearly always	No	Yes
A	Present information/demonstrations and/or give class instructions	☐	☐	☐	☐	☐	☐
B	Provide remedial or enrichment instruction to individual students and/or small groups of students	☐	☐	☐	☐	☐	☐
C	Help/advise students in exploratory and inquiry activities........................	☐	☐	☐	☐	☐	☐

Appendix B

Indices/ICT indicators at classroom level (Ngololo, 2011)

Construct	Description	Computation	Reliability (Cronbach alpha)	Exact number of science teachers		
				low	*medium*	*high*
Pedagogical use of ICT	ICT use for teaching science.	A sum of scores was computed across 33 items: yes=1, no=0	0.887	97	9	31
Leadership	Developing an overall view of how to use ICT, channelling school development and inspiring goals.	A sum of scores was computed across 3 items based on Likert scale: not at all=0, a few times= 1, monthly=1, often=2)	0.613	3	49	85
Vision	The focus of ICT implementation in the education system, particularly with ICT use in enhancing science education.	A sum of scores was computed across 3 items based on Likert scale: not at all=0, a little= 1, somewhat=1, a lot=2).	0.786	45	23	69
Collaboration on ICT related matters	Collaboration between teachers in the same school sharing knowledge in a team and the ability to consult teachers from other schools.	A sum of scores was computed across 4 items based on Likert scale: not at all=0, a little= 1, somewhat=1, a lot=2).	0.625	8	95	34
Technical support	Technical support given to science teachers when necessary to support teaching. Students also be able to access computers	A sum of scores was computed across 3 items based on Likert scale: not at all=0, a little= 1, somewhat=1, a lot=2).	0.756	107	22	8
Digital learning materials	Availablity of digital learning educational content whether formal or informal. This includes educational computer programmes.	A sum of scores was computed across 13 items based on Likert scale: never=0, sometimes=1, often=2, nearly always=2.	0.922	134	0	3
Expertise (ICT related)	Teachers need to have sufficient knowledge and skills in order to utilise ICT to achieve educational objectives.	A sum of scores was computed across 12 items based on Likert scale: never=0, sometimes=1, often=2, nearly always=2, no=0, yes=1.	0.898	24	98	15

Construct	Description	Computation	Reliability (Cronbach alpha)	Interpretation Exact number of science teachers		
				low	*medium*	*high*
ICT infrastructure	Availability and quality of computers, networks, and Internet connections.	A sum of scores was computed across 10 items based on Likert scale: never=0, sometimes=1, often=2, nearly always= 2.	0.846	114	23	0
Professional development	Teacher training programme with regard to ICT skills and ICT integration in the science subjects.	A sum of scores was computed across 7 items based on Likert scale: No, I do not wish to attend=0, No, I would like to attend if available=1, Yes, I have=1.	0.685	5	120	12
Attitude	Pedagogical ICT skills necessary to help structure and organise learning processes.	A sum of scores was computed across 8 items based on Likert scale: not at all=0, a little= 1, somewhat=1, a lot=2).	0.890	97	9	31

*) Legend:

- Unless mentioned otherwise, all indicators are calculated as the arithmetic mean of constituting items
- Interpretation of indicator level: *low* if mean ≤ 33.3%; *medium* if mean between 33.3% and 66.6%; *high* if mean ≥66.6%.

Comment: Reliabilities have been used to describe constructs.