

The diverse educational needs and challenges of Information Technology teachers in two black rural schools

ELSA MENTZ

North-West University

ROXANNE BAILEY

North-West University

MARIETJIE HAVENGA

North-West University

BETTY BREED

North-West University

DESMOND GOVENDER

University of KwaZulu-Natal

IRENE GOVENDER

University of KwaZulu-Natal

FRANK DIGNUM

Utrecht University

VIRGINIA DIGNUM

Delft University of Technology

This article reflects on the first phase of a research project aimed at the empowerment of Information Technology (IT) teachers in black rural schools in the North-West province of South Africa. In order to empower these IT teachers, the first phase aimed at understanding their unique challenges and needs. Qualitative research methodology was used to determine the IT teachers' experiences of teaching a difficult subject such as IT in black rural schools. We report on the unique needs and challenges that these teachers experience. Results indicate that mutual challenges exist with regard to Internet access, lack of technical support and learners not having computers at home. Challenges with regard to electricity supply, shortage of textbooks and insufficient software also occur in some instances. We conclude with some recommendations on how the unique needs and challenges of these schools could be addressed in order to empower the teachers in their desire to facilitate success among IT learners.

Keywords: Rural education, Information Technology, IT teachers, professional development, Computer Science Education.

Introduction

The National Plan for Higher Education in South Africa (DoE, 2001:15) indicates a shortage of high-level professional and managerial skills, especially in information technology, engineering, technological and technical occupations. According to Robb Cutler, president of the Computer Science Teachers Association (CSTA), Computer Science as an academic discipline provides the knowledge foundation for the above-mentioned skills (CSTA, 2006). To increase enrolment in the field of Computer Science (CS) and Information Technology (IT), we need to expand opportunities for learners to succeed in the subject IT in schools in South Africa (SA).

IT is one of the 29 subjects offered in the Further Education and Training Band (Grades 10 to 12) in SA schools. Learners can select the subject in Grade 10 without previous knowledge of computers or programming. The larger part (60%) of the subject content deals with programming (DoE, 2003:13). The subject is challenging as high-level problem-solving skills are required in order to write computer programs and specialised resources are necessary to effectively teach the subject. According to the Curriculum and Assessment Policy Statement (CAPS) for IT (DoBE, 2011:10), schools need to have up-to-date computer technology, specific software, anti-virus protection, a data projector and Internet access in order to equip learners with the necessary skills. The CAPS stipulates that the provision of infrastructure, equipment and finances for the subject is the responsibility of the school.

In the North-West Province (NW) the number of IT learners is, on average, lower than those of other subjects. Nevertheless, Grade 10 enrolment of IT learners is relatively high at black rural schools. In this research ‘black rural schools’ refers to schools which predominantly have black learners, in remote areas in the countryside, far removed from metropolitan areas. It seems as though these learners believe that computers could be the pathway to a future career. Unfortunately, a low pass rate has been obtained at these schools over the past three years. This is in contrast to more affluent urban schools where a 90-100% pass rate in each grade is not unusual. Where many urban schools offer IT as subject, it is rarely available in black rural schools. From the 24 schools in the NW offering Grade 12 IT in 2010, only two were black rural schools (Varughese, 2011).

The words of former president Nelson Mandela, namely that the rural areas of SA continue to lag behind the rest of the country in the post-apartheid era, seems to be true for IT teaching as well. Mandela argues that one of the challenges facing SA is to improve the quality of education in rural schools (HSRC-EPC, 2005:vii). Despite numerous efforts for the upliftment of rural schools (Herselman, 2003:948-950), Amedzo (2007:85) found that very few changes seem to be occurring in this regard in rural areas. Nonyane and Mlitwa (2008:94) also state that the majority of schools in rural areas in SA still lack basic resources and experienced, skilled teachers. Chikoko (2008:80) mentions that each rural school is unique; therefore, there may not always be universal solutions to educational problems. To improve the quality of education in these schools, it is necessary to know the specific needs of, and challenges experienced by teachers (Amedzo, 2007:80).

It is an enormous challenge to find qualified teachers in SA, especially in rural schools (Ndandani, 2001:381). Chikoko (2008:75-76) argues that the teacher is best placed to develop the learners’ potential, underscoring the importance of professional development of these teachers. This specifically concerns IT teachers. The rapid changes that CS is experiencing, with new technologies and programming languages continuously influence IT as a school subject, resulting in frequent changes in the IT curriculum. It is therefore not surprising that SA has a shortage of qualified IT teachers. Furthermore, the change from a procedural to an object-oriented programming approach in 2004 caused an immediate need for professional development of IT teachers. According to CSTA (2006:19), a worldwide crisis in CS education is inevitable due to a shortage of professional development opportunities that allow teachers to develop and keep their technical and pedagogical skills current.

This research focused on the two IT teachers at the two black rural schools mentioned earlier. We aimed to determine the experiences and specific needs and challenges of these teachers with regard to teaching IT in rural schools, and to establish whether these differ. This will assist us in further research to empower IT teachers in rural areas and establish guidelines for the support of these teachers.

In the next section we explain *computer programming*, which is a major component of the IT school curriculum, as well as the term *rural* as used in the context of this study. We then indicate the research methods applied to determine the special needs of the two IT teachers. Finally, the results, discussion and conclusions follow.

Theoretical framework

Computer programming is a difficult, complex cognitive task, including skills such as planning, reasoning and problem solving (Ali, 2009:517). Since programming is low based in theoretical knowledge and

memorisation, it requires a dynamic and practical approach, with the ability to apply abstract concepts when solving a problem (Gomes & Mendes, 2007). Despite the extensive research on teaching a first programming language (Guibert & Girard, 2003; Xiaohui, 2006), it still poses a challenge to teachers and learners. Hassinen and Mäyrä (2006:117) claim that there is no shortcut in learning to program. It requires extensive practice and sufficient time to master the programming skills. Recent research conducted by Stamey and Sheel (2010:35) support the notion of learning-by-doing as they found that having learners writing several different computer programs dramatically improves learners' programming performance. Learners in rural areas are not as exposed to computers and programming as their urban counterparts, so the question of computers, programming and rurality poses interesting research challenges.

Cloke (2006:18-19) states that rurality is often seen as the opposite of urban and argues that it is in the social distinction of rurality that the significant differences between rural and urban remain. There exists, though, no single definition of rural. According to Coladarci (2007:2), a number of different criteria for rurality exist, such as the population size and density, proximity to an urbanised area, type of economic activity, income and educational attainment levels. Cartwright and Allen (2002:7) define rural schools as those located in rural and small towns where the population of the town lives outside the urban centres and where less than 50% of the employed individuals commute to the urban core of a metropolitan area. Balfour, Mitchell and Moletsane (2008:102) name poverty, inaccessibility of infrastructure and absence of support as key characteristics in rural SA and, although urban areas are not free of poverty, the same intensity cannot be found in urban areas. Chikoko (2008:76) also admits that the concept of rural schools should not be seen as homogeneous, as rural communities are varied and schools in these communities could operate at very different stages of development.

Research design and methodology

To understand the experiences of the only two Grade 10 IT teachers in black rural schools in the NW and develop an in-depth analysis of these two cases, we conducted a qualitative, comparative case study. Yin (2009:18) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". A comparative case study examines two or more instances of specific phenomena to discover contrasts and similarities of patterns across the cases (Campbell, 2009:174). In this research the two IT teachers in black rural schools in the NW form the two-case design and were compared with regard to *how* they experience IT teaching in a particular school and *what* their challenges and needs are.

Although multiple forms of data collection can be used for case study research (Creswell, 2008:488), the interviews formed the primary data collection instrument for this research. Semi-structured interviews were used to determine how the teachers experience their teaching. The two teachers were interviewed and follow-up visits were paid to clarify certain aspects from the interviews. They had to elaborate on needs and challenges mentioned while explaining their experiences. The interviews were transcribed and data were analysed using ATLAS.ti™ software. We mainly used open-coding, a data-driven approach (Gibbs, 2010:45), to determine the evolving needs and challenges of teachers. Themes were identified from the analysis and a comparison of the cases was drawn. These will form the basis of the discussion and will result in the drawing of conclusions.

Permission to conduct the research was obtained from the North-West Department of Education, the ethics committee of the university, as well as from teachers and principals of the schools. Teachers were informed that participation is voluntary and anonymous and that they can opt out at any stage of the research.

Construct and internal validity were assured by interviewing teachers directly involved with IT teaching in rural schools and follow-up visits to clarify any uncertainty which arose from the interviews. Apart from co-researchers who evaluated and monitored the research process, one of the co-researchers independently reviewed the data analysis and interpretation, as well as inferences made, in order to further establish validity. To establish reliability, all research procedures were clearly documented and explained to enable co-researchers to check that results derived from the data were consistent and dependable.

Although a two-case design does not necessarily provide a solid base for generalising results, it could provide a sense of the particular circumstances of the case as well as for more general relevance and interest (Hartley, 2005:324). We hope to apply the results from this research in planning the further empowerment of these IT teachers.

Results

With regard to the analysis of the teachers' experiences, two main themes evolved from the interviews, namely resources and equipment, and knowledge and skills. Each of these themes involved certain challenges which the teachers experience in their teaching and will be discussed for each teacher respectively.

Teacher 1 (alias John, 22 March 2011, 15:00-16:15), completed a four-year diploma in Applied Information Technology, specialising in networking and software engineering, and received training in several different programming languages. Even though he already has three years' teaching experience, he is currently enrolled for a Post-Graduate Certificate in Education (PGCE). John is a very committed teacher and declares that he enjoys teaching. He is the only IT teacher at his school and is responsible for IT Grade 10, 11 and 12. He also teaches Mathematics and Technology in order to maintain an adequate teaching load. This prohibits him from focusing solely on teaching IT, and support from colleagues in IT-related matters is limited. The IT class has 32 fully functional computers with the necessary software.

John's challenges with regard to *resources and equipment* involved four aspects: no Internet access, learners without computers at home, no technical assistance for maintaining computers, and limited variety of textbooks and reference resources available.

The school does not have Internet access, resulting in learners being unable to complete research assignments and in John having to use his personal Internet at home to retrieve information for learners.

These learners don't have access to the net, so I have to do research so that I can come and give them a handout or notes.

One of the assessment standards for Grade 10 (DoE, 2003:20) requires learners to retrieve information by navigating the Internet, which these learners cannot do. The lack of Internet access results in a challenge to the teacher to equip his learners with the necessary skills required in the IT curriculum.

... you cannot give them [an assignment] to go and research this, because they don't have any way of doing this.

John has 26 Grade 10 learners in his IT class, none of whom have computers at home. "*The only computer they know is this school computer. After school they don't have access to computers.*" Due to the fact that learners do not have the necessary computer skills, the teacher needs to invest extra time in order to equip learners with the basic computer skills.

... [T]hey don't know what is a mouse. So sometimes I start doing computer literacy skills which is outside the curriculum in IT, like how to type ... you cannot teach them programming if they don't know how to type. I have to go an extra mile so that I can close that gap."

A further challenge is that learners cannot prepare or practise programming at home. John tries to overcome this by asking learners to write computer programs on paper.

I assign homework that they can write on a piece of paper, then I can check it. When they come to school, they can just program, testing what they have on paper.

They can only practise their programming in class, which results in John having to be available after school hours to assist them.

I have arrangements like Mondays and Wednesdays Grade 10s they come and two days it's Grade 11s then Saturday Grade 11 and Grade 12

John is expected to maintain the computer laboratory himself as the school has no computer technician. Although he has adequate knowledge, it poses a problem as maintenance is a time-consuming task, especially during examination periods when all the computers need to be restored and checked.

With regard to resources, every learner has a textbook, but John mentioned that they only use one specific textbook for programming and that additional examples are needed. With regard to knowledge and skills, John has no problems with the IT content. Concerning the pedagogical and methodological issues, John relies on a basic knowledge of teaching and admits that he needs to acquire more relevant skills.

Personally I don't have any problem with the IT content itself ...but just adapting to the new system, these things like filing, recording, questioning techniques, things like that, so but I think my PGCE is helping me.

John does not formally teach any problem-solving strategies, nor does he require learners to write algorithms before commencing with a programming task. He generally uses direct teaching methods, using example programs and teaching learners general templates for programming syntax.

So I start with the general format like, which is more or less like a template ... then after that it's examples then class activity.

Teacher 2 (alias Tom, 23 March 2011, 13:30-14:45) completed his BEd degree, specialising in IT. Tom has four years' IT teaching experience. He enjoys teaching, though he states that it requires much work and energy to deal with more than one person's progress at a time. He is the only IT teacher in his school teaching IT Grade 10, as well as other school subjects. The IT laboratory has 29 computers, yet few are in working order due to problems with electricity supply and computer viruses. As a result, the 22 learners in Tom's Grade 10 IT class do not have the privilege of working on their own computer. Tom does not have his own computer at home and uses the school's computer for preparation.

Tom's interviews revealed needs with regard to resources and equipment such as hardware, anti-virus software, maintenance, Internet connectivity and a lack of teaching support.

As mentioned above, most of the computers are not in a working order due to problems with electricity supply, malfunctioning components such as power supplies and screens, as well as server and network configurations.

...[I]t's a problem because they need to always conceptualize what you are telling them and if most of the computers don't work, it becomes a problem for them.

Another challenge Tom faces are viruses on the computers.

Actually it's a major problem now some of the computers are there but they are not working because of viruses.

He only has five anti-virus software licences, but as the computers are connected to a network all computers are vulnerable. Consequently some computers are unusable.

Tom does not feel competent to maintain the computers himself, and has to rely on an outside technician, who is expensive and unreliable.

It's expensive, ... we don't have money for that. Sometimes you find the problem you can sort it [out] yourself but if it persists then I call the other person [technician]. So the one we are using now is very difficult to find.

Tom's school has only one computer connected to the Internet for all staff members. He uses the Internet often for preparation and extra resources for his learners; however, he needs more resources.

I spend a lot of time trying to find resources from the Internet, but there are very few.

The fact that learners do not have Internet access poses problems as they cannot complete the prescribed research assignments.

...especially the practical assessment tasks you have to do research on the Internet. Now the problem we have here at this school is that we have one Internet, one computer that has Internet here.

It seems that the school cannot afford to install Internet in the IT class.

... the telephone company told us the problem is it's too expensive for them to put an interchanger here...not a lot of people are using Internet here so for in the cities they have the interchanger because for ADSL, we need the interchanger.

As learners have no opportunity to work on the Internet, Tom used to make photocopies for them, but it's expensive, it takes a great deal of time and the photocopier is not always in working order.

One of Tom's biggest challenges is the fact that they do not have any programming textbooks for the Grade 10 learners. The teacher's copy is the only textbook in class.

So the only way to go about doing that is to write notes on the blackboard.

They tried to get the parents to buy the books, but parents could not afford them. There is a data projector in the IT class, but it needs to be mounted before it can be used.

Due to the problems experienced with the computer equipment and timetable scheduling, learners dropped out after Grade 10 in IT last year and moved to other subjects.

The other problem was attempting to schedule classes – there were a lot of clashes, so we had to sacrifice those 5 [learners] so the timetable could work.

With regard to knowledge and skills, Tom does not have any problems with the IT content and also mentioned that he feels confident teaching the subject. He mainly uses direct teaching methods.

I told them ...; I show them....; They are used to just memorising, this is how we do this.

Learners only practise programming on the computers during class time, providing that the computers are working, as they do not have computers at home.

I will actually give them homework but they are going to write it down.

Because learners are not used to working on a computer they type slowly. Tom does not apply group work in his classes as it "always spins out of control". He believes that there will only be one person doing all the work and the rest end up talking or relaxing.

Tom's own words summarised his overall experience of teaching IT in a black rural school:

Even now again it's a big problem, if you have limited resources and of those resources some of them you have them but someone must come and fix them, you end up not really doing your work correctly.

Discussion

From the analysis of the teachers' experiences, a number of similarities and differences can be identified regarding their needs and challenges. The common ground lies in the fact that these schools are in remote areas where community exposure to technology is minimal. The findings concur with findings reported by Balfour *et al.* (2008:102), which indicated the absence of support and the inaccessibility of infrastructure in rural schools in SA. Although the teachers have relatively up-to-date computer equipment, it is not always in a working order. As a result, these learners lack the learning-by-doing aspect of studying programming (Hassinen & Mäyrä, 2006:119).

Both schools' learners cannot access the Internet at school. Teachers need to access the Internet and print notes at additional cost in order to enable learners to complete their research assignments. Since no learners in either one of the schools have computers at home, most do not even have basic computer skills when starting IT in Grade 10. Teachers can only give homework assignments in the form of handwritten programs.

Both schools are unable to afford outside technicians to maintain the computers; therefore, IT teachers need to take responsibility for maintenance as well. In both schools there is only one IT teacher and in order to balance their workload they are required to teach other subjects; thus, dividing their time and focus. Also, in both schools, there are more than 20 IT learners in Grade 10, which is above average for IT learners in schools in the NW. With regard to knowledge and skills, unlike what researchers such as Herselman (2003:947) and Ndandani (2001:381) reported about inexperienced and unskilled teachers in rural areas, these two teachers are knowledgeable enough with regard to IT content knowledge.

Differences between the two schools also exist. The way in which the teachers handle their challenges is unique to their specific situations. Tom's school experiences include frequent problems with electricity supply, which concurs with what Herselman (2003:945) states on rural education. John did not express

any concerns with regard to electricity supply. John has recently updated anti-virus software licences for all the computers in his class. Tom's problems started with not owning enough anti-virus software licences for the computers in his class, which affected their performance. Unfortunately, Tom's computers are not in good working order and learners do not get enough exposure to working on a computer, whereas John's computer laboratory is fully functional. Although Tom asked for assistance in this regard, the school did not have the necessary funding. As Chikoko (2008:77) argues, poverty and low levels of education characterises rural communities in SA, but still the schools in these communities vary with regard to resources and infrastructure and operate at very different stages of development.

John is willing to stay after school until 16:00, and on Saturday mornings to assist learners in becoming computer literate and to practise programming skills. Tom needs to prepare his lessons after school in the staff room as he does not own a computer nor is he able to access the Internet in any other way, lessening the opportunity learners have for extra lessons in the afternoons.

John has adequate knowledge of the maintenance of computers. He performs strict control over learners bringing their own memory sticks into his classroom and has no trouble with viruses. Tom does not feel capable of doing all the maintenance in his class and due to the remoteness of the school it is expensive and difficult to get a technician.

Where John is fortunate enough to have textbooks for each of his learners, Tom only has his own copy and needs to write notes on the board as copyright protection and costs prevent him from copying notes. The shortage of textbooks, also mentioned by Amedzo (2007:62), may be due to a lack of adequate telephone and e-mail communication between the school and the education department. This could be attributed to problems with electricity supply.

Conclusion

From the discussion it is clear that the two rural schools in NW do have generic needs and challenges, typical of rural schools, but also experience unique problems and needs not prevalent in all rural schools. The challenges these schools experience with regard to IT teaching do not promote the increase in numbers of IT learners at school level. It is impossible for learners to achieve the set outcomes for IT without working computers and Internet connectivity. It is quite understandable why the Grade 12 results of these schools differ from urban schools in the province. To fully support learners in their endeavour to succeed in IT, a school needs to be fully equipped with the necessary hardware, software and Internet connectivity. As learners in rural schools do not have an opportunity to work on a computer after school hours and as programming skills cannot be acquired without enough practice, teachers' workloads need to be adjusted to accommodate extra classes in the afternoons.

As maintenance is less available and more expensive in rural schools, continuous support is needed from the Department of Basic Education as a once-off provision of equipment is inadequate. As long as the policy of the Department of Basic Education (DoBE, 2011:10) is that schools must provide infrastructure, equipment and finances for the subject, this will remain a problem in black rural schools. IT as a school subject will become extinct in rural schools and learners' career opportunities will be shattered. This also links to what Kajee (2005:104) sees as a lack of infrastructure and resources having a detrimental effect on South African global IT participation and development.

The provincial Departments of Education should also take into consideration that standard communication channels between rural schools and the department is not a given; thus, additional measures should be taken to ensure that rural school receive all notices and information.

This study shows that the teachers from the two rural schools have not given up hope, but are trying to meet their own needs and challenges with the resources available. The DoBE, provincial Departments of Education, the school, and the teacher need to be partners in their endeavour to find the right solutions to their specific problems. It is important to assist the large number of learners who want to take IT, but cannot achieve the desired outcomes. SA cannot afford not to empower learners who are interested in a career in IT.

The findings of this first phase of the research will be used in further research to establish how the IT teachers at the different rural schools can be empowered and supported.

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