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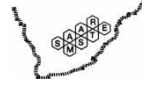Witwatersrand, Johannesburg.
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Teachers' Self-directed Professional Development: Science and Mathematics teachers' adoption of ICT as a professional development strategy

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This paper is part of a larger study that was carried out to investigate the use of information communication technology (ICT) in the self-directed professional development (SDPD) of mathematics and science teachers in Zimbabwe. The educational context provides an example of how teachers compensated for lack of structured government initiatives to support teachers' professional development. This paper focuses on the ways in which these teachers were using ICT resources to further their professional development. The study is based on 259 questionnaire responses from A-level Science and Mathematics teachers in Zimbabwe. Doyle and Ponder's *Practicality Ethic* and Loucks-Horsley et al.'s *Concerns-Based Adoption Model* provided the theoretical framework for analysing teachers' decision making and led to the development of a model for teacher empowerment with respect to the use of ICT. The study results showed that around 60% of teachers experienced difficulties in accessing ICT for their professional development. About half of the non-users did not access ICT even when it was available at their schools. Some of those who did access ICT used innovative methods to ensure access, including using their own resources, and pooling resources. The findings also show that teachers have three main drivers for using ICT for SDPD, including word processing for generating instructional materials; accessing and downloading web-based learning materials; and emailing for networking with peers and professional organisations. The results of this study demonstrate the great potential that ICT has for teachers' SDPD.

Keywords: self-directed professional development; concerns-based adoption model; practicality ethic; ICT usage

Introduction

This paper is part of a wider impact study on teachers' use of ICT for their self-directed professional development (SDPD). SDPD in this context, is distinct from formalised/structured professional development in that SDPD deals with teachers' voluntary, deliberate efforts to develop themselves in areas that they perceive themselves to be limited or lacking (Mushayikwa, 2011). The voluntary efforts are driven by a felt need to raise their classroom or professional efficacy (see Mushayikwa & Lubben, 2009). The study arose out of the need to understand how A-level science and mathematics teachers in Zimbabwe were coping with educational reforms introduced in that country since independence.

The enormous professional pressures resulting from these reforms can be summarised as follows. At Independence in 1980, the new Government expanded the education system by increasing enrolment and investing in the education sector. The general education index (a measure of the educational development of a country as defined by the United Nations) increased from 0.46 in 1980 to 0.79 in 2001 (UNDP, 2003). The increase was caused by the rising enrolment at both primary and secondary levels

(UNESCO, 2005). However, the expansion in education could not be matched with a proportional expansion in resources and personnel, and over the years, teachers found themselves teaching large classes of ill-prepared students with fewer textbook and equipment resources (Chivore, 1986). Zimbabwe has since experienced a reversal in education quality and capacity (UNDP, 2011), with the education index dropping to 0.57 in 2011. The greatest pressures in the provision of quality education, has been felt by A-level science and mathematics teachers, who need specialised equipment, resources and training.

As part of the response to the enrolment challenge, more teachers' colleges and universities were commissioned, and curricula and programmes at the existing institutions had to be modified to cater for the increased demand. To date, Zimbabwe has seven state and four private universities. Most of these are involved in initial teacher training. In addition, the government had entered into partnership with friendly countries, to help train science and mathematics teachers to teach up to A-level. This increased the number of routes that prospective science and mathematics teachers could take to acquire their qualifications. Unfortunately, the diversity of training routes also presented challenges to professional development as, although they all covered training in the essential strands of teacher education, i.e. subject content, professional foundations and teaching practice, the training institutions had no standardised curriculum. This lack of standardisation resulted in teachers who had diverse capabilities and strengths depending on the resourcefulness and pedagogical focus of their training institutions. These teachers also had very different views about the epistemology of teaching and what it means to be a teacher. Inevitably, individual teachers experienced gaps in preparedness, pedagogy, content, innovation and resourcefulness in dealing with unforeseen pedagogical events. These gaps translated into lowered professional and classroom efficacy.

The establishment of the Zimbabwe Schools Examinations Council in 1994 and the subsequent localisation of O-level examinations in 1998 (reported in Machinga, 2000) were accompanied by a shift in perspective and emphasis on the O-level curricula, as new syllabi were introduced. Localisation of O-level examinations resulted in a transition gap in pupil knowledge between what they learned in O-level and teacher expectations at the start of the lower sixth form (i.e. the first year of A-level). This meant that lower sixth form teachers could no longer assume pupil prior knowledge when introducing topics. Thus A-level teachers had to cover the pre-requisites as well as the unwieldy, content-rich A-level syllabus within the 18-month provision for A-level.

The overall effect of these educational reforms was a perceived drop in the quality of educational provision (Engels & Ncube, 1995). The lack of professional support and resources, compounded by large classes, resulted in stress and frustration for teachers as they were still expected to produce good passes at the end of A-level.

Problem Statement

Initial observations at science and mathematics centres (SMC) indicated that one of the strategies that teachers adopted for their professional development was the use of ICT. The aim of this paper is to establish how and why teachers adopted ICT for their SDPD.

Significance of this Study

It is important to understand the choices that teachers make when faced with resource constraints, and also when they are provided with resources in the absence of structured or formalised support. In 2011, Zimbabwe approved an IT policy (MICT, 2011), which, among other aims, strives to increase ICT access for all citizens by 2014. If we can understand the drivers of SDPD that teachers use in making decisions about their continuing professional development, we will be able to use this knowledge in the development of effective professional development programmes in the country.

Literature Review

The Professional Development Process

Bertani and Tafel (1992) see professional development as 'the acquisition of knowledge, experience and skills, and the development of personal qualities for the execution of professional and academic duties that enable the individual member to effectively contribute to the institution and the community' (p. 12). These authors recognised three important aspects of professional development: experience, knowledge and skills. They also recognised the need for the professional teacher to be emotionally involved in their profession by developing certain attitudes or '*personal qualities*'. There is a symbiotic interaction between the needs of the institution and the professional development needs of the individual teacher. In other words, professional development is a directed process, i.e. it is goal-oriented.

Although there has been a spurt of interest in SDPD activities—mainly in education and health sciences (see Brown, Hinton, Ferrill, & Shek, 2001; Yan, 2010), this area of study is still developing. Unlike other professional development activities, SDPD places the teacher at the centre of the professional development process, i.e. teachers exercise full freedom of choice in selecting and prioritising their areas of development (Bouchard, 1996). Bouchard argues that professionals embark on SDPD, as a means to solve a real self-defined and immediate problem to meet their specific needs. Beavers (2009) concurs with this view and argues that teachers should be given a voice in their own professional development.

Under normal circumstances, teachers can rely on their institutions to provide the necessary support to enable them to adjust to a changing professional environment and keep abreast of developments in their profession. However, in impoverished societies this support is not forthcoming. Zimbabwe has hitherto relied on donor agencies to provide support for teacher professional development. However, support from donors is usually fragmented and temporary and thus might not be effective, and over the last few years many donors have withdrawn from the country. Teachers therefore have to invest in their own professional development and in some cases this means that they have to use their own resources to ensure that their students do well.

ICT is versatile enough to enable teachers to engage in SDPD with minimal support from their institutions. As a result, there is growing consensus among researchers that learning through the Internet and other ICT related activities is on the increase as teachers take responsibility for their professional development as free agent learners (Preston, 2000).

Most of the literature regarding the use of ICT for teachers' development is concerned with managed/organised groups of teachers (e.g. studies by Preston, 2001). There is no indication how individual teachers use information accessed outside the framework of managed professional development activities. These studies do not tell us anything about how teachers who are isolated initially will benefit from access to online resources or how they come to make decisions enabling them to benefit from these online communities. The situation in Zimbabwe appears to indicate that teachers are isolated, because of school ethos and cultural practices that promote competition between schools and among teachers. The economic turmoil of the past few years, and the increased brain drain resulting thereof have tended to accentuate this isolation (Mushayikwa & Lubben, 2009). Information about how teachers use ICT would give an indication to how they are struggling to come to terms with their isolation.

Theoretical Framework

This study focused on the use of ICT as a vehicle for SDPD. As such the focus is not so much on ICT use as on the pressures that led teachers to adopt the technology for as Straub (2009, p. 625) argues; 'Technology adoption is a complex and inherently social, developmental process'. The study was guided by two main axioms: The first axiom dealt with what Doyle and Ponder (1977) called the '*Practicality Ethic*'. The second axiom, related to the technology adoption model developed by Loucks-Horsley, Hewson, Love, and Stiles (1998), which they called the *Concerns-based Adoption Model (CBAM)*. These axioms are discussed in turn below:

Doyle and Ponder (1977) argue that, teachers' perceptions of issues important to their practice, influence their selection and prioritisation of professional development activities. They suggested that

teachers evaluate the practicality of using an innovation (in this case ICT) for their professional development using three main criteria, i.e.:

(a) Instrumentality–the usefulness of (in this case) ICT to provide teachers with exemplars of the intended resources or activities such as lesson plans, worksheets or guidelines which can be tried out in a real situation. Instrumentality provides teachers with the confidence to accept and use the resource materials or ideas.

(b) Value congruence–providing a fit between the values held by teachers about their practice and the values transmitted through the use of the ICT packages. Value congruence is also affected by the teachers' perceptions of the credibility of the resources' origin. Thus if materials are perceived to present erroneous content, or seem to originate from dubious sources, teachers are more likely to reject their use. In this study, the researcher also sought to understand how teachers aligned their use of ICT to their values and beliefs about their profession.

(c) Cost-benefit analysis–teachers make mental comparisons between investment and perceived benefits. Doyle and Ponder (1977) argue that teachers make these comparisons on the basis of financial expenditure, effort, time, satisfaction, learning outcomes and peer recognition. In the ideal case, teachers want low investment yielding high results.

Fuller (1969) argued that teachers undergo well-defined stages of concern when faced with the challenge of adopting an innovation. Hall and Loucks (1978) expanded Fuller's *stages of concern* about an innovation model to include levels of use. This technology adoption model became known as the Concerns-based Adoption Model (CBAM). CBAM describes adoption concerns in terms of orientations. These orientations include; (a) awareness—where the teacher is just aware of the information, but not interested to apply it to their situation; (b) self-orientation—whereby the individual shows slight interest in how the innovation could be useful in improving their own development. This interest is demonstrated by the individual seeking additional information about the innovation; (c) task orientation—the teacher is concerned about time spent in preparation, implementation, transferrable skills learning, and acquisition of material resources; (d) impact orientation—in this case, the quality of the questions and concerns that the teacher raises shifts towards a focus on implementation with students. Questions demonstrating value congruence and extensions of the innovation are raised. Horsley and Loucks-Horsley (1998) further argued that these concerns are accompanied by observable levels of use, which characterised users of the innovation versus non-users. Table 1 illustrates the levels of use, as conceived by the Horsleys in 1998.

The level of use model has six levels. Levels 0–2 characterise non-users whose behaviour range from lack of interest and culminates in active preparation for the use of ICT. Levels 3–6 characterise users and exhibit behaviours ranging from poor organisation of initial implementation to expert mastery of implementation. These expert implementers then seek to build on the innovation and extend its use. By studying the ICT usage patterns of the teachers, one can determine their level of

Table 1: Levels of use of ICT for SDPD (Adapted from Horsley & Loucks-Horsley, 1998, p. 17)

Level	Characteristics	Behaviour	Category
VI	Renewal	Seeks more alternatives to the established use of the innovation	USERS
V	Integration	Deliberately seeks other ideas and opinions on the innovation use	
IVB	Refinement	Assesses the effectiveness of the innovation (impact) and makes additional changes to make it more effective	
IVA	Routine	Establishes a pattern of use. Teacher is comfortable with implementing the innovation. Fewer changes to implementation	
III	Mechanical	Implementation is poorly organised. The teacher makes numerous changes to better organise themselves	
II	Preparation	The teacher prepares to use ICT	Non
I	Orientation	The teacher seeks more information about how to use ICT	Users
0	Non Use	The teacher takes no action with regard to the use of ICT	
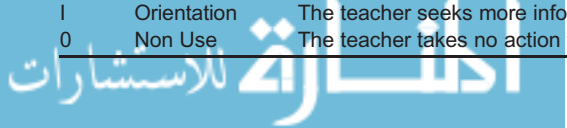
use. The CBAM is therefore a good technology adoption model suitable for the analysis of ICT use by teachers.

Research Questions

This paper focuses on the extent to which Zimbabwean A-level science and mathematics teachers used ICT resources at school and at the SMS centres for their own professional development. In so doing, the report will attempt to provide answers to the following questions:

(1) Who used ICT for SDPD among the A-level science and mathematics teachers in Zimbabwe?
(2) How did science and mathematics teachers use ICT?
(3) What technology adoption model emerges from the teachers' use of ICT for their own professional development?

Methodology

This research was carried out as part of a wider study aimed at understanding the impact of ICT on the SDPD of A-level science and mathematics teachers in Zimbabwe. For this purpose, the researcher adopted a cross-sectional research design using the social survey (Bryman, 2001), in order to look for patterns of association between teacher-characteristics and the use of ICT for their professional development. Interviews and questionnaires were the main methods used for gathering data, leading to quantitative and qualitative data analysis methods. This use of mixed methods has been dubbed 'the third paradigm' by Johnson and Onwuegbuzle (2004). This report will focus mainly on the questionnaire findings, with interview results used as supporting evidence.

The target population for the study was the Biology, Chemistry, Mathematics, Geography and Physics A-level teachers. Questionnaires were distributed to 418 of the estimated 800 A-level teachers teaching these subjects at the time of the study. These teachers were selected through convenience sampling, as they attended workshops, or happened to work at the Private Schools designated for postal questionnaires. A high response rate, calculated as the ratio of usable questionnaires divided by sample total, minus unusable questionnaires (see Bryman, 2001) was achieved by using both postal questionnaires (for in-accessible schools) and hand-delivered questionnaires at workshops and schools. A *response rate* of 62% (254 questionnaires) was obtained.

Interviews were carried out throughout the country, at SMC and at Teachers' workshops. Fifty-five teachers were interviewed in two phases—an initial phase, and a secondary phase which was used to follow-up selected teachers.

The questionnaire was designed to provide data on the patterns of ICT access and use by the teachers. It focused on the following aspects of ICT use:

(a) Background information and demographics: experience; subject taught; type of school; qualifications; level; Initial teacher training institution and (for Science and Mathematics Centre interviewees) reason for visiting the Science and Mathematics Centre;
(b) ICT access and Teacher Concerns: frequency of access; reasons for access; perceived benefits of access; Identification of favourite sites, reasons, problems faced, possible solutions;
(c) Professional and classroom practice: services and materials accessed; reasons for access; use of resources and materials obtained from the internet; perceived benefits to professional life and to teaching; quality of downloaded materials and resources; professional communication.
(d) ICT access problems/solutions, general comments.
(e) CBAM stages of concern and levels of ICT use items as indicators of the teachers' confidence in using the technology

Semi-structured interviews focused on the reasons why teachers used (or did not use) ICT for their SDPD. Questions ranged from access of ICT services; what teachers used the ICT services for; how they used the ICT services; and why they selected ICT as their preferred SDPD route.

Results and Discussion

Who used ICT among the Science and Mathematics Teachers?
Table 2 shows the responses grouped according to participants' access and use of ICT. 40% of the participants had used ICT in the last 12 months. Four out of every five teachers (202/254) who responded to the questionnaire indicated that they worked in schools which had ICT facilities. However, slightly more than three quarters of these teachers (158/202) had actual access to ICT facilities within their schools.

To provide a better picture of the access dynamics to these facilities in schools, responses to questionnaire items 9 (*ICT facilities at school*), 10 (*can access ICT facilities at school*) and 11 (*used ICT in last 12 months*), were combined. Such a combination would provide insights into the dynamics of access and use of computers by teachers. Using these combinations, it was possible to divide questionnaire respondents into six categories as shown in Table 3.

From Table 2, the six categories of teachers can further be grouped into users and none users. Categories A, C and E are the users and these constitute 40% of the sample. Categories B, D and F are non-users and they constitute 60% of the sample.

The Non-users
From Table 3, it can be deduced that:

(1) Almost half of the teachers who can access ICT facilities in their schools [B / (A+B)], have reportedly not used the facilities in the last 12 months.
(2) Despite the fact that four out of every five teachers who participated in the questionnaire came from schools that had ICT facilities, almost two-thirds (~60%) of the teachers in the whole sample had not used ICT in the last 12 months.
(3) Ironically, among the non-users group, more than two-thirds (111/153) of them came from schools that had ICT facilities, and 70% of these teachers could access computers at their schools, but chose not to. According to the CBAM levels of use model, these teachers remained at the level of mere awareness.

From Table 3, one in five teachers teaching at schools where ICT facilities are available were not able to access ICT at their schools in the last year [(C+D)/(A+B+C+D)].

The Users
Table 3 also shows that:

(1) Forty-five per cent of teachers from schools which had ICT facilities were able to access ICT during the period under study (algebraically represented as (A+C) / (A+B+C+D). However, one-eighth (11/91) of these teachers did not access the computers from their schools, but had to access them elsewhere.

Table 2: Demographic characteristics of users and non-users

Demographic characteristic	Variable	Used ICT in last 12 months		Did not use ICT in last 12 months		Total
		N	%	n	%	N
Overall		101	39.8	153	60.2	254
ICT Facilities at school	Yes	91	45.0	111	55.0	202
	No	10	19.2	42	80.1	52
Can access ICT at school	Yes	80	50.6	78	49.4	158
	No	21	21.9	75	78.1	96

Table 3: Access of ICT facilities at school

	Access and usage	Category	Number of participants	Percentage %
ICT USERS	Have facilities at school, Can access these facilities, have used ICT in last 12 months (YYY)	A	80	31.5
	Have no facilities at school, but have used ICT in the last 12 months (NNY)	E	10	3.9
	Have facilities at school, cannot access these facilities but have used ICT in last 12 months (YNY)	C	11	4.3
	Total (ICT Users)		101	39.8
ICT NON-USERS	Have facilities at school, cannot access these facilities and have not used ICT in the last 12 months (YNN)	D	33	13.0
	Have facilities at school, Can access these facilities but have not used ICT in the last 12 month (YYN)	B	78	30.7
	Have no facilities at school, and have not used ICT in the last 12 months (NNN)	F	42	16.5
	Total (ICT non Users)		153	60.2
	Total		254	100

(2) Of the teachers who had accessed ICT in the last 12 months (A+C+E), one in 10 teachers came from schools with no ICT facilities.

(3) It can be deduced from Table 3 that approximately one-fifth of the users did not access computers from their schools (C+E) / (A+C+E).

An interesting observation from Table 3 is that four out of five teachers using ICT within the past year have used it at school. This observation seems to point to the fact that A-level schools in Zimbabwe are investing in computers and these are largely accessible to teachers. Evidence for such a trend was also corroborated by interviewees.

An initial analysis of variation, using Fisher's Test between teachers' ICT use and other demographic variables yielded results shown in Table 4.

Exact significance values are quoted in line with the recommendations made by Neie (1974) who argues that since significance levels are arbitrarily defined by statisticians, researchers should quote actual *p*-values to enable critical readers to make informed judgements on the significance of their work.

Significant associations were found for the type of school, teaching subject, whether or not the teacher's host school had computer facilities and whether the teacher could access these facilities at school. Teachers from private and mission schools tended to access ICT more frequently, use ICT more widely and have access to computers at school more often when compared to teachers from

Table 4: Comparison of ICT use with demographic variables (using SPSS)

Variable	N	X^2	Df	significance
Gender	254	1.418	1	0.26
Type of School	254	9.788	2	0.00
Teaching Experience	254	1.409	2	0.49
Initial Training Institution	250	0.237	1	0.36
Teaching subject	254	26.573	5	0.00
ICT facilities at school	254	11.51	1	0.00
Can access ICT at school	254	20.62	1	0.00

public/government schools. A possible reason for this observation could be that both private and mission schools tended to have better access to funding from the school Board of Governors and NGOs, and could therefore afford to purchase better ICT facilities for use by teachers.

Thus the first research question established that most schools had ICT facilities, but these facilities were not always accessible to the teachers. Only 39% of the 254 teachers who answered the question-naire, could be categorised as ICT users.

How did Science and Mathematics Teachers Use ICT?

Table 4 also suggests that ICT use was related to the teaching subject. Most of the research that has been carried out to date, has concentrated on structured professional development programmes in which science and mathematics teachers have been introduced and encouraged to use ICT as part of the programmes. However, none of these programmes have investigated the possibility of teaching subjects, as exerting an influence on teachers' choices to use or not to use the internet.

When teachers were asked to describe how they used the ICT resources they had accessed in the last 12 months, most teachers claimed to use the facilities to access teaching resources over the inter-net, rather than for other purposes. During interviews, teachers indicated that the resources sought ranged from simulation programmes for use during teaching (MAS04 V, ME12M), instruments to provide assistance in identifying pupil misconceptions during teaching (ME14N, MN47M) to the setting up of design practicals (MN50 Ma, MN43 L).

The teachers' responses imply that ICT use was tied to the particular demands of the subject taught. For example, teacher ME26N has recently moved to his new school where he teaches A-level Physics. After highlighting the problems he faces in his teaching as a result of shortages of textbooks and equip-ment at his new school, he made this remark:

> I have downloaded detailed examples and demonstration notes on topics such as electronics, which really improved my presentation to students… the notes from the internet, for example, pertaining to the gain in operational amplifiers were much more detailed and practical…. The quality was good especially for elec-tronics, it was at the right level for my students and was presented in a very simplified way that is easy to understand, with lots of practical examples (ME26N, lines 35–46)

For this teacher, the internet acted as a resource for practical teaching ideas that he could use in class to compensate for the absence of expensive physics textbooks. However, mere access to teaching materials represents mechanistic use of ICT as represented on the CBAM levels of use model.

Doyle and Ponder (1978) argued that for teachers to develop an interest in an innovation, they must first be convinced of the usefulness of the innovation by carrying out a cost-benefit analysis. In this case, experienced teachers must be convinced that an innovation adds value to their existing practice. One teacher used this argument to explain why some head teachers initially resisted the introduction of ICT in their schools:

> I remember the headmaster saying in a staff meeting that the school did not need computers since it had achieved high results and established a reputation without their use. There was no reason why teachers should learn to use computers since they did not need them in their teaching. (MN48M, lines 85–88)

The same teacher went on to claim that the major reason why centres were patronised by younger tea-chers was that they came to use the computers, rather than to learn how to use them:

> So I tell you, most of the teachers who were trained before computers came into the schools are very uncomfortable in terms of the technology. On the other hand, younger teachers have adopted the technol-ogy from the period of their training and see ICT as a partnership in education. So now ICT centres enjoy large patronage from these teachers. Also younger teachers already possess ICT skills which they obtained from their colleges and they come here already knowing the basics of what they want to do. The most affected subjects in this region are mainly physics, chemistry, geography and literature. (MN48M, lines 93–100)

In the interview sample, as well as among the questionnaire respondents, some teachers mentioned that they had access to computers at home. For these teachers, the distribution of ICT resources did not greatly affect them. However, the cost of access was still prohibitive especially for MAS22 V and MN46S who had to pay for the dial up network connection as well.

Non-formal skill acquisition is driven by personal interests and needs, rather than by coercion (Seldin, Miller, & Seldin, 2010). It appears there was a growing perception of ICT as an essential skill among teachers. For example, when asked to comment on how he benefited from using ICT, MW17C replied:

> I think I benefited greatly. I think ICT is a must for teachers to keep pace with modern trends and also to keep informed with the fast pace of knowledge production nowadays. Books quickly become out-dated and expensive to upgrade. The Internet provides us with a cheap way of upgrading ourselves and getting up-to-date information on topics. Also you find articles written by people from all over the world and in various fields. So it provides a rich variety of opinions and interpretations on the same topic. This is good and enriching. (lines 98–105)

The fact that a large number of teachers in the sample had invested their time and resources into acquiring ICT skills through non-formal means illustrates the fact that ICT-use was becoming an accepted part of the teachers' personal professional activity.

From teachers' interviews, one got the impression that teachers found accessing ICT resources a challenging and novel experience. When asked why they bothered to access and use ICT, teachers explained that computers are becoming a common feature in schools and the greater society. Pupils are becoming computer literate ahead of teachers and teachers feel threatened by this loss of authority and control over knowledge dissemination:

> Students are being taught computer science, so they go to the internet shops and they have access to some information, some of which is up to date, so the teacher might have a problem with that. He might not have information which is up to date, so there might be that problem with students, so they (teachers) need to be above the students they are teaching, for them to be able to earn the respect of the students. (MN47M, lines 16–20)

Thus teachers experienced both personal and professional pressures regarding the use of ICT. In a dynamic and increasingly technological world, teachers needed to move with the times to avoid becoming obsolete. The teachers believed that these activities empowered them and led to their professional renewal. Interviewed teachers reported that they felt more empowered as a result of the process and were more confident of their professional identity. The reasons proffered by these teachers are by no means unique, as other researchers working in the areas of technology adoption (Ertmer, 2010; Nguyen, 2009; Straub, 2009; Teo, 2009) have also discovered that there are both external and internal drivers that facilitate the adoption of technology.

Teachers in private schools on the other hand were generally supported by the schools and shielded from both expense and access problems. In almost all the private schools represented in the sample, teachers were allowed and encouraged to have unrestricted access either in their departments (H38 W), library (H31A) or computer laboratories. In some schools, IT support staff was employed to assist teachers to access information on the Internet (ME30G, M08H).

The Adoption Model Emerging from the Teachers' use of ICT for their SDPD

Figure 1 shows the process of SDPD at work. This model follows the generalised structures of technology adoption models as described by Nguyen (2009, p. 180). In empowering themselves, teachers went through a complex process of decision making. Typically, the process began with a felt professional development need. At this position, the teachers felt inadequate, and experienced lower self-efficacy with respect to a particular aspect of their work. They made a decision, to do something to meet this need. For example, a female teacher who was seeking ways to help her students
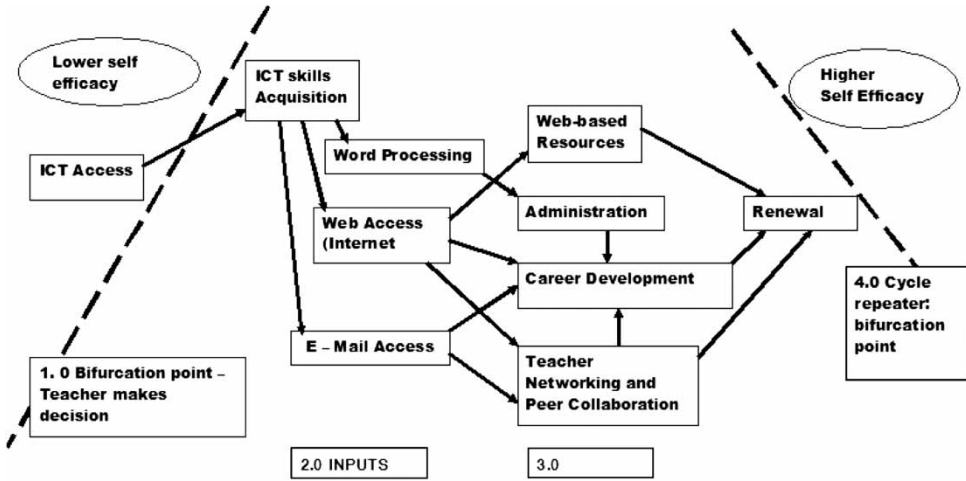
Figure 1: Empowerment model through ICT use (Mushayikwa, 2011, p. 327)

understand abstract mathematics concepts in the face of lack of resources and laboratory equipment remarked:

> I also benefited by using simulations to concretize abstract concepts and my students benefited as they understood what I was talking about. So in the classroom, I became more confident and could answer their questions. (MAS24M, line 46)

Another respondent revealed that she was teaching in a male-dominated environment, and felt unusually under pressure to earn her colleagues' respect and rise above gender bias. She said:

> I was given the syllabus and was told that I was teaching lower 6th and carrying it up to upper 6th. The students were quite sceptical because *I was young and being a woman* I guess they did not think that I could meet the challenge. I think that is what inspired me to use the ICT packages in the first place – the need to prove that I was capable. It made me more confident to realise the support that I could get. (MAS34S, lines 125–133, own emphasis)

From Figure 1, teachers used ICT for their own professional development in three main ways; (a) for word processing in preparing instructional materials and general administration; (b) to access the worldwide web with the intention to access web-based instructional materials, to seek new career opportunities or to network with professionals and organisations in similar fields; (c) to access email facilities—mainly for networking and peer collaboration.

Understanding these three drivers for SDPD implies that we have to move away from the traditional approach of providing structured continuing professional programmes, or school-based professional development, towards a more holistic model where teachers are free to choose the type of support that they need, when they need it, where they access it and how they use that support. This constitutes a completely new way of looking at professional development, and at present, ICT remains the main vehicle through which such a model could operate.

Implications of the Study

The situation in Zimbabwe has been quite fluid in the last 4 years, because of political and economic turmoil. It is quite conceivable that the reality relating to teachers' access to computers has changed
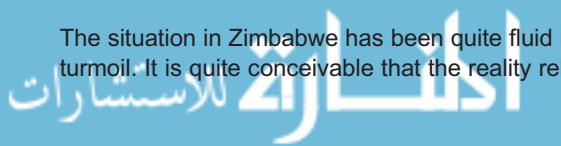
greatly. For instance, the use of laptops, tablets and smart phones, and the evolution of cellular communications companies into internet services providers has dramatically increased access opportunities. However, the results of this study demonstrate the great potential impact that this increased access has on the SDPD of teachers. The technology adoption model developed in this paper, as well as the SDPD model to which it leads (see Mushayikwa & Lubben, 2009), need to be tested further, in different settings, to increase their validity and relevance to different operational contexts. These models help professional developers to gain practical overviews of how the process of SDPD works.

Suggestions for Further Research

As reported earlier, the educational situation in Zimbabwe remains fluid. However, the advent of cellular technology has made the internet more accessible even to rural teachers. There is a need to develop effective online support mechanisms which can be accessed both through traditional computer access, as well as utilising the new cellular 3G technologies. A study of how much these new cellular technologies meet the teachers' needs for professional networking and any other support that could be provided for them can only be undertaken effectively if we understand what drives teachers towards SDPD. Some of these drivers are identified in this study, but there is a need to extend these studies in view of the ever changing educational terrain in Zimbabwe and other countries. More importantly, would these three drivers apply when vehicles of SDPD other than ICT are used?

Conclusions

This research emphasises the increasing role played by ICT as a vehicle for teachers' SDPD. The data provided in this study showed that there is an increasing trend whereby teachers are relying more on ICT to access services they could not otherwise get. The advent of smart phones and 3G enabled notebooks, at increasingly affordable prices means that more and more teachers will be able to use this route for their professional development. The trend towards SDPD also implies a growing need to review professional development provision and to move towards a more holistic and flexible model that allows teachers to choose the type of support they need.

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