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The quality of ICT use in South African classrooms

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Abstract

South African learners particularly in schools with limited resources have continuously underachieved in the gateway subjects like Mathematics and Science. The government has turned to modern technology to strengthen teaching and learning and to redress past inequalities in its schools. This intervention has made little or no progress despite the availability of Information and Communication Technologies (ICTs) in these institutions (PanAfrican Research Agenda, 2008-2011). The teachers in these schools are still in the phase of using ICTs to merely transmit subject content rather than utilise the technologies to enhance learning. The ICT in Education policy, (DoE, 2004) advocates the pedagogical integration of ICTs that promotes the development of higher-order thinking skills. Teachers in these schools need competence and innovativeness to maximise the potential of digital devices if their use will improve thinking skills that are a significant component in enhancing learner performance. This literature review attempts to provide better understanding on what quality ICT use in the classroom entails to facilitate the advancement of teaching and learning. The intention is to demystify misconceptions associated with pedagogical use of ICTs in schools that tend to be responsible for failure to achieve educational goals by teachers in not well-resourced schools. Experiences of other educational institutions, globally and locally will later be reviewed, to demonstrate how ICTs have been used to enhance learning.

Key Concepts: Quality of ICT use for teaching and enhancement of learning.

Background

The South African Department of Education through its ICT in Education policy, the White Paper on e-education (DoE, 2004) and the Guidelines for Teacher Training and Professional Development in ICT (DoE, 2007) has developed guidelines for the distribution and use of digital resources in schools such that equity and quality in education are achieved at school level. Results from PanAf Research Agenda (2008-2011) reveal that the ICT policy is poorly implemented particularly by those the government is trying to rescue from economic and social discrimination (in some cases, exclusion) caused by the digital divide. Due to factors supposedly beyond their control, previously disadvantaged schools are still struggling to keep up with well-resourced schools where adapting to new teaching and learning approaches with available ICTs is concerned. Lundell et al (2000) in their study of the use of computers in South African schools argue that, the problem is not always caused by the lack of resources, but how teachers use the available educational tools in their teaching. In the same study the researchers give evidence that teachers in schools with limited resources do not maximise the use of computers for pedagogical purposes. The critical issue therefore is if the usage provides quality education or not through the use of ICTs.

Lundall et al (2000) later highlight exclusive substantiation from their data that discloses how some of these schools rise above the disabler of financial constraint and maximise available ICTs in their institutions. Although the extent to which they use them is not so clear, such a scenario counteracts inferences that associate lack of funds with failure to adopt ICTs in education. It is an indication that there is need for overt justifications for poor implementation of ICT use in these schools and for interventions that support teachers in ways beyond simply providing them with the digital tools.

Misconceptions associated with ICT use

This literature review attempts to highlight and tackle the following misconceptions that seem to contribute to the sub-standard use of ICTs in most South African schools that has compromised the advancement of learner thinking skills in order to improve learner performance.

1. Access to ICTs is equivalent to quality use for educational purposes.
2. Representational ICT use for teaching is equivalent to quality use to improve learner performance.
3. Basic ICT teacher training prepares teachers for quality ICT pedagogical integration.

Access to ICTs versus quality use

The introduction of ICTs in South African schools has been driven by the inclination to give education access to all. This is generally misinterpreted by teachers and learners as having access to information from the internet and using it as is (PanAf, 2008-2011) to prepare educational tasks. Oppenheimer (1997:61) argues that schooling is not only about information, but making learners "...think about information. It's about understanding and knowledge and wisdom". Learners must interact with the information to an extent that they are able to manipulate and use it to come up with strategies that are critical in addressing individual or societal challenges. Such an experience demands that the teacher creates a learning environment that promotes and equips learners with advanced thinking capabilities through the effective use of appropriate digital tools. Access without an intention to improve the status of the user deems the instrument redundant.

Representational ICT use for teaching versus quality use to improve learner performance

The type of ICT use in the classroom depends on the teacher's capacity to integrate the new tools into their subject teaching. To understand and determine the level of South African teacher ICT use to accentuate the need to empower them for quality usage, this paper has used the following South African Teacher Development Framework (DoE, 2007) to locate their aptitude. It presents five teacher capacity levels to illustrate the development of ICT usage in subject teaching.

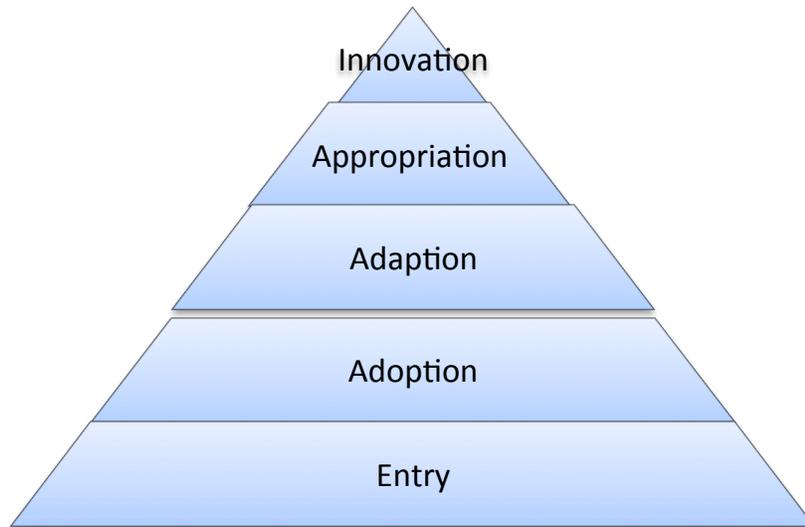


Figure 1: *The Teacher Development Framework*

This framework describes the *highest level* as the *innovation* stage, where a teacher is able to:

develop entirely new learning environments that use ICT as a flexible tool, so that learning becomes collaborative and interactive. ICT is integrated as a flexible tool for whole-school development through redefining classroom environments and creating learning experiences that leverage the power of technology. Guidelines for Teacher Training and Professional Development in ICT (DoE, 2007).

Such teachers have strong pedagogical and content knowledge and are able to transform classroom environment into an exciting and rich knowledge generation for learners. It is not so much the tools they use, but their ability to structure content using suitable teaching methods that can stimulate the advancement of learner thinking processes and draw the best out of learners. In other words, through the use of ICTs, they equip learners with what it takes to develop their thinking skills to such an extent that they are able to independently search, analyse and synthesise information to help them solve authentic problems using available technology.

The lowest two levels in the framework denote teacher abilities that are restricted to using ICTs for limited generation or interaction with knowledge. The reasons range from the teacher not having skills to tailor make learning activities that will promote advancement in learning abilities with the new teaching tools or simply not having appropriate knowledge to integrate them into

their teaching. As the levels ascend, teachers are able to adapt ICT use to suit learner educational needs and thus be able to extend their thinking skills.

Most teachers in South African schools with limited ICTs are at the *entry* and *adoption* stages (Wilson-Strydom and Thomson, 2005). Their use of ICTs is not at a level where they are confident with the new tools to use them to enhance learning. The power of technology is witnessed when learners are able to successfully engage with complex tasks. Although the guidelines (DoE, 2007:6) suggest that there is frustration at the entry level, this paper suggests that it is at that stage where quality use of ICTs is compromised as the teachers do not possess the attributes that enable them to achieve educational goals that will be discussed later. In addition, teachers' attitudes, expertise, lack of autonomy and lack of knowledge to evaluate the use and role of ICT in teaching are prominent factors hindering teachers' readiness and confidence in using ICTs (Hennessy et al: 2010). It is therefore expected that quality use would be a challenge if the teacher is not in a position to make decisions on what and how content should be taught as the teaching tool's affordances are not maximised. The shallow understandings are worsened by the misconception that will be outlined in the next section.

Basic ICT teacher training versus quality ICT pedagogical integration

Teachers in most South African public schools have attended ICT training and generally these sessions constitute basic computer skills. These acquired abilities have proved inadequate to equip teachers with 'the' skills they need to infuse ICTs into their subject teaching (PanAf, 2008-2011). A research carried on ten South African schools by PanAf (2008-20011) show that the majority of teachers cannot go beyond using ICTs to type lesson plans, tasks and tests for their learners. They are not maximising the potential of computers especially for enhancing the actual teaching and learning of their subjects. Moersch (2002) has cautioned such initiatives emphasising that the basic skills are not enough to prepare teachers to integrate ICTs pedagogically. The result of such initiatives has been the integration of ICTs that is limited to what Strydom and Thomson (2005:4) describe as mere representation of "information in another medium". This type of ICT use implies that the teacher is still using the old teaching methods and the difference is that he or she is using a different tool. The use of slide shows for presenting notes on a screen instead of the board for

learners to copy for instance do not make ICTs superior and more effective in improving learning. The fact that teachers struggle to innovatively use the skills they acquire from the trainings to tailor make lessons that will extend or improve learning is evidence that these interventions might not be addressing the classroom needs of teachers.

Teacher support in the form of material resources is important, but beyond that, their capacity to deal with constraints is what needs to be developed. Above the use of ICTs, teachers need to be trained in the skills and knowledge they need to produce good results they can attain if their learners' thinking skills are developed to enhance learning. The following discussion highlights approaches that need to be understood and considered when thinking about what South African teachers need to improve the quality of their use of ICTs, to enhance learning.

Quality use of ICTs

Quality use is that which endorses what entails quality in education in a particular context (Durkheim, 1956). An education context encompasses its setting in terms of place and time. The level of the learner as a recipient of the instruction determines the quality of knowledge to be taught. In other words, what and how which learner is taught contributes in the assessment of whether learning takes place or not. Quality use of ICTs therefore is that which promotes the development of cognitive skills that inevitably leads to enhancement of learning .

Quality use and enhancement of learning

It is imperative that a clear understanding of what entails enhancement of learning as a product of quality use of ICTs is established. To begin with, learning takes place when the cognitive system acquires and keeps information for further use (Dror, 2008). If the process is flawed, learning may not take place and even if acquisition has occurred, the learner may struggle to remember and struggle to use the knowledge to extend understanding or to engage in thinking procedures that demand merging of different ideas to solve complex problems. Learning therefore is *enhanced* when the teaching tools or learning activities are used and designed such that they augment the

process in a way that the learner is able to independently operate at a higher thinking level to deal with abstract forms of knowledge with less difficulty (Dror, 2008).

Although learning can take place with minimal teaching or guidance, there are circumstances that can advance the efficient development of one's thinking ability. Laurillard (1993) suggests that a combination of the learning process and the desired outcomes (capabilities required for the learning experience) can be used to generate the internal (cognitive system) by using external conditions (instructional design). In this context, when teaching strategies integrate ICTs to create these conditions in a learning environment, the probability of attaining a more advanced capacity to acquire, retain and apply knowledge (learning process) is higher. That way, quality usage is achieved.

At an educational system's level, Karagiorgi et al. (2004:22) argue that the role of ICT is twofold: "as a facilitator for the delivery of the curriculum and as a factor for the formulation of the curriculum". Associating ICTs with facilitation is driven by notions that link the role of technology as that which contributes, enables or aids dissemination of the curriculum content. Such a premise has its origins in the constructivists' theory that perceives learning as (1) "an active process of constructing rather than acquiring knowledge", and (2) considers instruction as "a process of supporting that construction rather than communicating knowledge" (Duffy et al. not dated:2). ICTs are therefore given the role of ensuring learners' interaction with knowledge, using them as tools to improve their understanding of subject matter. Tweddle cited in Karagiorgi et al. (2004:22) believes such usage of digital technology demands "new approaches to the curriculum". They advocate a '*humanistic* model of ICT integration' where technology is perceived as a tool "which empowers children with subject knowledge, thinking skills and problem solving alternatives" where the learner is regarded as a 'constructor of knowledge' who through exposure to computational media is able to perform at a higher level. Therefore ICT use in a learning environment becomes quality when it promotes this kind of enhancement to learning.

The variation theory views learning as experiencing, understanding, perceiving or seeing something differently (Runesson, 2006). The use of ICTs for teaching and learning facilitates these learning aspects as some of the devices substitute experiences that learners cannot

have or be exposed to due to constraints associated with their diverse contexts. Learners assimilate knowledge in different ways and the wide range of options in presentation and manipulation of knowledge provides an ideal platform for rich learning environments. The characteristics of ICTs accommodate the diversity of learning styles and types, and can be integrated into many teaching approaches through the use of different forms of texts, “images, sound, and movement” (Hadaad, 2002:33). The challenge though with employing the options is that the teacher has to be an expert in the subject and pedagogical knowledge if the approach is to be effective.

Vygotsky’s social constructivist theory highlights the role of mediation in the learner’s progression from “what he or she can do independently” (actual development level) to what can be done by the ‘novice’ with the assistance of the ‘knowing other’, (the zone of proximal development level -ZPD) (Moll, 2001). At the actual development level, the learner’s understanding of a concept is established to the extent that he or she can operate within the limits of the knowledge acquired with little or no effort. Vygotsky’s theory advocates that knowledge is not transmitted but constructed during the interaction of the learner and the mediator who can be the other learners (peers) or the teacher as they skilfully use different mediation tools. According to Vygotsky (1987:282), “Thought is not only mediated externally by signs” (or by the help of others), but “is mediated internally by meanings” developed through social interaction. Gagné, R. (1985) brings to light the importance of how the teacher designs instruction in a way that facilitates effortless meaning making. Moll (2001:113) cites mediation tools as “procedures, thought methodologies, and cultural objects that have to be appropriated, practices of discourse and reasoning that have been developed, and play or study practices that have to be exercised”. When ICTs are used as mediation tools (to bridge the gap between the knowledge and the learner or the external and the internal) to make sense of abstract forms, the learners’ ability to improve understanding is enhanced to the extent that the actual level is easily reached even in intricate tasks. Quality ICT use therefore would entail engagement with the tool that does not immobilise growth of the learning process, but empowers the learner with developmental abilities.

At an individual level, quality ICT use would mean developing cognitive skills by empowering learners to solve ill-structured problems. Kitchener (1983) claims, such difficulties are usually

found in the real world and proposes the following model of cognitive processes that account for the development of a learner's capacity to engage with complex tasks. The model presents three levels of information processing that one progressively goes through when faced with an abstract formation to deal with. In the first one, the learner is involved in the knowledge foundation building and Multiple Choice Questions (MCQ) in automated assessment for instance could play an important role in the assessment of this dimension. This stage is similar to the first three Bloom's taxonomy levels (knowledge, comprehension and application). At the second stage, the learner develops the ability to think about what cognitive processes are needed, how and when to apply them to solve problems. WebQuests promote the implementation of this process as learners make decisions on how to solve authentic problems online. At the final stage, the learner is aware of the "limits of knowing, the certainty of knowing, and criteria of knowing" (Kitchener, 1983:222). At this stage, he or she is equipped with skills for analyzing, synthesizing and generating their own knowledge as they work towards solving these ill-structured problems. At that moment, there is an influx of online resources like IntelThink and the K-12 Thinking Tools that help the learner develop these higher-order thinking skills.

Piaget's cognitive principles extend Kitchener's hypothesis by presenting the following definitions of knowledge:

"Knowledge is not a copy of reality. To know an object, to know an event, is not simply to look at it and make a mental copy, or image, of it. To know an object is to act on it. To know is to modify, to transform the object, and to understand the process of this transformation and as a consequence, to understand the way the object is constructed" (Ripple et al., 1964:8).

The concept of a 'mental copy' resonates with the first stage in the Bloom's Taxonomy, (knowledge) where the learner regurgitates information from a text. This represents a lower level of demonstrating evidence of knowledge by the learner and the use of ICTs to simply present slides and typed notes as the only learning resource limits learning to these mental copies. In fact, Piaget does not consider that a precursor for knowing as the learner would not have started 'assimilating' the new knowledge. ICTs should assist learners to advance to a position where they

can say they ‘know’ as Piaget describes in the excerpt above when they are able to explain learnt concepts to other learners, successfully apply knowledge to solve problems using whatever media they have been exposed to. Quality use of ICTs in the classrooms would therefore mean increasing the learner’s ability to move from the first three levels as presented in the Bloom’s Taxonomy and advance to the higher levels of thinking.

Attributes for teacher quality ICT use in the classroom

Teacher quality ICT use in the classroom demands competence in the implementation of teaching principles as the new tool is selected and used in the appropriate teaching and learning activities. Principles related to ICT use in the classroom have been selected and will be discussed in order to highlight proficiencies required and to extend understandings on the teacher’s responsibility in the process.

Technological Pedagogical Content Knowledge (TPCK)

Quality ICT usage requires the integration of three principles that make the implementation process legitimate in this context: the lesson content, the teaching and learning (pedagogy) as well as the use of ICTs (technology) to develop higher levels of thinking. The three features are similar to the Technological Pedagogical Content Knowledge (TPCK) Mishra and Koehler (2006) proposes that a teacher needs to effectively integrate ICTs pedagogically into the curriculum. The concept was developed from Shulman’s (1987) notion of *pedagogical content knowledge* (PCK), which is the amalgamation of the teacher’s two basic knowledge bases. Shulman (1987:8) explains this condition as the “understanding of how particular topics, problems, or issues are organised, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction”. Technology comes in when it is incorporated into the well-structured lessons; most powerful explanations; demonstrations and examples a teacher gives that make it easy for learners to understand new knowledge and skills, and manipulate them to extend their learning independently. The quality of these attributes determine the level at which learners engage with knowledge.

The contention in this paper is that teachers should possess Shulman’s (1987) PCK knowledge base and apply it with whatever technology is available. However the concern is whether they are effectively using it to advance learner performance. The level at which they use ICTs could be a reflection of how much they know about the potential of the gadget or their limitation in infusing it into their teaching.

Mishra and Koehler (2006) have developed an approach that demonstrates the blending of each knowledge type as the teacher integrates ICTs into the teaching of their subjects. The figure below illustrates their concept:

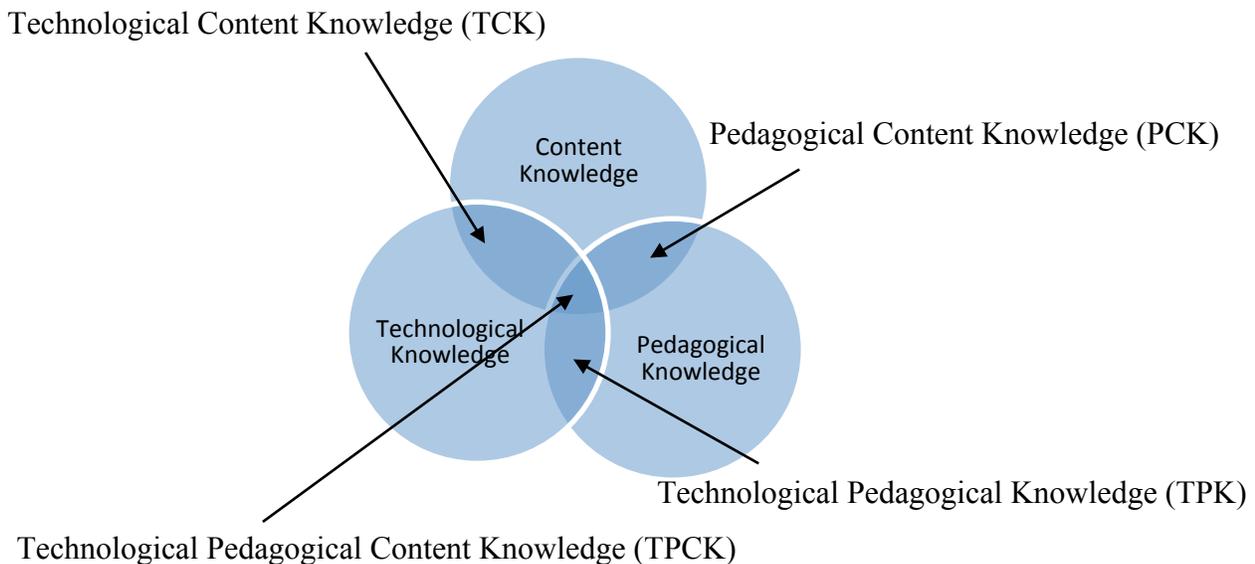


Figure 2: *Technological Pedagogical Knowledge (TPCK) Mishra and Koehler (2006)*

This concept accentuates the importance of not introducing teachers to technology in isolation as in such a case the emphasis is placed on the technology at the expense of PCK. This could be the reason why teachers restrict the use of ICTs to activities that focus on the application of lower cognitive levels. The learning outcome for the content taught should determine the teaching method to be used and thereafter, what technology to use (Haddad, not dated online, www.ictinedtoolkit.org). The choice should be motivated by the impact technology would bring to the learning process. Innovation becomes a necessity in this complex process that demands expertise in the practice and creativity in knowing how to make all fit articulately in such a way that abstract forms of knowledge appear simpler and easier to assimilate and apply at advanced

levels. The following teacher knowledge bases augment TPCK and contribute remarkably to the teacher's engagement with learners and knowledge (Shulman, 1987:8):

- *general pedagogical knowledge*, (that which pertains to the creation of an environment that exposes learners to principles of the subject matter),
- *curriculum knowledge* (goals and programmes to be used within the context of the local needs and the subject area)
- *knowledge of learner* (awareness of the learners' needs and making decisions on what and when to use a specific approach in which phase of the content presentation)
- *knowledge of the education context* (how the school vision and culture, the department of education policies and community's needs are reflected in the classroom)
- *knowledge of educational ends, purposes, and values, and their philosophical and historical grounds* (sound knowledge of the field)

A teacher that is able to effectively integrate ICTs at this level is also aware of all these expectations and draws from the different aspects of knowledge to make learning a wholesome and an enriched experience. Such a teacher uses technology to construct the learning environment in such a way that learners are not only engaged in the "two senses", the visual and listening skills offered by technology claims, but incorporates all senses in the learning and production of authentic artefacts that contribute to contemporary life solutions which come as a result of employment of higher level thinking skills (Henning cited in Oppenheimer, 1997:54).

Selection of ICTs for quality teaching

The integration of ICTs as an approach to teaching requires the accommodation of the new tool into the teacher's practice if their use is to be described as quality and educationally productive. The teacher's capacity to select and manage the learning processes and activities using different media has a huge impact in the development of skills that are critical to learner performance.

Teaching and learning principles should be priority when ICTs are used in the classroom if quality in education is to be achieved. The selection of the technology should be based on how and when it will be used as the lesson progresses, and not much on what looks exciting to the learners (in some cases the teachers) at the expense of learning. Such decisions have a significant influence in determining whether learning will be enhanced or not. Lim and Tay (2003) suggest the following types of ICT tools that can be used to support an achievement of specific learning objectives:

a) Situating tools – are settings where learners can experience the context and events of the item they are learning about to their understanding of a new concept. These can be simulations, games and virtual reality. Hogle in Lim et al. (2003) proposes that simulation and games can improve cognitive learning strategies like; organisation, memory and compensatory, especially where engagement requires critical thinking and problem-solving skills. The purpose of the game and its context should determine its function in the learning.

b) Constructive tools – are devices or instruments used to manipulate information and use it to construct new forms of knowledge. Some of these can be ‘mindtools’ like the databases, spreadsheets, semantic working programs, modelling tools and hypermedia authoring tools that enable learners to represent knowledge in different forms. These do not take the responsibility off the teacher, but triggers the mind to operate at its highest potential. Jonassen and Carr in Lim and Tay (2003:430) report that higher-order thinking skills are only developed when learners construct their own knowledge or tools, rather than when they merely use them. The learners are given an opportunity to evaluate, analyse, connect, elaborate, synthesise, imagine, design, solve problems and make decisions with the ICT tools. The acquisition of relevant skills in the use of authoring tools and the basic concepts of multimedia design process becomes a prerequisite in such a case.

c) Communicative tools – are systems used for the teacher-learner or learner-learner interaction outside the classroom. These can be emails, chat, teleconferencing and electronic whiteboards. Such tools can be used to develop and negotiate meaning in a given context. Asynchronous participation for instance gives the writer time to think about his or her understanding and uses others’ feedback to view it in different perspectives so as to facilitate formulation of a well-rounded knowledge.

Abadzi (2006) suggests characteristics that teachers should foster in learners in order to help them develop their thinking skills. These are “self-regulation” through “perseverance”, “effort” and inculcating a “sense of responsibility” over their learning (Abadzi, 2006:189). Software, such as Scratch and Pac-man, for developing their own games or competitions like Mathletics in Maths and others, motivate learners to learn independently and when they set targets for themselves they control or “regulate” their learning (Lees,2008). Abadzi (2006:189) also advocates for the acquisition of “self-monitoring”. In that case, the teacher evokes their thinking skills by posing questions that demand reflection of their “own thinking and learning processes” (Abadzi, 2006:189). Assimilation comes into play and is refined as the learner seeks to establish and be in control of their learning.

Teacher training approaches

Teacher ICT training approaches that are lightly to prepare teachers for quality use ICT in the classroom are: the *Learning technology by Design*, *Just in Time* and *Just in Case*.

The first approach is an extension of understandings around Technological Pedagogical Content Knowledge (TPCK) discussed earlier. It insists on “constructing learning environments where all three components are treated in an integrated manner” (Koehler et al., 2007:744). The teachers’ practice is enhanced as they tackle authentic problems by integrating different forms of subject and pedagogical knowledge to create communities of practice where expertise is shared and applied in the development of a solution (Koehler et al., 2005). Such participation promotes integration of ICTs into the curriculum in a more meaningful way as it is project-based and design-based, giving a prototype of the thought processes they should engage in when preparing learner tasks that will develop their higher-order thinking skills. ICTs are “neutral, powerful and flexible” tools that need creativity from the teacher if they are to be used to develop HOT skills, Lim and Tay (2003: 431). Innovation in “managing learning and the learning environment; the models used in designing, developing, and evaluating instruction; and the strategies implemented to improving human performance” (Driscoll, 2001:336) are inevitable qualities for a teacher using ICTs to improve thinking skills.

The Just in Case approach uses generic methods to teach technological skills that can be used in case they are needed. The ICT skills are not taught within the teacher's disciplinary constraints and the assumption is that he or she will develop an aptitude to apply them when the need arises in their teaching.

On the contrary, Just in Time approach trains teachers on the use of ICTs in their subject contexts. It can be used either to support learning before a task is performed or as a prerequisite for learning a subject matter (Kester et al., 2001). In the first instance, the learner (teacher) already has basic knowledge of an aspect in the subject and because there is a need to extend understanding, he or she uses technology just-in-time to facilitate deeper understandings. In the second approach the learning of the skill and subject matter occurs simultaneously. Either way; the teacher's learning experience is situated within the subject context and is brought in, just when it is needed, to either extend learning or to explore subject matter.

Case studies on quality ICT use for teaching

Quality teacher ICT use consequently promotes the development of higher-order thinking skills. This overview highlights the nature of teacher engagement with ICTs at international level and in South Africa. It examines how learning in different contexts is enhanced through the development of higher level thinking skills.

International Studies on the development of HOTS with ICTs

Wenglisky cited in Polly et al. (2009:29) claim that teachers are not 'adequately' integrating ICTs pedagogically, despite the influx of computers in schools. They describe the ideal process as one where teachers "design and facilitate learning experiences that develop students' higher-order thinking skills". In their study of a south eastern school in the United States, they illustrated this concept by using WebQuests as activities that teachers could use in their integration as they have the potential to develop higher-order thinking skills. Webquests have the following qualities that promote HOTS: 1) they contextualize learning in meaningful ways that bring real life problems for them, 2) expose them to learning pathways that involve a number of ICT resources and 3) they

are likely not to forget the experiences as they would have been participants in bringing about the solution 4) the product of the activity is original as it presents content in a different form.

In 1994 Christopher Moersch developed a framework for Levels of Technology Implementation (LoTI) based on the principles of higher level thinking skills, to help tell if ICTs were used by teachers to enhance learning (1995). They developed from non-use to where the teacher used ICTs flawlessly. At the highest level, the teachers were able to plan learning experiences that extended learners' understandings beyond the classroom to an extent that they were able to independently resolve complex challenges.

Preparing for ICT pedagogical integration takes a lot of time as teachers have to either develop their own materials or spend time looking for localised or specialised software to use in their classrooms. Sicilia (2005) says teachers in Canada spend a lot of time designing projects that incorporate use of new technology. With the emergence of new technologies, more time is needed to learn and gain experience and confidence to use it in the presence of learners who in most cases know better than them (Becta: 2004).

If teachers are to use ICTs effectively, they need to be conversant with basic knowledge of the characteristics or the affordances of the technology they are using and how they should adapt their teaching approaches to enhance learning with it. Pelgrum (2001) and Al-Al-Oteawi (2002) argue that lack of technological competence constrains the adoption and acceptance of ICTs by teachers. Bingimlas (2009) confirms that surveys conducted in Syria, Arabia, Europe and Denmark have proven that teachers lack ICT knowledge and skills to start the integration process. Most in-service teachers are what Prensky (2001) would refer to as digital immigrants for the reason that they were not born and probably trained in the age where modern technology was used to the extent that it is used now.

Özden (2007) and Toprakci (2006) say there is lack of adequate in-service training. They recommend that teachers acquire the basic computer literacy skills that prepare them for operating the machines and what Van Dijk (2004) refers to as instrumental skills. Most teachers are given this training as soon as the gadgets are delivered in schools, and yet despite the efforts to prepare

them for ICT usage, Albirini (2006); Balanskat et al. (2006); Beggs (2000); Özden (2007); Schoepp (2005); Silicia (2005); Toprakci (2006) agree that there is lack of effective training. Gomes (2005) confirms that there is lack of training in digital technology and Becta (2004), Albirini (2006) and Newhouse (2002) advises that it is best if that kind of training is done in the initial teacher training and that is not yet happening at the level that would help them develop skills, knowledge and attitudes about effective use of ICTs in their teaching. Such exposure grants the trainees confidence to move from instrumental skills to information skills that would prepare them for constructing knowledge. Cox et al cited in Bingimlas (2009:240) says teachers are still not integrating ICTs because they are taught how to ‘run a computer’, because ‘courses focus on teacher acquisition of basic ICT skills and not developing pedagogical aspects of ICT’. It is therefore evident that the instrumental skills that are offered to teachers fall short in preparing the teachers for ICT integration.

Pelgrum (2001) considers inadequate teacher training as a major contributor for low productivity in ICT usage in the classroom. That diverts ICT teacher training focus from instrumental skills to integrating technology into their teaching. Becta (2004) and Gomes (2005) as cited in Bingham (2009:239) call for ‘pedagogical and didactic training in using ICT in the classroom’ and uses the example of Netherlands teachers who have technological skills, but lack competence to integrate ICTs pedagogically.

On the other hand Watson (2001) recounts the effective pedagogical integration of ICTs by teachers in Canada, Netherlands, England and Spain to the practitioners’ approaches to delivery of their subject matter. The teachers realize and “enjoy the pedagogical potential of ICT because it relates to their own philosophical underpinnings about and the nature of their subject” (Watson 2001:259). They value the exploratory work that learners engage in through the use of ICTs and how these technologies are able to supplement their subject teaching.

Lim and Hang (2003) conducted a research in Singapore to investigate teachers’ integration of ICTs to develop their learners’ HOTS. They learnt that when ICTs were introduced, the technocentric approach was used and as a result the teachers’ lesson presentations were a duplication of old methods of teaching. Later, the teachers used technologies for developing

HOTS by making the resources available to whoever needed them and whenever they were needed in the computer labs. In 2001, Singapore was reported as reaching maturity levels in ICT pedagogical integration as a result of the approach they took in the use of ICTs. The new technologies are now used as ‘meditating tools’ that significantly contribute to the progressive development of higher level thinking skills through activities that are “goal-directed, multi-step and strategic processes...” (Lim and Hang, 2003).

South African Studies on the development of HOTS with ICTs

South Africa and many African countries are faced with the challenge of employing unqualified or under-qualified teachers to fill in spaces created in their effort to offer education services universally. A sound understanding of one’s content knowledge and pedagogy places a teacher in a position where he or she can both create a subject content package electronically and be in a better position to select software that would benefit practice. Digital content can then be used to supplement or present knowledge or skills in a way that would make learning easy. Creation or designing of materials online demands a high level of understanding in the learning theories – how learning takes place, particularly in this new learning platform and an awareness of digital technologies that have a potential to produce the learning effects desired either in the presence or absence of a teacher. In most learning management systems and digital content available, constructivism (designing of the learning materials) and behaviourism (in assessment) have been used. The application of this knowledge determines the impact the digital content or assessment has on the learning. Most teachers particularly in developing countries still lack that knowledge and as a result software with materials irrelevant to local contexts have been bought and used in classrooms making it difficult for learners to grasp the concepts taught in the subject.

In 1998 a survey to look at the nature of ICTs in South African schools was undertaken by Lundal and Howel for the Education Policy Unit in the University of the Western Cape. The researchers concluded that “effective use of ICTs adds value to the process of teaching” Lundal et al. (2000:142). Their evidence proved that a small fraction (32%) of the secondary schools used computers for learners to tackle problem-solving tasks and 22% used them for drill and practice. Schools with better (more advanced) digital equipment had a higher inclination to effectively use

ICTs for teaching and learning. Based on the history of the South African Education system, the disadvantaged schools still face the challenge of limited resources and the evidence above eliminates most of them from effective use of ICTs for educational purposes. On the other hand, Wilson and Thomson (2005:9) argue that “increased access to computers alone does not necessarily mean increased implementation of technology-integrated lessons”. The same may go for effectiveness in the use of computers for teaching purposes. However the two studies agree on the fact that the length of time schools have had with computers has an impact on the extent to which they are used for enhancing teaching and learning. It should therefore be expected that schools that have recently acquired computers are still in the lower phase of integrating ICTs and probably not using them at a level where they can help learners develop higher thinking skills.

Wilson and Thomson (2005) investigated the level at which South African teachers are integrating ICTs. The research was specifically examining the teachers’ uptake and application of the Intel® Teach to the Future programme skills. 93% of the teachers had access to computers for teaching and yet 48,5% used them for “more than once per month” and integrated them into their teaching practice (Wilson and Thomson (2005:18). Although most teachers in this research were placed at the ‘application’ (second) stage of the UNESCO 4 level model for ICT integration, the study did not observe the lessons to determine whether HOT skills were developed in the process. The researchers recommended that further studies be made on the ‘pedagogical practices’ to find out if the present usage is aligned with the White Paper on –Education policy where the nature of ICT integration in schools is concerned.

Howie and Blignaut (2009) carried a study to determine if South African secondary schools were ready to integrate ICTs into the teaching and learning of Mathematics and Science. They discovered that teachers with less confidence in using the computers were unlikely to develop competence in using ICTs for teaching. Confidence is developed through the use of computers over time and challenges of accessibility constrain this attribute in teachers.

When comparing the methods used to prepare teachers for ICT integration, Thailand educators relied more on the information they read from professional journals and yet South Africans preferred informal channels like colleagues and observation. That has an impact on their capacity

to develop themselves, which is a requisite for innovativeness required to use ICTS effectively. Only 15% of South African teachers were reported as using computers in their courses and this could be a reflection of the number of teachers who are not competent in using ICTs pedagogically and yet the quality of usage becomes an issue.

du Plessis and Webb (2009) carried out a study in the Faculty of Education at the University of Nelson Mandela Metropolitan to apply the learning as a design framework to develop a Grade six class' critical outcomes. They used the generative use of computers in a hypermedia project-based approach. The approach creates an environment where they “construct knowledge by designing and creating their own representations of knowledge through mindful and challenging learning” (du Plessis and Webb, 2009:16). The learning experience is authentic, posing real-life problems that are ill-structured and demand deep thought and reflection. The findings showed that besides learners acquiring new computer skills as they pursued the solution for their tasks, they developed higher-order thinking characteristics like knowledge creation, evaluation and analysis of knowledge through use of multimedia to design hypermedia artifacts (du Plessis and Webb, 2009:24).

Recent studies in South African schools that have attempted to investigate the utilisation of ICTs in the classroom present evidence that shows quality ICT usage is in small and insignificant patches which should be a cause for concern for a country that values quality and equity. More research is needed on investigating the quality of ICT usage in the classroom, to find out if it enhances learning, particularly in previously disadvantaged schools where access to quality education is lacking due to inadequacy in both human and physical resources.

Conclusion

The key to quality use of ICTs hugely depends on the teacher's capacity to teach effectively with or without the technologies. There is no doubt that “Teachers are critical in facilitating learning and in making it more efficient and effective; they hold the key to the success of any educational reform” (Haddad, online, www.ictinedtoolkit.org. The tool on its own, no matter what it is or how many of it we have in a classroom or computer laboratory cannot enhance learning on its own. It

takes human effort (teachers) to utilise it in a way that will help achieve the goals we have for education. This literature review has highlighted critical issues responsible for the misconceptions that reduce ICT use for teaching to just giving unproductive access and use that comes about as a result of inadequate preparation of teachers for this complex and multifaceted process.

Recommendations

As ICT in education policy implementers, South African teachers from disadvantaged communities need to prioritise subject content knowledge. To transform the content, they need pedagogical knowledge. For a teacher to successfully teach subject knowledge, he or she should possess the two knowledge domains. If knowledge of one is weak, productive learning will not take place, even with ICTs. Productive learning entails enhancement of learning that empowers learners to reach higher levels of cognitive development to actively participate in the production of knowledge.

Training of teachers in the use of ICTs plays a critical role as the modelling or instruction will either promote poor use of the resources particularly where they are limited. Focus must be on giving them authentic and relevant experiences with the available tools in their subject teaching contexts, rather than provide them with skills that confine ICT use to the reproduction of old methods that do not develop higher levels of thinking to enhance learning and are no longer relevant in this emerging information society.

In summary, the following considerations for quality ICT use in the classroom have been adapted from Haddad's (2007:5) four broad conditions for effective use of ICTs.

1. What subject outcomes do we want to achieve?
2. What technologies can help best achieve the outcomes?
3. What technologies are we talking about or do we have?
4. To what use are we putting ICTs in the advancement of learning?
5. Is the potential of ICTs properly exploited?

6. Are the conditions for ICT effectiveness met? (the effectiveness can be measured by the quality of learner performance used in each subject area)

These conditions override the circumstances the tool user finds him or herself in, but focus on taking precaution that the use of ICTs promotes enhancement of learning. These considerations demands that the teacher engages innovation as a powerful mechanism in developing thinking skills that the ICT in education policy seeks to produce even in learners in disadvantaged schools through the quality use of digital technologies.

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