Issues and Impediments Faced by Canadian Teachers while Integrating ICT in Pedagogical Practice

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ABSTRACT
Teachers in many schools struggle to integrate Information and Communications Technology (ICT) as part of their teaching practice. Among the issues faced by teachers when attempting to integrate ICT into their classrooms are gaps in ICT knowledge and skills, lack of training and inadequate support and scaffolding. Other issues include inability to translate training into pedagogical practice and curriculum design and lack of access to current hardware and software. Research in the field addresses the exponential pace of technology development and obsolescence as well as the financial and educational implications of teaching and learning in such an environment. Teachers are core to the integration of ICT in the classroom and hence are often under pressure, since ICT integration is not just about having the right hardware and software; it is deeper and covers many layers. Integrating ICT requires a harmonious synchronicity of content, teacher knowledge, compatible theoretical framework and suitable pedagogy all at the appropriate stage of knowledge acquisition. This review explores the current obstacles to ICT integration in the Canadian classroom as well as the issues faced by educators related to these obstacles.

Keywords: Review, ICT integration, ICT issues, Pedagogical practice, Barriers

INTRODUCTION
Since the advent of the personal computer and the beginning of the Information Age in the 1970's, there has been a continuous effort to introduce new technologies into teaching and learning in education. The approval of Information and Communication Technology (ICT) integration universally in the education system has frequently been touted on the assumption that technological implementation and changes will improve and transform the system and provide students with a stronger position to deal with working in the information age. Pelgrum (2001) suggested that ICT is considered to go beyond providing the infrastructure for the Information Society to serving as a medium for reform that converts students to 'productive knowledge workers' (p.163).

Scholarly research in this area confirms the belief that the implementation of ICT in science and mathematics education can help improve students' problem solving skills, theoretical understanding, and group productivity skills (Culp, Honey & Mandinach, 2005; Tao & Gunstone, 1999). Eggen and Kauchak (2003) observed the advantages to students on an internal level and suggested that technology can elucidate motivation in learners by compounding self-efficacy and self-esteem, increasing attendance, fostering goodwill towards educational institutions, eagerness towards activities outside classroom and more student participation in learning activities (p.420).

On an external level, the benefits to students were noted by the International Confederation of Principals (ICP) (2003) as the ability to transcend time and space in transforming learning both inside and outside the classroom (p.1). Among additional perceived benefits to learners that the principals noted were quick access to enormous amounts of information, global access to quality material, opportunities to interact with peers and experts without any geographical restrictions. Also noted were the possibility of experimenting with simulations and working with a variety of tools appropriate for diverse learning styles. Similarly, Dhanarajan (2002) summarized benefits for learners suggesting that an enhanced and personalized learning milieu that caters to the desired pace, peers and place of learning can be brought about using the tools of ICT like email, internet, audio-visual media, and computing (p.74). These tools and opportunities were previously unavailable to educators until the 1990's.

Although continuous effort on a global scale has been committed to the integration of ICT in education, Goktas et al. (2013) suggested that integration issues do arise from time to time and are sometimes challenging. It should also be noted that ICT does not cater to all the educational needs. In fact, if used incorrectly, it could create problems and add to those previously present (ICP, 2003). In order to integrate ICT in the classroom environment, a number of factors need to be aligned for a successful ICT setup. These include, appropriate hardware and software, computers proportional to the number of students, teacher understanding and

commitment to the technology as well as ICT appropriate teaching methods and techniques (Becta, 2004; UNESCO, 2004). The complexity increases when there are blurred lines between what each school means when they refer to ICT integration (Hadjerrouit, 2009).
Hadjerrouit (2009) referred to Rautopuro (Rautopuro et al., 2006; Webb, 2002), in suggesting three facets ICT in school education:

a) The use of ICT to support teaching and learning processes, using word processors, spreadsheets or databases in disciplines like mathematics or science.
b) The provision of educational materials like LMS (Learning Management System) or Web-based learning to create a learning environment in order to facilitate learning through ICT.
c) To learn the processes, concepts, skills, and knowledge of ICT as a discipline in itself (p.155).

Schools (K-12) are under pressure to implement all the three aspects of learning ICT, however with limited support, this goal is not always possible and mostly ICT integration is a balancing act by implementing some of each of the three aspects. Frequently in schools, there is a mismatch between the availability of finances to purchase the technology and the price of current technologies available in the market. This problem is amplified because "digital technologies morph and change quickly at a rate that generally outpaces curriculum development" (Johnson et.al., 2011, p.4). With limited budgets and dwindling government support (http://www.cbc.ca/news/canada/nova-scotia/story/2012/02/10/ns-school-boards-funding.html; http://www.thestar.com/news/gta/education/article/1210468--toronto-and-peel-school-boards-prepare-for-biggest-cuts-since-harris-years), a number of schools set their ICT policies and type and level of integration based on what they can afford. This situation puts tremendous pressure on teachers who are expected to flawlessly integrate ICT in their classrooms under such conditions.

To further confound the issue, teachers vary in their background and approach to ICT (Nikolopoulou & Gialamas, 2016). Research in this area shows that in a significant number of schools, the potential of learning with ICT is lost as several educators still have gaps in their ICT knowledge and hence do not use ICT in their teaching despite its apparent benefits for educational purposes (Bingimlas, 2009; Pelgrum, 2001; UNESCO, 2004). Another problem is that teachers are very seldom consulted when ICT policies are developed and their subsequent integration recommended. When this oversight happens, teachers are unable to develop a positive attitude towards ICT and hence reject the applicability of ICT in their teaching practice (Hammond, 2014; Watson, 1998; Woodrow, 1992).

The National Teacher Survey (2005) of teachers based in the United States showed that only about 54% teachers integrate computers into daily instruction and just about 25 % believed that their training was adequate enough to use recent instructional software packages. Another noteworthy point was that just 21% of teachers thought that they had had adequate professional development training in the use of assessment software. Ertmer (1999) suggested that teachers' classically entrenched core beliefs are resistant to change and therefore impact fundamental change. The analogous reality is that educational change is reliant on "what teachers do and think – it's as simple and as complex as that" (Fullan, 2007, p.129). The point being that the role of the teacher influences educational technology. Teachers' perception of and response to technology, and also their use of educational technology to achieve their intended outcomes will affect its future employment within the classroom (Roblyer, 2003 in Magliaro & Ezeife, 2007). McGehee and Griffith (2004) recommend that educators need to incorporate new technologies into their teaching so that they can maximize the potential benefits of ICT, resulting in improved student performance.

One of the elements impacted by the reduced financing capability of the school is student-computer ratios. A higher student-computer ratio in the classroom has been noted as a barrier to successful ICT integration (Pelgrum, 2001; Statistics Canada, 2005; U.S. National Teachers Survey, 2005; Korte & Hüsing, 2007; Bingimlas, 2009). However, all is not lost here, since studies have shown that increasing the number of computers showed no significant relationship to student performance (Hu, 2007; Lei, 2010). So the issue then boils down to 'optimal' usage of the technology on hand.

Shared use of computers has been the reality since microcomputers were introduced into classrooms. Developmental and learning theories suggest that social interaction and peer support can stimulate learning and help in knowledge building. In the normal course of life, we gain knowledge through peer interaction and based on evidence, "under the right circumstances, groups are remarkably intelligent, and are often smarter than the smartest people in them" (Surowiecki, 2004, p.xiii). Hence, to support optimal learning using ICT, if we use a carefully planned approach instead of simply placing students together in groups, we should be able to achieve a successful learning environment that could potentially be richer than an individualized learning environment.

Keeping the benefits, obstacles and research-based realities of integrating ICT in mind, my research looks at ways in which educators can address some of the issues and support the integration of ICT in classrooms that have limited ICT infrastructure.

STATEMENT OF PURPOSE

The purpose of this study was to explore current obstacles to ICT integration in the classroom as well as the issues faced by educators related to these obstacles. Research in the areas of technology and obsolescence, classroom student-computer ratios and teacher perspectives on the integration of ICT was gathered and analysed.

REVIEW

This review examines the impact of technology on ICT integration in K-12 schools as well as research in the area of school and teacher issues and attitudes towards the integration of computer technology in teaching practice.

Literature Selection Process

In order to conduct a detailed systematic search of the research literature on impact of technology on ICT integration in K-12 schools, multiple electronically available databases were selected and searched to identify all published studies relevant to the topic (Cook & West, 2012). Indexing databases selected for this search were Educational Research Information Center (ERIC), Psychological Information (PsycINFO), Scopus, and Web of Science. The following keywords were used in the literature searches: ICT integration, ICT issues, pedagogical practice, K-12 schools, Canada and review. Papers yielded by the searches were initially screened for inclusion based on their title, followed by a review of the abstract. However, not all studies generated by the electronic search were reviewed as further criteria were used to screen their suitability.

The inclusion criteria were that:

(i) they were a review or meta-analysis or a study in the area of ICT integration in K-12 schools and that they were from a peer-reviewed source;
(ii) they reported on ICT integration in K-12 schools or research in the area of teacher issues and attitudes towards the integration of technology in teaching practice; and
(iii) only documents published in English were used (to focus on directly usable material)

and the exclusion criteria were:

(i) unpublished theses, dissertations or presentation abstracts that were not published in peer-reviewed journals (grey literature);
(ii) reviews they were simply descriptive; and
(iii) not clearly linked to the concepts under review or parallel lines of research in other areas

TECHNOLOGY AND OBSOLESCENCE

"The only big companies that succeed will be those that obsolete their own products before someone else does" Bill Gates - Founder, Microsoft Corp.

The computer industry frequently and unfailingly launches products that are smaller, more powerful and less expensive than their predecessors. This stems from the conviction that every piece of technology so far, (hardware and software) is affected by Moore's law which states that "The number of transistors incorporated in a chip will approximately double every 24 months" (Intel, 2005). Moore's law predicts and is valid to the way technology is advancing. However, does that mean that we 'need' the latest (better and smaller) technology in education to teach the basic concepts of other (non-computing) fields like Biology, History and so on?

There are other factors at play and not just the fact that technology is moving at a rapid pace. Among these factors is the concept of 'planned obsolescence'. Planned obsolescence is a term that can be traced back to 1932 with Bernard London's pamphlet '*Ending the Depression through Planned Obsolescence'* in which right at the beginning (even before a product is manufactured) the idea is to deliberately make sure that the product's useful life is limited. This causes the consumer to feel the need to purchase newer products as replacements for the older 'obsolete' ones. In the technology industry, Sandborn (2007) suggested that hardware and software have developed a symbiotic relationship where hardware enhancements trigger software manufactures to make their software obsolete in relation to the hardware technology. This situation in turn causes older hardware to become out-dated. For example - CorelDraw X5 needs a minimum processing power of Intel® Pentium 4, AMD Athlon 64 or AMD Opteron. But a Intel® Core™ Duo 1.83 GHz, AMD Dual-Core 2.0 GHz or higher is required for video editing (Corel Corporation).

Hindle (2008) conceptualized this software/hardware relationship using the analogy of children being born with the ability to speak a language that they understood but their parents could not, yet being able to understand the language of their parents. Similarly, new versions of software can understand and communicate with previous

generations of the software but communication in the opposite direction may not always be possible, thus reducing the utility of older versions in time (p.147).

As an example of hardware requirement changes necessary for running the newer software, in the older version of Windows Operating System (OS), Windows 98, the minimum memory requirements were 64MB, which now have increased to 1GB (1024MB) for the Windows 7 version. Similarly highlighting the case of changes in newer and improved software, for example, let us examine the differences in the Microsoft program – Word (a type of document typing and editing software). Between the product's first launch in 1989 and the following 10 years, the number of toolbars went from 2 to 23, to 31 in another 4 more years and more in the following years! So by the time people are trained to understand the workings of the new software, the newer one is launched or ready to launch, starting the whole process of training again.

Aronson (2008) confirmed that by the time many of us get our hands on the latest piece of technology, there is already the successor (or replacement) getting ready to roll out of the manufacturing plant. Hence, the major concern with adopting new technology in schools is that it puts an incessant strain on the limited budgets and dwindling resources often leaving a significant number of schools with either obsolete technology or high computer to student ratios for new technology. With technology advancing and rapidly getting obsolete, for schools, there is an emergent widening gap between the integration of advanced technology and teaching and learning. For teachers, it becomes a challenge to integrate this ongoing advancement into the classroom, which in turn impacts the student.

CURRENT SETUP IN SCHOOLS

According to the Merriam-Webster dictionary, a Personal Computer (PC) is defined as: "A general-purpose computer equipped with a microprocessor and designed to run especially commercial software (as a word processor or Internet browser) for an individual user". The key terms I wish to highlight here are 'personal' and 'individual'. Both terms confirm the fact that the PC is a single user machine and has not been designed for the use of more than one user. However, this has not been the case since the introduction of microcomputers in schools, and even today many schools allocate a single PC to multiple users.

Schools are under pressure to allocate significant time and money for integrating technology into curriculum, with the prime intent of improving student academic achievement (OECD, 2001; Plante & Beattie, 2004; U.S. Department of Education, 2000). Since teachers are fundamental to any integration plan, they have been under pressure to learn technology skills and then teach by incorporating ICT into their practice. However, current trends of increasing budgetary constraints and projected economic conditions make it difficult for a large number of educational establishments to provide this technology adequately to their students (Ali, 2007; Zhao et al., 2002).

Validating the costs associated with technology acquisition, in a significant number of schools, it is unlikely that the PC is used 'individually'. According to Ertl and Plante's (2004) report, published by Statistics Canada, in 2003/04 about 72 computers per school were used for educational purposes. With a median of 12 minutes per school computer dedicated to support and maintenance each month, the number of working PC's for use available at one time for teaching drops below the average of 72 computers per school. Also, less than 25% of the K-12 schools in Canada were operating with around 50% of their PCs running the most recent Operating System (OS), with Quebec and the Atlantic provinces trailing the list (Statistics Canada, 2004).

Research surveying educational practitioners, over a number of countries spread across continents, identified that an insufficient number of computers hindered the integration of computing technology in schools (Bingimlas, 2009; O'Mahony, 2003; Pelgrum & Law, 2003). Similarly, Mumtaz (2000) reported similar results and further suggested that both an insufficient number of computers and improper software can significantly impact the implementation of ICT. Recently, Nikolopoulou & Gialamas (2016) found that lack of equipment was a key issue in Greek classrooms as well. Under these conditions, options for appropriate technology use are reduced, hindering the opportunities available to the quality use of ICT in the classroom.

Can it be assumed that if a sufficient number of computers are made available with appropriate software, then we should be able to integrate ICT in schools easily? Fabry and Higgs (1997) noted that the appropriate amount and right types of technology along with adequate access is vital for the effective integration of computers and that a suitable numbers of computers alone does not assure proper utility of the technology. This issue is echoed by Zhao et.al. (2002) who state that; "Although in recent years there is a great progress in bringing computers and networks to schools, we found that in many schools teachers did not have easy access to either of the two infrastructures" (p. 512). Based on observations of the above mentioned researchers, it can be said that if

teachers have poor access to technology, it will be reflected in their integration of ICT and teaching. Norris, Sullivan and Poirot (2003) point out the importance of accessibility for teacher's use as: "…teachers' use of technology for curricular purposes is almost exclusively a function of their access to that technology" (p. 25).

Although we can contend that access is key, once the technology is available in the school, however, researchers have identified more facets of the issue and highlight a number of other equally vital factors that weigh in similarly with regards to the integration of ICT in schools. According to Becta (2004), improper organisation of resources, low quality hardware, inappropriate software, or lack of access each can impact the ICT usage in schools. The report *'Integrating ICTs into education'* by UNESCO (2004) cites that "The integration of computers and technology into schools is an expensive and sometimes complex process. It requires all the necessary equipment, competent staff to get it up and running, technical support, and teaching of others to use it correctly and effectively"(p.7).

In Nova Scotia, the 'Computers for Schools' program operates where people and businesses can donate their used but still useable computer equipment to the program. The point to note here is that most of the equipment is older and has been used. Assuming that planned obsolescence is a factor, the equipment should be reaching a point where it has 'lived its life' and hence the possibility of equipment failure or breakdown starts to increase. Bennett (2011) claimed that "Nova Scotia has 60,000 computers in a system serving 127,000 students, many of which badly need replacement" (online report). This claim is validated by the Nova Scotia Department of Education in their ICT report (2005) which states that "In Nova Scotia, 77 technicians support approximately 40,000 computers (a ratio of worse than 1:500)" (p.9). Findings by Preston, Cox, and Cox (2000) as well as the British Educational Suppliers Association-BESA (2002) suggested that when the equipment available is old and less reliable, teachers tend not to embrace using ICT in teaching.

STUDENT COMPUTER RATIOS

In his survey on educational practitioners' views in 26 countries (from the continents of North America, Oceania, Asia, Africa and Europe), Pelgrum (2001) identified that the top barrier to successful implementation of Information and Communication Technologies (ICT) in schools was an insufficient numbers of computers. This sentiment was echoed in the United States by the National Teachers Survey (2005) which found that 62% teachers responded to not having the right computers to student ratio in their classrooms.

According to research conducted by Wastiau, Blamire, Kearney, Quittre, Van de Gaer and Monseur (2013) covering 27 European countries, they observed that in schools in Europe, a computer is shared on an average between 3-7 students. In Canada, the school median is 5 students per computer (Statistics Canada, 2005). This number still falls short of the research suggestions by Corbett and Wilms (2002), that recommended that ratios better that one computer per four or five students, are necessary to ensure significant improvements in learning. However, for essential practices to be fundamentally changed, DiSessa (2000) suggested that the critical ratio is one computer per three students. According to the US National Teachers Survey (2005), only 13% of teachers had one computer to two or three students in their classroom.

Fabry and Higgs (1997) found that a large number of schools highlighting their low student to computer ratio had a significant number of computers that did not provide easy access for learning and were of poor hardware and software specification. Agyei and Voogt (2014) echo this and suggested that limited technological resources in schools present themselves as a key barrier to the integration of ICT in classrooms. This situation makes us question the value of such low ratios, since such dated technology and incompatible software specification would not be able provide the improvements suggested by Corbett and Wilms (2002) and DiSessa (2000) in learning. More recently, Larkin (2011) questioned the optimal one computer per student ratio recommending instead that one computer be available for every two students. His research suggested that "1:2 computing is preferable to 1:1 computing to achieve a balance between productivity, student engagement, social activity, and individualised learning" (p.101).

Studies have shown that increasing the number of computers showed no significant relationship to student performance (Hu, 2007; Lei, 2010). However, Lei's (2010) study also suggested that "for technology to have meaningful impact on teaching and learning, close attention must be paid on the quality of technology use: how is it being used, what is used and for what purposes" (p.468).

TEACHER INTEGRATION OF COMPUTING TECHNOLOGY

McGehee and Griffith (2004) recommended that educators need to incorporate new technologies into their teaching so that they can maximize the potential benefits of ICT, resulting in improved student performance. The

Algemeen Directeurenoverleg Educatieve Faculteiten (ADEF) (2009) suggested that a teacher should be proficient and competent in key areas in order to integrate ICT in the classroom. These key areas were:

1. Instrumental skills

The teacher has enough technical or operational skills required for the use of a computer in order to employ ICT in lesson situations and in educational organisation.

2. Information skills

The teacher is knowledgeable about media and skilled regarding information.

3. General pedagogics

The teacher makes appropriate use of ICT in lessons and is able to combine digital and non-digital teaching materials (blended learning), to make learning more effective and/or efficient.

3.1. Presenting

The teacher is adept in integrating digital material into lessons and can employ varying pieces of hardware to achieve desired educational outcomes.

3.2. Collaborating and communicating

The teacher is familiar with a number of synchronous and asynchronous digital forms of communication and is able to employ these in the lessons.

3.3. Working individually

The teacher is able to guide students working independently with ICT.

3.4. Guiding and evaluating

The teacher is able to use ICT in teaching and evaluating students. To this end the teacher is capable of gaining insights into the student's learning using ICT.

3.5. Testing

The teacher is able to develop/compile, administer and evaluate simple digital tests.

4. Designing and developing

The teacher can use ICT for designing and /or developing digital teaching material. (p. 3-6)

However, research in this area showed that in a significant number of schools, the potential of learning with ICT was lost as several educators still have gaps in their ICT knowledge and hence do not use ICT in their teaching despite the apparent benefits of the use of ICT for educational purposes (Bingimlas 2009; Pelgrum 2001; UNESCO 2004). The US National Teacher Survey (2005) showed that slightly over half (54%) of teachers integrate computers into daily instruction and just about a quarter of them thought that their training was adequate enough to use current instructional software packages. Professional development training in the use of assessment software was perceived as adequate by only 21% of teachers. These statistics suggest that a majority of teachers might resist adopting technology-related practices.

Research by Barak (2006) suggested that teachers are cautious about integrating advanced technologies in schools even though they take advantage of ICT for their personal development and learning. The reason that teachers are cautious can also stem from research like Slaouti & Barton (2007) who observed that hindrances such as time pressures, accessibility of equipment, lack of mentors and opportunities for apprenticeship or observation also have an impact on teachers' ability to integrate ICT. Globally, researchers believed that integrating ICT for instructional purposes eventually rests on the attitudes of teachers toward the technology (Huang & Liaw, 2005; Teo, 2008). In the case of learning environments, technology optimization should not be the 'holy grail'. For instance, although there are potential benefits of using ICT in teaching and learning, one should bear in mind that the value of knowledge that can be imparted and gained on its own with limited use of technology is valuable. This sentiment is echoed by the President's Panel on Educational Technology (1997) who suggested that lessons using ICT should "emphasise content and pedagogy, and not just hardware" (p.8). That is, the focus when implementing ICT might shift from student learning and achievement to the state and capability of the technology. Such a focus would need to be examined critically.

Earlier research in this area of teacher integration of ICT in the classroom still shadows some of the current issues faced. Hodas (1993) talked about "technology refusal" by teachers, identifying concerns that teachers sometimes fear both technology and loss of control that might result from increasing technology use in the class. Tying these concerns in with current research by Tella et al. (2007), it was found that "inadequate knowledge to evaluate the role of ICT in teaching and learning, lack of skills in the use of ICT equipment and software had resulted in a lack of confidence in utilising ICT tools" (p.14). So since 1993, limited changes have occurred in regards to some of the factors identified as hindrances to the integration of ICT by teachers.

Some of the key factors like teacher attitude, experience, knowledge, training and integration of ICT into the curriculum are discussed in detail next. These factors can be either facilitators or hindrances. In Canada,

according to Statistics Canada, the usage and acquisition of ICT by teachers is in line with research in other jurisdictions.

Table 1 presents the most recent data collected by Statistics Canada in the context of teacher ICT development. It shows the percentage of schools that promote teachers' understanding of ICT and the techniques they use in helping them learn and integrate the technology in their practice.

Table 1: Strategies to Help Teachers Learn How to Use ICT

	Mentoring or coaching activities with teachers or ICT professionals	**Information-sharing or discussion with staff**	**Personal learning activities**	**Professional development**	**Training sessions**	**Staff meetings**	**Organized after-school sessions**
	% of schools						
Canada	**25.1**	**18.2**	**14.6**	**12.8**	**12.2**	**8.0**	**7.2**
Newfoundland and Labrador	17.3	12.7	6.6*	7.8	6.1*	4.4*	X
Prince Edward Island	27.4	17.4*	X	13.6*	x	x	X
Nova Scotia	21.0	16.1	16.4	11.9	10.2	5.5	5.5
New Brunswick	20.4	12.6	12.0	10.0	12.3	7.6	8.7
Quebec	30.9	16.8	20.6	11.7	19.3	10.2	9.8
Ontario	24.9	21.4	12.6	13.1	10.6	8.6	7.1
Manitoba	24.9	16.9	14.5	14.0	14.8	5.6	4.9
Saskatchewan	19.7	13.9	12.0	10.9	10.4	5.3	6.4
Alberta	31.3	21.8	17.3	20.2	13.0	9.0	8.8
British Columbia	17.8	12.8	11.2	8.5	7.0	5.7	4.0
Yukon	33.3	33.3	X	X	x	x	X
Northwest Territories	X	x	X	X	x	x	X
Nunavut	X	x	X	X	x	x	X

Note: Estimates reflect the answer category 'a lot of emphasis placed by principal on strategies to help teachers learn how to use ICT'.
* Lower reliability estimates due to sample size.
x Suppressed to meet confidentiality requirements of the *Statistics Act*.

(Source: Information and Communications Technologies in Schools Survey 2003/04, Centre for Education Statistics, Statistics Canada, p.26)

Beliefs and attitudes

Embracing and integrating ICT in the classroom can be strongly influenced by the teachers' attitudes towards ICT (Chai et. al., 2009; Drent & Meelissen, 2008; Jimoyiannis & Komis, 2007). Kulik, Kulik and Bangert-Drowns (1985) conducted a meta-analysis of 32 comparative studies on the impact of computer-based instruction on elementary school students' achievement. This earlier research focussed on the student rank and achievement. Factors such as teacher's attitude and level of integration were given less weight at that time. These factors are now being highlighted in current research and acknowledged as having a significant impact on student learning.

Recent research into the barriers to ICT integration in schools highlights that teacher attitude is not just a personal dynamic, but it is strongly influenced by the support and scaffolding available to the teacher in terms of implementing ICT. This support and scaffolding also demonstrates itself in the form of access and failure rates of available equipment, the opportunities for training given and the school philosophy towards the integration

and application of ICT in the environment. (Becta, 2004; Dawes, 2001; Ertmer, 2005; Mumtaz, 2000). For example, a teacher who is hindered by the failure of equipment on a number of occasions might reduce their integration of ICT in their teaching. When assessed, this situation can reflect as a negative attitude towards the integration of ICT. Nikolopoulou & Gialamas (2016) echoed the research by Awan (2012) and noted that factors such as access to equipment, training, and the support of the education community, played a huge part in the attitude the teacher had and their inclination to integrate the ICT in their practice.

Teacher's attitudes in integrating ICT also have an impact on the attitude of the students towards ICT. Sime and Priestley (2005) in their research found that "individual teachers were also perceived as having the power to model children's attitudes towards ICT and their attitude in this sense was considered as crucial. When teachers were enthusiastic and dedicated to finding ways of using ICT in teaching, and gave pupils meaningful tasks on the computer, pupils were thought to be more involved in their learning with ICT" (p.137). Their research also found that "even when resources were limited and access to computer suites was problematic, students thought that the individual teachers' attitude was the vital factor in determining ICT use" (p.137).

Teacher's attitudes and beliefs are fundamental for the successful integration of ICT in education. However, they are not standalone factors in the integration of ICT. A positive attitude towards ICT along with the right support and scaffolding for the institution can go a long way in the successful application of ICT in schools.

Knowledge and experience

Pelgrum (2001) cited lack of skill and/or knowledge as well as issues with integrating ICT into the lesson, as the top non-material hindrances to developing a successful ICT school environment. These hindrances could be explained in the research completed by Oren, Mioduser, and Nachmias (2002) who noted that teachers had limited knowledge of integrating ICT into their practice since "… most current teachers' pre-service preparation, and subsequent in-service courses were devised in reference to traditional educational technology and settings (e.g., printed materials, frontal lectures, and face-to-face group work)" (p.15).

According to Oblinger and Oblinger (2005), most of the children born in and after the 1980's belong to the 'Net Generation' (a term coined by Don Tapscott in 1997) where the use of technology and the internet were part of the environment growing up. Being exposed to ICT earlier on in their childhood makes technology an embedded part of the children's thought process. This experience is in contrast to that of teachers who may not have had such an exposure and have to acquire this technology and the various aspects of the technology from the ground up.

The issue confounds itself when teachers who don't have technical backgrounds have to integrate technology and achieve a level of proficiency in using the ICT. Montgomerie and Irvine (2001) noted that when schools employed graduates with a higher qualification in education, it was expected that they have a reasonable level of ICT knowledge and exposure to ICT implementation. Even in the case where the teacher may have had a formal training in Instructional technology, there is a very high chance that they have little to no knowledge on how to translate that training into their teaching practice and curriculum design (Bauer, 2000; Hardy, 2003). The problem here is that even though the teachers' are entering the schools with a comprehensive grounding in their core subjects as well as training in ICT, there is a possible disconnect between their knowledge and successful integration of ICT with the subject matter and the subsequent presentation of that material for teaching.

The way this can be represented is in the form of an inverse pyramid (Figure 1). At the top, academic knowledge and prior experience along with teaching skills form the foundation of the pyramid. This foundation (in many of the current school systems) is enriched with ICT training (so that ICT can be integrated with the teaching).

Figure 1: *Knowledge Pyramid*

However, the final application and integration of ICT is heavily reduced and is not a cumulative effect of the merger of the two prior factors of foundational knowledge and ICT training (which ideally it should represent). In other words, ICT training that fails to focus specifically on integrating technology into classroom curriculum does not necessarily lead to the desired results. Since all thought processes occur inside the teachers' heads, they cannot be verified. However, how a teacher comprehends and then presents his/her knowledge to the class may be one of the most important variables in the implementation of ICT in the educational environment.

Borko and Putnam (1995) suggested that where knowledge directly influences a teacher's thinking, it predicts their actions in a classroom. To understand teaching, one must then examine the teacher's knowledge system, which includes the teacher's thoughts, judgements and decisions, associations between their knowledge systems and cognitions and how these lead to action. A famous quote attributed to Albert Einstein said, "Not everything that can be counted counts, and not everything that counts can be counted." To facilitate the improvement of teacher's practice, Borko and Putnam suggested that we assist them to expand their knowledge systems (p.37).

Training

Training teachers in the use (and eventual implementation) of ICT is vital for integrating ICT in the classroom. This area has come under scrutiny by the research community since there is an obvious relationship between training teachers in ICT and its subsequent implementation. The rational approach that most of the schools have taken since the introduction of ICT in schools is to train teachers in the use of ICT so that they can implement ICT in their respective teaching. This (expected) simple transition does not always translate from learning to teaching in a number of cases. The reasons are complex and multifaceted - from continuously upgrading hardware and software, to student computer ratios, to prior knowledge, to amounts of training and many more areas that are being highlighted as research in this area continues.

The type of training given is also noteworthy since according to Phelps, Hase and Ellis (2005), "many ICT programs are directive, training through a series of step-by-step instructions and concentrating on a particular program or computer utility" (p.68). The key issue here according to their research, is that computer technology is developing at a fast speed. For those individuals undertaking traditional learning in the use of a software program, the knowledge will become out-dated rather quickly (p.68).

Browne and Ritchie (1991) found that a noteworthy constraint of in-service teacher training is that it becomes a medium for "simply providing knowledge to teachers and doing little to help transfer the skills to actual classroom implementation" (p.28). Such transfer needs to be explicitly modeled – since it cannot be assumed that teachers will automatically generate these ideas on their own. A significant number of teachers in training as well as in-service teachers accept the fact that they are not trained adequately and are frequently not given appropriate tools to implement ICT in their practice (Hardy, 2003). This finding corroborates that of the US National Teacher Survey (2005) when only one quarter of the teachers perceived that their training was adequate enough to support their use of current instructional software.

The issue spreads itself beyond the perimeter of adequate training. For example, Bosley and Moon (2003) found inconsistencies between the extent of ICT training received by a teacher and the degree to which the teacher applied that training in their practice. The authors believed, that this finding suggested a lack of confidence in relating the learning (from the training) into a successful implementation in the classroom. According to Brown and Ritchie (1991), the teacher must present the information in a cognitive form and also demonstrate

confidence and autonomy in the application of the material with students during classroom utilization of technology skills (p.30).

Another dimension to consider is that training a person on the usage of a system does not directly translate to a full blown application of the product, since teachers are not usually given any specific training in the area of multiple users on single-user computer systems. In this area as well as others highlighted in current research, it has become crucial that teachers need to be specifically trained - not just in understanding how the technology works but also the applicability of the technology in order to successfully integrate ICT in their teaching (Markauskaite, 2007; Mitchem, Wells, & Wells, 2003; Yildirim, 2000). During their research Kafyulilo, Fisser and Voogt (2015) found that attending directly relevant ICT professional training courses positively impacted the teachers' confidence when engaging with technology.

Phelps, Hase and Ellis (2005) suggested that end-user computer education programs require modifications in attitudes, values and beliefs to allow change and provide the confidence for ongoing learning. They noted that program participants need application skills more than training because any directed learning software they learn in a training program will be outdated soon with its successor (p.68). Hence, Castro Sánchez and Alemán (2011) suggested that teachers engage with ICT integration in classroom with flexibility and receptiveness.

DISCUSSION

Summarising the literature by various experts in the field, a number of hindrances were identified. However, when looked at closely, the principal factor that was frequently emphasized was (lack of) knowledge/skill. This factor impacted most on the other factors that were identified as hindrances: lack of knowledge and skills caused some teachers to - fear loss of control (Hodas, 1993), lack of confidence in utilizing ICT tools (Tella et al. 2007), inability to translate training into their teaching practice and curriculum design (Bauer, 2000; Hardy, 2003), inability to connect pre-service training to classroom application owing to variations in learning the material and teaching it (Oren, Mioduser, and Nachmias, 2002). Addressing a part of this issue is the work of Nikolopoulou & Gialamas (2016) and Kafyulilo et.al. (2015) that suggested attending directly relevant ICT professional training courses. These courses positively impacted the teachers' confidence when engaging with technology.

The other key factor highlighted was equipment. Nikolopoulou & Gialamas (2016) echoed the research by Awan (2012) and noted that factors such as access to equipment, training, and the support of the education community, played a huge part in the attitude the teacher had and their inclination to integrate the ICT in their practice. Keeping these concerns in mind when it comes to developing learning environments, it was realized that the focus needed to be shifted from developing technology intensive classrooms. For instance, although there are potential benefits of using the latest ICT in teaching and learning, one should bear in mind that the value of knowledge that can be imparted and gained on its own with limited use of technology is valuable. Hence, Castro Sánchez and Alemán (2011) suggested that teachers engage with ICT integration in classroom with flexibility and receptiveness. This open-minded approach would allow teachers to acquire new pedagogical strategies and easily familiarise themselves with the technology leading them to integrate it with comfort. The President's Panel on Educational Technology (1997) echoed a similar sentiment by suggesting that lessons using ICT should not focus on just the capability of the hardware; they should highlight the content and pedagogy (p.8). The focus then in the implementation of ICT shifts from the state and capability of the technology to what advances in comprehension can be achieved by the students during learning with technology.

A key issue to raise is that if group instruction and group learning using ICT is the current reality, then why not embrace it and modify current teaching and learning practices accordingly? Shared use of computers has been the reality since microcomputers were introduced into classrooms. Hence, to support optimal learning using ICT, if we use a carefully planned approach instead of simply placing students together in groups, we should be able to achieve a successful learning environment that could potentially be richer than an individualized learning environment.

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