Technology Implies LTD plus FTE

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(Abstract)

This paper deals with four areas – student learning, teacher development, funding, and teacher education -- as each relates to technology in the school system. The discussion conveys the affiliation between and among the areas. The implementation and appropriate use of technology in the classroom is beneficial to students' learning curve. The realization of this benefit however is very much dependent on the training and retraining of teachers in the field and those about to enter the field. In addition, a commitment to up front and continual infusion of dollars must be the order of the day. Current provincial and territorial practices appear to acknowledge these realities in their varying and similar adopted strategies. Specific policy directions are recommended for each of the four areas. As well, five research questions are suggested to help policymakers reach well-informed decisions about the recommended policy directions. Specifically, the questions are: What levels of thinking skills are being taught through the application of technology in the classroom? What technology professional development programs are utilized by school boards for their teaching force? To what extent are teachers taking advantage of these programs? What is the cost commitment to a school, school board, and ministry of education to introduce and maintain the use of technology in education? What is the cost to establish a three-way partnership between boards of education, private industry, and ministries of education for the purpose of ensuring teacher preparation programs' produce technological literate teachers? How can ministries of education together with school boards finance equitable access to technology?

1. Introduction

Government policy decision-makers are continually faced with the question of whether their decisions are really changing teaching and learning or whether their influence stops at the classroom door. As we are aware, increasing student achievement ultimately depends on changing classroom processes. The issue of bridging the gap between policy and practice has taken on greater importance with the new curriculum reforms that have and continue to occur in our provinces. The adoptions of a new curriculum often create expectation that changes will occur in teaching and learning and many policy makers are closely watching what is happening in classrooms. They want feedback on the impact of newly implemented curriculum reform initiatives. The one reform that appears to generate agreement, in terms of its need, is the incorporation of technology into the learning environment.

This agreement has not meant the removal of conflict. As noted by IBM[1], "there are real barriers - and a legacy of resistance to change involving funding, proper tools and training for teachers, public understanding and even public policy - that need to be addressed before the power of technology can be translated into the power of knowledge for our young people." Although the dialogue continues, there remain debates on what should be the focus of attention.

In some arenas the debate centers on the connections between technology-based instruction and the achievement outcomes of students as reflected by test scores. Other arenas claim that the concern should be the connection between skills obtained and the ability of the student to succeed in the world of work. Still, other arenas view the incorporation of technology as a means of making the entire education system more efficient and productive. In this case, the learning environment encapsulates the student independent of geographical location as well as the administrative processes that run the system. Finally, technology has been viewed as the means for encouraging and facilitating reforms in the structure of the education system, the curriculum, teachers' development, and student learning. If this viewpoint is accepted, the

[1] http://www.can.ibm.com/public_affairs/education/index.html (p.1)

matter is of primary importance and requires priority in policy formulation and funding.

These varying orientations are intertwined. Some are more narrow in their scope than their companion debates. Still, they all aim to identify the knowledge areas that must be given further consideration with regards to the policy issue of technology and the accomplishment of the goal of education that results in improved student achievement. These areas are student learning, teacher development, teacher education at the tertiary level, and funding. Each area is discussed in greater detail in the paper.

2. Learning

Technology in schools has been and continues to be driven by industry. Not surprisingly therefore, early technology education responded to the local economies of the provinces and territories. This response up until the beginning of World War One focused upon agriculture and resource extraction. The two World Wars accelerated the shift of the Canadian economy away from agriculture to manufacturing. Technology in schools followed close behind with many government incentives to promote this shift.

The economy has been undergoing still another major shift in the skills it requires from graduating students. This most recent shift is requesting and even demanding educational institutions to produce graduates with computer and technical skills, strong work-habits, effective teamwork skills, problem-solving skills as well as the literacy and numeracy skills. This is a radical movement from the expectations of the past. Furthermore, educational systems are expected to instill a minimum level of awareness and comfort with technology in general in their students.

Much evidence has been presented about the potential of technology to enhance learning in schools. Grégoire, Bracewell, and Laferrière (1996) in an extensive review of the literature for the purpose of identifying the potentials of information- and communication-rich learning environments for students pointed out that research clearly demonstrates a positive connection between technology and student learning. The authors pointed out that technologies in schools

have the power to stimulate the development of intellectual skills such as reasoning and problem solving ability, learning how to learn, and creativity. As well, the authors note that the type of technology (e.g., simulations, virtual manipulation, rapid merging of a wide variety of data, and graphic representation) integrated into the learning activity is a major factor in the understanding of that learning and the linking of new information with previous knowledge.

Also, the authors point out that the attention span or concentration that the majority of students are willing to devote to learning activities is greater when they use a new technology in contrast to the traditional setting and traditional resources. In contrast to presently widely used assessment methods, new technologies use and manage more demanding assessment methods. These technologies foster a positive, close association of students with the assessment of their own learning. Movement in some provinces would suggest strategies are being put in place that would not necessarily capture this potential linkage between learning and use of technology. For example, in Ontario, Elementary Design and Technology classrooms that were incorporating what the research literature would suggest are being dismantled to accommodate a new curriculum. This has the potential to create an educational system which divides itself on the fault line between academics and technological education. As of September 1999, Grade 9 students will have to choose between ‘academic courses’ and ‘applied courses’.

The positive effects evident in the Grégoire, Bracewell, and Laferrière review of research were culled from more than 70 studies. Their research clearly demonstrates the positive and potentially positive connection between technology and student learning. Perhaps the single longitudinal study that showed many of these results was the 10-year study sponsored by Apple Computers. The study found that technology acts as a catalyst for fundamental change in the way students learn and teachers teach, students became re-energized and much more excited about learning-- resulting in significantly improved grades, and dramatically decreased dropout and absentee rates. Because of the similarity in findings, critics of corporate-sponsored research who caution the consumer that such research has potential benefit to the sponsor must acknowledge, technology has the promise to help students to better achieve.

The Center for Applied Special Technology (CAST) in a 1996 study of the effects of online use on elementary and middle school students learning including information processing, communication, and presentation skills found that students using online communications produced better projects. "In particular, students with online access were more effective in their ability to: present their work, state a civil rights issue [focus of the project], present a full picture (who, what, when, where, why, how), bring together different points of view, and produce a complete project" (p.4). Furthermore, students who used online access became more confident and students without online access became less confident. A surprising finding of the CAST study was students' confident level in the basic skills of reading, writing, and arithmetic was not affected.

This finding can perhaps be explained somewhat by a recent report (Wenglinsky,1998) exploring the relationship between grade four and eight students' math scores, teachers' use of technology in teaching math (along with their training to do so), and school climate, the use of computers in the classroom was an important variable. The study found that when computers are used to teach higher order concepts, and when teachers are trained to direct students to such applications, computers are associated with significant gains in math achievement, as well as improvements in the social environment of the school. This finding appears to be in agreement with past studies. Earlier studies also have suggested, without evidence, that lower order thinking skills could perhaps be achieved without the aid of computers and some suggest that the achievement may be greater if other techniques were adopted. The 1998 study produces evidence that when computers are used for drill and practice (a lower order thinking skill), computer use is unrelated to achievement, and in some cases can be harmful. Alberta Education movement toward the introduction of an interim program (June 2000) of studies that highlight technology learning outcomes for students[1] appears to be in the right direction. Students will be encouraged to grapple with the complexities, as well as the advantages and disadvantages, of

[1]http://ednet.edc.gov.ab.ca/techoutcomes/

technologies. Furthermore, the program is intended to be infused within existing courses. This approach should avoid the negative results found in the Wenglinsky's report. Additionally, the interim program advances a significant finding (see Grégoire, Bracewell, and Laferrière, 1996, p.12) about enhancement of learning. Specifically, research has found that technology can stimulate more extensive investigations of problems, leading to greater satisfaction to the resolution of the problem.

Clearly, the implementation and appropriate use of technology in the classroom are beneficial to students' learning curve. What also is evident from the numerous studies that have been conducted is that the positive results of technology in the classroom are dependent upon the application of the technology by the classroom teacher. However, adjustments in the way the curriculum was delivered appeared to be central to whether technology was a positive or neutral and sometimes a negative tool. The presence or availability of technology alone was insufficient in eliciting improved student learning. This point is exemplified by many of the provincial ministries of education undertakings, for example, EDnet as established by Nova Scotia Department of Education and Culture and in particular its Junior High School Network Project. To complement this Project, the Department of Education and Culture has also put the Junior High Network Project Listserv in place. "It is a closed (private) list wherein these teachers can freely share their ideas, concerns, resources, teaching/assessment, strategies, and other information to support each other's learning and teaching."[2] Melmed (1995), in summarizing the proceedings of a workshop that discussed successful school models in the adoption and application of educational technology, reports factors including excellent teachers, staff development and flexible scheduling for student-centered approach to learning as key to improved learning. Consequently, the strategies that are found in a number of the provinces in terms of directing considerable effort toward the training of teachers is encouraged. As cautioned about, unless teachers are able, willing, and have the infrastructure support to alter

[2]http://jh_network.EDnet.ns.ca/listserv.html

their delivery of a curriculum so as to concentrate on the higher-order learning skills, technology can be dysfunctional to students' learning.

3. Teacher Development

> Teachers are the key to effective and efficient technology utilization. When technology is available, however, it is frequently used with styles of teaching that fail to maximize its full potential. ... This could be the result of inability, improper training, technophobia, or a lack of practice using alternative teaching strategies. Therefore, adequate professional development is needed if technology is to help schools improve learning. (Fullerton, 1998, p.69)

Teachers must remain central to the strategies associated with government policy; unless the view is taken that students only need to be directed to the hardware for learning to commence. The prior section of this paper would dissuade one from this position. In fact, much of the literature concluded that benefits to students using new technologies is greatly dependent on the technological skill of the teacher and the teacher's attitude. This raises the question, what can provinces and school boards do to better prepare and maintain a high quality and technologically literate teaching force.

In an attempt to move teachers to literacy in technology, Alberta has developed a partnership among Alberta Education, the Alberta Teachers' Association, the Alberta School Boards Association, the College of Alberta School Superintendents and the TELUS Bright Futures Foundation. In order to provide Internet training to teachers the TELUS Learning Connection Alliance trains Alberta teachers for the purpose of ensuring that every school will have at least one teacher as an Internet resource and leader for both students and teachers. Applying the "cascade" or "train the trainer" model, these teachers will in turn provide training for additional teachers. In this way, professional growth and mentorship is supported. Prince

Edward Island Department of Education also has adopted the cascading method to at least facilitate the use of the Internet within schools.

Why have these teacher training strategies been necessary? Students today have access to learning technologies that were nonexistence when many of their teachers were trained. When computer use in schools was first introduced, much of the educational software was developed on the assumption that the vendor had to do the work of the teacher. The mis-communication and non-communication that occurred during this period were a disservice to the teachers and consequently the students. This error appears to have been recognized. With improved communication between the educational system and software vendors, today educational software products help to enhance teacher functions by augmenting instructional capability. Many current software applications foster group interaction and problem-solving skills.

How do teachers develop the skills and competencies to increase their technological literacy and make effective use of these new tools in the classroom? IBM (1997) suggests that "It is key that teachers receive support for integrating technology into their work, continuing professional development, practice/learning time, staff assistance for detail technical activity, and peer communication for promoting best practices and content skills" (p.1). These training needs vary among teachers. Fullerton, citing the results from the U.S. Congress Office of Technology Assessment, states "30 hours of training are needed to successfully use technology at a basic level. For a teacher to have good operational knowledge of hardware and perform basic troubleshooting requires 45+ hours of training and 3 months of experience. For a teacher to actively develop entirely new learning techniques that utilize technology requires 80+ hours of training and 4 to 5 years of experience" (p.70). Alberta Education experience suggests that "three-year technology plans can ensure technology is integrated in education by dealing with the various components in a co-ordinated manner (e.g., goals of technology integration, learning, teaching and staff development, staff supports, data and information, hardware and software,

networking, budgeting)."[1]

The Edison Project (see Harvey and Purnell, 1995a) three C's"– comfort, confidence and creativity-- is a helpful guide. In the first year teachers simply become comfortable with the new technologies. During the second year they develop the confidence to use it, and in the following years it is expected that teachers will become creative users of technologies, e.g., Internet, CD-ROMs, video images, sound, and multi-media. One example that works to facilitate the three C's is the education discussion areas[2] provided on the web site of Saskatchewan Education. Here, teachers as well as others are encouraged to engaged in dialogue about educational issues such as technology. What support infrastructure is required? The challenge is not only to increase the density and scope of information and communication, but to do so in a meaningful way and in a manner which keeps students as the focus and prepares them for the challenges of today and tomorrow. This may mean a real departure from much of the current modes of professional development. For example, Harvey and Purnell (1995a) counsel that it could mean "not only ending teacher isolation but building human networks in an infrastructure that includes teachers, parents, principals, school board, and district personnel" (p.2). Within these frameworks technology is used as an enabler. It will definitely mean a generation of realistic expectations about what technology can accomplish. The key to success will be for policy makers and educators to manage the technology and the teacher development in order to achieve educational goals while the structure and relationships within education are being profoundly altered.

Teachers need to see a practical benefit to the use of technology and they need to feel that technology is the tool not themselves. The school environment has to be seen as one that allows the teacher to learn and grow while making the inevitable mistakes that accompany both. This position is strongly supported by Grégoire, Bracewell, and Laferrière (1996) review of the literature on the consequences of appropriate use of new technologies on the teaching function

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[1]Personal Communication, November 6, 1998.

[2]http://www.sasked.gov.sk.ca/docs/discussion.html

of teachers. In this review, it is clear that effective use of new technologies changes the function and work of teachers

in the classroom. There is some evidence to support the contention that when students use the technological media for instruction the teacher has more time to support each student in the individual process of discovery and mastery of knowledge, skills and attitudes. In this context, the teacher becomes a facilitator in the process of information dissemination and understanding. This change becomes for the student a more personal and shared approach to learning.

Thus, the primary challenge, at least for teachers trained in the pre-technology thrust in schooling, is to have teachers appreciate the opportunity of technology. But, as cautioned by Yentzer (cited in Harvey and Purnell, 1995a), when teachers do not have access to technology in their classroom or have never experienced its use in the classroom how can they imagine the possibilities. The turnover in the teaching force, due primarily to retirements, is lessening this concern. In the meantime, the process entails a change in attitudes toward technology and the practice and support of teaching. An example of an attempt to help teachers become more technologically literate is the OCRI's Tech Coaches program. Since 1995, the Ottawa Centre for Research and Innovation (OCRI) has placed educators with skills in both technology applications and curriculum development into area schools to support teachers and students with the integration of information technology into the curriculum. These individuals are guided by school board staff and are called "Tech Coaches". The Tech Coaches assist with staff development for the schools by offering training, conducting presentations and providing support on topics such as the Internet in the classroom, curriculum integration of educational software, Internet search skills and database and spreadsheet integration. The process is and will remain dynamic.

The willingness of teachers to become technologically literate is further exemplified by the high, usually maximum, enrolment in technologically related course offerings for teachers

during the summer by the New Brunswick Department of Education.[3] The Yukon Department of Education in its "GrassRoots Program"[4] aims to facilitate teachers' use of the Internet for learning activities with students and to develop, through that process, curriculum related materials of value to other teachers.

4. Funding

Technology is not cheap. This is particularly true with the associated *continual* costs commanded by technology. These costs mean that it becomes a permanent budget item. Furthermore, though the per unit cost of technology is decreasing, the overall amount spent on technology is increasing dramatically. As a result, costing out and determining the source of funds are important reality checks for "phasing in" any technology plan.[5]

Cost elements would include: Internet service; increasing the number of classroom computers; adding one or two servers for local use and for Internet mail; adding a dial-in model pool for student and parent use at home; printers and scanners; analog video service for distance learning; school-site wiring for power; additional operating costs for technical assistance, either school staff or in the form of a maintenance and service contract; teacher training in the educational applications of all the technologies; materials and supplies. In addition to these cost factors, Fullerton (1998) reminds us that the longevity of software and the amount and type of technical support that is provided with equipment warranties needs to be considered. There can be little doubt that financing the substantial expenditures required, if schools are to enter the information age in any serious way, is a profound problem. But, as Rhodes (cited in Fullerton, 1998, p.68) cautions, "the focus must be on the *information* that technology enables students,

[3] http://www.gov.nb.ca/education/curriculum/dates.html

[4] http://www.yesnet.yk.ca/newsf.html

[5] http://www.netc.org/cdrom/serve/html_old/text/7.html

teachers, and administrators to access and on the *connections* that will support that information flow." The works of Schofield (1995) and other researchers makes it clear that computers offer great promise for helping to organize and structure classroom tasks, foster collaboration and offer new learning interactions for students. What is also clear is that in order for important and positive ongoing changes to occur, there is a need for a carefully thought out integrated plan.

Harvey and Purnell (1995b) reports "that the cost issue is not a serious problem at all for new school buildings. These buildings can easily be wired as they are put up. For existing schools, it appears that expenditures will have to rise from about 1 percent (or less) of per pupil spending on technology to an average of about 2 to 4 percent" (p.5). Generally, the comment regarding new school buildings would go unchallenged. However, at the local level in some jurisdictions serious cost problems have occurred. A reason for this somewhat surprising situation is the provision allowing local decision makers, such as School Councils, to alter building designs (including wiring for technology). When this has occurred, the new school building is no further ahead of existing and older school buildings in their need to be structurally updated to take advantage of existing technologies. This increase demand on funds represents a real increase in school budgets. Consequentially, some top-down financing and planning are required. It must be addressed in a systematic manner.

Another possible complication is the donations of computers, wiring efforts and technical expertise to bring technology to individual school operations. Following this route often leads to little control over what technology schools have, when they have it, or how the technology will be upgraded.

Fortunately, the need for some provincial intervention financially and for the coordination of the wiring concern has been recognized and acted upon by many ministries and departments of education. For example, the British Columbia Ministry of Education, Skills and Training announced on April 14, 1998 that it was investing $123 million over six years in an information highway (PLNet) that links all provincial public schools, colleges and institutes. The cooperation between SHL Systemhouse, a private company and The Information Technology Services

Division (the provincial government's network operator), will provide marketing and client support services including long-range service planning, network monitoring and help-desk support. The Information Technology Services Division will be responsible for network delivery including design, engineering and operations management. In contrast, the Province of Ontario has authorized each school board to create their own electronic information highway. The province is assuming that the boards will adopt standard business protocol and accept that Internet protocol has been established. The province now wishes to address the connectivity concern at the school level for the entire province. Thus, its assumptions about board practice in the creation of their own information highway will be tested. The New Brunswick Department of Education reports that all schools in the province are connected to the information highway. As is the case in other provinces, this connectivity has been accomplished in partnership with private industry. The connection enables all schools access to the Internet, SchoolNet, as well as each other. Prince Edward Island Department of Education has generally followed the practice of the other provinces of ensuring Internet access to schools. However, the Department has restricted this access. Specifically, all schools now have filtered Internet access with BorderManager, a software program offering filtering capabilities.[6] BorderManager restricts access to the Internet using sets of filtering rules (primarily established by CyberPatrol, an Internet filtering system designed to manage Internet access) that either grant or deny users access to Internet web sites. It also guards against the possibility of infiltration of school networks by outside sources. Similar precautions in other regions are known to have been adopted.

In addition to putting in place an adequate information highway for schools, it is important that software purchased supports key aspects of the educational learning component. The concern extends to ministries of education whose current practice is to enter into provincial contracts with software companies such as Corel and Microsoft. The contracts are very attractive

[6]http://www.gov.pe.ca/media/getrelease.asp?number=856

financially and they do result in a tremendous increase in available educational software for schools. Nevertheless, this practice could harvest an environment whereby educational practice is asked to adjust to the contracted available software rather than contracting software that compliments and enhances practices in the classroom. It is comforting to learn in conversation with ministries and departments of education personnel that efforts are being put forth against the establishment of such an environment. For example, in the Province of Ontario a software acquisition program (OSAPAC[7]) has been set up. One mandate for OSAPAC is to "review software titles that meet the indicated needs of all Ontario schools and forward recommendations for province-wide licenses to the Ministry of Education and Training".[8]

These worries are coupled with the reality that the lack of technological expertise in schools, together with rapidly changing technologies, makes it impossible for most schools to make fully informed choices about technological purchases or to provide the necessary ongoing technical support to their teaching staff. Ongoing support has proved, at least in the CAST study (1996), to be a real problem. In this study, "control teachers [non-online use of technology] reported increasing satisfaction with support from administrators and technology staff over the course of the study while the experimental teachers [online use of technology] reported decreasing satisfaction" (p.6). The reduced level of satisfaction of online teachers appeared to be associated with insufficient support for their new needs.

Schools and school districts wishing to advance quickly have to overcome the problem of meeting a substantial front-end capital cost. The traditional instrument of choice does not match the four to five year life expectancies of computer technology very well. A more helpful approach may be to establish leasing options that could be adopted by the education community. This paradigm shift would enable school boards to continually monitor and improve the technology for the purpose of improving instruction and learning. Such a paradigm would enable

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[7]http://ww.tvo.org/osapac

[8]Ibid

school boards to make judgments regarding the use of the equipment. In this context, leasing is suggested not in terms of leasing to own (a practice common in many local jurisdictions) but leasing with no obligation to buy. Instead, the obligation would be to continually upgrade (for example, every two to three years). The practice of leasing to own only delays a problem of disposing of outdated hardware.

Having said the above, it would be advisable not to allocate funds prior to schools developing an education plan that defines how students will perform well, details what technology provides the most benefit to student achievement, and prioritizes when acquisition should occur. A number of recommendations from the studies emerge and emphasize that for effective technology use to occur, all aspects must be planned and documented, including installation, support, training and maintenance. Schools must also actively seek out money that may be able to be shifted to technology investment as a result of the increased use of technology and the costs it may save (e.g., video instead of long distance busing; CD-ROMS instead of increased library size; library pooling via networks) (Harvey and Purnell, 1995b).

5. Teacher Education

Teachers require ongoing training in technology literacy, given the new tools and software that are available and the speed with which they are continuing to develop. It should be a core skill developed by all individuals in teacher preparation programs at the tertiary level. Leadership should come from these tertiary institutions, who have prime responsibility for training teachers, at least for today.

IBM (1997) claims “Teacher preparation programs need to focus more on technology as a tool to increase productivity and communication in the classroom, and as an aid to instructional decision making. University professors need to integrate technology within the preparation programs and develop models for its use as a teaching tool and resource” (p.1). Although many, including facilities of education, would have no difficulty affiliating themselves with IBM position, too many exceptions to this position exist. Technology is just not central to the

teachers' preparation experience (see for example, Queitzsch 1997). Too often the experience is one of learning about technology and its application as opposed to actually teaching with technology across the curriculum. Given that most field placements are in schools not technologically rich, even the apprenticeships do not in part compensate for the weakness in the on-campus part of teacher preparation. The one feature that is present in teacher preparation programs is the provision of Internet and e-mail access to students. All to often it is then, unfortunately, left to the skills, capability, and self-initiation of the student to benefit from this accessibility to technology.

What faculties of education need to appreciate is that in the information age, "teachers will change from 'knowledge experts' to 'knowledge facilitators' working with students who follow individual and team learning plans" (Fullerton, 1998, p.71). In order words, the role of the teacher in the information age is *knowledge manager*. Teacher preparation programs must shift their focus and development of the future cadre of teachers accordingly.

Having said this, the reality is that the problems that the school systems are dealing with, in cooperation with their ministries and departments of education, in terms of teachers' readiness to appropriately and comprehensively integrate technology in the curriculum is also a real problem at the tertiary level. This raises the question whether the preparation of future teachers is more effectively and more cost efficiently done within a different structure. It would appear that the structural support that is currently in place for teacher development within the school systems is an alternative that needs to be explored. It is definitely a structure that is advanced in comparison to what is occurring in the traditional teacher preparation structures. There really is no justification in duplication of efforts, especially when one effort is more advanced than the other in terms of preparing technologically literate teachers and having them integrate this literacy in their delivery of the curriculum. There is thus strong reason to attempt to capitalize on the successful efforts of the various ministries and departments of education. Given that this suggested shift also means a shift in funding that is now directed to universities the costs of an alternative structure to prepare future teachers is minimized.

6. Recommendations and Policy Direction

While there is general acceptance that Government has the main responsibility for learning environment issues and school boards for education delivery, responsibilities for infrastructure issues are much more debatable. The technology policy issue falls within this infrastructure area. The application of new technologies creates dilemmas and challenges for the organization. This paper has dealt with this issue within the framework of four areas – student learning, teacher development, funding, and teacher education. The discussion conveys the affiliation between and among the areas. It is with this affiliation in mind that the following policy directions are recommended.

Student Learning

- Provincial and Territory sponsored demonstrations using electronic publishing to update textbooks or other curriculum materials.
- Provincial and Territory strategic decisions regarding expected higher order learning skills and the use of technology. These decisions should be made in consultation with teachers.

Teacher Development

- Regional training centers explicitly focused at teacher needs.
- Provincial and Territory sponsored workshops on professional development and technology as a teaching tool.
- Government adoption of the role of convener to facilitate meetings between the professional development of teachers and technology communities (e.g., Nortel, Corel).
- Provincial and Territory recognition that the education system must be restructured to permit and encourage the technological development of teachers.

Funding

- Development of common standards for communications among various systems so that

teachers and others can gain access to the various resources in the "technology pipeline" as they need it, when they need it, and where they need it – at home, at school, and at work. Technologies in becoming instruments for educational reform must not create a dual-stream system, one for the rich and one for the poor.

Teacher Education

- A requirement that integration of educational technology into curriculum units or portfolio is mandated in the preparation of teachers.
- A requirement that apprenticing teachers, through their instruction of the curriculum, must demonstrate their technological knowledge.
- Requirement for graduation is that the teachers are technologically literate.

7. Suggested Research Questions

Four areas have been discussed for the purpose of exploring concerns that surround the issue of the impact of new information technology on education. To explore these concerns so as to inform policymakers with essential data, the following research questions are suggested.

1. What levels of thinking skills are being taught through the application of technology in the classroom?

2. What technology professional development programs are utilized by school boards for their teaching force? To what extent are teachers taking advantage of these programs?

3. What is the cost commitment to a school, school board, and ministry of education to introduce and maintain the use of technology in education?

4. What is the cost to establish a three-way partnership between boards of

education, private industry, and ministries of education for the purpose of ensuring teacher preparation programs produce technological literate teachers?

5. How can ministries of education together with school boards finance equitable access to technology?

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