Introduction

Information and Communication Technology is increasingly becoming common in learning environments across the modern world. However, having technology alone does not make great differences either in quality of learning or education in general. Neither, it means that teachers will make use of it just because it is available. Many of current strategies for technology in education tend to simplify learning and increase unnecessary cost and complexity of required technologies. The concern is with complex systems and architecture, e-learning standards and re-packaging of information into courses with automated results collections for delivery on “twenty four-seven” basis. Knowledge, that is, human capacity to deal with the complex word and self, is often considered as external to individuals and it is equated with electronically managed information and data. Assumptions are frequently made that as long as we have computers everywhere and content placed on-line, learning will happen spontaneously. Removing learners from complex world and placing them into this kind of technology environment assumes that all that is needed for learning is an “automated teacher” capable to repeat information in parrot-like fashion and to provide a shower of computer-tracked quiz questions. In this paper, I argue that utility of technology for learning must be guided at least by the following critical issues:

(a) The reasons for employing technology for learning in the first place;
(b) Principles of human learning, how does technology facilitate learning as a particular kind of human activity, and how can technology-based learning be organized to support human learning, and
(c) Understanding knowledge and beliefs of educators.

Each of these areas requires thorough discussion, which is not possible to achieve in one paper. Nevertheless, I will attempt to raise certain issues that are important in the context of technology integration for learning.

Why Technology for Learning?

How can we put technology in service for our learning, not just as an information and data channel, but rather to help us to master, develop and expand our own intelligence beyond this technology and in synch with demands of contemporary time and democracy? Ability of human to locate, organize, exchange and use information and data has changed dramatically since appearance of information and communication technology. We are now approaching fusion of television, computing, and
communication into a set of tools deliverable through the Internet over super-fast satellite and terrestrial connection. Internet is becoming a socio-cognitive grid with intelligent agent and resources that help us run our day-to-day activities and beyond. At the cutting edge of contemporary technology and its affordances for human learning, we must not remain in the business of automation of instruction and mass teaching. What we must do is to articulate powerful tools and environments for learning by leveraging on unique affordances of technology. Essentially, we must use technology to empower human learning and other activities rather than to submit to laws of some secondary disciplines.

As new technologies penetrate all aspects of human endeavor, it becomes important for educational institutions to embrace these technologies and create opportunities for students to develop as technologically literate “knowledge-workers”. However, “How to prepare individuals for life and work in the contemporary world?” is today greatest challenge for educational institutions across the globe. Much of education today remains based on outdated concepts and most of what is learnt remains to be “...wrong knowledge of the modern world” (Collins, 1996; p.348). To let go of old practices requires not just new practices and access to technology but also a shift in mindsets of teachers and learners. Many of current education practices remain to focus on “timed” delivery of curriculum content. This content is often separated from any authentic application and it is segmented into independent disciplines. This practice in education could be suitable for the previous century when educational institutions selectively produced useful “professional–technical–laboring” mix of individuals for industries of that time. In the contemporary world, education must concentrate on development of human capital relevant to its needs. At the center of this human capital are knowledge workers -- a new class of technologically-empowered individuals whose central strengths include capacity to: (a) work with information, data and knowledge to solve problems and create innovation, and (b) continuously advance their intellectual frontiers though lifelong learning in order to remain relevant. These kinds of individuals, besides being backbone of economy in a knowledge society are liberated, consistently employable, economically independent, and intellectually satisfied.

In education, there must be higher emphasis on inquiry, problem solving, collaboration and independent learning as a strategy for preparation individuals for relevant world. This demands a shift away from teacher-centered to learner-centered pedagogical practices (Shaw, 1997; Tsang-Kozma, 2004; Smith, 2004). In teacher-centered practices, it is the job of the teacher to guide his or her students to think in particular ways and to arrive at “correct” answers (Carter, 1997; Tsang-Kozma, 2004; Smith, 2004). Learner-centered practices promote independent thinking and collaboration in inquiry, project work, and problem-solving (Dwyer, Ringstaff & Sandholtz, 1985-1998). Learning in learner-centered approaches requires learners to use mediating tools to construct knowledge and complete activities. In learner-centered practices, learning occurs within an activity (Jonassen & Rohrer-Murphy, 1999). This activity involves knowledge-work (knowledge use, creation and innovation). In teacher-centered practices, learning is assumed to result from a teacher and resources, while activity is understood as something that reinforces knowledge through practices and games. Teacher-centered practice is the recipe for preparing individuals for the past. Purpose for technology in learning should be to support learner-centered practices.
Many educational institutions understood that it might be appropriate to reduce curriculum content and to allow learners more time for inquiry, problem solving and other learner-centered activities. Effectiveness of this approach is questionable in the context of current information and knowledge age. The challenge is how to keep up with the increased information influx while adequately preparing students for independent learning, inquiry, problem solving and other situations where they construct, use and create knowledge. Technology for learning should be perceived as a response to this challenge. Strategies for use of technology for learning should include: (a) use of technology as a tool that facilitate processes of knowledge use and creation, and (b) use of technology as an effective mean to create and distribute compacted information and data through representations which minimize time for learning and maximize depth of understanding, that is, enable learning more in shorter time.

**Technology and Learning as a Human Activity**

For use of technology in “educational knowledge work” we must articulate the best strategy for design of engaging learner-centered technology-based experiences. This strategy needs to be based on some principles of how human advance frontiers of their knowledge through active experiences and roles of technology-based tools in those experiences. In this section of the paper, I will address one approach to design of learning experiences which is partially based on certain theories of Russian psychologist Lev S. Vygotsky (1896--1934). I propose consideration of learning as a particular kind of human activity and utility of technology within that activity. Technology resources should be considered as tools that enable individuals to complete objectives of their activities.

In any human activity, including learning, a subject of an activity intentionally acts and transforms an object of that activity. The process is mediated with use of tools. Use of tools and act upon object of an activity result in learning based on that experience. Accordingly, learning is an activity -- activity is experience -- experience is learning. Through this experience, a learner as a subject of an activity (a) constructs and uses knowledge to act on world, and (b) uses world acted upon to create new knowledge. Psychological processes and actual doing merge into meaningful engagement in a learning experience. I represent learning as an activity in the Figure 1.

![Figure 1. Conceptual model of learning based on the activity theory](image_url)
Three kinds of learning artifacts that can be produced by learners in an activity (Jonassen & Rohrer-Murphy, 1999):
- Physical Artifacts -- e.g., a robot or a cardboard model
- Soft Artifacts -- e.g., a computer-based model or a multimedia presentation
- Cognitive Artifacts -- e.g., a solution to a problem or a theory

Two kinds of tools are used in any human activity (Vigotski, 1996):
- Technical tools used to act upon and to change properties of an object, e.g., scissors used to create a triangle from a sheet of paper; and
- Psychological tools which are direct at our own psychological processes, e.g., graphical representation that aid conceptualization of a triangle and subsequent decisions.

Greatest increase in capacity of knowledge evolves when the psychological tools become internalized form of external tools. An example of internalized psychological tools is language. One of most important function of psychological tools is that they might aid integration of separate mental function into a system of function and contribute to our cognitive capacity. However, research needs to establish what kind of technology-based tools hold capacity to become internalized form of psychological tools or at least to contribute to an internal development of any physiological tools at all. At this stage, it might be argued that technology affordances enable creation of powerful reusable representation of our knowledge that can be utilized as mediating tools within learning activities for others. These reusable representations must be built based on unique affordances of technology to combine and deliver interactive visualization of complex data and information. These reusable representations should be designed to allow faster learning and deeper understanding of the fundamental concepts from disciplines. I propose international cooperation of content experts, psychologists, learning designers and technologists to develop a base of fundamental mediating tools for learning. These tools will be delivered in “low end” technology-based environments for everyone and anywhere. Teachers would be able to utilize these tools when creating learning experiences for their learners.

Teachers Knowledge and Beliefs

Effective use of technology in schools depends on what educators do and what they think. This is based on their knowledge and their beliefs than based on availability of technology. In the relation to technology, we frequently hear that educators do not have technology that they need or that they do not need technology that they have. For Pierson (1999) schools were so eager to purchase and to get teachers to use technology, that they mistook the fact of simply having and turning on a computer as integration and “...this perpetuates the misconception that any curricular connection automatically indicates technology integration, with no concern for the quality of the teaching into which the technology is fitting” (p.222). Technology often appears to be used as an excuse for poor integration. However, what is important, are educators’ knowledge and beliefs that guide technology integration.

It is critical to establish a strategy for technology integration that is sensitive to educators’ knowledge and beliefs before technology is made available. Educators’ knowledge and beliefs relevant to technology integration and design of learner-centered
environments appears to dominate academic discussions, but not so much the school-based agenda. Although many reports provide “...an increasing understanding of technology use in schools, they tell us little about how ordinary schools and ordinary teachers are utilizing, managing, integrating, and defining technology in their classrooms” (Milman, 2000, p.3). Some attention is given to educators’ knowledge and beliefs and use of technology in a classroom with large research projects, e.g. “Apple Classroom of Tomorrow” study by Apple Computer, Inc. (Dwyer, Ringstaff & Sandholtz, 1985-1998) and the “Teachers’ Tools for the 21st Century” (National Center for Education Statistics, U.S. Department of Education, 2000). Much less, attention is given to thinking of teachers in the design of learner-centered technology-based experiences. Assumptions often appear that when integrating technology: (a) teachers can leverage their existing pedagogical knowledge to design instruction, (b) they can quickly acquire technical expertise from short courses, and (b) they can embrace procedurally based instructional design approaches as heuristics for effective design of technology-based lessons. However, alternative approaches are needed to support teachers’ technology integration that better comport with their current knowledge and beliefs.

In the study “Technology Integration Practice as a Function of Pedagogical Expertise”, Pierson (1999) underlined that similar thinking informs planning of instruction and planning of use of technology for learning. Pierson suggested that a close relationship exists between teaching ability and technology using ability and informed that “...unless the teacher views technology use as an integral part of the learning process, it will remain a peripheral supplement” (p.226). Pierson proposed teachers’ knowledge for technology integration can be represented with the framework shown in the Figure 2.

![Three types of teacher knowledge for effective technology integration (Pierson, 1999, p.225)](image)

Three types of knowledge in addition to content and pedagogical knowledge and pedagogical-content knowledge emerged from the Pierson’s framework:
- Knowledge of content-related technology resources (area A);
- Knowledge of the methods to manage and organize technology use (area B), and
- Combination of the knowledge of content, pedagogy, and technology, or technology integration (area C)
If technology integration is to be effective, the teachers need to be prepared for it as their existing training has focused only on classroom strategies and it has not prepared them to use technology effectively beyond that environment (Brush et al., 2003). As teachers learn to change strategies, they also must transform their underpinning beliefs. Pierson (1999) highlights the problem when she writes that “…as integrating technology is becoming inseparable part of the job of good teaching, theoretical assumptions reminded unchanged” (p.6). Intervention might be essential to support teachers to transform their underlining beliefs. Alternative approaches to design of technology-based learning that support changes in teachers’ thinking are essential. However, in order to understand these approaches, teachers thinking and their decisions must be examined to extract the key areas of beliefs, which are likely to prevent effective technology integration.

Recently I examined beliefs of a group of teachers who were designing technology-based learner-centered lessons (Churchill, 2004). The intention of that study was to gain an understanding of their theories in order to propose an alternative framework for the design that is sensitive to these teachers’ thinking. Four areas of beliefs emerged to be obstacles to effective technology integration: Assessment, Learners, Technology and Management. These four areas of beliefs appeared to originate from two frames (see Figure 3).

![Figure 3. Two frames in the teachers’ areas of beliefs that affected the design of activity-based e-learning](image-url)

The first frame was based on beliefs about learners (e.g., learning abilities, confidence and thinking skills), assessment (e.g., purpose of assessment and when to assess) and technical skills (e.g., a participating teacher’s belief about his or her own technical competency). The second frame was influenced by institutional system and culture. These included beliefs about assessment (e.g., assessment methodology and frequency of assessment), technology (e.g., hardware, software, methodologies and computer classrooms, etc.), and beliefs about management (e.g., expectations, work allocation, and communication of initiatives). Any strategy designed to support teachers in effective technology integration should give particular attention to these four areas of beliefs.

**Summary**
In this paper I attempted to address certain important issues in relation to technology integration into teaching and learning. It was discussed that effective technology integration should be guided by carefully examined set of critical issues amongst which are: clear and relevant reasons for employing technology for learning, understanding of learning as a human activity, and understanding of knowledge and beliefs of educators. Overall argument is that effectiveness of technology integration in education is less dependent on availability of technology than educators’ understanding of learning and purposes for employing technology. Technology will be effective only to the extent to which it is used as a tool that facilitates solution to a specific set of problems. These solutions must address development of critical capacity of human capital for relevant society and for individuals themselves. One important idea that briefly surfaced in the paper was the argument for collaborative human activity to promote development of technology-based resources (mediating tools) which should be made available to teachers and learners anywhere.

References
