Role of Technology in Education

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Introduction

The only constant is change and mankind is in a period of rapid technologically driven change. Although the personal computer and the internet are less than 30 and 20 years old, respectively, information and communication technology (ICT) has revolutionized how we live, work and communicate. The commercial mantra of smaller, faster, cheaper, smarter has put intelligent mobile devices in the hands of today’s learners, but technology has had little real impact upon education. The purpose of this paper is to examine the role of technology in education because the problem will only get worse as technology improves.

Learning

Learning is based upon four tenets: meaningful learning is more than accumulating knowledge; knowledge and skills are linked; learning requires far transfer, being able to apply principles to a new situation; and cognitive load, transfers between long-term memory and working memory are unlimited (recall), but transfers between working memory and long-term memory (learning) are limited because working memory (seven unique pieces held for 20 seconds) can be easily overloaded (Cook & McDonald, 2008).

Behaviourists and cognitivists (direct instruction) believe knowledge can be transferred, so they divide learning into small chunks from the simple to the complex. Constructivists believe knowledge cannot be transferred, but must be constructed by the individual, so they use open-ended questions to let learners construct their own answers (cognitive constructivism) and group discussions on answers to correct misconceptions (social constructivism). But an instructional approach must only be as complicated as necessary to achieve learning (Spiro, Feltovich, Jacobson, & Coulson, 1995).

Kirschner, Sweller, and Clark (2006) believe that minimal, constructivist-based
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instruction: is less effective than direct instruction for novice and intermediate learners and only equally effective for expert learners; and may have negative results as learners make errors constructing knowledge. Kirschner, Sweller, and Clark (2007) feel the search for answers forces novice learners to overload their working memory, with little transfer to long-term memory and weak guidance causes cognitive overload as learners form weak problem-solving strategies. A novice struggles to learn new material because everything is new. An intermediate learner does better because they understand some of the material. Expert learners easily separate material to concentrate on central arguments or concepts.

The greater the correlation between the learner's expertise and learning, the easier the assimilation and less assistance or scaffolding required. Their personal expertise makes them an expert and learners use prior learning or schema to incorporate the learning into their reality. The smaller the correlation means the learning is harder and more scaffolding is required. The learner functions as a novice, since their prior learning does not apply and can actually be a hindrance. All learners try to leverage prior learning to complete tasks regardless of the complexity of answers, until the prior learning does not work or they find a better way. Failure to complete tasks does not mean learners are motivated to learn and they can choose not to learn for any reason: not important; too difficult; or differs from their world-view. Learners are comfortable stepping outside their own reality when they perceive a need to learn new material or Ausubel’s meaningful learning (1962, as cited by Novak, 1998). If the learner does not perceive the material is important, the learner will use memorization, which is easily forgotten or Ausubel’s rote learning (as cited by Novak).

Digital Natives vs Digital Immigrants

Prenksy (2001a) describes Digital Natives as the generation that “have spent their entire
lives surrounded by and using computers, video games, digital music players, video cams, cell phones, and all the other toys and tools of the digital age” (p.1) and Digital Immigrants as the generation that grew up before the digital age, who have adapted to technology but their fluency is limited by growing up in a non-digital world. Prenksy contends that curriculum and Digital Immigrants are holding Digital Natives back and advocates that instructors change to a constructivist methodology with learners using technology to find answers, with instructors providing support as needed and change the curriculum to relevant traditional curriculum and new technology based curriculum. Prenksy (2001b) believes that continuous exposure to technology via video games has rewired the brains of the Digital Natives and to take advantage of this, educational video games should be used. Playing a game committed to long-term memory is one thing, but their learning is still limited by working memory, which has not changed. Recent research has shown no statistical differences in ICT capabilities for different age groups (Guo, Dobson, & Petrina, 2008).

Through the years, Prensky has proposed many technologies as the vehicle for transforming formal education: simulation (Prensky, 2001c); modding older open-source games (Prensky, 2003); complex educational games (Prensky, 2005a); cell phones (Prensky, 2005b); Web 2.0 software (Prensky, 2007); and student created games (Prensky, 2008).

**Games/Simulations**

All learners play games, so it is conceivable that learners could learn by games. Digital games are divided into mini-games and complex games (Prensky, 2005a). Mini-games are mainly recreational based (Freecell™, Sudoku), but can be educational (Where in the World is Carmen Sandiago™). Prensky feels that individual mini-games lack the breadth and depth to educate, but complex games requires “a player to learn a wide variety of often new and difficult
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skills and strategies, and to master these skills and strategies by advancing through dozens of ever-harder ‘levels.’ ... requir[ing] both outside research and collaboration with others”. So he feels complex educational games could be created for learning.

The problem with creating educational games is summed up in a quote by Will Wright (as cited by Prensky, 2008) as “All games are educational…Good games are hard to design. But designing a good game around specific subject matter is really difficult.” It is difficult to see how meaningful educational games covering a full course curriculum will ever exist due to the complexity of curriculum and some learners may not consider a good educational game to be worth playing. The difficulty and cost of developing a good video game means that the main market would be for entertainment, but some curriculum may be able to piggy-back on to entertainment games such as Second Life.

Prensky (2008) cites examples where students have developed games for learning and extrapolates this into covering complete curriculums by having different students create mini-game components for a complex game covering the whole curriculum. To achieve this, he feels several million students will volunteer to create the several thousand mini-games that will be required. Is this even realistic? How many students are programmers or have any interest in programming? Even if the mini-games were created, would other students play them? Can Digital Natives succeed where professional game programmers cannot? Who would manage and fund the mega learning project? Designers of instruction (designers as learners) achieve a deep level of understanding because “the process of instructional design forced them to reflect upon their knowledge in a new and meaningful way” (Reeves & Jonassen, 1996). So there is merit in the idea because the individual game developers would achieve meaningful learning about the specific topic, but would the learning be as meaningful playing other mini-game modules?
In many ways, a simulation is a game that attempts to model something in the real world. Some instructors and textbook authors have developed small web-based simulations to illustrate scientific principles (solar system, sextant, friction, circuits), that they share with others on the internet. These interactive applets, with some scaffolding, allow learners to experiment with the principles for understanding. Experiential learning using the simulations without scaffolding would: take longer; introduce misconceptions; and achieve weaker learning. If you do not understand Ohm’s Law, playing with a circuit simulator will not help you learn it. These simulations are based upon the experience/requirements of the developers, so the quality may be poor or the functionality may be incorrect or too advanced. But there are thousands of simulations with common concepts having many versions, so a relevant example can typically be found. But as with mini-games, their relevancy for education is limited.

**Technology**

The reinventing of the wheel as different individuals develop simulations for the same concept serves to illustrate the problem with encouraging individual instructors to adopt technology. There are also issues that adopting technology in the classroom that would have to be dealt with: who pays for usage fees; learners without technology or lower capabilities; learners with different technological skill sets; abuse of technology; cyber stalking; and eventual obsolescence of any technology, which requires replacement or redoing course materials.

Technology does not teach, but it is how technology is used that learning is achieved, so technology for technology’s sake is wrong. Technology that makes learning easier; achieves greater learning; or reflects technology used by industry, have been added to curriculum, such as computerized drafting for mechanical engineering or Geographic Information System (GIS) software for geography.
**Mindtools**

The best use for technology in learning is as a mindtool. A mindtool is any computer program the learner uses to engage and facilitate critical thinking and higher order learning (Jonassen, 2000). Reeves and Jonassen (1996) feel education benefits when learners use computers as cognitive tools to try to represent what they know (learners as designers). They feel “students learn and retain the most from thinking in meaningful (mindful) ways. Some of the best thinking results when students try to represent what they know”. They feel learners use cognitive tools or mindtools to organize, restructure, and represent their knowledge. When learners use computers, the workload is divided into areas each partner is good at: computers calculate, store, and retrieve information; and learners recognize and judge patterns of information and organize information (Jonassen, Carr, & Yueh, 1998).

**Distance Education**

Distance education on the web is based upon constructivism and uses 100% technology for delivery, such as D2L™ (Desire2Learn) or WebCT™ (Web Course Tools). A constructivist learning environment uses open-ended questions to promote extensive dialogue among learners (Rovai, 2004). Conceptual change occurs when learners are confronted with information that contradicts their conceptualizations (Jonassen, 2006). Jonassen feels that low domain knowledge learners will not notice the contradictions, low interest learners are unlikely to engage in conceptual change, and experts are unwilling to change because they feel they are correct. So social constructivism cannot exist without good quality discussions.

There are distinct advantages from using technology (anytime, anyplace, asynchronous delivery), but distance education materials can feel like snapshots of face-to-face courses that can quickly become outdated, irrelevant and broken. So although distance education uses 100%
technology, the technology is being used for facilitation and not education.

**Learning Community**

Formal education’s problem is that it is based upon factory schools, which treat learners as empty vessels to be filled. Carroll (2000) feels that teachers from the 1800s could substitute into the schools of today because our schools have not kept up-to-date with educational theories and must be transformed to meet the demands of our information age economy. Caine and Caine (1991) feel that the factory model is inappropriate for teaching for two reasons, it fails: to give students the relevant skills and attributes required to succeed in life; and to take advantage of the brain’s capacity to learn. They believe that schools organized on the factory model do not open doors to the future but imprison students in their own minds. Carroll lists the reasons schools have to change are: anytime and anywhere web learning; ICT allows constructivist learning; workers require upgrading; learning communities have no boundaries; home is becoming a learning place; and Digital Natives learn from technology.

It is difficult to see how an individual instructor, who has to deal with the day-to-day concerns of course delivery, can transform education by using technology. Even if the instructor succeeds, the students must still deal with other instructors that have not changed. It is a case of putting the cart before the horse. But by transforming schools into learning communities that facilitate student-centered learning, the learners can choose what and how they will learn. The horse or horses can pull the cart any way they want.

The model can be simple. Elementary stays the same and learners master basic reading and writing, math and science. As students move into secondary, they become self-directed. Learners start a learning sequence by negotiating a learning contract that states: proposed learning; significance; deliverables; time-line; appropriately sized content; identified resources;
and rubric for different deliverables. The contract can be signed by students, teachers and parents to ensure each understand their roles in the process. This process allows students to select any method to demonstrate successful learning: program a game; complete an existing game; write a report; do a presentation; create a web page; compose a song; teacher-centered instruction if available, etc. At the end, a teacher and the student assess if the learning was achieved. The learning contract can be renegotiated if the learning was not achieved or repeat the process for the next learning contract.

This allows for groups of students to take advantage of social constructivism and power their way through the required curriculum and individual students to use any technology. The student’s are motivated because they can: understand the curriculum’s importance; learn relevant content; learn by playing; learn when they want to; manage their own time; and possibly graduate earlier. As students complete curriculum, they document all learning with a learning portfolio. Initial learning may be with partnerships in their school, but as learners become specialized into areas of interest, learners can form partnerships with like-minded individuals on the web. The teacher’s role changes from ‘sage on the stage’ to ‘guide on the side’. Teachers will provide support for students, which will most likely involve: management or help for individual learners; problem solving by identifying new resources; resource development; development of individualized instruction modules; and evaluation.

Students will have to learn the self-directed learning (SDL) process, so teachers and eventually older, successful self-directed learners will provide the scaffolding. Sample learning contracts will be provided to be used as a guide to help learners to create their own contract and the size of the initial content will be kept small to help learners learn the process. As the students develop confidence with SDL, the input from the scaffolder decreases, until the learner is
learning on their own. Teachers are available to help learners resolve problems.

The curriculum can be the actual secondary and post-secondary curriculums. Achievement of grades, programs or degrees requires learners to complete specific core and optional competencies. All schools evolve to become learning centers and university degrees change from 3-5 years to lifelong learning, with each degree being unique to the individual. As individuals need training, they turn to the learning community.

This process is not new. As defined by Knowles in 1975, SDL is:

a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes (p. 18).

Knowles (Hatcher, 1997) believed that by 2020, all education from primary to post-secondary would be SDL. Knowles (1991) transformative model of education consists of a network of learning centers that contain information about the community’s learning resources, including: specialists learning skills assessors; educational diagnosticians; educational planning consultants; and support staff, and the organizing principle is lifelong learning, where every individual, organization and institution of the community is a learning resource.

Formal education does not teach the individual how to do a specific job, so learners have to use informal learning, which means formal education is the tip of the iceberg with regards to all the learning that a learner must engage in through their life, so SDL is essential. The days of working for one company, doing the same job are over. A career will consist of working for a number of companies, doing different jobs. Technology will continue to change, making some careers obsolete and creating new ones. To meet the training needs of individuals and to deal
with the challenges of the future, universities and colleges have to move from full-time programs to supporting SDL, where individuals are continually upgrading their skills. Gray (1999, as cited in Kerka, 1999) believes that the Internet is one of the most powerful and important SDL tools. So as the internet grows and pressure from technological change increases, the pressures on formal education to transform increases.

Conclusion

Society benefits when: the education of the average individual increases; and the individual is an educated, productive member of society. The formal education system works as an agent of society to transform man as a product of society. So to transform the formal education system, we have to transform society. Society has to realize formal education is producing a product that does not meet societies needs. So the true role of technology in education is transformation, as the agent for change and at this point in time, communications.

The proponents of technology have not gone far enough. Education can not change by getting individual instructors to adopt any technology. Individual instructors are frozen by curriculum, work load and regulatory agencies. They must always balance the equation of deeper learning versus time consumed!

No learning occurs in games unless that learning was placed there by the game designer. Technology does not teach, but it is how technology is used that learning is achieved. If a technology has a benefit for education, instructors will readily adopt the technology.

The main reason for adopting many technologies is motivational, to take advantage of the interest of learners. Twitter™ can be used for education but how much meaningful learning can be packed in 140 characters or less! What society and individuals need is hope, not hype!
References


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