

Redefining Technology Role in Education

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Received February 25th, 2011; revised April 13th, 2011; accepted May 24th, 2011.

The paper is a conceptual attempt to explore the new roles of technology in education which has increasingly become more than a sole medium, as was its description in the past. Basically, the key idea is that technology, with the powers of ICT, in education has now three main roles, namely: a medium/resource, a management, and a delivery. These new roles, when combined, could set the stage for restructuring the education institutions in an innovative way that leaves the current education system in history.

Keywords: Educational Technology, Roles, Education, E-Learning

Introduction

Historically, audiovisual movement at the beginning of the twentieth century adopted the use of new innovations of film and audio to reach a diverse audience with an emphasis on educational materials production by faculty to improve their teaching. Learning theory, systems theory, and information theory then merged to form the instructional design approach which, in practice, shifted the evaluation to the learners measuring their achievement according to prescribed learning objectives in observable format within eight domains of learned capabilities and tasks. Programmed learning also evolved and applied in the 1950s followed by the visual model of the stages of instructional systems design in the 1960s (AECT, 2004). Programmed learning was based on many of the same principles to which Bork and other enthusiasts of educational technology allude: clearly stated behavioral objectives, small frames of instruction, self-pacing, active learner response to frequent prompts and questions, and immediate individualized feedback to responses.

These principles were in turn based on the behaviorist precepts of the noted psychologist B. F. Skinner, and were implemented in the United States at the University of Illinois in 1960 (AECT, 2004). Instructional strategies, needs analysis, and communication theory were incorporated in other instructional systems and communication models. Constructivism applications lead to active environment based on interactions and learning activities in project based learning, inquiry based instruction, and student-centered learning. Acquisition of collaborative, management, metacognitive skills and Reflection is important for designers throughout the entire instructional design process. In addition, prototyping enables designers to learn from other design projects and apply it to new designs in order to increase efficiency using new technologies and innovations.

New Technologies

Technology is changing the way faculty teaches and students learn. It becomes a critical complement to the educational experience, opening more opportunities for the learner than can be encompassed by one campus. Advances in technology mean

that it can now be an effective tool in learning and development. Many organizations and educational institutions are utilizing technology for a variety of reasons.

Literature on educational technology has a narrow focus on the characteristics of the technology itself but to gain a full understanding of why a particular piece of technology is or is not used, or used in particular ways or has a particular impact, we need to pay careful attention to the social context of its use and incorporate business values, and workplace skills (Kandlbinder, 2004: pp. v). It is important to know the way through which technology is used to support learners, and make learning more efficient and the learning experiences more memorable, improve access to ideas and information, enhance and extend an individual's abilities to express themselves. Students in different social positions can have very different experiences with the same technology.

Technology Role in Question

The need to redefine technology role in education is ingrained in literature. As Roblyer (2005) stated: "If technology is to be viewed as having a clear and essential role to play in education, it must have a clearly articulated research agenda and high quality studies that both document and shape its impact." In relation to subject area such as mathematics, Kissane (2003), suggests that technology has three roles: a computational role (humans using technology to complete difficult mathematical tasks), an influential role (availability of technology needs to be considered in deciding what is most important for the mathematics curriculum), and an experiential role (new possibilities for teaching and learning mathematics by technology). Masood (2004), after conducting a content analysis of (200) articles of the Educational Technology of Research and Development (ETR&D) for most dominant themes emerged, grown, or diminished in the field of educational technology, concludes that the top ranked content analysis concept cluster is "delivery systems or media format" which consistently appeared first.

This paper tries to answer the question: "whether we should continue to consider educational technology as a sole medium (represented by the famous example of a wagon transferring

goods) or should it be considered as a major component of the educational system?" The study contributes to the efforts of understanding the changing technology roles in education and gives exemplary guides for this change management.

Emerging Roles of Technology in Education

It seems that education empowered with the conventional, information, communication, and digital technologies has taken three distinctive roles in education which require us to distinguish between. These roles cover educational technology system stages of: the medium or resource role, the management role, and the delivery role (see Figure 1).

Medium/Resource Role

Technology as a medium includes many formats and is used to enhance rather than replace instructors where instructor determines the pace for technology integration.

Technology also plays a "resource" role where information is at instructors'/students' fingertips. Thanks to digital technology, all types of traditional audio visual materials such as: books, transparencies, photographic slides, PowerPoint slides, compact discs, videotapes, audiotapes (and their accompanying presentation equipment of various projectors and computers) are "digitized" in several formats, stored, and retrieved in huge "resource" repositories. The library, as a physical resources place, is about to be completely replaced by "e-books" and digital libraries accessible anywhere, anytime, and by anyone. "Resources" seekers are also about to be replaced with "e-communities" and virtual research centers. This forms a global resource system of technology supported education.

Instructional materials can be now saved on student's home computer and used on computers at school using the flash drives. Students can take photos or record video on school activities for inclusion in projects and assignments. Mobile devices such as: iPods, mobile phones, Mp3 players, and PDAs can become more functional and useful (Spence & Haughey, 2005). Most students have mobile devices nowadays which can be used to enhance students' engagement and use of technology in and outside the classroom. Students become able to upload their portfolios and diaries onto these devices and store school timetables. Teachers can use these devices to text student information about assignments or remind them about homework's due dates. Students, on the other hand, message teachers

with work and ideas and getting help when they require it. Mobile devices can be utilized by teachers to record student reading, map student progress and celebrate the successes of students. Students can use them to record lessons to help them understand complex and difficult concepts. They can be used to speak with experts on certain research or school work. Rutz, et al. (2003) perceives that the use of educational technology improves student performance.

Futuristic educationalists see that education, through technology role as a medium/resource, will become highly interactive, individualized, flexible, and accessible (Garson, 2000). People in a diverse range of work places will use portable devices such as laptops and phones to learn and students can review their work in class at any time where the use of these devices will free up the reliance on physical labs. Moreover, the reliance on wireless technology should enable the students to download information from internet. This should ease their "connectedness" with the world.

However, there are some concerns about the role of technology as a medium/resource in learning on the depersonalization of education and the substitution of "real people" with technology. In addition, mobile devices can make students misusing time in class (Spence & Haughey, 2005). Inappropriate use of these devices may include: taking photos, texting friends, playing games, cheating in exams. Further, computers are to some extent expensive and internet is not available to every student, and its speed is not the same in all geographical regions. This may lead to the issue of digital divide which means that there is less opportunity to take part in the new information-based society. It also means that there is less opportunity to take part in the education, training, shopping, entertainment and communications opportunities that are available on line. Digital divide may also include females' and some social classes' reservations about the computer culture. Gender equity in technology access and knowledge to master skills is important. Barriers to incorporating instructional technology as a medium/resource may also include insufficient or obsolete hardware and software, inadequate facilities and support services, lack of time and money, inappropriate reward structures, scarcity of information about good practice, and underestimating the difficulties in adopting new technologies, and theft (Spence & Haughey, 2005).

Management Role

Technology has transformed many non-instructional campus functions, including enrollment management, registration, timetabling, billing, and financial aid, parking services, library services, payroll, and employment resources. Technology helps us to manage growth in personnel by designing institutional webpages, promotional materials, and departmental portals, and conducting interactive teleconferencing interviews. Administrators use technology either to perform routine tasks to maximize productivity and/or assist staff in completing non-mechanical tasks.

Faculty members are now highly dependent on technology for administrative purposes as well as for teaching and research. Technology encompasses the role of faculty members in: resource-based learning; organization of course delivery, involvement in academic decision-making, academic staffing and recruitment, students' monitoring and evaluation.

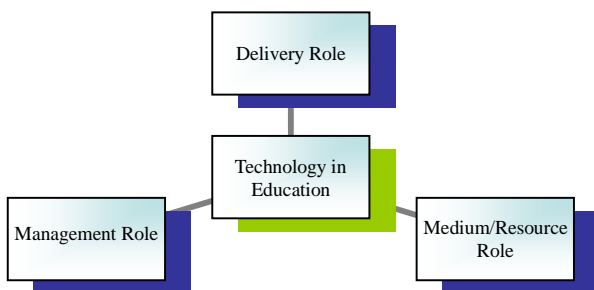


Figure 1.
Technology roles in education.

Technology can take the management role in fields of: teaching support and technical service; institutional administration, distribution and production of instructional materials; provision of consultancy on the curriculum; academic staff professional development; provision of formal and informal blended courses; and engagement in research. Administrators should look into the implications of using technology in education in terms of: infrastructure, technical support, professional development, institutional planning, and relevance to institutional mission. These issues are greatly related to factors such as: technological competencies, technophobia, skilled staff recruitment, availability and accessibility to computers and internet, online services provision, and organizational environment of innovation and change.

In achieving its management role, technology has first to be disseminated throughout the institution using prototypes and cases so faculty, administrators, and students perceive its benefits and advantages. Second, technology should be localized to the institutional administrative environment needs so people have sense of ownership. Third, technology needs to be applied and adapted by the staff and the students to realize and feel its positive effects on their administrative performance. Finally, they need to collectively assess technology policies and practices in institutional management. This assessment should be shared in an institution-wide practice form and integrated throughout the institution in order to increase technology effectiveness as its impact on administrative tasks is general; local innovative instances should be followed in other areas and locations. Integrated efforts of administrative leaders in academic, educational, and technological fields get the most out of coordination and support. This could take forms of committees to share ideas, exchange experiences, set plans and strategies, and make decisions on using technology for administrative purposes.

Technology role in management can affect institutional cost-effectiveness. Technological applications improve the quality of education in institutions by making the lecturers seeable, readable, and hearable for ever-increasing number of students and crowded classes. Spence and Haughey (2005) mention that the use of technology in education can no longer be ignored because instructors are using it and students are demanding it. They call on colleges to review their mandate in terms of the integration of educational technologies and prepare for increased demand in the use of technology in teaching by planning for capital expenditures as well as allocating funds for instructor support through this growth. Technology can save institutions' expenditures and make them better cope with the continuous cuts in their budgets. However, planners and administrators should be aware of tailoring their technological plans to match the real needs of teaching and learning processes and institutional mission and strategies, and that they keep abreast of advanced technologies to get optimal return on investment on the long run.

Delivery Role

ICT are progressively being used to enhance the instructional process. In addition, web-based learning becomes an integral component of student-faculty communication managed by e-learning management system e.g. Blackboard, WebCT, and Moodle. Therefore, technology is transformed to have a new

role, a delivery one, through e-learning, multimedia learning, virtual learning, or m-learning using Internet and mobile devices capabilities to deliver knowledge and instruction.

E-learning can be defined as a delivery method that combines a variety of non-traditional instructional techniques, tools, and approaches to design, develop, manage and evaluate the learning process. It considers students' needs, technological feasibility, and a professional preference. It can be supported by other technological delivery modes such as: web-resourced learning, mobile learning, virtual learning, and blended learning. E-learning, as a delivery mode, has the following features:

- **Flexibility:** it offers self-learning modules that may be completed by the students taking their preferences in consideration (Landen, 1997) at their pace and/or time.
- **Accessibility:** combining various online delivery methods should extend the students' access and choices to learn knowledge from any location.
- **Feasibility:** E-learning can reduce and balance instructional costs to the minimum by combining various online delivery methods that use simple self-paced materials, documents, case studies, recorded events, text assignments, and PowerPoint presentations.
- **Collaboration:** Students may collaborate to learn using various methods while linked through educational technologies anywhere and anytime.

E-learning will be therefore disseminated to learners delivering education to them in their places beyond the barriers that may impede learning in the traditional instructional environment.

Implications

The new technology roles in education have affected many aspects of the existing structures of "traditional" institutions and it will continue to affect them for years to come. In this part of the paper, I will present three future transformational effects in higher education institutions. However, these changes can later lead to even more advanced and revolutionary ones.

Learning Theories and Content Design

The need to probe the ways of integrating technologies in teaching and learning triggers the efforts to understand its implementation and theorize for its effects on both the students' achievement and content design. For instance, technogogy, a learning model adopted by Idrus (2005), is defined as the transformative use of technology to foster learning where the power of multimedia and Internet makes it possible for technology to cater for the needs of pedagogical and andragogical elements that can be viewed from the standpoint of technology. Technogogy combines technology and pedagogy and allows the content design for a continuum from the young to the adult in a way that addresses both learning needs and activities.

Siemens (2005), on the other hand, proposed connectivism which is a new theory of learning incorporating learning styles and the use of technology and networks. He stated that: "including technology and connection making as learning activities begins to move learning theories into a digital age. We can no longer personally experience and acquire learning that we need to act. We derive our competence from forming connections". Connectivism, a theory based on that knowledge exists

in the world rather than in the head of an individual, integrates previous learning theories (i.e. behaviorism, cognitivism, and constructivism), social development, and technology to construct a new learning theory for the digital age. Commenting on the limitations of the previous theories, he states that:

“A central tenet of most learning theories is that learning occurs inside a person. Even social constructivist views, which hold that learning is a socially enacted process, promotes the principality of the individual (and her/his physical presence—i.e. brain-based) in learning. These theories do not address learning that occurs outside of people (i.e. learning that is stored and manipulated by technology)”. (Siemens, 2005)

The content design in this theory indicates that learning and knowledge rests in diversity of opinions through a process of connecting specialized nodes or information sources where it may reside in non-human appliances. According to connectivism, capacity to know more is more critical than what is currently known and, therefore, nurturing and maintaining connections is needed to facilitate continual learning where the ability to see connections between fields, ideas, and concepts is a core skill. Hence, currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities and decision-making is itself a learning process (Siemens, 2005).

The notion of connectivism has implications in all aspects of life; namely, management and leadership because complete knowledge cannot exist in the mind of one person and, thus, requires a different approach to creating an overview of the situation; media, news, information institutions which are being challenged by the open, real-time, two-way information flow of blogging; personal knowledge management in relation to organizational knowledge management; and design of learning environments (Siemens, 2005). Again, these new learning theories and models substantiate arguments addressed in this paper calling for redefining the role of technology in education specifically in its relation to content design.

Saying this, one should not ignore the importance of traditional learning theories and pedagogical approaches as one can also teach mathematics, for example, in a Socratic manner (Garlikov, n. d.) as it gives the students and teachers a chance to experience the attendant joy, enthusiastic participation, inventiveness, and excitement of discovering (often complex) ideas. Nonetheless, questioning, brainstorming, and role playing are teaching methods and techniques that were used in the past but can be supported by the appropriate and innovative use of technology. Kramarski and Gutman (2006) found that students studied mathematics through e-learning supported with self-metacognitive questioning significantly outperformed their colleagues who studied the same subject using e-learning but without explicit support of self-regulation in problem-solving procedural and transfer tasks regarding mathematical explanations. They also found that the first group of students outperformed their counterparts in using self-monitoring strategies during problem solving. In addition, Garrido (2002) investigated webstorming, software based in brainstorming techniques for decision makers on the web, and found that it was indicated as a possible consensual solution for the proposed challenge and characterized with interaction and cooperation. Vijayakumar (2011) stated that “technological brainstorming will facilitate the thinking process and provide sufficient content for the learners. Above all teachers need to familiarize themselves with

technological tools available for brainstorming, and enable the learners achieve the learning objectives.” However, he added that a good teacher should balance and blend the technological and traditional methods.

Colleges of Education

Mishra and Koehler (2006) proposed a framework on the teacher education requirements in the digital age constructed of the Technology Pedagogy Content Knowledge (TPACK) where teacher candidates should be trained in a blend of the three (technologic, instructive, and academic) areas. They, therefore, are required to master the skills of: Technology Content Knowledge, Technology Pedagogy Knowledge, and Pedagogy Content Knowledge. Kinuthia, Laurie, and Clarke (2010) studied the potential of technology integration teaching cases to develop pre-service mathematics teachers’ Pedagogical Technology Integration Content Knowledge (PTICK) and indicated that the development of PTICK as a whole and individual aspect of PTICK. They observed enhanced pedagogical knowledge and reflective knowledge and found that placing the instructional technology course within the pre-service teachers’ program is important as the pre-service teachers were better able to drawing connections between case concepts and mathematics pedagogy content. Within these findings, I believe that education colleges and departments will cease to exist in their traditional forms and be organized in a way that reflects these new technology roles in education and the need to integrate and develop the three (technologic, instructive, and academic) skills. The re-arrangement of the colleges could be seen as follows:

- At least, some departments are expected to merge together in the foreseen future. Obviously, three traditional departments; namely, “curriculum”, “teaching methods”, and “educational technology” departments will eventually form new departments.
- We start to witness this by many studies conducted in areas linking curriculum content and teaching methods to technology-based delivery modes. With time, traditional teaching methods (e.g. individualized learning, cooperative learning, discussion, brainstorming... etc.) will be integrated in new technology-based delivery modes. In fact, many of these traditional methods are indeed implemented using online technologies in forms of collaborative communities, social networks, educational forums, and virtual learning environments. One can easily look at web 1.0, 2.0 and 3.0 to realize the major effects of technology on teacher preparation and his/her role in schools (Alison & Alison, 2010; Richard, 2009; Kumar, 2009; Topcu & Ubuz, 2008).
- Therefore, education colleges and departments will need to keep abreast of these new trends providing students with a more sophisticated and informed approach to learning technologies in an autonomy-supporting environment (Landen, 1997; Kandlbinder, 2004: pp. ii). To achieve that, they will need to shift their focus to prepare new generations of educational graduates and workforce with skills in online, mobile, and blended course design, instruction, and evaluation.
- In summary, colleges of education should be restructured and start to institute departments of: “e-learning”, “blended learning”, “mobile learning”... etc. through which tradi-

tional teaching methods and content design will be integrated and taught under “online teaching/learning delivery methods”.

Technology Services

Technology services will be also organized in a “virtual educational technology and resources center” (VETRC) including traditional library and information services. I will propose a model to organize a VETRC to serve its e-community members with different technical, production, and instructional resources that incorporate these new roles.

- First of all, such a center needs to have an instructional development (ID) service to: increase the clients’ awareness of virtual instructional media and assist them to design, develop and implement their use in teaching. ID service should be incorporated as an in-service training program for its e-community members. This means that this service runs online workshops to train its clients to design media and courses tailored to their audiences’ needs and abilities. ID service is also expected to conduct research with regard to technology-enriched delivery environments and modes.
- Second, the VETRC has to recruit competent instructional technology specialists and designers. Those should acquire four skills: design, development, implementation, and evaluation of instruction (Rempel, Montgomerie, & Szabo’s, 1998). They need to focus on providing their e-community members with the required technology-based instructional knowledge and skills. A key role of these technologists will be always to help their clients integrate new technologies into their instruction.
- Third, a VETRC needs to have a technical service that design, develop, and produce the instructional resources using the cutting-edge technologies capabilities to serve their clients’ academic needs by using technology-enriched applications such as simulations, robots, and gaming to create virtual learning environments of science laboratories, e-books, and 3-D maps. This service should produce and launch tools through which the e-communities will interact with each other. These tools include: e-mails, learning content management systems (LCMSs), websites, wikis, social networks, blogs, and other software.
- Fourth, the virtual center has to administer the online delivery by installing learning management systems (LMSs) and digital libraries and providing training and support to the clients, especially faculty members, to manage and offer online courses to their audiences.
- Fifth, a technical service should be part of the VETRC in order to provide the clients with any required technical assistance and respond to possible system, network, media/resources digitization, and/or equipment needs/repairs.

Conclusion

Roles of technology in education can no longer be ignored as lecturers and students demand to have more technologies. They need to use them in many aspects in their daily activities. It is not acceptable anymore to describe educational technology as a medium only. It is more than that. It has three roles: a resource, a management, and a delivery/teaching mode. These roles dictate that institutions enter a transformation phase that actively

responds by restructuring themselves in a way that incorporates the technological changes.

To achieve this, educational environments and courses enhanced with appropriate interactive resources, management support, and delivery modes can promote institutional structure and their students’ learning. Colleges of education, for example, need to combine their academic programs and make sure they reflect an integrated technology based approach. Traditional technology services need to go “digital” in terms of resources and “online” in terms of managing these resources link to “virtual” classroom in terms of delivering instruction. This will require them to offer “on-demand” training on technology skills to lecturers and students providing them with a solid infrastructure of ID and IT Specialists, who understand technologic and pedagogic principles to design, develop, implement, and evaluate the learning resources.

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