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Emerging educational technologies: Tensions and synergy

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Abstract A review of high level sources with regard to new and emerging technologies was conducted. Three technologies, according to these sources, appear especially promising: (a) massive open online courses (MOOCs), (b) personalized learning, and (c) game-based learning. This paper will review information from the US National Science Foundation, the US Department of Education, the New Media Consortium, and two European Networks of Excellence with regard to new and emerging technologies. A critique will then be provided using established principles pertaining to learning and instruction and a recommended curriculum for advanced learning technologies. The general result is that it appears that some educational technology advocates are overstating the likelihood of these three technologies having a significant and sustained impact in the near future, although there are promising aspects to each of these technologies in the long term.

1. Introduction

It is obviously true that technology changes and that changes are happening at an ever increasing pace with regard to digital technologies. This rapid pace of change places a burden on educators and instructional designers. The challenge is to make effective use of new technologies while preparing students for productive lives in the 21st century. Three technologies will be examined in this paper with regard to their likely impact on learning and instruction: (a) massive open online courses (MOOCs), (b) personalized learning, and (c) game-based learning. The sources that will be examined that propose these as promising technologies include a report entitled "Roadmap for Education Technology commissioned by the National Science Foundation" (Woolf, 2010), the US National Educational Plan (REF), the European Network of Excellence for Technology Enhanced Learning (STELLAR; REF), the European Network of Excellence for Game-based Learning (GaLA; REF), and the New Media Consortium's 2013 Horizon Report for Higher Education (REF). A critical review will be provided that shows that there are serious challenges for each of these promising new technologies. The conclusion will suggest what needs to be done in order for these technologies to have the impact their proponents envision.

As a foundation for what follows, several definitions and principles are necessary to consider. First, it is necessary to say how education should be considered. Education involves the systematic development of knowledge, skills, and attitudes that are likely to prepare individuals and groups of individuals to be responsible, thoughtful and productive members of society (Dewey, 1910, 1938). Each part of this definition is essential. Education clearly involves learning (knowledge, skills and attitudes). Developing responsible individuals involves the application of knowledge, skills and attitudes to the benefit of many without disadvantaging any particular individual or group (responsibility). Thoughtfulness is of vital

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importance to a stable and sustainable society; having citizens who are critical thinkers and who can actively contribute to the future is essential in an open society. Having a population of productive workers who can and do contribute to the general wellbeing of society is also important. These are the critical attributes that most societies value in an education system, although they have yet to be universally or uniformly embraced in many education systems.

Of obvious relevance to education is the concept of learning. Simply stated, learning is characterized by stable and persistent changes in what a person or group of people know and can do (Spector, 2012). A key attribute of learning is change – learning is aimed at changing what people know and can do. This attribute leads to an assessment principle – namely, assessing learning is fundamentally about determining that desirable changes have occurred and are likely to persist. Instruction is that which is intended to facilitate and support learning. Technology can be defined as the systematic application of knowledge for a purpose – typically a purpose that is aimed to benefit a group of individuals. While these definitions are commonly and widely accepted, they are often overlooked when discussing educational technology and learning in the 21st century.

Based on these definitions, one can generally describe three kinds of digital objects often involved in learning and instruction. First, there are knowledge objects. A knowledge object is primarily an information resource, often available in a digital form through the Internet. Many such knowledge objects can be found on the Internet, and the number and variety of such objects is increasing quite rapidly. Obvious examples include the information found in Wikipedia and other Internet encyclopedias and knowledge repositories are widely available and frequently accessed on the Internet. While we have at our fingertips a wealth of knowledge objects, they do not constitute learning or instruction. A learning object can be defined as a knowledge object linked to a particular learning goal or objective. There are fewer such learning objects available on the Internet compared with the wealth of knowledge objects readily available. Teachers often provide a learning objective to help students find relevant knowledge to support learning. Still, learning objects lack essential attributes of instruction – namely, active support for learning (developing desired changes) and a way to determine that desired changes have occurred (assessment). An instructional object can then be defined as a learning object with support for learning and assessment added.

As the three promising technologies are discussed in what follows, the extent to which each of those technologies has the attributes of knowledge, learning and instructional objects will be indicated. In addition, there are well established principles of learning that should be taken into account. Of particular relevance are the following principles: (a) timely, informative feedback is an essential aspect of instruction; (b) time-on-task is an essential aspect of mastering learning tasks; and, (c) prior knowledge and understanding is essential for mastering many new learning tasks. Each of these principles needs to be applied in a manner that takes into account individual differences. Advanced learners require less feedback than learners new to a learning domain. Motivating individuals to spend more time on a learning task varies a great deal with individuals who have different beliefs and attitudes. Providing meaningful examples and non-examples also varies for individuals with different backgrounds and preparation. It is not reasonable to assume that all students are equally well-prepared and bring all of the relevant background and interest to a particular subject or learning task.

Finally, it is worth noting that learning is a naturally occurring human activity. People naturally and continually create internal representations of the things they experience in life and in a learning experience in order to make sense of those experiences. These internal representations can facilitate or inhibit learning. A particular challenge for teachers is to determine what these internal representations are like and how they may be helping or hindering learning. This is a challenge since those internal representations are not easily accessible and only indirectly observable. Fortunately, humans have a second naturally occurring capability – namely, language. People talk about their internal representations, and sometimes they create other artifacts that reflect those representations. As a consequence, this discussion assumes a socio-constructivist epistemological perspective (Spector, 2012) with regard to the critique of educational technology.

2. Materials and methods

2.1. A roadmap for education technology

The 2010 NSF *Roadmap for Education Technology* (Woolf, 2010) cites eight grand challenges for education technology (http://www.cra.org/ccc/files/docs/groe/GROE%20Roadmap%20for%20Education%20Technology%20Final%20Report.pdf):

- Personalizing education (customizing learning and instruction to match individual interests, knowledge, skills, attitudes, and interests),
- Assessing student learning (providing formative feedback during instruction as well as summative assessment after instruction that is clearly linked to desired outcomes),
- Supporting social learning (engaging groups of learners in meaningful activities as this will be expected in many work environments and is likely to promote learning complex tasks),
- Diminishing boundaries (making instruction more accessible to workers, parents, and others outside a traditional school-based environment),
- Alternative teaching methods (as learners gain competence and confidence, providing more open-ended exploratory activities likely to result in deeper insight),
- Enhancing the role of stakeholders (engaging decision makers at multiple levels to ensure that learning and instruction are adequately supported),
- Life-long learning approaches (active recognition and support for learning that continues beyond the boundaries of formal learning programs), and
- Addressing policy changes (promoting evidence-based policies at a high level so that promising new technologies are not used simply as replacements for existing tools and methods but as tools to reform and promote deep understanding).

Formative feedback is feedback provided to the learners during instruction aimed at improving knowledge, skills,