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Digital Technology a Catalyst for Innovation in Educational Resources: A Review

Dr. Syed Noor-ul-Amin

Department of Education, University of Kashmir

Abstract

Digital technology as innovative medium in education is an essential to ensuring a flexible, modern education system. As in other sectors, education should benefit from a strong innovative industry developing resources and devices that improve its effectiveness and efficiency. The innovative digital technology-supported to improve outcomes, including the development of educational resources and to expand the range of learning opportunities available to students. The aim of the present study was to estimate the contribution of new digital education resources which have made significant impacts, as have new formal and informal education environments and change working cultures in education. Present paper mostly review the digital technology-supported models based on educational gaming, online laboratory experiments, collaboration through digital technology, aligning a skills-based curriculum with technology and real-time formative assessment which facilitates and increase students test scores and conceptual understanding as well as enhancing students' creativity, imagination and problem-solving skills. Online laboratories (remote or virtual) provide a wider range of experimentation and learning-by-doing than would be possible without technological support. Besides, digital technology increases possibilities for intercultural collaboration, providing students with the opportunity to experience the sort of international collaboration that is common in today's professional environments. Finally, digital technology facilitates assessments that allow teachers to monitor student learning as it happens and adjust their teaching as required and identify the skills students need to acquire in a more comprehensive way than would otherwise be possible.

Keywords: ***Digital Technology, Educational Gaming, Educational Resources, Innovation.***

Introduction

Education systems face the challenge of widening access to high-quality opportunities to learn. In the 20th century education at scale and standardization have led to an extraordinary expansion of education systems. However, scale and standardization have had their limitations have not brought opportunities to all. The opening presentation in this session reflected on the challenges of widening access and improving quality at the same time. New educational resources including digital and open education resources have made significant impacts, as have new formal and informal education environments. Digital technologies increase access to education and opportunities to learn, but technology is not a magic wand, we need to think about other factors including access to technology and connectivity; social attitudes to learning; legal issues associated with use; skills and competences of learners and teachers.

"Digital educational resources are offered on line (although sometimes in print) freely and openly to teachers, educators, students, and independent learners in order to be used, shared, combined, adapted, and expanded in teaching, learning and research. They include learning content, software tools to develop, use and distribute, and implementation resources such as open licenses. The learning content is educational material of a wide variety, from full courses to smaller units such as diagrams or test questions. It may include text, images, audio, video, simulations, games, portals and the like."

In terms of access to information, digitization is introducing many new and more possibilities than ever before. Traditionally, students were limited to access to a textbook and to a teacher. When trying to solve a problem in class, students could study the textbook or ask the teacher. Now things are different – connectivity, devices and access to a world of information in digital format is fundamentally changing this dynamic. In terms of presentation of learning material and how discussions in class and beyond take place, digitization has introduced many technological developments; discussion on the digital revolution to concentrate has tended to concentrate around presentation, rather than access to information. In the longer term, the revolution in access to information is likely to have a greater impact than the changes in the presentation. It seems obvious that digitization should be considered an opportunity to rethink pedagogies and teaching practices, and more broadly, to change working cultures in education.

Digital Technology a Source of Educational Gaming

Educational gaming offers a promising model to enhance student learning education, not just improving content knowledge, but also motivation and thinking and creativity skills. Educators and policy makers should consider using it to enhance learning outcomes and problem-solving skills and motivation.

Designing games appears to lead to even deeper learning than just using the m for educational purposes. In educational gaming, students interact with video games, simulations or virtual worlds based on imaginary or real worlds, also seen as highly interactive virtual environments (Raju, Ahmed and Anumba, 2011; Shaffer, forthcoming; Aldrich, 2009). Educational gaming also includes collaborative project-based learning experiences where students themselves become game designers and content producers (Prensky, 2008; Jaurez et al., 2010; Raju, Ahmed and Anumba, 2011). As a promising model for various disciplines and education levels, educational gaming may promote learning by doing. The interactive, reactive and often collaborative nature; of educational gaming enable students to learn about complex topics by allowing them to (repeatedly) make mistakes and learn from them. Real-life based gaming allows experimentation that would otherwise be too costly or dangerous. Gaming can be particularly useful when educating professionals who need the capacity to think and work simultaneously, while relying on tacit knowledge such as architects, engineers, chemists, physicists, doctors, nurses, or carpenters (Raju, Ahmed and Anumba, 2011; Lin, Son and Rojas, 2011; Shaffer, forthcoming). Educational gaming which covers specific topics or subject areas and takes place within a set of rules can increase students' achievements and subject specific knowledge (Akinsola and Animasahun, 2007; Papastergiou, 2009; Yien et al. 2011; Bai et al., 2012; Shaffer, forthcoming). Constructing educational games seems to increase deep learning more than just using existing games (Vos, Meijden and Denessen, 2011).

Being based on play and increasing challenges, educational gaming can foster student engagement and motivation in various subjects and education levels (Papastergiou, 2009; Annetta et al., 2009; Wastiau, Kearney and Van den Berghe, 2009; Lin, Son and Rojas, 2011; Yien et al., 2011; Yang, 2012; Shaffer, forthcoming). Low-achieving students may find the educational gaming experience more engaging than high-achieving students (Grimley et al., 2012). Students' motivation can increase more when they construct games themselves as opposed to just playing an existing game (Vos, Meijden and Denessen, 2011). Games have the potential to help students find new ways around challenges, use knowledge in new ways and "think like a professional" (Shaffer, forthcoming). Educational gaming may also improve students' skills such as problem solving (Yang, 2012).

Online Laboratories as a Digital Educational Resource

Online laboratories, whether remote or virtual, are another promising innovation intended to enhance technology-supported teaching and learning. Virtual online laboratories allow students to simulate scientific experiments while remote ones allow students to use real laboratory equipment from a distance

through the Internet (Jona et al., 2011; Tasiopoulou and Schwarzenbacher, 2011). Educators and policy makers should consider online laboratories as a promising way of increasing access to a wide range of experimental learning. Using online laboratories only requires access to the Internet and allows teachers and students to access more experimental equipment than a single school can generally provide. While remote laboratories can give students' access to expensive equipment, virtual laboratories can allow them to vary the conditions for the experiments. Online laboratories are thus a good complement to - or substitute for – school science labs. The use of online laboratories can be at least as effective in terms of learning as the use of on-site physical equipment, and many resources are freely available on the web. As promising innovations particularly for science instruction, online laboratories can be expected to offer the potential benefits. Online laboratories may help bridge the digital divide by providing students with faster access to experimental learning at a relatively low cost (Burd, Seazzu and Conway, 2009; Flint and Stewart, 2010; Nedungadi and Raman, 2011; Jara et al., 2011; Ku, Ahfock, and Yusaf, 2011). Simulations may be less expensive than experimental hardware, although "little empirical data exists on the actual costs of providing online laboratory access at scale" (Jona et al., 2011). Online laboratories can enable flexible access to practical experiments, allowing increased study time that is not tied to a specific timetable or location. (Ku, Ahfock, and Yusaf, 2011; Almarshoud, 2011).Online laboratories can help support student understanding and achievement at least as well as physical hands-on learning does (Yang and Heh, 2007; Pyatt and Sims, 2012; Chini et al., 2012). Virtual manipulatives may be used in a blended format together with physical manipulatives of experimentation to further increase student understanding (Nedungadi and Raman, 2011; Olympiou and Zacharia, 2012). An excellent example is the online laboratories for upper secondary physics and mathematics developed by Amrita University in India.

Educational Collaboration through Digital Technology

Collaboration through digital technology can enhance students' interaction, engagement, learning and thinking skills, in addition to increasing the flexibility and diversity of their educational experience. Digital technology-supported collaboration can enhance students' awareness of global challenges and develop their understanding of other cultures and policy makers should consider digital technology as a way to increase collaborative learning including over long distances and between different cultures. Policy makers could facilitate this process by creating platforms for international collaboration among schools, classes, teachers and students. Collaboration can be supported by tools such as cloud computing, video-conferencing, or online platforms. New technologies allowing for real-time communication make

international collaboration much easier than in the past. For example, the project enabled students from different countries to compare their findings and reflect on the challenge of quality internationally and to increase their awareness of another culture.

In digital technology-enabled collaboration, students work together (in groups) and/or interact with each other to enhance their learning with the help of various technologies (Resta and Laferriere, 2007; Zhu, 2012) often with facilitation from the teacher (Resta and Laferriere, 2007). When combined with other learning approaches, technology-enabled collaboration can form a part of project or problem-based learning or supplement face-to-face learning (Resta and Laferriere, 2007). Digital technology-enabled collaboration models may include in-built assessment features taking into account also team performance and/or collaborative activity (Zhu, 2012). As a promising education and other disciplines at various education levels, collaboration through technology may improve. It enables students to collaborate and practise at "their own pace", beyond the formal classroom hours and without limitations of physical location (Resta and Laferriere, 2007; Zhu, 2012). It can significantly increase the chances for intercultural interactions by broadening the scope of collaborations to distant locations, even across borders (Resta and Laferriere, 2007; Crawley et al., 2008; Karpova, Correia, and Baran, 2009; Rogers, 2011; Rautenbach and Black-Hughes, 2012).It may support student learning, in both individual and group outcomes (Resta and Laferriere, 2007; Thompson and Ku, 2010; Kelly, Baxter and Anderson, 2010), although not necessarily more than faceto- ace interaction (Tutty and Klein, 2008). There can also be cross-cultural differences (Zhu, 2012). In general, positive results from co-operative learning on student achievement have been shown to depend on group learning goals and individual accountability (Slavin, 2010).

Digital technology-enabled collaboration can encourage students' group work skills, interaction and engagement (Nevgi, Virtanen and Niemi, 2006; Resta and Laferriere, 2007; Nussbaum et al., 2009; Kelly, Baxter, and Anderson, 2010). However, students do not automatically adopt "active learning strategies" (Wang, 2010) and activity may differ across cultures (Zhu, Valcke and Schellens, 2009; Zhu, 2012). In general, co-operative learning has shown clearly beneficial results on affective student outcomes (Slavin, 2010). Online collaboration may enhance higher order thinking even more than face-to-face collaboration through "more complex, and more cognitively challenging discussions" (Resta and Laferriere, 2007). This can also be the case for "questioning behaviours" and "project performance" (Tutty and Klein, 2008).

Digital Technology as a Source of Real-Time Formative Assessment

Digital technology significantly facilitates the use of formative assessment – that is, frequent, interactive assessment of student progress and understanding (OECD, 2005a). Clickers, tablet computers and other kinds of technology enable instantaneous interaction and feedback between teachers and students. In real-time formative assessment, software enables a variety of inputs to be used for student assessment including open format replies, student questions, pictures or mathematical formulas (Enriquez, 2010; Briggs and Keyek- Franssen, 2010; Kohl et al., 2011; Gardner, Kowalski and Kowalski, 2012). Some of the software is freely available. Real-time formative assessment can be combined with various instructional models.

Educators and policy makers should consider using real-time formative assessment to enable more personalized learning. The immediate feedback it provides allows teachers to personalize their instruction to the needs of individual students or to specific groups of students. Real-time formative assessment can also help ensure every student participates in classroom discussions, something that does not generally happen in group instructions, for example because of time constraints or shyness. As promising educational innovation, real-time formative assessment could enhance targeted instruction. It allows teachers to monitor student learning as it happens and better adjust their teaching to the needs of individual students (Enriquez, 2010; Briggs and Keyek-Franssen, 2010; Kohl et al., 2011; Gardner, Kowalski and Kowalski, 2012). Real-time formative assessment can increase student achievement by promoting students' reflection about the needs of and engagement in their own learning (Enriquez, 2010; Briggs and Keyek-Franssen, 2010; Gardner, Kowalski and Kowalski, 2012; Wu et al., 2012). It provides avenues for assessing different types of activities and variety of student skills such as problem solving or creativity potentially enhancing the acquisition of these skills (Looney, 2009, 2011a; Enriquez, 2010; Kohl et al., 2011; Wu et al., 2012; Gok, 2012).

Aligning a Skills-Based Curriculum with Digital Technology

Using digital technology to align with skills-based curricula can promote more accurate assessment of the variety of skills. While it is becoming increasingly common to develop these kinds of skills-based curricula, their eventual impact on actual teaching and learning also depend on the availability of adequately aligned support systems (Ananiadou and Claro, 2009; Looney, 2011b; Karkkainen, 2012). This is particularly true for student assessments, but also for learning materials, teaching guides and teacher professional development (Ananiadou and Claro, 2009; Karkkainen, 2012). Adequate

measurement is needed to truly promote certain skills, to give teachers an incentive to teach students in that way (Looney, 2009). In contrast, assessments those are poorly aligned with standards and curriculum make it "impossible to draw valid conclusions about the success of student learning" (Looney, 2011b). Although "no system can achieve perfect alignment" (Looney, 2011b), technology can become a great support in developing adequate measures for approaching this goal. As a promising innovation for advancing skills, digital technology can improve adequate curriculum alignment through. It can help measure complex skills such as reasoning or problem solving through measures such as essays, blogs or virtual learning environments (Looney, 2009, 2011b; Ramirez-Corona et al., 2013).

Conclusion

Digital technology holds significant potential for expanding the range of learning opportunities available to students and for the formative assessment of a wide range of skills for innovation. The variety of learning opportunities and personalization digital technology can offer may make education more interesting and enjoyable for students. Digital technology-supported education that provide wider ranges of experimentation and learning-by-doing than are possible without technological support. Simulations provide one route to greater experimentation. Online laboratories (remote or virtual) using simulations can enable relatively low-cost flexible access to experiential learning. They can allow increased study time, and offer access that is not restricted to a specific timetable or location. In addition, technology-supported simulations can allow the study of subject matter that would be almost impossible otherwise. Parents are likely to be unhappy if their children were to work with radioactive in a live laboratory. Remote or virtual laboratories offer the experience of studying and working with radioactivity safely. Nor can any school afford an unlimited supply of physical experimental resources. Online and remote laboratories, as well as other virtual environments, can be used to complement the resources available on site and enhance teachers' and students' teaching and learning opportunities.

Digital technology also increases the possibilities for intercultural collaboration, overcoming geographical distance and formal classroom hours; they are able to work together despite being a world apart, conducting real scientific research into water pollution. Similarly, collaborated and planned teamwork in a virtual built environment project that required them to go through all the stages of a construction project with peers. These projects provided students with an opportunity to experience international collaboration, to gain insight into other cultures and differences, and to be exposed to multicultural communication. This type of collaboration closely emulates the collaborative nature of

today's international professions. Finally, digital technology facilitates real-time formative assessment and some forms of skills based assessments that improve monitoring of student learning, and supports personalization of teaching. Real-time formative assessment allows teachers to monitor student learning as it happens, and to immediately adjust their teaching to the needs of individual students. It may also enable the active participation of more students in the classroom discussion. Technology-supported assessment enables students' skills development to be monitored, and the skills they still need identified in a more comprehensive way than would be possible without digital technology.

Suggestions

The challenge of adopting these digital technology models is more to do with integrating new types of instruction, rather than overcoming technology barriers. Their adoption by teachers is most likely to be sustained and effective when there is adequate support from policy makers. The efficacy of digital technology-supported models comes largely from the pedagogy that it supports; teachers need the resources and understanding of how to use them. Real-time formative assessment may allow teachers to observe students' learning in real time, but they still have to use this information in their teaching. Experiential learning is most likely to improve students' understanding and skills if teachers encourage them to repeat their experiments and provide them with a robust scaffolding to understand them. In order to meet this pedagogic challenge, teachers need adequate professional development. A common barrier to adopting new teaching models and resources is lack of formal teacher training, peer learning and more. Teachers also simply need time to integrate new technology-enhanced educational models into their pedagogy. While success is driven by pedagogy, digital technology-supported models generally require a certain level of equipment although mainly relatively low-cost and familiar devices such as computers, tablets or mobile phones, with Internet connections. Another critical success factor is the availability of a critical mass of teacher-friendly educational content and resources. Many digital resources are also freely available to teachers; these include simulations in virtual environments (remote or online laboratories, games) and software for real-time formative assessment. Context also counts a great deal when projects are scaled up; innovations must be responsive to local needs and educational structures.

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