2014-05

Learning Technologies in Higher Education

Brown, Barb

University of Calgary

LEARNING TECHNOLOGIES IN HIGHER EDUCATION

Barb Brown, Michele Jacobsen, Deb Lambert

University of Calgary

This paper highlights key ideas from a review of the research literature on ways in which contemporary learning technologies are influencing teaching and learning experiences in higher education. The diverse ways in which students and professors connect, communicate, collaborate and create knowledge for learning and teaching both on campus and in blended and online learning spaces are explored. Promising and emerging practices from the research literature and the implications for faculty members, leaders and higher education institutions of learning are discussed. Challenges for higher education as teaching and learning undergoes change are described.

Contemporary educational technologies can enhance and enrich teaching and learning experiences on and beyond campus and often serve as a disruptive force in higher education. In this article, we share key themes and findings from a review of the research on high quality technology enhanced learning experiences in higher education. Ideas are organized in three sections: (a) trends impacting higher education learning environments, (b) a framework for exploring the use of technology in teaching and learning, and (c) implications of learning technologies for higher education. Each section expands on

the ways in which contemporary learning technologies and innovative pedagogies can improve learning in higher education.

TRENDS IMPACTING HIGHER EDUCATION

Higher education learning environments are undergoing changes in the context of major societal and technological shifts. Current advancements in digital and social technologies increase connective, collaborative and expressive human capability. Using networked mobile devices, individuals are accessing and contributing to a growing knowledge base and influencing global conversations. Higher education is shifting from a closed learning environment (prescribed content, teacher directed, pre-selected, distributive, individual expression) to open learning environments (student selected, self-organized, collaborative, participatory, interactive, networked) that invite and enable participation beyond traditional class enrolment (Jenkins, 2009, 2006; Johnson, et al., 2013; Siemens & Tittenberger, 2009). Instructor controlled, content delivery approaches in large lecture halls are giving way to a spectrum of new learning experiences in classrooms expanded with online components, pervasive and mobile technologies, and fully online learning experiences that engage global learners in virtual environments and progressive participatory cultures (Graham, Woodfield & Harrison, 2013). Technology-enhanced learning environments, defined "as complex learning environments that enable appropriate use of technological resources in order to continually enhance the conditions conducive to learning," (Brown, 2013, p. 304) enable learners to connect, collaborate and create knowledge with others in online and offline spaces and across geographic boundaries using 21st century literacies that are increasingly important for today's graduates (Jenkins, 2006, 2009).

Current research on learning and signature pedagogies (Shulman, 2005; Schank, 2011) influence faculty designs to include more meaningful, relevant and connected learning experiences. For instance, several qualities of participatory cultures, such as openness, collaboration and interactivity (Jenkins,

2009, 2006), are combined and actively designed into technology enhanced learning experiences to promote knowledge building and to make learning and teaching more visible in higher education (Bereiter & Scardamalia,2010; Clifford & Friesen, 1993; Hattie, 2009; Jacobsen & Friesen, 2011; Sawyer, 2012, 2006; Thomas & Seely Brown, 2011). Technology plus transformative pedagogies enable teachers to expand beyond being the sole information provider and embrace their role as designers of engaging and interactive, technology enabled, participatory learning experiences. Research on the importance of community and how technology can enable and enhance the development of global learning communities continues to evolve. Students work on meaningful and authentic learning tasks in connected learning communities, and learn by working alongside diverse peers, build on previous experiences, and work collaboratively to construct knowledge (Anderson, 2003a, 2003b; Bransford, Brown & Cocking, 2000; Garrison & Anderson, 2003). Images of high-performance, multi-disciplinary research teams in which novices and experts come together to address genuine problems in the field are better suited to how people learn best in higher education than the information delivery models that have persisted in the 21st century (Bransford, Brown & Cocking, 2000; Sawyer, 2006, 2012; Swartz & Fischer, 2003, 2006). Research demonstrates that people learn best by doing, rather than learning about first then doing.

Several key challenges that face higher education emerged from the review of literature:

- Learning environments are changing and it can be challenging to develop/use/sustain effective instructional strategies across the spectrum of different course-delivery modalities.

- Programs need continuous research-informed review and renewal to keep pace with technological advances and the changes in how people socialize and learn.

- Theoretical influences on pedagogy challenge educators with a new role as developers of continuous research-informed designs for learning.

- Technological influences on pedagogy require ongoing, continuous support for faculty in advancing knowledge building and social constructivist approaches in technology enhanced and enabled learning environments.

- Advances in learning research challenge faculty to ensure that practices and designs for learning are research-informed and foster both individual growth and collective growth in communities of learners.

- Networking infrastructure and classroom technologies need to support faculty and students to be open, flexible, responsive and connected leaders of learning.

- Changed approaches to teaching, and recent research on learning, challenge higher education to develop authentic approaches to formative and summative assessment.

A current challenge for higher education is the use of contemporary technologies to support conventional information delivery and assessment of learning using tests and grades. A challenge for institutions is to provide networking infrastructures coupled with high quality, continuous professional learning that cultivates and supports contemporary pedagogies and the design of participatory learning environments. Current faculty members need support in designing learning experiences with technology and developing appropriate approaches for assessment and self-regulation (Earle, 2013). Brown, Eaton, Jacobsen, Roy and Friesen (2013) describe an approach to collaborative course design that employs integrated assessments for learning and instructional designs that integrate technology for meaningful learning. Time and resources are needed to support faculty in developing collaborative design teams to incorporate formative and assessment practices in technology-enhanced learning environments.

4C FRAMEWORK

The authors developed a framework based on the review of current literature to organize technology use in higher education within four categories: connecting, communicating, collaborating and creating. Rather than offering distinct, progressive or developmental categories, the framework offers interconnected and mutually reinforcing categories that can be used to explore promising and emerging practices that transform learning experiences and learning environments in higher education. First, making *connections* as part of learning in higher education has expanded beyond classroom walls; technologies can support connections among learners, professors and with local and global experts beyond the classroom. A connected learning environment can be defined by three characteristics according to Smith (2013): (1) Seamless integration with planning and advising services to help students plan for degree completion; (2) Personalized learning with diverse learning options (online, on campus, or through a blended alternative); and (3) Engaged and authentic learning experiences (p. 1). The literature identifies how learning technologies can support connected learning in higher education, such as using tablets or mobile devices, leveraging learning analytics for data-driven decision making and offering Massive Open Online Courses (MOOCs) as a mode of education delivery with no limit to enrolment.

Second, *communicating* in higher education continues to include traditional one-time interactions between professor-learners and learner-learner in classroom spaces. However, technologies have now expanded how and when communications in higher education take place and who may participate in the conversation. Communications with learning technologies can expand knowledge sharing to include a broader audience and provide students with options to control time, space, pacing and playback of communications. Researchers report that using learning technologies for communications increases student engagement (Liu, 2012; Oztok, Zingaro, Brett & Hewitt, 2013; Rajasakeran, 2013), develops higher-order thinking skills (Cheong, Bruno & Cheong, 2012), promotes reflective

interactions (Rogers & Lea, 2005), deepens learning in scholarly communities of inquiry (Garrison & Akyol, 2009), and results in achievement gains and positive student ratings (Brecht, 2012; Kay & Kletskin, 2012; Wong, 2013). Common learning technologies for communication purposes include clicker technologies, mobile applications, videos/flipped classroom approaches, learning management systems, discussion boards, email, blogs, microblogs, and web conferencing.

Third, many of the same technologies used for connecting and communicating can foster *collaboration* and learning alongside and with others. Working in collaboration is a necessary requirement for today's students (Karpova, Correia & Baran, 2009). Examples of technologies currently used for collaboration in higher education are networked mobile devices, wikis, and online collaborative workspaces. Fourth, everyone has the capacity to contribute to collective knowledge *creation*; however, established systems of learning in higher education still emphasize knowledge transfer (Allen, Caple, Coleman & Nguyen, 2012; Martin, Morris, Rogers, Martin & Kilgallon, 2009; Schwartz & Fischer, 2003) and value individual expressions of learning. More emphasis is needed on building expressions of learning through deep learning experiences, collaborative and creative designs and shared knowledge creation. Examples of technologies used for collective creation include games, gamification and virtual worlds. Table 1 organizes the technologies reviewed. The examples are not meant to provide an exhaustive list and many of these examples can be used to illustrate multiple categories in the framework as well as contribute to new conceptualizations of the 4C Framework.

4Cs	Learning Technologies & Learning Opportunities from the Literature
Connecting	**Tablets** are used for staying connected to learning networks, to search for resources (i.e. search engines, library websites, news websites, etc.), during fieldwork, and for organization purposes, such as taking notes or annotating lecture templates (Jones, Johnson-Yale, Millermaier & Perez, 2008; Mang & Wardley, 2012; Pegrum, Howitt & Striepe, 2013). **Learning analytics** or data analysis techniques of large data sets (Siemens et al., 2011; van Barneveld, Arnold & Campbell, 2012) used to inform and intentionally design and shape higher education learning environments around the learners (Ali, Asadi, Gasevic, Jovanovic & Hatala, 2013; Herrington, Reeves & Oliver, 2010; Fournier, Kop & Sitlia, 2011; Pea, 2006) and for strategic planning and to improve course delivery in online and blended learning environments (Dzuiban, Moskal, Cavanagh & Watts, 2012). Two types of **MOOCs** are commonly discussed in the literature: c-MOOCs, associated with connectivism (Siemens, 2004) are open with freely provided materials designed to foster connections and collaborative knowledge building extended to global participants and x-MOOCs follow a more tutor-centric model with levelled progressions (Rodriguez, 2013).
Communicating	**Clickers,** easy-to-use, increase performance through instantaneous feedback, increased attention, attendance and participation (Keough, 2012) and student engagement (Liu, 2012; Rajasakeran, 2013). **Mobile applications** are found to engage students, promote higher-order thinking skills in lectures and interactive processes (Cheong et al., 2012); can extend reach of communications beyond the classroom. **Videos** can be used for a **flipped classroom** or inverted approach in which the lecture and homework are reversed (Hamdan, McKnight, McKnight & Arfstrom, 2013) and many faculty experiment with the flipped classroom model (MacMillan et al., 2013). Studies found video lectures and access to online recordings/tutorials for repetition or adapted pacing can result in achievement gains and positive student ratings (Brecht, 2012; Kay & Klestskin, 2012; Wong, 2013). Students find access to managed course content and communications valuable (Naveh, Tubin & Pliskin, 2010) even though **LMS** are modeled after traditional pedagogies (Jones et al. 2008; Dunlap & Lowenthal, 2009) and emphasize content delivery (Siemens & Tittenberger, 2009). **Discussion boards** offer asynchronous text-based communications, reflection and interactions can promote social presence, a shared sense of belonging, shared social identity (Rogers & Lea, 2005) and deep learning in scholarly communities of inquiry (Garrison & Akyol, 2009). **Email** commonly used for class communications, announcements, to seek/provide clarification, submit assignments, share resources/course materials, set up meetings (Jones et al., 2008; Karpova et al., 2009) and can positively impact student engagement and provide a sense of community (Oztok et al., 2013). Individual **blogs** are mainly used for self-expression and dissemination of ideas with potential for commentary and discourse (Schwier, 2013) and authentic writing and reflection (Bartholomew, Jones & Glassman, 2012). Community blogs with co-ownership provide opportunities for contributions to a larger professional learning network (Bartholomew et al., 2012). **Microblogs** are used for interactions, information/resource sharing, requesting/offering assistance, commentary, and networking with others, to name a few (Veletsianos, 2012).

Web conferencing is used for synchronous virtual learning mainly for seminar presentations (Falloon, 2011). Although technical issues are often cited as a barrier for web conferencing, Karpova et al. (2009) found web conferencing useful for brainstorming and group decision-making in comparison to other communication tools, such as discussion boards.

Collaborating	Personally owned **networked mobile devices** are common (Chen & Denoyelles, 2013), enable learners to consume and produce content (Anderson, 2013) and learning designs can increase participation, communications and collaboration with peers (Andreu, Delgado-Almonte & Pedraja-Rejas, 2010). **Online collaborative workspaces** using cloud computing and shared applications allow for collaborative creation (feedback, tracking changes) and shared knowledge building (group contributions). Schneckenberg, Ehlers & Adelsberger (2011) reported increased student engagement and positive student ratings for online collaborative learning sessions using Google Apps. Open access **wikis** or secured wikis integrated in the learning environment are used and Carroll, Diaz, Meiklejohn, Newcomb and Adkins (2013) found academic writing improved through a collaborative, iterative and competitive process of publicly sharing, reviewing and critiquing peers' contributions.
Creating	Educational **games** (e.g., computer games, video games) and **gamification**, that is a combination of game and non-game elements, are reported to support critical thinking, creative problem solving, team work (Johnson et al., 2013) and active learning (Lee & Hammer, 2011). Students are also motivated and engaged through design and creation of games for learning (Li, Tay & Louis, 2012; Tzuo, Isabelle, Ling, Yang & Chen, 2012; van Eck, 2006). Higher education institutions are experimenting with personalized and immersive online environments to supplement classroom learning or for online learning in **virtual worlds**, such as Second Life (Tan & Waxman, 2013). Potential uses of virtual worlds include communication, collaboration, interactions through role-play activities, synchronous meetings, simulations, group projects, problem-based learning (Inman, Wright & Hartman, 2010) and collaborative creative design tasks (Keskitalo, Pyykkö & Ruokamo, 2011; Tan & Waxman, 2013).

Table 1: Promising learning technologies and practices in a 4C Framework

Despite common barriers cited in the literature that can inhibit the adoption of learning technologies and innovation, such as leadership, faculty and staff capacity, institutional characteristics and technological infrastructures (Buabeng-Andoh, 2012; Buchanan, Sainter & Saunders, 2013), learning technologies are being used effectively for connecting, communicating, collaborating and collectively creating in higher education learning environments.

IMPLICATIONS FOR HIGHER EDUCATION

Essential conditions for effectively using learning technologies in higher education that we distilled from the literature include:

- Leadership in developing effective institutional vision and aligned processes (Dziuban et al., 2012; Jackson, 2013; Taylor & Newton, 2013)

- A culture that values learning, risk taking and ongoing faculty development (Dziuban et al., 2012; Jackson, 2013)

- Robust and reliable technological infrastructure and technologies (Dziuban et al., 2012; Inman et al., 2010; Kenny, Van Neste-Kenny, Park, Burton & Meiers, 2009; Mang & Wardly, 2012) and hardware/software requirements

- Technologies for learning are integral components purposefully incorporated in the course with clear objectives and across different course delivery modalities (Inman et al., 2010; Lin, Hoffman & Borengasser, 2013; Kerawalla, Minocha, Kirkup & Conole, 2009; Mang & Wardley, 2012; Pegrum et al., 2013)

- Instructional designs consider logistics for use and pedagogies fostering authentic, student centred learning experiences, creative development activities and collaborative knowledge building, all of which need to be surrounded by authentic approaches to formative and summative assessment (Inman et al., 2010; Jackson, 2013; Karpova et al., 2009; Kerawalla et al., 2009; Lin et al., 2013; Mang & Wardley, 2012)

- Student guidance, support with benefits/scaffolded experiences w/learning technologies (Inman et al., 2010; Lin et al., 2013; Kerawalla et al., 2009; Mang & Wardley, 2012)

Innovative use of learning technologies is occurring in higher education and research can inform faculty, leaders and institutions about participatory learning designs; however, more research and support is needed to improve learning experiences and to keep pace with new approaches to connecting, communicating, collaborating and collectively creating in a global community.

References

Ali, L., Asadi, M., Gasevic, D., Jovanovic, J., & Hatala M. (2013). Factors influencing beliefs for adoption of a learning analytics tool: An empirical study. *Computers & Education*, 62, 130-148. doi: 10.1016/j.compedu.2012.10.023

Allen, B., Caple, H., Coleman, K & Nguyen, T. (2012). Creativity in practice: Social media in higher education. In M. Brown, M. Hartnett & T. Stewart (Eds.), Future challenges, sustainable futures, Proceedings ascilite Wellington 2012 (pp.15-20): New Zealand.

Anderson, E. K. (2013). Mobile devices and functions. In R. C. Richey (Ed.), Encyclopedia of terminology for educational communications and technology (pp. 212-213), New York, NY: Springer.

Anderson, T. (2003a). Modes of interaction in distance education: Recent developments and research questions. In M. Moore and G. Anderson (Eds.), *Handbook of distance education*. (pp. 129-144) NJ: Erlbaum.

Anderson, T. (2003b). A second look at Learning Sciences, classrooms and technology. In T. Duffy & J. Kirkley (Eds.) *Learner centered theory and practice in distance education*. (pp. 235-249). NJ: Lawrence Erlbaum.

Andreu, H. B., Delgado-Almonte, M., & Pedraja-Rejas, L. (2010). Information technologies in higher education: Lessons learned in industrial engineering. *Educational Technology & Society*, *13*(4), 140-154.

Bartholomew, M., Jones, T., & Glassman, M. (2012). A community of voices: Educational blog management strategies and tools. *Techtrends: Linking Research & Practice to Improve Learning*, *56*(4), 19-25. doi: 10.1007/s11528-012-0583-3

Bereiter, C. & Scardamalia, M. (2010). Can children really create knowledge? *Canadian Journal of Learning and Technology*, *36*(1), 1-15.

Bransford, J., Brown, A., & Cocking, R. (2000). *How people learn: Brain, mind, experience, and school*. Washington, DC: National Academic Press. Retrieved from http://www.nap.edu/openbook.php?isbn=0309070368

Brecht, D. H. (2012). Learning from online video lectures. *Journal of Information Technology Education: Innovations in Practice*, 11, 230-250.

Brown, B. (2013). Technology-enhanced learning environment. In R. C. Richey (Ed.), *Encyclopedia of terminology for educational communications and technology* (pp. 304-305), New York, NY: Springer.

Brown, B., Eaton, S., Jacobsen, M., Roy, S., & Friesen, S. (2013). Instructional design collaboration: A professional learning and growth experience. *MERLOT Journal of Online Learning and Teaching, 9*(3). Retrieved from http://jolt.merlot.org/vol9no3/brown_0913.htm

Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *International Journal of Education and Development using Information and Communication Technology (IJEDICT), 8*(1), pp. 136-155.

Buchanan, T., Sainter, P., & Saunders, G. (2013). Factors affecting faculty use of learning technologies: implications for models of technology adoption. *Journal of Computing in Higher Education*, *25*(1), 1-11. doi: 10.1007/s12528-013-9066-6

Carroll, J.A., Diaz, A., Meiklejohn, J., Newcomb, M., & Adkins, B. (2013) Collaboration and competition on a wiki: The praxis of online social learning to improve academic writing and research in under-graduate students. *Australian Journal of Educational Technology*, *29*(4), 513-525.

Chen, B. & Denoyelles, A. (2013). Exploring students' mobile learning practices in higher education. *Educause Review*. Retrieved from: http://www.educause.edu/ero/article/exploring-students-mobile-learning-practices-higher-education

Cheong, C., Bruno, V., & Cheong, F. (2012). Designing a mobile-app-based collaborative learning system. *Journal of Information Technology Education: Innovation in Practice*, *11*, 97-119.

Clifford, P. & Friesen, S. (1993). A curious plan: Managing on the twelfth. *Harvard Educational Review, 63*(3), 339-358.

Dunlap, J. C. & Lowenthal, P. R. (2009). Tweeting the night away: Using Twitter to enhance social presence. *Journal of Information Systems Education*, *20*(2), 129-135.

Dziuban, C., Moskal, P., Cavanagh, T., & Watts, A. (2012). Analytics that inform the university: Using data you already have. *Journal of Asynchronous Learning Networks*, *16*(3), 21-38.

Earle, L. M. (2013). *Assessment as learning: Using classroom assessment to maximize student learning* (2nd ed.). Thousand Oaks, CA: Corwin A SAGE Company.

Falloon, G. (2011). Making the connection: Moore's theory of transactional distance and its relevance to the use of a virtual classroom in postgraduate online teacher education. *Journal of Research on Technology in Education*, *43*(3), 187-209.

Fournier, H., Kop, R. & Sitlia, H. (2011). The value of learning analytics to networked learning on a personal learning environment. In P. Long, G. Siemens, G. Conole, & D. Gašević (Eds.),

Proceedings of the First International Conference on Learning Analytics and Knowledge (pp. 104-109). New York, NY: ACM. doi: 10.1145/2090116.2090131

Garrison, D. R., & Akyol, Z. (2009). Role of instructional technology in transformation of higher education. *Journal of Computing in Higher Education*, *21*(1), 19-30. dOI 10.1007/s12528-009-9014-7

Garrison, D.R. & Anderson, T. (2003). E-Learning in the 21st century. London: Routledge.

Graham, C. R., Woodfield, W., & Harrison, J. B. (2013). A framework for institutional adoption and implementation of blended learning in higher education. *Internet and Higher Education*, *18*, 4-14. doi:10.1016/j.iheduc.2012.09.003

Hamdan, N., McKnight, P. E., McKnight, K. & Arfstrom, K. M. (2013). A review of flipped learning. Flipped Learning Network. Retrieved from http://flippedlearning.org/cms/lib07/VA01923112/Centricity/Domain/41/LitReview_FlippedLearning.pdf

Hattie, J. (2009). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. New York, NY: Routledge Taylor & Francis Group.

Herrington, J., Reeves, T. & Oliver, R. (2010). A guide to authentic e-learning. New York, NY: Routledge.

Inman, C., Wright, V. H. & Hartman, J. A. (2010). Use of second life in K-12 and higher education: A review of research. *Journal of Interactive Online Learning*, *9*(1), pp.44-63. Retrieved from http://www.ncolr.org/jiol/issues/pdf/9.1.3.pdf

Jacobsen, M., & Friesen, S. (2011). Web exclusive: Hands on vs. hands up: Technology-enabled knowledge building in high school. *Education Canada*, *51*(3). Retrieved from http://www.cea-

ace.ca/education-canada/article/web-exclusive-hands-vs-hands-technology-enabled-knowledge-building-high-sch

Jackson, N. (2013). *Developing students' creativity through a higher education*. Paper produced for the International Symposium, Macao Polytechnic Institute, China. Retrieved from http://www.normanjackson.co.uk/creativity.html

Jenkins, H. (2006). Confronting the challenges of participatory culture: Media education for the 21st century. An Occasional Paper on Digital Media and Learning for the MacArthur Foundation. Retrieved from http://eric.ed.gov/?id=ED536086

Jenkins, H. (with Purushotma, R., Weigel, M., Clinton, K. & Robison, A. J.) (2009). *Confronting the challenges of participatory culture: Media education for the 21st century.* Cambridge, MA: MIT Press.

Johnson, L., Adams Becker, S., Cummins, M., Estrada, V., Freeman, A. & Ludgate, H. (2013). *NMC horizon report: 2013 higher education edition*. Austin, Texas: The New Media Consortium.

Jones, S., Johnson-Yale, C., Millermaier, S., & Perez, F. S. (2008). Academic work, the Internet and U.S. college students. *Internet and Higher Education*, *11*(3-4), 165-177. doi:10.1016/j.iheduc.2008.07.001

Karpova, E., Correia, A.-P., & Baran, E. (2009). Learn to use and use to learn: Technology in virtual collaboration experience. *Internet and Higher Education*, *12*(1), 45-52. doi:10.1016/j.iheduc.2008.10.006

Kay, R., & Kletskin, I. (2012). Evaluating the use of problem-based video podcasts to teach mathematics in higher education. *Computers & Education*, *59*(2), 619-627. doi:10.1016/j.compedu.2012.03.007

Kenny, R. F., Van Neste-Kenny, J. M. C., Park, C. L., Burton, P. A., & Meiers, J. (2009). Mobile learning in nursing practice education: Applying Koole's FRAME model. *Journal of Distance Education*, *23*(3), 75-96.

Keough, S. M. (2012). Clickers in the classroom: A review and replication. *Journal of Management Education*, *36*(6), 822-847. doi: 10.1177/1052562912454808

Kerawalla, L., Minocha, S., Kirkup, G., & Conole, G. (2009). An empirically grounded framework to guide blogging in higher education. Journal of Computer Assisted Learning, 25(1), 31-42. doi: 10.1111/j.1365-2729.2008.00286.x

Keskitalo, T., Pyykkö, E. & Ruokamo, H. (2011). Exploring the meaningful learning of students in second life. *Educational Technology & Society*, *14* (1), 16–26.

Lee, J. J. & Hammer, J. (2011). Gamification in education: what, how, why bother? Academic Exchange Quarterly, 15(2), pp. 1-5. Retrieved from http://www.gamifyingeducation.org/files/Lee-Hammer-AEQ-2011.pdf

Li, Q., Tay, R. & Louis, R. (2012). Designing digital games to teach road safety: A study of graduate students' experiences. *The Journal of the Canadian Game Studies Association 6*(9), 17-35. Retrieved from http://journals.sfu.ca/loading/index.php/loading/article/view/102/114

Lin, M. G., Hoffman, E., & Borengasser, C. (2013). Is social media too social for class? A case study of Twitter use. *TechTrends: Linking Research & Practice to Improve Learning*, *57*(2), 39-45.doi: 10.1007/s11528-013-0644-2

Liu, A. (2012). Exploring the use of clickers to support active learning and knowledge building by pre-service teachers in large lectures. Unpublished Masters Thesis, Faculty of Education, University of Calgary.

MacMillan, K, Ullyot, M., Eiserman, J., Hall-Beyer, M., Hoenle, S., Kelly, P., Macphail, E., Policzer, P. & Reaume, R. (2013). Knowledge networks: Post-secondary education in a digital age. A Report by the Faculty of Arts Dean's Advisory E-Learning Working Group. Retrieved from http://knowledge.ucalgaryblogs.ca/files/2013/11/WG-Report-2013-11-06_14.31.pdf

Mang, C. F. & Wardley, L. J. (2012). Effective adoption of tablets in post-secondary education: Recommendations based on a trial of iPads in university classes. *Journal of Information Technology Education: Innovations in Practice, 11*, 301-317. Retrieved from http://www.jite.org/documents/Vol11/JITEv11IIPp301-317Mang1138.pdf

Martin, P., Morris, R.D., Rogers, A., Martin, V. & Kilgallon, S. (2009) *Encouraging creativity in higher education: the experience of the Brighton Creativity Centre.* In Dialogues in Art & Design. Group for learning in Art and Design (GLAD) conference 21 Oct 2009 . ADM HEA. ISBN 9780955897818

Naveh, G., Tubin, D., & Pliskin, N. (2010). Student LMS use and satisfaction in academic institutions: The organizational perspective. *Internet and Higher Education*, *13*(3), 127-133. doi:10.1016/j.iheduc.2010.02.004

Oztok, M., Zingaro, D., Brett, C., & Hewitt, J. (2013). Exploring asynchronous and synchronous tool use in online courses. *Computers & Education*, *60*(1), 87-94. doi:10.1016/j.compedu.2012.08.007

Pea, R. D. (2006). Video-as-data and digital video manipulation techniques for transforming learning sciences research, education and other cultural practices. In J. Weiss, J. Nolan & P. Trifonas (Eds.), *International handbook of virtual learning environments*. Dordrecht: Kluwer Academic Publishing.

Pea, R.D. (2002). Learning science through collaborative visualization over the Internet. In N. Ringertz (Ed.), *Nobel symposium: Virtual museums and public understanding of science and culture*. Stockholm, Sweden: Nobel Academy Press.

Pegrum, M., Howitt, C., & Striepe, M. (2013). Learning to take the tablet: How pre-service teachers use iPads to facilitate their learning. *Australian Journal of Educational Technology*, *29*(4), 464-479.

Rajasakeran, A. (2013). Effects of audience response systems on student engagement and participation in large undergraduate education lectures. Unpublished Masters Thesis, Faculty of Education, University of Calgary.

Rodriguez, O. (2013). The concept of openness behind c and x-MOOCs (Massive Open Online Courses). *Open Praxis*, *5*(1), pp. 67–73. Retrieved from http://webcache.googleusercontent.com/search?q=cache:OjLlMkId3O8J:www.openpraxis.org/index .php/OpenPraxis/article/download/42/pdf+&cd=2&hl=en&ct=clnk&gl=ca

Rogers, P. & Lea, M. (2005). Social presence in distributed group environments: The role of society identity. *Behavior & Information Technology*, *24*(2), 151-158. doi: 10.1080/01449290410001723472

Sawyer, R. K. (2012). *Explaining creativity: The science of human innovation* (2nd ed.). New York, NY: Oxford University Press.

Sawyer, R. K. (Ed.). (2006). *The Cambridge handbook of the learning sciences*. New York, NY: Cambridge University Press.

Schank, R. (2011). *Teaching minds: How cognitive science can save our schools*. New York: Teachers College Press.

Schneckenberg, D., Ehlers, U., & Adelsberger, H. (2011). Web 2.0 and competence-oriented design of learning – Potentials and implications for higher education. *British Journal of Educational Technology*, *42*(5), 747-762. doi:10.1111/j.1467-8535.2010.01092.x

Schwartz, M. & Fischer, K. (2006). Useful metaphors for tackling problems in teaching and learning. On campus, *11*(1), 2-9.

Schwier, R. A. (2013). Blog. In R. C. Richey (Ed.), *Encyclopedia of terminology for educational communications and technology* (pp. 24-25). New York, NY: Springer.

Shulman, L. (2005). Signature pedagogies in the profession. *Daedelus, 134*(3), 52-59.

Siemens, G. (2004). *Connectivism: A learning theory for the digital age*. Retrieved from elearnspace everything elearning: http://www.elearnspace.org/Articles/connectivism.htm

Siemens, G., Gasevic, D., Haythornwaite, C., Dawson, S., Buckingham Shum, S., Ferguson, R., & Baker, R. S.J.d. (2011). Open learning analytics: an integrated & modularized platform: Proposal to design, implement and evaluate an open platform to integrate heterogeneous learning analytics techniques. Solar Society for Learning Analytics Research. Retrieved from http://solaresearch.org/OpenLearningAnalytics.pdf

Siemens, G. & Tittenberger, P. (2009). Handbook of emerging technologies for learning. Retrieved from: http://elearnspace.org/Articles/HETL.pdf

Smith, S. R. (2013). The connected learning environment. *Educasue Publications*. Retrieved from http://net.educause.edu/ir/library/pdf/PUB9013.pdf

Tan, L. & Waxman, L. K. (2013). Designing for virtual learning spaces: A *Second Life* example. *International Journal of Designs for Learning, 4*(2), 72-79.

Taylor, J. A., & Newton, D. (2013). Beyond blended learning: A case study of institutional change at an Australian regional university. *Internet and Higher Education*, *18*(), 54-60. doi: 10.1016/j.iheduc.2012.10.003

Thomas, D. & Brown, J. S. (2011). *A new culture of learning: Cultivating the imagination for a world of constant change*. [Kindle Digital Editions version].

Tzuo, P. W., Isabelle, J., Ling, O. P., Yang, C. H. & Chen, V. H. H. (2012). Re-conceptualizing pedagogical usability of and teachers' roles in computer game-based learning in school. *Educational Research and Reviews*, *7*(20), 419-429. DOI: 10.5897/ERR11.072

van Barneveld, A., Arnold, K. E., & Campbell, J. P. (2012). Analytics in higher education: establishing a common language. *Educause Learning Initiative*, Retrieved from http://www.educause.edu/library/resources/analytics-higher-education-establishing-common-language

van Eck, R. (2006). Digital game-based learning: It's not just the digital natives who are restless. *Educause Review*. Retrieved from https://net.educause.edu/ir/library/pdf/ERM0620.pdf

Veletsianos, G. (2012). Higher education scholars' participation and practices on Twitter. *Journal of Computer Assisted Learning*, *28*, 336-349. doi: 10.1111/j.1365-2729.2011.00449.x

Wong, L. (2013). Student engagement with online resources and its impact on learning outcomes. *Journal of Information Technology Education: Innovations in Practice*, *12*, 129-146.