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Technology-Enhanced Learning Environments in Higher Education: A Review of the Literature

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Abstract

The purpose of this literature review is to present a research-informed summary of the ways in which learning technologies change teaching and learning experiences in higher education. The following is necessarily a selective rather than an exhaustive review of promising learning technology designs in higher education. The rationale for this review is derived from the purpose of the Learning Technologies Task Force, which is to develop a strategic framework for high quality learning experiences at the University of Calgary that are enhanced and enabled by technology. An overview of promising and emerging practices from the research literature on using learning technologies to create outstanding learning experiences in contemporary higher education contexts is provided.

Keywords: learning technologies, higher education, emerging practices, literature review

Contemporary educational technologies can enhance and extend teaching and learning on campus and have become a disruptive influence in higher education. Learning technologies can change the ways learners and professors connect, communicate, collaborate and create knowledge for learning and teaching both on campus and in blended and online learning spaces. Learning technologies can also change who participates in a university learning experience, learners' expectations for the experience, the kinds of learning environments in which learners thrive, and the challenges faced by learners, teachers and leaders on campus. Successful universities aim to leverage learning technologies to enhance the depth and breadth of learning experiences and to improve the quality of teaching that is critical to students' success in their chosen fields and to their development as engaged citizens.

The purpose of this literature review is to present a research-informed summary of the ways in which learning technologies change teaching and learning experiences in higher education. The following is necessarily a selective rather than an exhaustive review of promising learning technology designs in higher education. The rationale for this review is derived from the purpose of the Learning Technologies Task Force, which is to develop a strategic framework for high quality learning experiences at the University of Calgary that are enhanced and enabled by technology. An overview of promising and emerging practices from the research literature on using learning technologies to create outstanding learning experiences in contemporary higher education contexts is provided. This review is organized into three sections:

1. Section One: Higher Education Learning Environments
2. Section Two: Framework for Exploring Technology for Teaching and Learning
3. Section Three: Implications for Higher Education

In the first section, a review of societal and technological trends impacting higher education is presented. Changes in higher education learning environments are discussed along with challenges and implications for faculty, leaders and institutions of learning.

Section One:
Higher Education Learning Environments

Overview

Higher education is attracting a diverse student demographic ranging from high school graduates entering undergraduate programs to professionals with extensive career experiences returning for a second or third degree. Students expect engaging and relevant learning experiences in higher education learning environments (Dunlap & Lowenthal, 2011), and in both physical and online spaces. Higher education has been characterized by increased formal online learning opportunities for students over the last decade (Hachey, Wladis & Conway, 2012). Students' expectations for flexible options to engage in experimenting, playing, and exploring ideas as part of their formal learning experiences (Johnson et al., 2013) are accompanied by workforce demand for increased informal learning experiences and an expectation for employees who are 21st century, life-long learners with capabilities to work collaboratively and efficiently (Dunlap & Lowenthal, 2011).

Advances in modern technologies and networking capacity coupled with new understandings about knowledge, learners and teaching and learning greatly impact higher education. Several themes emerge from the literature relative to the changes that technology brings to meaningful learning and teaching on campus along with the challenges that come with using learning technologies in higher education (Table 1).

First, learning environments on campus are changing. Well-established brick and mortar images of higher education learning environments have expanded to include a wide range of more accessible and designer learning experiences. University learning still includes the conventional classroom-based course with no technological enhancements, and increasingly includes technology-enabled classroom learning environments, blended courses with a combination of classroom and online learning activities, and fully online learning experiences where learners from all over the world do not meet face to face during the course yet are fully engaged in learning with and from each other. Learning environments can include a range of combinations that include synchronous and asynchronous learning experiences. A spectrum of course delivery modalities in higher education is shown in Figure 1.

Table 1

Changes and challenges involved with using learning technologies in higher education

Areas of change in higher education:	**Associated challenges:**
1. Learning environments	It is challenging to develop/use/sustain effective instructional strategies across the spectrum of different course-delivery modalities.
2. Technological advances	Programs need continuous research-informed review and renewal to keep pace with technological advances and the changes in how people socialize and learn.
3. Theoretical influences on pedagogy	Educators are challenged with a new role in developing continuous research-informed designs for learning.
4. Technological influences on pedagogy	Support for faculty is needed in advancing knowledge building and social constructivist approaches in technology enhanced and enabled learning environments.
5. Communities of learners	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.
6. Connected Learning	Networking infrastructure and classroom technologies need to support faculty and students to be open, flexible, responsive and connected leaders of learning.
7. Assessment for Learning	Changed approaches to teaching coupled with recent research on learning with technology challenge higher education to develop authentic approaches to formative and summative assessment.

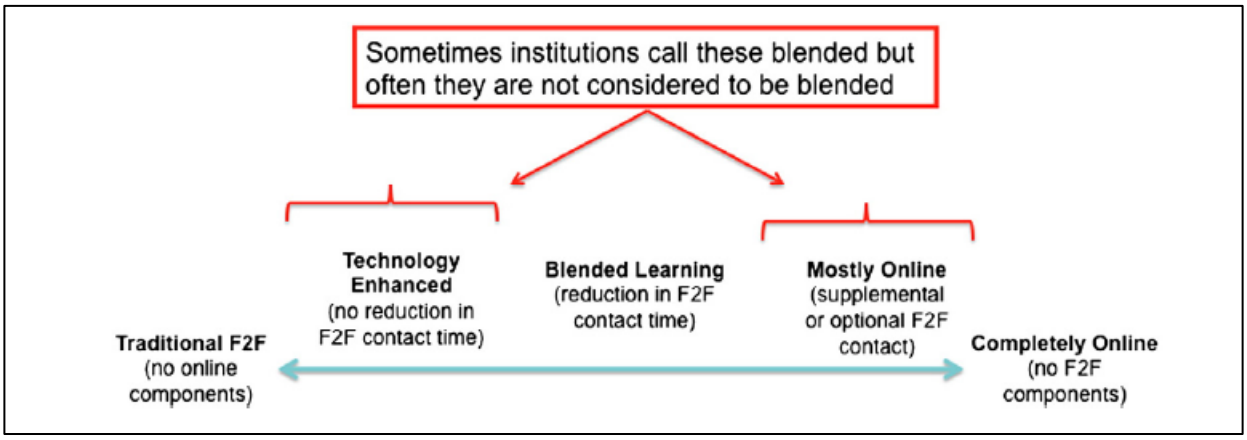

Figure 1. Spectrum of course-delivery modalities in higher education (Graham, Woodfield & Harrison, 2013).

Virtual learning environments support learning experiences enabled with technology and can be offered entirely online or using a blended approach. The combination of some in-person

learning and some online learning can be described as hybrid, blended or converging learning environments (Taylor & Newton, 2013). Some challenges that can come with blended learning are issues related to instructional strategies, governance structures and support (Graham et al., 2013); strong leadership and institutional strategies are needed to overcome these challenges (Taylor & Newton, 2013). Researchers predict the term will fade altogether as all on-campus courses will likely include some form of blended learning in the future (Garrison, 2013).

Learning environments are not limited to same space and time learners or classrooms. Learning in higher education is taking place in a variety of formal and informal spaces as learners have increased options for learning using pervasive and mobile technologies for participation. Students can learn by attending on-campus classes, online off-campus classes, or a mix of on-campus and off-campus learning; students can arrange flexible learning schedules and can participate in higher education experiences anytime, anywhere and anyplace.

Second, technological environments on campus are changing. The world has seen major changes in the media and technology landscape in the last half century. Established broadcast media, such as television and radio, largely offer a one-way pipeline of information. Early networked technologies helped to support widespread communication and connection to multimedia information. In the past twenty years, interactive technologies, such as the World Wide Web, virtual worlds, social networking and videoconferencing, have provided support for simultaneous global conversations, for media and information sharing, and for knowledge building in community (Jacobsen, 2010). Current advancements in digital and social technologies have led to increases in connective, collaborative and expressive human capability. Using networked mobile devices, individuals can both access and contribute to a growing knowledge base, they can capture, edit and publish audio, video and images from anywhere and at anytime, and by adding their voice, they can influence global conversations.

Technological advancements also alter the skills and competencies of the future work force and change approaches to work, including always on, global collaborations (Economist Intelligence Unit, 2008). Jenkins (2009, 2006) describes a participatory culture and the necessary 21C literacies for today's learners, such as connecting with each other, collaboratively creating knowledge and drawing upon diverse sources and cultures when accessing ideas. Kumar, Liu and Black (2012) predict "in addition to communicating and collaborating in online communities in the future, they will also have to be creative contributors and circulators of online content" (p. 256). New technology and media forms are altering how people socialize and learn (Macarthur

Foundation, 2013). As such, there is a demand for integrated formal and informal learning environments that leverage new media forms and interaction in higher education. So, one challenge for higher education institutions is to engage with the community and participate in ongoing review, design and renewal of programs to reflect the disciplinary knowledge, technological advancements, and 21st century competencies that today's graduates need to succeed, lead and contribute in a connected world.

Third, current research on learning is changing and challenging higher education. While emerging technologies have supported a shift from broadcast and individual expression, to interactive and participatory engagements and expressions of learning in an increasingly connected world, educational research has also yielded new insights on the importance of social connectivity and distributed intelligence over individual learning. Seminal work by Vygotsky (1978) describes learning as largely a social process carried out with the aid of mediated tools. The most valuable and resonant experiences in learners' educational processes occur when learners interact, in a context, with more experienced peers and teachers who provide intellectual scaffolds that help them to perform more complex tasks than might be possible alone (Vygotsky, 1978). Extending upon such theories as social constructivism, current research in the learning sciences advances our collective understanding of the importance of situated and active learning (Collins, Brown, & Newman, 1989; Greeno, 2006), knowledge building versus knowledge borrowing (Scardamalia & Bereiter, 2006; Schwartz & Fischer, 2003), computer supported collaborative learning (Stahl, Koschmann & Suthers, 2006), along with examining diverse ways to support online learning in communities (Bruckman, 2006). Educational research from the neurosciences on misconceptions in science (Masson, 2012; Masson, Potvin, Riopel, Brault Foisy & Lafortune, 2012) and the challenges in promoting conceptual change (diSessa, 2006) provide important insights into designs to better support learning, along with research on storytelling, case and problem based learning designs to promote the conceptual, analytic, and social cognitive processes that underlie effective thinking and learning (Schank, 2011).

In order to leverage recent educational research on learning with advancements in technology, several qualities of participatory cultures (Jenkins, 2009, 2006) can be combined and actively designed into technology enhanced learning experiences in higher education to promote knowledge building and to make learning and teaching more visible (Bereiter & Scardamalia, 2010; Clifford & Friesen, 1993; Hattie, 2009; Jacobsen & Friesen, 2011; Sawyer, 2012, 2006; Thomas & Seely Brown, 2011):

- Expertise and teaching is distributed so the most experienced can mentor new members
- Learners are socially connected with one another within and beyond the classroom
- A culture of inquiry supports idea creation and the sharing of creations
- Students are provided with multiple opportunities for engagement, expression and representation
- Collaboration and knowledge sharing is expected, and learners believe their contributions matter
- Group memory and knowledge building is a collective responsibility and endeavour.

Signature pedagogies, which are salient forms of instruction and pervasive teaching practices that characterize a field, such as inquiry-based, case-based and problem-based approaches to designing learning experiences (Shulman, 2005; Schank, 2011), can support the deeper engagements in collective knowledge building and sharing called for by current research on learning and by the connected learners who are served by higher education. One challenge for higher education is to effectively leverage the possibilities of signature pedagogies and participatory technologies for the design and evaluation of high quality learning experiences that are informed by the latest research on learning.

Fourth, technological influences on pedagogy are changing higher education. While faculty are often enthusiastic about the use of emerging technologies relevant to their research, the adoption of learning technologies for teaching requires changes to the design of learning experiences to engage student's use of technology for learning. Given advancements in learning technologies and current research on engaged learning and the social construction of knowledge, the role of the educator is shifting from information delivery and testing to the design and evaluation of engaging learning experiences. A designer of learning provides increased access to peers, external expertise and global resources; responds to the demand for personalized learning experiences and performances (Johnson et al., 2013); uses new approaches to interacting and participating in learning (Siemens & Tittenberger, 2009, p.33); and deploys collaborative technology-rich approaches to the design of learning (Garrison & Akyol, 2013; Lee, Hugh & Reigeluth, 2013).

Martinez and Stager (2013) argue the combination of technology with transformative pedagogies can advance learning that leads to deep thinking related to knowledge building pedagogies (Barab, Arici & Jackson, 2005; Bereiter & Scardamalia, 2010). There is growing

awareness that social constructivist approaches to teaching coupled with learning technology needs to be integrated more into higher education. Researchers argue there is potential to transform learning environments with emerging instructional technologies and collaborative constructivist ideas (Garrison & Akyol, 2009). Despite professors' scarce use of technology for learning, students still attempt to create a digital culture in the educational environment (Kumar et al., 2012). A challenge for universities is that a minority of faculty members have developed awareness of and proficiency with technology enhanced pedagogies (Oblinger & Hawkins, 2006) and only a few have developed shared epistemic agency for leading innovation (Scardamalia & Bereiter, 2006). The challenge for higher education is to create a culture of expectation around innovative teaching practices, along with providing ongoing, continuous and collaborative professional learning opportunities for faculty that focuses on current learning technologies coupled with signature pedagogies that are informed by the latest research on learning.

Fifth, advancements in learning research over the last two decades have transformed our understanding of communities of learners. It is common for higher education learning environments to describe innovation in face-to-face and virtual spaces as integrated learning environments or architectures (Moyle, 2010) with a technology-enhanced socio-constructivist approach (Comrie, 2011). In higher education, innovation can also be considered the exploration of possibilities and engagement in pushing boundaries of existing practices and views of community (Siemens & Tittenberger, 2009, p. 20). Molenda (2013) describes innovation as "a technological product or practice that is novel to a given population and that adds value to the user" (p. 152). It can be argued that higher education learning environments are only beginning to demonstrate innovation in optimizing participatory technologies, in designing physical and online learning spaces and through hybrid and distance learning options that integrate and leverage new media forms and teaching practices in a community. In order to risk changes to teaching designs and practices that focus on individual learners, and to explore the range of possibilities for cultivating learning communities enabled and enhanced by technology, faculty need to be supported, valued and recognized for their efforts. Schneckenberg, Ehlers and Adelsberger (2011) describe five common characteristics related to innovation in higher education learning environments:

1. Learning is ubiquitous. It is no longer understood as restricted to the classroom but evolves in many different contexts.
2. Learners increasingly take on the role of organisers.

3. Learning is a lifelong process. It has many episodes, and is not exclusively linked to educational institutions.
4. Learning takes place in communities; Learners participate both in open and restricted learning communities.
5. Learning is informal; it takes place at home, at the work place and during leisure time, and it is no longer centred around teachers or institutions. (p. 748)

Across learning and instructional contexts, there is growing evidence of the effectiveness of developing a community of learners to enhance the student experience and improve learning outcomes (Anderson, 2003a, 2003b, 2004; Anderson, Annan & Wark, 2005; Garrison, Anderson & Archer, 2000; Rourke, Anderson, Archer & Garrison, 1999; Rourke & Anderson, 2002; Scardamalia, 2002). In a community of learners, students learn by working with peers and by becoming a part of a larger community of learners. Instead of taking information in as disseminated, students work collaboratively to construct knowledge in the service of meaningful projects and tasks, and build on knowledge they have gained previously (Anderson, 2003a, 2003b; Bransford, Brown & Cocking, 2000; Garrison & Anderson, 2003). In a work that anticipated the increased emphasis on problem solving in community, Edens (2000) notes,

> A new approach emphasizes the students' active role in constructing knowledge and students' actively engaging in inquiry and problem solving, typically in a collaborative framework. Learning is anchored to real-world or authentic contexts; students learn how to apply inert knowledge to real problems...Problem-based learning holds promise as a teaching tool that provides for the acquisition of problem-solving skills to meet the challenges of the twenty-first century workplace (p. 55).

A problem that may stand in the way of widespread quality teaching in higher education is that much of university teaching practice is not informed by current research on learning. As discussed earlier, knowledge transmission and teaching as telling is the prevalent conception and enactment of the teacher's role on campus – practices that are not supported by current research on how people learn best. The challenge for higher education institutions is to collectively draw upon and contribute to current research on learning in the design and evaluation of quality teaching and the design and evaluation of quality communities for learning.

Sixth, higher education needs to question well-established conventional teaching practices in the context of current technological infrastructures to determine whether and how these pedagogies are serving connected learners well, and what innovations will better serve learners. While there are pockets of innovation and promising practices, the technological infrastructure and network designs used widely on campus – built on broadcast media and information delivery assumptions about knowledge flow – do not serve students or professors well. Schwartz and Fischer (2003) argue "the university experience risks perpetuating a view of learning that only focuses on the manipulation of borrowed concepts and schemas" if learning experiences are absent of opportunities for learners to build representations for learning (p. 11). Connected learners require learning opportunities and technological infrastructures for constructivist approaches.

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 (Bransford, Brown & Cocking, 2000; Sawyer, 2006, 2012; Swartz & Fischer, 2003, 2006). Research demonstrates that people learn best by doing, rather than learning first then doing. Faculty and graduate students in the MIT Media Lab rarely sit around waiting for inspiration to strike; rather than thinking about what to build, they dive in and build what they are thinking about together (Moss, 2011). Currently, too many post secondary educators believe that students need to assemble a knowledge base in their undergraduate education and then somehow miraculously recover the ability to invent new ways of thinking, knowing and doing in their graduate education. This assumption is seductive because it easily justifies the use of traditional pedagogies where knowledge is viewed as something that can be transferred from authoritative sources to ready, but naïve recipients.

Contemporary signature pedagogies using participatory technologies, social media and knowledge building can disrupt comfortable and established "teaching as telling" practices by visibly supporting participatory learning, and by enabling:

- Learners to talk to each other, build and share information together, and to publish ideas and expressions online for a global community.
- The co-creation of knowledge that is publicly shared by learners and by teachers.
- Information to come from many diverse sources, cultures, and locations.
- Immediate access to current information and knowledge and to each other.

- An already huge knowledge base to grow at an exponential rate (Jacobsen & Friesen, 2011).

The challenge for higher education is to be critical of current practice and not simply add technology to current teaching designs and at the same time resist the urge to dismiss conventional practices that work in particular situations. Increasingly, university students and professors can engage in connected learning, that is collective knowledge creation within contemporary technology-enhanced learning environments. There is a demand for technology enabled learning experiences that engage students in deep thinking and collaborative knowledge building and sharing – experiences that make teaching and learning visible (Hattie, 2009). A key challenge for higher education is to question under what conditions, for what learners, for what purpose do we integrate technology for meaningful learning experiences. Simply layering technology onto unquestioned teaching practices will not improve the quality of learning in higher education –the focus needs to be on active learning and knowledge building in order to prepare professional and disciplinary leaders for a connected world.

Seventh, widely recognized teaching practices, such as professors choosing standardized information and ideas, and distributing content in small, manageable, and simplified chunks, and then testing students on the retention of this information, is well established and too often are unquestioned approaches to delivering a course and assessing student performance. Too often, technology is simply layered onto existing teaching and assessment practices. Assessment can and should be an integral part of all higher education teaching practices and learning processes versus just measuring learning at the end. Current research differentiates between three approaches to assessment (Earl, 2013) : assessment ***of*** learning (i.e., grades and marks), assessment ***for*** learning (i.e., formative, continuous feedback), and assessment ***as*** learning (i.e., self-assessment, self-monitoring and self-regulation). "Learning is not a linear process. Assessment doesn't come at the end. Teaching is not the filling in the sandwich between curriculum and assessment. Taken together, curriculum, teaching, learning, and assessment interact in an iterative and cyclical process" (Earl, 2013, p. 92). Tests, grades and marks are well established in higher education. However, participatory approaches to teaching with technology incorporate active learning and knowledge building approaches that go beyond individual learning. When learners are invited to engage with each other in meaningful work that culminates in significant projects, diverse products and performances, then tests and marks are insufficient to capture the learning that has occurred. Along with changes to designs for learning, faculty will

need to invest time and effort to design and use diverse and appropriate approaches to authentic assessments for learning and as learning to adequately capture the learning that occurs.

Faculty are updating course design, development and delivery using integrated instructional design approaches along with changed notions of assessment for learning (Brown, Eaton, Jacobsen, Roy & Friesen, 2013). For instance, in a recent co-design of a graduate level writing course, faculty used Wiggins and McTighe's (2005) backward design approach, known as beginning with the end in mind, to guide the workflow for the collaborative design team and to plan learning experiences and assessment strategies based on course learning outcomes. Assessment incorporated formative assessment strategies, such as peer feedback loops and summative assessment, assessment rubrics with evaluation criteria, quality definitions and a scoring strategy (Reddy & Andrade, 2010) to guide the online learning experiences and technologies needed for the course. Collaborative approaches to instructional design can provide rich experiences and professional learning for faculty, including a deeper understanding of formative and summative assessment and how technologies can enable different learning and assessment approaches. A challenge for higher education is to provide sufficient time and resources for faculty to build relationships and to engage in and contribute to collaborative design teams and for ongoing professional learning related to authentic formative and summative assessment practices in contemporary technology-enhanced learning environments.

In the next section, a framework for exploring the selective review of promising learning technologies for teaching and learning in higher education is provided.

Section Two:
Framework for Exploring Technology for Teaching and Learning

Frameworks can be used to review technologies and describe their action-potential. For instance, Siemens and Tittenberger (2009) offer a framework for considering how contemporary technological resources (i.e. Blogs, Wikis, Skype, Google Reader, etc.) contribute to the changing information cycle and group the technologies according to six categories: access, presence, expression, creation, interaction and aggregation (p. 41). Since learning technologies are constantly evolving and new resources and processes advancing, the authors of the present literature review developed a framework based on four categories emerging from the current research focusing on technology used for teaching and learning in higher education as shown in Figure 2. In the present literature review, studies demonstrate technology can increase connections, communications and interactions among learners for collaborating and creating.

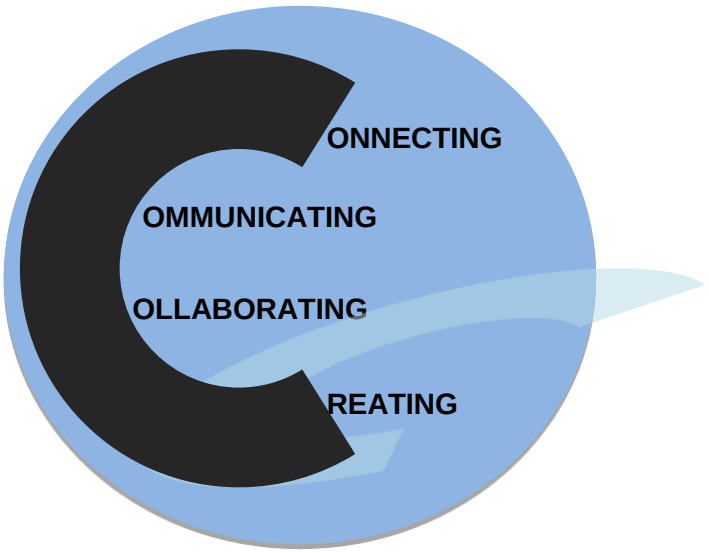

Figure 2. The Four Cs Framework for exploring technology for teaching and learning in higher education.

The framework is similar to the four steps of networking as described by Shirky (2008), namely (1) sharing your work, (2) creating a group identity, (3) collaborating to produce shared creations, and (4) generating collective action. Although Shirky's steps for networking are progressive, and

the categories selected to frame the discussion in the present literature may also appear progressive or as distinct categories, the authors consider and have used the four categories as an interconnected and mutually reinforcing framework.

It is evident a shift is occurring in higher education learning environments from closed (prescribed, teacher directed-selected, distributive, receptive, individual expression) environments to open (student selected, self-organized, collaborative, participatory, interactive, networked) environments and purposes, beyond traditional class enrolment (Jenkins, 2009, 2006; Johnson, et al., 2013; Siemens & Tittenberger, 2009). The four categories: connecting, communicating, collaborating and creating are characteristic of participatory learning designs and can be used to frame this review of how promising learning technologies are currently used in higher education. Many of the technologies described in subsequent sections could have been used as an example in more than one category of the framework. The technologies selected for illustration of each category are not an exhaustive list.

For the purposes of the present literature review, the technologies are listed according to the category in the framework that best describes the use of the technology based on the specific findings of the cited research. The technologies are also listed in Table 2 across the spectrum of higher education learning environments ranging from face-to-face learning environments to completely online learning environments. As such, it is recognized that other studies not cited in this literature review may contribute new conceptualizations for how the same technologies can be used for diverse purposes in higher education learning environments.

Table 2

A framework for technology use in higher education: connecting, communicating, collaborating and collective creation for learning

4 Cs	F2F ⟷ Completely Online
Connecting	Tablets, Learning Analytics, MOOCs
Communicating	Clickers, Mobile Applications, Videos, Flipped Classrooms, LMS, Discussions, Email, Blogs, Microblogs, Web Conferencing
Collaborating	Networked Mobile Devices, Online Collaborative Workspaces, Wikis
Collective Creation	Games & Gamification, Virtual Worlds

Connecting

For the purposes of this review, connecting is taken to include an extensive number of ways in which professors and learners as well as learners and learners are connected to each other on campus, connected in global communities and with expertise within and beyond the classroom and in blended and online learning experiences beyond bricks and mortar using various technologies.

Higher education "is entering a new, evolutionary phase defined by connections between everything and everyone—a highly connected ecosystem of technologies that support sharing, collaboration, and global links to specialists and students in every area of endeavor" (Educause, 2013, para.1). In the past, connections were fixed and primarily established through common classroom enrollments in face-to-face learning experiences that did not include online spaces or communities. Now, social networking and communication technologies can enable teachers and

students to self-organize and form dynamic connections in virtual spaces. Smith (2013) identifies three characteristics of a connected learning environment:

- Seamless integration with planning and advising services to help students plan for degree completion;
- Personalized learning with diverse learning options (online, on campus, or through a blended alternative); and
- Engaged and authentic learning experiences. (p. 1)

Connected learning has implications for learners and how they meet their educational goals, for instructors and how they plan and design learning across different learning environments and for institutions constructing new programs and models of learning (Abel, Brown & Suess, 2013). Moreover, tools and practices such as learning analytics are emerging that can provide insights for researcher and practitioner innovation in education (Siemens et al., 2011).

In the next section, three examples are provided to illustrate how learning technologies can support connected learning in higher education: first, tablets—that can be used as a "portable personalized learning environment" (Johnson et al., 2013, p.15); second learning analytics— that "can be used to reveal pathways for students, whether those are personalized learning pathways, course-selection systems, or tools to ensure students stay on track to graduate" (Oblinger, 2013, p.4); and third, Massive Open Online Courses (MOOCs)— to "foster discussions, create and share videos, and engage in all the other activities that have become essential to teaching and learning in a modern online learning environment" (Johnson et al., 2013, p.12).

Tablets.

Tablets can be described as portable personalized learning environments or as single, mobile devices "with significantly larger screens and richer gesture-based interfaces" that do not require peripherals (Johnson et al., 2013, p.15). According the New Media Consortium's Horizon Report (2013) many higher education institutions are already using or will adopt tablets over the next year. Students are also bringing their own devices to class and many students are selecting tablets to support their research and learning. Tablets are ideal devices for fieldwork especially in higher education institutions where handheld computers are preferred in place of "cumbersome laboratory equipment, video equipment, and various other expensive tools that are not nearly as portable or as inexpensive to replace" (Johnson et al., 2013, p. 17).

In current studies, researchers have observed that the use of tablets to support connecting to resources and networks for learning. In a case study, Pegrum, Howitt and Striepe (2013) found that iPads supported pre-service teachers' learning in four ways: 1) developing understanding of content, 2) developing understanding of pedagogy, 3) staying connected and 4) staying organized. The pre-service teachers also found using iPads helped them to develop a sense of learning spaces and learning networks for their own teaching.

Similarly, researchers explored the use of tablets (iPads) for academic engagement in university classes for both structured and unstructured tasks (Mang & Wardley, 2012). For example the instructors created and distributed lecture templates to students, who opened the templates on the iPad to write annotations during seminar. Students who used tablets indicated they were less likely to engage in off-task activities (such as instant messaging, social networking, or watching videos) in comparison to using laptops where multiple applications can be viewed on one screen simultaneously. Students primarily used the iPads for taking notes during lectures, conducting research during class and connecting to networks (i.e. Internet, library searching, etc). Likewise, Jones, Johnson-Yale, Millermaier, and Perez (2008) reported students' use of networks to search for online resources included using search engines, library websites, news websites, online encyclopedias and other sources.

Mang and Wardley (2012) make several recommendations for the adoption of tablets to enhance the academic experience of the students, such as faculty should:

- Attempt to understand "everything" about the tablet operating system prior to distributing tablets to your students
- Decide early on how you would like to use the tablet in your class
- Ensure that you work closely with your institution's IT department
- Make the tablet an integral component of your class
- Describe the features and benefits on the first day
- Carefully consider how to distribute the tablets (pp. 309-313).

It is clear that with proper attention to the design of the learning experience, professors can leverage the use of tablets as mobile, personalized, networked learning environments in higher education.

Learning Analytics.

New approaches to connecting learners and professors can be understood and informed by learning analytics processes and resources. There is an abundance of underused data in education and learning analytics can provide "educators, learners, and decision makers with actionable insight to classroom and course level activities" (Siemens et al., 2011). There are a variety of terms currently used in analytics, which is still a new area of practice and research relative to the educational domain (van Barneveld, Arnold & Campbell, 2012). van Barneveld et al. (2012) provided definitions that allow for a common language among practitioners. For some definitions, we have aligned Siemens et al's (2011) work that demonstrates the level or object of analysis specifically, as shown in Table 3.

Table 3

Definitions and level or object of analysis for analytics in higher education

Term	**Definitions according to van Barneveld et al. (2012)**	**Level or object of analysis according to Siemens et al. (2011)**
Analytics	An overarching concept that is defined as data-driven decision making	
Academic Analytics	A process for providing higher education institutions with the data necessary to support operational and financial decision making	**Regional (state/provincial)**: comparisons between systems, quality and standards; and **National/International** comparisons
Learning Analytics	The use of analytic techniques to help target instructional, curricular, and support resources to support the achievement of specific learning goals and purposes	**Course-level:** social networks, conceptual development, discourse analysis, intelligent curriculum; **Departmental:** predictive modeling, patterns of success/failure; and **Institutional:** learner profiles, performance of academics, knowledge flow, resource allocation
Predictive Analytics	An area of statistical analysis that deals with extracting information using various technologies to uncover relationships and patterns within larger volumes of data that can be used to predict behavior and events	

Generally stated, analytics can be described as a process of using large data sets and data analysis techniques to inform the learner, the teacher and the institution in making decisions. Dziuban Moskal, Cavanaugh, and Watts (2012) discuss the importance of interconnected top-

down (institutional decisions) and bottom-up (learner-centred decisions) forms of analytic approaches. Top-down analytics can inform organizational effectiveness at a broad level and bottom-up analytics can impact personalized learning with early interventions, advising, tutoring, course selections, graduation planning and other forms of student support (van Barneveld et al., 2013). Furthermore, bottom-up analytics can "identify trends, compare performance, and track the progress of distributed learning" (Dziuban, , 2012, p. 26). Learning analytics can be "envisioned as an effective, efficient way to assess student responses, provide immediate feedback, and make adjustments in content delivery and format (Johnson et al., 2013, p. 24). As such, learning analytics can be viewed as an iterative cycle of learner and learning assessment, feedback and action.

Pea's (2006, 2002) research on collaborative visualization (CoVIS) expands taken-for-granted notions of "smart classrooms" and Herrington, Reeves and Oliver's (2010) research on authentic e-learning environments is constructed on contemporary ecological images of learning informed by learning analytics. Within these environments, experiences are intentionally designed so that the environment takes shape because of who participates, how they participate and the initiatives and problems they undertake.

In research on using institutional data to improve course delivery and student success in online and blended learning at the University of Central Florida (UCF), Dziuban et al. (2012) argue that "data do(es) not make decisions, people do" (p. 27). Likewise, based on findings from a case study on the use of learning analytics in a free Massive Open Online Course, Fournier, Kop and Sitlia (2011) report that learning analytics can provide information about the interactions of large groups in a learning environment but it requires human interpretation and analysis (or advanced artificial intelligence capacity) to make the information meaningful.

In a study using a large dataset for strategic planning, Dziuban et al. (2012) identified four integrated domains of an effective analytics program, including student engagement, faculty engagement, information value, and student and faculty support. Along with the human element necessary for learning analytics, the researchers suggest there are conditions for a successful analytics initiative, including: effective institutional goals and objectives, proper alignment, organizational capacity, a workable vocabulary; faculty development and course development/analytics support, robust and reliable infrastructure, institutional level on effectiveness, proactive policy development, and an effective funding model (Dziuban et al., 2012, p. 27).

Researchers evaluated the acceptance of learning analytics, with participants from Simon Fraser University, University of Belgrade and Athabasca University and other researcher/learning analysts (Ali, Asadi, Gaševic, Jovanovic & Hatala, 2013). The participants engaged in video tasks as they responded to survey questions about a learning analytics tool (i.e. LOCO-Analyst tool) used in this study to assess learning processes and log data in one module of an introductory computer science course offered online. The findings suggest the participants had positive perceptions of using a learning analytics tool and that the pedagogical role of the participant is important for adoption. The researchers conclude that online instructors can relate to the utilities of the learning analytic tools and are more likely to adopt these tools for their practice when tied to pedagogical goals.

Research exploring the use and contributions of learning analytics in higher education has been appearing more regularly in the literature as a reference point for colleges or universities interested in adopting learning analytics to evaluate learners and learning, and to support overall academic performance. As higher education continues to shift in the direction of virtual learning environments and provide more services online, an increasing number of academic institutions will gather and use large data sets and learning analytics to inform broad institutional decisions, to support achievement and to predict relationships and patterns.

Massive Open Online Course (MOOCs).

Massive or Massively Open Online Courses (MOOCs) are becoming more prevalent in higher education to "foster discussions, create and share videos, and engage in all the other activities that have become essential to teaching and learning in a modern online learning environment" (Johnson, et al., 2013, p.12). MOOCs are described as a virtual learning opportunity that "brings together people interested in learning (or 'students') and an expert or experts who seek to facilitate the learning" (Liyanagunawardena, Adams & Williams**,** 2013, p. 204). The functionality of MOOCs rely on a variety of cloud based applications, such as wikis, video sharing and document sharing services (Johnson et al., 2013) and can be described as:

> a model of educational delivery that is, to varying degrees, massive, with theoretically no limit to enrollment; open, allowing anyone to participate, usually at no cost; online, with learning activities typically taking place over the web; and a course, structured around a set of learning goals in a defined area of study. (Educause, 2013, n.p.)

MOOCs can be provided by higher education institutions in partnership with external organizations (i.e. edX, Udacity, Coursera etc.) and also by extending a formal learning experience to global participants. Coursera is an example of an educational technology company that partners with Universities to provide free online non-credit courses and fee based signature track courses for certification (https://www.coursera.org/about/terms). Upon successful completion of the course, participants receive badges or letters of accomplishment. Learning in a virtual environment with a large numbers of students participating is a challenge for both participants and instructors in MOOCs (Rodriguez, 2013) as well as valid student assessment (Pappano, 2012).

Two distinct types of MOOCs are discussed in the literature, namely c-MOOCs and x-MOOCs (Daniel, 2012; Rodriquez, 2013; Siemens 2012); however these terms lack clear definitions (Liyanagunawardena et al., 2013). Generally, c-MOOCs are associated with connectivism, defined by Siemens (2004) as the "amplification of learning, knowledge and understanding through the extension of a personal network" (Connectivism section, para. 9). Described as more open with freely provided materials, c-MOOCs are designed to foster connections and collaborative knowledge building across formal and informal learning environments. In a c-MOOC, participation and the connections established are emphasized; the instructor facilitates knowledge coherence and the learners expose, explore and deepen ideas and understandings (Rodriguez, 2013). In contrast, x-Moocs (i.e. Coursera, Udacity) are based on cognitive-behaviorist pedagogy and a tutor-centric model; these courses are more restrictive with traditional approaches to learning including video lectures, weekly assignments, and online quizzes (Rodriguez, 2013).

In a review of 45 peer-reviewed publications about MOOCs from 2008 to 2012, Liyanagunawardena et al. (2013) classified 21 articles with a case study design and use of multiple methods for data collection such as multiple surveys, email interviews, focus groups, log data, discussion forum data, blogs and observations, to name a few. Despite the volumes of data that can be generated from online courses, most of the research to date is limited and has focussed on learner perspectives involved in MOOCs. Thus, Liyanagunawardena and colleagues **(**2013) argue that the growing interest in and enthusiasm for MOOCs needs to be coupled tightly with more disciplined research to explore:

- Creator/facilitator perspectives

- Technological aspects
- Cultural differences and tensions among participants
- Ethical aspects of using MOOC data
- Mobile learning for increasing global participation
- Strategies used by active participants who complete the course
- Experiences of non-completing participants
- Why individuals are motivated to participate in MOOCs

As a caution, Johnson et al. (2013) warn that as MOOCs "continue their high speed trajectory in the near-term horizon, there is a great need for reflection that includes frank discussions about what a sustainable, successful model looks like" (p.12). Thus, continued research on MOOCs and their role in higher education is needed.

Communicating

Communicating, for the purposes of this review, includes untethering and expanded notions of time and space, flexible designs that move from limited one-time interactions to opportunities for students to control pacing and playback, and expanding the audience for knowledge sharing beyond the professor-learner interaction/transaction.

Studies exploring students' uses of the Internet have mainly focussed on findings related to transmissive, or broadcast communications (Bretag & Hannon, 2010; Jones et al., 2008). For example, using an autoethnography and a discourse analysis approach, Bretag and Hannon (2010) analyzed the ways of writing and talking about technology in higher education and found three categories emerged when exploring online learning (1) technology as a bridge to globalized opportunity; (2) technologies as delivery of learning; and (3) technology as communication and building relationships for learning. So, there is room for growth in the innovative use of learning technologies to increase opportunities for learner-learner and faculty-learner communications about content and learning in higher education in classroom or lecture like environments and in virtual formats. Moreover, social technology, such as personal learning networks, social networking tools and other Web 2.0 applications create opportunity for educators to develop new educational approaches (Schneckenberg et al., 2011) and increase the level, depth and reach of communications (Siemens & Tittenberger, 2009, p. 39).

Next, examples are discussed from the literature describing learning technologies currently used for increasing the level of communications across the spectrum of learning environments ranging from lecture-like environments to completely online and virtual environments. The research on learning technologies for expanded communication includes clickers, mobile applications, videos & flipped classrooms, learning management systems, discussion boards, email, blogs, microblogs and web conferencing.

Clickers.

Typically, introductory courses in higher education are offered in a face-to-face or in-person communication format in medium to large seminar formats. Common learning technologies used in lecture-like environments include display and clicker technologies. A variety of terms used to describe clicker technologies include audience response system, voting system, performance system, feedback system, and communication systems, to name a few (Keough, 2012). Clicker technologies tend to include student transmitters, provided by the instructor or apps on the student's smartphone, wirelessly connected to an instructor-controlled receiver and computer. The instructor can prepare questions (generally true/false, multiple choice or short answer) and students can respond synchronously using the clickers. As a form of instantaneous feedback, the instructor can review and display responses immediately and determine if additional information or review is needed. In a review of 66 clicker based studies focusing on student perceptions/outcomes, students perceive clickers are easy to use and the use of clickers increases their performance, attention span, attendance, and level of participation (Keough, 2012). The most promising and innovative use of clickers is for active learning, engagement and participation and knowledge building which involves the instructor carefully and thoughtfully designing questions and stewarding follow up discussions that engage students in exploring contentious issues, trends and emerging ideas in a discipline of study (Liu, 2012; Rajasakeran, 2013).

Mobile Applications.

Mobile phone applications (apps) can be used in lecture-like environments as an additional channel for communications, such as the MyVote app described by Cheong, Bruno and Cheong (2012). Similar to clicker technologies, mobile apps can be used to ask students questions and aggregate responses from the students. In this case the student's personal mobile device is the transmitter eliminating the cost and need for managing sets of transmitters, but

increasing the need for robust, wireless network connectivity and bandwidth. Through a variety of scenarios, researchers describe how this type of system can engage students and promote higher-order thinking skills in lectures using a Delphi-like iterative and interactive process of knowledge construction (Cheong et al. 2012). There are also future possibilities for students contributing to question sets and sending to peer groups outside of class as a method of extending the reach of communications.

Videos.

Researchers have found that the instructional value of videos prepared by the course instructors with the same content as the classroom lectures (Kay & Kletskin, 2012) and the use of slower pacing to supplement classroom lectures (Brecht, 2012) can positively impact student learning. Kay and Kletskin (2012) used a series of 59 problem-based video podcasts in a first year university mathematics course as pre-study tools and reported achievement gains and positive student ratings. Through analysis of survey data and grade distribution, Brecht (2012) found students voluntarily used the supplementary online videos as tutorials or as a tutoring resource; the videos were found to improve initial learning and topic understanding, reduce drop-out rates (especially for weakest students) and improve student grades. Similarly, Wong (2013) surveyed students with access to online options for learning resources (online recordings and tutorials). Although students preferred traditional face-to-face delivery, the findings revealed a positive relationship between the level of student engagement with the online resources and overall academic results (Wong, 2013). Video podcasts can also be used for a flipped or inverted classroom approach. Thus, video podcasts may be used for viewing lectures virtually and can have a positive impact on student learning as shown in recent studies (Brecht, 2012, Kay & Kletskin, 2012; Wong, 2013).

Flipped classrooms.

The flipped classroom is described as "a pedagogical model in which the typical lecture and homework elements of a course are reversed". This idea draws upon concepts such as "active learning, student engagement, hybrid course design, and course podcasting" (Educause Learning Initiative, 2012, What is it? paras.1, 2). Students view short video lectures at home, and class sessions become more student-centred, in which "students collaborate with peers on projects, engage more deeply with content, practice skills, and receive feedback on their progress" (Hamdan, McKnigh, McKnight, & Arfstrom, 2013, p.3). During these class sessions, instructors

can devote more time to coaching or facilitating student learning and providing "individualized support as students work through the activities designed to help them master the material, meeting them at their readiness level" (Hamdan, et al., 2013, p.4).

A review of the literature reveals that in the context of higher education, humanities and law professors, especially, have used the flipped classroom model for decades (Berrett (2012). To date, there is an increasing number of higher education faculty using the flipped classroom model in their courses. For example, a video production class at the Algonquin College has been using this model to explain the process of editing software, a procedure that is difficult to explain in a standard lecture; in an accounting course at Penn State, class sessions are used for open discussions, featured guest speakers, or hands-on problem solving where student assistants supplement instructor support (Educause Learning Initiative, 2012); and at the University of Calgary, professors in the Faculty of Arts are experimenting with the flipped classroom model in their courses (MacMillan, Ullyot, Eiserman, Hall-Beyer, Hoenle, Kelly, Macphail, Policzer & Reaume, R., 2013).

Despite the increased use of the flipped classroom model in educational programs, there seems to be no "scientific research base to indicate exactly how well flipped classrooms work" to date (Goodwin & Miller, 2013, A Growing Practice, but Little Research, para.2). Instead, there seems to be an established body of documented research supporting some of the key elements of the flipped classroom model (Hamdan, et al., 2013). Hamdan and colleagues cite two cases in higher education institutions where faculty had successfully implemented flipped learning models in their courses and at least one reporting negative results.

In one of the cases, Papadopoulos and Roman (2010) employed an 'inverted' model of learning, which was similar to the flipped learning model, in an electrical engineering class, and discovered that the students' progress through the content was quicker; they understood the topics in greater depth; covered additional content without sacrificing the quality of the course and their test scores exceeded those of their counterparts in the traditional learning environment. In another case, Warter-Perez and Dong (2012) used the model in a freshman and sophomore Introduction to Digital Engineering course and reported that flipping the classroom seemed to be effective in helping students understand the course content and develop design skills. Their findings were reinforced by satisfaction surveys and focus groups in which over 70% of students indicated that the learning environment was more interactive.

Research on flipped classroom learning in higher education has started to point to essential conditions of the model. In a computer applications course, Johnson and Renner (2012) report they found no significant differences between the mean test scores of students with whom the flipped classroom model had been used and those with whom it was not used. They explained that these results may have been influenced by the instructor's hesitance to use the model as he/she saw no need for its use in the course. Faculty must commit to the flipped model and use it as intended to realize the learning benefits for students.

Overall, a review of the literature on the flipped classroom seems to indicate that there are possible benefits of this model for teaching and learning in higher education. Goodwin and Miller (2013) note some of these benefits identified by proponents of the flipped classroom model:

- Improved Student–Teacher Interaction
- Opportunities for Real-Time Feedback
- Student Engagement
- Self-Paced Learning
- More Meaningful Homework

Questions remain as to whether the identified "benefits of flipped classrooms reflect research-based principles of effective teaching and learning" (Goodwin & Miller, 2013, The Indirect Research Base, para.1). It is, therefore, evident that more scientific research on using the flipped classroom model for teaching and learning in higher education is needed.

Learning Management System (LMS).

According to Naveh, Tubin and Pliskin (2010), a learning management system (LMS) is "used by instructors to build and maintain course websites" including management of the interactive course communications (p. 127). The findings from an examination of student use and satisfaction with an LMS suggest there is some value in course websites that support and extend conventional teaching by providing ready access to course content and content focused communications (Naveh, et al., 2010). However, Jones et al. (2008) and Dunlap and Lowenthal (2009) contend that many LMS or virtual lecture hall designs, and course web sites with online class notes, are (too) often modeled after traditional pedagogies. Researchers argue the focus of LMS is on managed content and that higher education has over-emphasized content delivery rather than the process or models of teaching and learning, design and delivery (Siemens &

Tittenberger, 2009). Moreover, it is important to build authentic and relevant opportunities for students to interact and connect using contemporary pedagogies in LMS learning spaces.

Discussion boards.

Garrison and Akyol (2009) argue "It is through the integration and sustainability of reflection and discourse where students become engaged in deep and meaningful learning experiences" (p. 22). For instance, using an online discussion forum where teachers and students can post messages at any time is a common example of asynchronous interactions using text-based communications with opportunities for supporting a scholarly community of inquiry based on principals of collaborative knowledge building (Scardamalia & Bereiter, 2006; Zhang, 2012). Metacognition indicators are present in online discussions (Akyol & Garrison, 2011) and can be described as "the product of interaction between an individual or among individuals and a surrounding context, rather than seeing it as merely and individual process" (Garrison & Akyol, 2013, p. 84).

Offir, Lev and Bezalel (2008) gathered data from interviews and observations and suggest limited interaction and dialogue in asynchronous environments may prevent students from asking questions to improve understanding and internalize content. Moreover, even students with a higher cognitive ability and a more autonomous learner profile preferred synchronous learning and increased teacher presence according to Offir et al. (2008). Furthermore, Karpova, Correia and Baran (2009) found students utilized the discussion board in the LMS but found it was not well-suited for discussions requiring immediate responses from team members or for reaching consensus and preferred video conferencing for those types of group communications.

Despite the limitations of online discussion forums, other researchers found that well designed text-based communications do not restrict social presence, and that distributed groups of online students can display high degrees of social presence without physical presence and develop a shared sense of belonging and shared social identity (Rogers & Lea, 2005). Nonetheless, it is important to recognize that Oztok, Zingaro, Brett and Hewitt (2013) found that "synchronous messages and asynchronous notes differ in terms of reading ease, academic content and social processes" (p.93) and it is necessary to continue to explore and expand the complementary roles of synchronous and asynchronous interactions in virtual learning environments in open learning spaces and accompany these designs with engaged and participatory approaches to teaching.

Email.

Email continues to be a common method of communication between students and professors. Jones et al. (2008) report 79% of college students surveyed use email to communicate with professors for reporting absences, seeking clarification about learning tasks, setting up appointments, or for submitting assignments. Likewise, Karpova et al. (2009) found students use email for communications and sharing personal information with peers as well as for document sharing; professors use email to provide class announcements, share information and to provide additional resources and materials for the course. Email and other Internet applications with direct messaging options (i.e. Facebook, Twitter) are also used by students to communicate with peers about course work and researchers contend private messaging does not reduce contributions to public discourse and can in fact support growth in a community of inquiry (Oztok et al., 2013). For example, in a recent study examining the relationships between students' use of asynchronous discussion forums and synchronous private messages in nine fully online graduate education courses in a large Canadian research University, results show that introducing private messaging to an asynchronous course can have positive effects in student engagement and for increasing a sense of community (Oztok et al, 2013).

Blogs.

Web logs or "blogs" are easy to create/use tools considered part of the Web 2.0 toolkit. Schwier (2013) describes blogging as a method of self-expression with potential for conversation using the commentary functions in blog tools. Likewise, other researchers define blogs as interactive tools that "offer students the opportunity to develop their own voice in the classroom, while commentary serves as an important reinforcement for self-reflection and continued participation" (Bartholomew, Jones, & Glassman, 2012, p. 19). Two types of blogs are commonly discussed – individual blogs with single ownership and community blogs with co-ownership. There are blog programs with open access and accessible beyond course participants or closed blogging platforms only accessible by students in the course. Bartholomew et al. (2012) defines the two types of blogs as follows:

- Individual blogs - where students post ideas/thoughts independent of their classmates
- Community blogs – where students contribute information to a larger community of learners (p. 22)

Kerawalla, Minocha, Kirkup and Conole (2009) studied the use of individual blogs in higher education courses in the UK. The researchers developed a framework to support educators designing learning tasks integrating blogs and to guide students in determining their use of blog tools and suggest the following five key pedagogical factors need to be considered by faculty to improve learning experiences and social interactions for building a community of inquiry using blogs:

- Integrating the technology within the course
- Clarifying the role of the technology within the pedagogy of the course to the students
- Providing guidance about the usage of the technology and related social norms
- Designing for socialization in online collaborations; and
- The activities and guidance should be designed to sustain the socialization throughout the course so as to foster the development of a learning community. (p. 40)

The five key pedagogical factors were also used by Bartholomew et al. (2012) in a study of blog interactions in undergraduate child development courses collecting data using participant observation, interviews and questionnaires. These authors argue a blog log used to track blog posts, commentary, interactions and contributions can be used as an effective tool for self-regulation and self-efficacy and for "keeping blogs on a positive trajectory" (p. 20). The findings from this study also suggest that open access blogging may have assessment challenges however, it still provides an authentic writing/reflective experience fostering personal ownership (Bartholomew et al., 2012).

Microblogs.

Microblogs refer to the use of Web 2.0 tools that allow for concise online communications and building connections with others, also known as microsharing. Although there are numerous freely accessible applications with microsharing capabilities (i.e. Edmodo, Tumblr, LinkedIn, Facebook, etc.), Twitter is a very popular microblog program that allows subscribers to post 140 character messages (tweets) including links to other digital media. Twitter is described as an interactive tool that can enhance social presence for learning by providing authentic opportunities for students to interact and stay connected with each other, with instructors and with global professionals in the community (Dunlap & Lowenthal, 2009). Microblogs are similar to text messaging and offer real-time communication using any Internet

ready device (i.e. laptop, tablet, smartphone, etc.). However, microblog applications, such as Twitter, typically limit to the number of characters in the message and by default immediately broadcast the message to all followers versus sending a direct message to one individual. Numerous applications are available with integrated services (i.e. TweetDeck, Twiterfall, paper.li, storify, etc.) to curate, aggregate and display the real-time content based on individual user preferences and needs. For example, Paper.li curates content from various web sources and aggregates information into a newspaper presentation style. In a large lecture, Twitterfall might be used to display a backchannel of dialogue, questions and interactivity on a large screen or in an online class, students might use a hashtag (keyword prefixed with #) to organize class messages and to communicate and interact with peers. Veletsianos (2012) quantitatively analyzed tweets from 45 scholars involved in research and teaching, and found the communications were commonly used for the following purposes:

- Information, resource and media sharing
- Sharing information about classroom and students (i.e. providing students with opportunities for interaction outside the classroom)
- Requesting assistance and offering suggestions
- Social commentary (i.e. current activities, interests, mindsets)
- Digital identity and impression management (i.e. work and professional endeavours)
- Connecting and networking; and
- Highlighting presence across multiple networks. (p. 342)

In a qualitative case study examining the use of a Twitter by undergraduate and graduate students, the researchers examined how students perceive microsharing as a classroom application (Lin, Hoffman, & Borengasser, 2013). The findings suggest that students generally used Twitter for information sharing purposes and "Twitter creates a largely one-way communication channel to push information from instructor to student" (Lin et al, 2013, p.44). Very little collaboration or interaction occurred in this study; however, the faculty and students involved in the study recognized there is opportunity for using microsharing applications beyond communication purposes. The researchers make the following recommendations for faculty using microsharing applications:

- Provide scaffolding for students in learning how to use microsharing applications and introduce or incorporate functions in the class.
- Address privacy to ensure oversharing is decreased and use techniques such as class hashtags for class purposes instead of requiring students to "follow" their classmates.
- Establish purpose such as using microsharing as a communication channel for information sharing, assignment reminders, class announcements, and quick student feedback. (Lin et al., 2013, pp. 43-44)

Overall, participatory technologies such as blogs, microblogs or other microsharing applications are showing early evidence of providing opportunities for dissemination of ideas and communications (Lin et al., 2013) beyond the classroom community (Bartholomew et al., 2012; Veletsianos, 2012) and for building professional learning networks (Veletsianos, 2012); however, it is also evident that more research on using online social spaces for teaching and learning in higher education is needed.

Web conferencing.

Web conferencing, a popular form of interactive communications using audio, video and other multimedia visuals in a virtual environment, is an example of synchronous virtual learning interactions. Through an interpretive case study, Falloon (2011) studied web-based virtual environments, such as Adobe Pro Connect, to promote quality dialogue and used Moore's Theory of Transactional Distance (1997) as a lens for assessing the value of using virtual classroom environments. Falloon (2011) observed "the potential in such tools lies in their ability to facilitate meaningful, real-time, two-way interaction and dialogue, and their use for essentially transmissive seminar presentation did not allow this potential to be realised" (p. 205). Some challenges in using web conferencing include:

- Students reluctant to contribute to dialogues due to insufficient time for reflection.
- Regular sessions are not convenient for everyone.
- Technical issues that affect a participants' ability to interact with others. (Falloon, 2011)

Similarly, McBrien, Jones and Cheng (2009) analyzed the ways in which a synchronous environment (using Elluminate Live!) affects students' learning experiences for quality distance learning experiences in higher education. In this study, the participants rated the following survey items as important elements in the learning experience: 1) convenience (although attendance is

unpredictable), 2) technical issues, and 3) pedagogical preferences. In comparison to discussion boards, participants in one study found web conferencing (using Skype) was better suited for brainstorming, reaching consensus and decision making with a group (Karpova et al., 2009) despite the possible limitations in having too much stimuli, a desire for non-verbal communications, experiencing technical problems (McBrien et al., 2009) and challenges in managing and recording conversations for future reference.

In this section on communication, many examples were provided of technologies used for purposes of expanded communication in synchronous and asynchronous learning environments. Clickers, mobile applications, videos, learning management systems, discussion boards, email, blogs, microblogs and web conferencing applications provide opportunities for self-reflection, interactive communications, conversation, information and resource sharing, to name a few of the advantages of integrating these instructional technologies. Furthermore, contemporary learning technologies can strengthen teaching presence, cognitive presence and social presence, known as elements of a community of inquiry (Garrison & Akyol, 2009).

Collaborating

In this review, collaborating is working alongside others to learn and share new knowledge. Contemporary pedagogies and learning technologies enable instructors to design ways and means for diverse learners to draw upon multiple perspectives and ideas to collaboratively build and share knowledge that matters to the world. Researchers suggest that the current shift from a distributive to a collaborative mode of learning is enabled by Web 2.0 tools (Schneckenberg et al., 2011), described as "interactive and participatory information sharing, creation and collaboration by users on the World Wide Web" (Jacobsen, 2013, p. 325). Likewise, Schneckenberg et al., (2011) define Web 2.0 as a "portfolio of emerging tools, which form the basis for a more mature and responsive Internet, in which users collaborate, share information, and create network and scale effects in large communities" (p. 750). In other words, new technologies provide opportunities for participation and a collaborative model of knowledge building in global learning environments.

Furthermore, there is a workforce demand for learning experiences and competencies developed through collaboration (Johnson et al., 2013). For instance, Karpova et al., (2009) argue

that "learning while working together is becoming mandatory to meet workplace performance requirements, and it is important for students to have authentic experiences while earning a degree" (p. 45) and more collaborative work and play spaces for creative products are needed (Moyle, 2010). Contextual features such as time structure, obligation for participation and technological tools can support collaboration; however, there are methodological challenges in studying the complexity of collaborative knowledge building (Arvaja & Poysa-Tarhonen, 2013).

It is important to note that online collaboration tools are among technologies most expected to improve academics in the future (Economist Intelligence Unit, 2008). The technologies discussed in this section provide examples of current collaborative tools studied in higher education learning environments, such as networked mobile devices, online collaborative workspaces, and wikis.

Networked Mobile devices.

Mobile devices are defined as portable technologies used for untethered access to data and can enable learners to consume and produce content for learning in collaboration with others (Anderson, 2013). Prior to high levels of student ownership of mobile devices, studies focussed on use of mobile devices supplied by the institution and the findings reveal mixed results (Andreu, Delgado-Almonte, & Pedraja-Rejas, 2010; Kenny, Van Neste-Kenny, Park, Burton & Meiers, 2009). For instance, Kenny et al., (2009) explored mobile learning with third-year nursing students and found a key feature was ready access to information and resources during point-of-care. However, participants in the study found hospital culture and policies as well as limited wireless connectivity presented barriers in using mobile devices when needed. Furthermore, the researchers suggest more research is needed to determine the potential of networked mobile devices for communications and interactions.

In a study using a quasi-experimental design comparing traditional coursework with a collaborative pedagogical model using hand held devices based on a portable pocket PC laboratory, researchers compared the pass rates of students in five industrial engineering courses (Andreu et al., 2010). The laboratory included 50 portable wireless pocket PCs with collaborative applications used in a classroom setting.

The collaborative pedagogical model used with the hand held devices as shown in Figure 3 is described as follows:

> The first step is to create a content database of multiple-choice questions. Step 2 consists in designing a classroom pedagogical activity, which may be an evaluation or a collaborative activity, by choosing questions from the database. This activity is then loaded into the instructor's Pocket PC acting as a server (step 3), from which it can be sent wirelessly to the students (step 4). Finally, step 5 is the activity itself in which the students work collaboratively in groups of three chosen at random. (Andreu et al., 2010, p. 144)

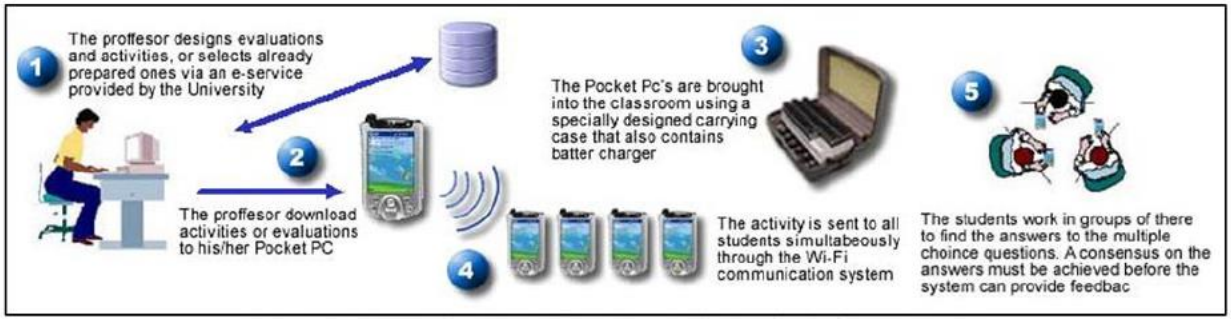

Figure 3. Application of mobile technology platform in the classroom (Andreu et al., 2010, p. 144).

The findings from this study suggest the use of the portable PCs did not correlate to an improvement in grades; however pass rates significantly increased in the courses using the technology in comparison to the traditional courses that were not using the hand held devices. Researchers also reported the following results from the group using the pocket PC laboratory:

- The technology was found to be attractive and its use in other courses would be welcomed.
- It was recognized that the technology increased communication and the effectiveness of work among peers.
- The technology was perceived to facilitate learning and greater participation. (Andreu et al., 2010, p. 148).

The studies of networked mobile devices supplied by the institution demonstrate that simply adding technology to a classroom environment does not automatically improve performance.

However, some mobile applications can increase communications and collaborative interactions (Andreu et al., 2010). Similar to clickers, mobile devices can sponsor increased participation among learners in classrooms with large populations. Furthermore, mobile devices can manage the logistics of establishing peer groups for collaborative learning opportunities making collaborative learning designs viable in a large classroom setting. It also noted that personally owned mobile devices are important to students and becoming ubiquitous in higher education learning environments according to a recent university-wide survey in the U.S. (Chen & Denoyelles, 2013). As such, more study is needed exploring the use of personally owned mobile devices and mobile applications for academic purposes and developing effective pedagogies for collaborating and learning with mobile devices.

Online Collaborative Workspaces.

Advances in cloud computing and shared applications are supporting both learners and faculty in higher education to engage in online, collaborative workspaces from anywhere, at anytime, and using any network capable device. Cloud computing is defined as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". (US Department of Commerce's National Institute of Standards and Technology ([NIST] 2011, p. 2). Faculty and learners increasingly use online collaborative workspaces, such as Google Apps, Dropbox, Wikispaces, BaseCamp and Ning, to name a few, to develop and participate in new processes for collaborative creation and sharing of knowledge.

In a case study exploring how e-learning can support the development of learner competencies in higher education, researchers rearranged the physical space to round tables for constructivist learning and used Google Apps as a collaborative learning environment (Schneckenberg et al., 2011). The researchers reported high levels of student engagement and course satisfaction with students in a business course: "the tools in Google Apps have been very useful to organise learning content, to enhance the constructivist model, to set up and to engage students into collaborative learning sessions, and to create transparency and equality of peers in the classroom" (Schneckenberg et al., 2011, pp. 757–758). Examples of the tools used in Google Apps learning environment included: Picassa for a learning artefacts gallery of brainstorming

activities, comment function in google sites for spontaneous reflections, google docs for peer reviews, wiki function for writing activities accessed by the whole group, and a google site specifically for student feedback freely accessible to all students in the course. Similarly, Denton (2012) conducted a case study with graduate education students and observed that even though some of the activities could be done with traditional methods, using cloud computing was efficient and effective in a traditional classroom environment.

Google apps have also provided opportunities for virtual collaborative learning. Karpova et al. (2009) define Google Docs a subset of the larger Google Apps as "a free web-based word processor that allows several authors to work in real-time on one document by keeping track of the changes and editing without downloading it to a computer" (p. 48). Google Docs works well for collaborative document creation and an advantage in virtual collaborations is the opportunity for students to collaborate with students from diverse cultures, different communication styles and geographically distributed (Karpova et al., 2009). As more online collaborative workspaces and cloud computing options become available, more study is required to determine educational advantages in using the tools for collaborative learning and beyond in higher education, and the new technological infrastructures and ideologies that will be required to support them.

Wikis.

In some cases wikis are embedded and part of an integrated learning environment or can be accessed as standalone applications (Alier Forment, Pedro, Jose Casan, Piguillem & Galanis, 2012). Some faculty may argue the embedded applications are less versatile and opt to use an open access application with more customization options; whereas, other faculty may find reviewing work and providing feedback in an open environment is more demanding so they might use a wiki secured in an LMS. Carroll, Diaz, Meiklejohn, Newcomb and Adkins (2013) integrated interactive online social media into assessment profiles and students were required to develop and showcase their research in a wiki for peer review and critique. Academic writing standards were raised during the learning process and the researchers reported, "The learning that occurred was done socially, publicly, collaboratively, and competitively; and via an iterative process wherein students observed and studied each other's' work and then both imitated innovative ways of conducting their own projects" (Carroll et al., 2013, p. 523).

Hand held devices, online collaborative workspaces and wikis were provided as examples of technologies studied in higher education environments that foster faculty and learner

interaction and collaboration. It is interesting to note that despite the limited use by their professors, students will use collaborative online tools even when not required for the coursework (Kumar et al., 2012). Thus, more research is needed to explore collaborative technologies and pedagogies that support collaborative student learning online and on-campus.

Creating

Creating, for the purposes of this review, refers to participatory cultures of learning in which the students, the teacher and the environment all have a mutually reinforcing capacity to make valuable contributions to continual idea improvement and development of "new concepts, processes and artefacts" (Martin, Morris, Rogers, Martin & Kilgallon, 2009, p.3). Thomas and Brown (2011) describe new cultures of learning that are made possible by relationships formed through shared interests, passions and goals and a system of reciprocity. All learners can contribute to knowledge creation, solve knowledge problems and participate in knowledge-building environments (Bereiter & Scardamalia, 2010). A creating environment is considered a collective and learning takes place continuously in the collective. Given pervasive networked technology, experts and amateurs can easily join efforts for increased data collection and the potential for collectively creating meaningful results, such as amateur astronomer observations from around the world informing scientific discoveries (Thomas & Brown, 2011). Another example is the website (www.NLNature.com) created by academics at Memorial University as part of ongoing research that asks residents and tourists to post their sightings of plants, animals and other interesting features of the province's landscape with the aim to contribute to conservation, monitoring and education efforts. As such, everyone has capacity for contribution, creativity and legitimate knowledge creation as part of a collective.

Creating in higher education is challenging (Oblinger, 2013) as it involves changing established systems and traditional pedagogies such as knowledge transfer by lecture (Allen, Caple, Coleman & Nguyen, 2012; Martin et al., 2009), knowledge transfer by providing answers or authoritative interventions (Schwartz & Fischer, 2003), and the persistent value for assessing and recognizing individual expressions of learning. Jackson (2006) contends that "Higher education needs to see creativity within the important role it plays in preparing people for an uncertain and ever more complex world of work; a world that requires people to utilise their creative as well as their analytical capacities" (p.2). In subsequent work, Jackson (2013)

continues to argue that creating has an important role in higher education and "the problem of how we cultivate creativity in university students has a lot to do with how we cultivate a culture of creativity in our universities" (p. 3)

Teaching and learning in higher education is influenced by access to Internet-based technologies with increasing opportunities for the design of engaging, technology-rich and creative open learning environments (Blessinger & Wankel, 2013; Jahnke, 2011) that can foster collective creation. Schwartz and Fischer (2003, 2006) argue pedagogies in higher education courses need to place less emphasis on knowledge transfer or borrowing ideas for understanding and should place more emphasis on building personal understanding through sense making and deep learning experiences through collaborative knowledge building. Examples of technologies that can provide opportunities for collective creation and learning in the higher education context include the full range from connection, communication, and collaboration tools accompanied by participatory pedagogies, to the two that are explored here: games & gamificationand virtual worlds.

Games & Gamification

Johnson et al. (2013) argue that it is well known that educational games (e.g., computer games, video games) increase and support critical thinking, creative problem solving and team work. As a result, an increasing number of educational institutions are experimenting with games in their delivery of programs across disciplines. They also note that with this increase in the use of games, there has also been increased attention surrounding gamification—an expansion of game-based learning and a term intended to demonstrate a move beyond simply using games for learning content or scaffolding learning experiences (Perrotta, Featherstone, Aston & Houghton, 2013). Elements of games (i.e. choice, moving to different levels, receiving badges, etc.) are combined with non-game elements such as simulations, real-time feedback, real-life scenarios and experiences (Johnson et al., 2013) to help support active learning (Lee & Hammer, 2011).

A review of the literature on the use of games in higher education suggests that designs building upon principles of gamification can foster student engagement in higher education. Some universities are utilizing game-based learning to motivate students to learn and acquire new knowledge and skills, to "encourage exploration and generate unexpected solutions to the problems posed by course content" (Educause Learning Initiative, 2011, What are the implications for teaching and learning? para.1). For instance, Johnson et al. (2013) provide the following examples:

- Henry Madden Library at the California State University, Fresno uses HML-IQ, a game built into Blackboard to orient students with the available library resources and how to use them.
- In partnership with game developer, Novel Inc., the Foster School of Business at the University of Washington transform real, complex scenarios from major companies, such as Starbucks and Nike into enterprise simulation games.
- In partnership with the Minnesota Hospital Association and a technology company, VitalSims, the University of Minnesota's School of Nursing has developed web-based interactive games that engage nursing students with real-life scenarios.
- Queen's University in Ontario, Canada, a professor is exploring how 'exergames'—video games that require physical activity to improve the well-being of teenagers who are afflicted with cerebral palsy. (p.22)

While games & gamification reflect the perception that games can be used as "effective tools for scaffolding concepts and simulating real world experiences, it should also include the larger canvas of . . . game design" (Johnson et. al., p.21). For example, students building or making their own games from scratch to learn content (van Eck, 2006) fits neatly on this canvas. A review of the documented research literature on students designing or creating/making games for learning in higher education, however, is sparse. There seems, instead, to be increasing amounts of empirical research on children's design and building of games for learning (for example, Papert, 1993; Kafai, 1995; Kafai, 2006; Li, 2010; Denner, Werner & Oritz, 2011; Shaw, Boehm, Penwala, & Kim, 2012; and Yang & Chang, 2013).

According to Kamenetz (2013), "Game-making represents an active and creative, rather than more passive, approach to technology. It's a core practice of constructionism, the learning theory championed at MIT's Media Lab that focuses on learners building their own relationship to knowledge" (para.1). Tzuo, Isabelle, Ling, Yang and Chen (2012) also note that in designing games for learning, "learning is signified at the macro level through reinterpreting and creating, which in turn leads to societal re-conceptualization by the reconstruction of values, knowledge and meanings". In this way, "identity is reformed along with learning and knowing . . . through triangulating the perspectives of designers and players when creating the story line and designing the task" (p. 423).

One example of a research study that has employed game making/design in a higher education course to investigate whether graduate students engage in more "effective learning and/or teaching constructs" while designing digital games to teach road safety was carried out by Li, Tay and Louis (2012). The study used a "unique approach by asking practicing teachers who are also graduate students with knowledge of game design, to create educational games to teach road rules" (p.18). Based on their findings, Li et al., (2012) noted that through this game design experience, the students realized the importance of:

> … iterative design, [in terms of] brainstorming of ideas, the paper prototyping, and the trying out of different solutions to solve problems; detailed planning[to] help align educational objectives with game play, but also lay the foundation and make the whole process, particularly the development process, go much smoother [and for] successful implementation of the game design; [mapping] the game design to the targeted audiences and the content to be taught through the game; [designing] games that were intrinsically engaging, fun and relevant to the learners. (pp. 25-27)

Empirical investigations can contribute new insights on how students in higher education can create "new materials, artefacts, new knowledge" and ideas in a participatory and engaging learning environment (Moyle, 2010, p.4). More research is required in the relatively new area of games & gamification for collective creation in education. However, some have predicted that over the next few years, games & gamification in higher education has the potential to sponsor new approaches to teaching and learning for increasing student motivation, engagement and deep learning (Johnson et al., 2013). McGonigal (2013), for instance, shared three examples of new games (*Foldit, Urgent Evoke*, and *Find the Future:The Game*) that are advancing a variety of fields of study, and suggested that the techniques underlying these games could help to revolutionize the ways through which higher education is delivered or assessed (as cited in Buck, 2013, The Future of Gamification in Education). The growing enthusiasm for games & gamification in higher education will, therefore, need to be accompanied by disciplined research on learning and teaching.

Virtual worlds.

The Educause Learning Initiative (2006) defines a virtual world as "an immersive, online environment, whose 'residents' are avatars representing individuals who participate through the

Internet…. they may foster constructivist learning by placing students in a context that challenges them to learn without explicit learning objectives and assessment" (para.1).

In virtual worlds, there is potential for a learner-centered model of exploration and knowledge development. Examples of 3-D virtual world applications include *ActiveWorlds*, *Second Life*, *OnLive! Traveler*, *Croquet* and *There* (Hew & Cheung, 2008). In Second Life, for example, residents can be imaginative and creative by "creating compelling and interesting content . . . often overcoming tremendous obstacles to acquire new skills and knowledge" (Ondrejka, 2008, pp.229-230). Virtual worlds can also offer students and teachers personalised learning strategies, which place an emphasis on self-direction and self-reliance. In this personalized learning environment, learners are trusted to make thoughtful and meaningful choices about what they learn and how they will learn it (UNESCO, 2009).

A review of the literature on the use of virtual worlds in higher education reveals that many institutions are experimenting with virtual worlds for educational purposes. It has been reported that numerous universities have been utilizing Second Life spaces, for example, to "enhance collaborative learning and problem solving as an extension of traditional face-to-face learning, while others are teaching entirely within these *Second Life* environments" (Tan & Waxman, 2013, p.72) for the potential to "foster experiential and constructivist learning" (Inman, Wright & Hartman, 2010, p.45). For instance, Harvard University created *River City*, a virtual world that presents users with an outbreak of disease, and allows residents to move through the environment to make inquiries and examine data in order to discover the source of the illness. Another example of a virtual world was developed at the University of British Columbia and based on real archaeological sites in which students use contemporary materials and techniques in order to create replicas of structures of the time (Educause, 2006).

In their review of the research on the use of Second Life in higher education, Inman et al., (2010) carried out a content analysis of actual documented research studies (23 out of 27 focused in higher education) and note the research includes mainly, personal accounts from educators using Second Life and how higher education is using Second Life for presence and progress. Despite the limited empirical research available, Inman et al. (2010) cite some of the potential uses of Second Life in learning environments to communicate, collaborate and interact through role-play activities, synchronous meetings, simulations, group projects and problem-based learning.

In their research, Keskitalo, Pyykkö and Ruokamo (2011) utilized Second Life in a Global Virtual Collaboration Project (GVCP) course in the field of engineering at four higher education institutions to evaluate the students' meaningful learning experiences as they worked in global teams on a collaborative creative design task, such as constructing a bridge. Among their findings, Keskitalo et al. (2011) report that

> Second Life supported the use of imagination and creativity. . . Students had the opportunity to decorate their global team rooms and design the appearance of their avatars. Students also felt that their task enabled creative thinking since it required assessment of the tasks, design model, and information as well as knowledge co-construction in order to create consensus for the final report. . . Creativity was also emphasized every time students needed to invent a new way of working when a planned tool or software did not work. (p.23)

Another interdisciplinary design-build team with faculty and students from the interior design, information science, and merchandising departments created a virtual library and virtual retail space for recruitment, orientation, and teaching and learning resources for the Florida State University (Tan & Waxman, 2013). The researchers found that Second Life was successfully used to design those spaces to meet client needs and support student learning outcomes and provided the team with valuable learning experiences through exposure to a variety of professional user groups' perspectives (Tan & Waxman, 2013). This design project shows promise for future interdisciplinary design work in virtual worlds.

As evident from this review of the literature, the possibilities for adopting innovative practices that transform learning opportunities and experiences in higher education are promising. The selective studies presented in the literature review reveal numerous opportunities for advancing new approaches to learning and teaching in technology-enhanced learning environments as summarized in Table 4.

Table 4

Promising learning technologies and practices

4C's	Learning Technologies	Opportunities for Learning
Connecting	Tablets	Support fieldwork, organization, searching, develop sense of learning spaces and connecting to learning networks
	Learning Analytics	Promote data-driven decision making for course activities and resources, and uncovering relationships and patterns
	MOOCs	Extend learning to global participants, foster connections and collaborative knowledge building across formal and informal learning environments
Communicating	Clickers	Provide instantaneous feedback, increase participation in lectures, reveal issues, and trends
	Mobile Applications	Engage students and promote higher-order thinking skills in lectures, provide a channel for communications and extending reach beyond the classroom
	Videos / Flipped Classrooms	Adapt to pacing and repetition needs of diverse learners, provide tutorial service; Encourage more student centred active learning as typical lecture and homework elements of the course are reversed
	LMS	Manage course communications and content
	Discussion Boards	Promote social presence, interaction, reflection, discourse for a shared sense of belonging and shared identity
	Email	Support private messaging for prompt responses
	Blogs & Microblogs	Encourage reflection, self-expression, dissemination of ideas, and building professional learning networks
	Web Conferencing	Support synchronous communications, brainstorming, reaching consensus and decision making
	Networked Mobile Devices	Facilitate participation and collaborative work among peers in large classroom settings
Collaborating	Online collaborative workspaces	Engage students into a collaborative learning environment, facilitates feedback, tracking changes for group contributions, provides transparency
	Wikis	Support iterative writing process and collaborative contribution
Creating	Games / Gamification	Engage and motivate students; support critical thinking, creative problem-solving and team work; sponsors iterative design processes
	Virtual Worlds	Support distance education delivery and simulations; team work in virtual communities; foster discovery, creativity, decision making, interaction, self-reliance, self-direction, and personalized learning

Learning technologies and research informed, signature pedagogies and authentic assessment practices can and should be combined to create outstanding learning experiences in contemporary higher education. A variety of factors can influence (enable or inhibit) the adoption of emerging practices and innovations in higher education, such as leadership, faculty and staff capacity, institutional characteristics and technological infrastructures (Buabeng-Andoh, 2012; Buchanan, Sainter & Saunders, 2013). One challenge for higher education leadership is to draw upon the extensive research base and to evaluate the internal landscape to identify and address the diverse range of factors that can and do influence the adoption of learning technologies in the development of strategic frameworks for high quality learning experiences that are enhanced and enabled by technology. The next section discusses some of the implications of this review of promising practices for higher education teaching and learning with learning technologies.

Section Three:
Implications for Higher Education

In the first section of this review, several changes that impact higher education learning environments were reviewed along with the inherent challenges of changed approaches to designing learning in technology-enhanced, contemporary learning environments. In the second section, a selective review of promising learning technologies and practices for connecting, communicating, collaborating and collectively creating knowledge were presented. Overall, this review of learning technologies research has illustrated a range of promising practices that are transforming learning experiences and learning environments in higher education. The research is clear that learning technologies can redefine the role of educators in the design, delivery and evaluation of technology enhanced learning experiences on campus.

Learning technologies can and do impact teaching and learning in higher education and "leaders and administrators are faced with the task of redefining the role of academy in a world of constant change and hyperconnectivity" (Siemens & Tittengerger, 2009, p. 53). Learning is becoming less dependent on closed classroom spaces; diverse options for designing and providing open technology enabled learning environments include hybrid learning, online learning, and collaborative models (Johnson et al., 2013). Learning environments are considered a global campus with self-service on demand opportunities for learning (Contact North, 2012). Learning is less teacher-centred and more learner-centred (Dunlap & Lowenthal, 2011).

A key challenge is to address the ongoing need for faculty development both for contemporary approaches to teaching using signature pedagogies and for incorporating or implementing learning technologies using research-informed learning and teaching designs. One study provides insight into addressing this challenge via collaborative course design. Faculty also benefit from using technology for collaborative curriculum development, course design and delivery (Brown et al., 2013; Comrie, 2011). Brown et al. (2013) provide three recommendations for instructors, instructional designers and faculty administration:

1. Establish collaborative instructional design teams to develop high quality online learning experiences and to provide continuous professional learning and growth for faculty and instructors;
2. Leverage current digital technologies and resources to facilitate instructor and student collaboration, communication and community building; and
3. Support and extend instructor-to-instructor communications beyond the design phase into the course delivery and online teaching phase, and post-course evaluation phase, to benefit from the mutual support provided when dealing with emerging course issues and outcomes.

Simply stated, higher education institutions are challenged to rethink how to provide outstanding learning experiences for student and faculty success and must consider how technology-enhanced learning environments can support both quality teaching and engaged learning across disciplines. There is a need to develop frameworks and a critical evaluation of the technologies for teaching and learning in open environments ranging from face-to-face models to complete online courses. It is evident there is a shift occurring from traditionally-closed environments for learning to open learning environments fostering the possibilities for connecting, communicating, collaborating and collectively creating knowledge. It is also important to consider the nested contexts that influence the four Cs (Figure 4).

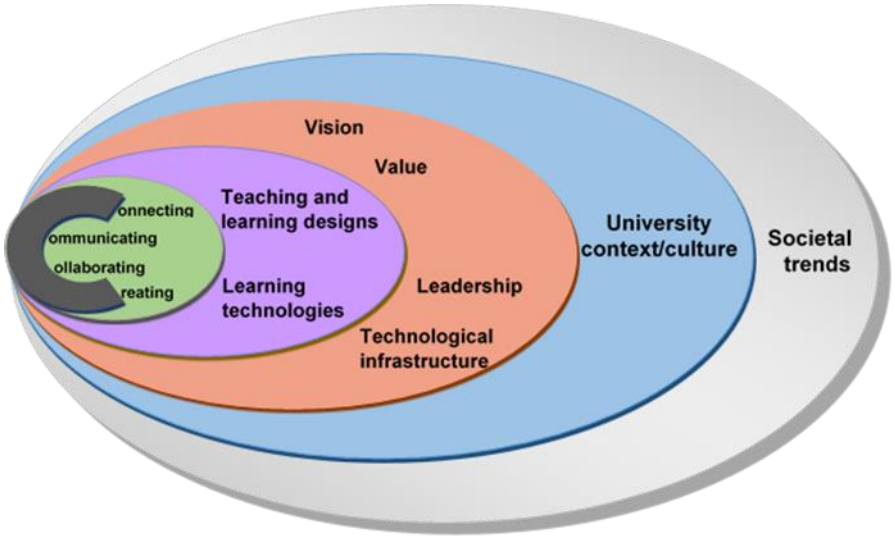

Figure 4. Contexts influencing the four Cs

More specifically, as illustrated in Figure 4, connecting, communicating, collaborating and collectively creating knowledge are influenced by and nested within research-informed teaching and learning designs that are supported by robust, reliable and supported technological infrastructure. High quality teaching and learning with technology is influenced / enabled by and nested within strong leadership, a shared vision for the use of learning technologies, and value for innovative learning designs on campus. The university context and culture continues to be influenced by and nested within changing societal trends.

To realize the benefits of diffusing promising learning designs in higher education, the influences and nested contexts need to be considered from developing a clear vision for quality learning with technology, to providing continuous leadership and faculty professional development, to developing a robust and reliable technological infrastructure along with ready IT support, and by cultivating engaged leadership at all levels of the academy, as well as promoting innovation and advancing new forms of authoring and assessment, changing status quo processes for faculty merit and promotion, and providing support for new models of flexible learning, to name a few. Furthermore, several essential conditions for effectively using learning technologies in higher education started to emerge from the literature, including the following:

- 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 et al., 2009; Mang & Wardly, 2012) and hardware/software requirements
- Technologies for learning need to be integral components purposefully incorporated in the course with clear objectives and across different course delivery modalities (Inman et al., 2010; Lin et al., 2013; Kerawalla et al., 2009; Mang & Wardly, 2012; Pegrum, et al., 2013)
- Instructional designs need to 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 and support with techniques/benefits/scaffolded experiences with learning technologies (Inman et al., 2010; Lin et al., 2013; Kerawalla et al., 2009; Mang & Wardly, 2012)

Additional essential conditions and insights and expertise from additional authors can and should extend this list. Clearly, there are implications for higher education institutions and faculty in establishing successful and sustainable frameworks for technology-enhanced learning environments in competition with traditional models.

Many young people are empowered by creating and curating original content and publishing information on wikis, blogs, and social media sites (Brenner, 2013). This review also demonstrates a growing number of professors who actively use and examine the role of learning technology for facilitating learning across various disciplines of study (Kay & Kletskin, 2012; Mang & Wardley, 2012; Inman et al., 2010; Siemens & Tittenberger, 2009; Veletsianos, 2012). There are learners and teachers in higher education who enact and study learning with mobile devices, social networks, and gaming systems (Jacobsen & Friesen, 2011; Law, 2011; Louis, 2013). While there is innovative use of learning technologies in higher education, it is still not widespread and both learners and teachers need support in using contemporary technologies for active learning and knowledge building across the disciplines of study. The emphasis for learning technologies on campus needs to be on new approaches to connecting, communicating, collaborating and creating using research informed and research active contemporary pedagogies

and participatory learning designs. When learners come to campus, they both expect and need engaged teachers who can help them to leverage promising and emerging learning technologies as resources for active learning and knowledge creation in contemporary learning environments.

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