PREPARING FOR THE DIGITAL UNIVERSITY:

a review of the history and current state of distance, blended, and online learning

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INTRODUCTION

In the field of educational technology 2012 was touted as the year of the Massive Open Online Course (MOOC). While the number of MOOC offerings have since rapidly increased, the research in this space has been lagging. To help facilitate the development of research and examine the potential of MOOCs in education the Bill and Melinda Gates Foundation supported the Massive Open Online Course (MOOC) Research Initiative (MRI). Athabasca University, long a pioneer in distance education, was selected as the principal investigator for the grant.

The MOOC conversation was largely occurring in the popular media and was focused on the technologies and the large numbers of learners enrolling. The sheer scale of numbers of students led to bold proclamations of education disruption and a sector on the verge of systemic change. However, from the perspective of 2015, these statements appear increasingly erroneous as MOOCs have proven to be simply an additional learning opportunity instead of a direct challenge to higher education itself. Many of the issues confronting early MOOC development and offerings could have been reduced if greater consideration was given to research literature in learning sciences and technology enabled learning. This report is the final component of the MRI grant. Additional work in the MRI Grant includes research reports[1], conference[2], and a special issue of the International Review of Research in Open and Distributed Learning[3].

The articles presented in this report provide an overview of research literature in:

- *Distance education*
- *Blended learning*
- *Online learning*
- *Credentialing*
- *MOOC research*
- *Future learning technology infrastructures*

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1 http://www.moocresearch.com/reports

2 http://www.moocresearch.com/mooc-conference/program

3 http://www.irrodl.org/index.php/irrodl/issue/view/64

It is our intent that these reports will serve to introduce academics, administrators, and students to the rich history of technology in education with a particular emphasis of the importance of the human factors: social interaction, well-designed learning experiences, participatory pedagogy, supportive teaching presence, and effective techniques for using technology to support learning.

The world is digitizing and higher education is not immune to this transition. The trend is well underway and seems to be accelerating as top universities create departments and senior leadership positions to explore processes of innovation within the academy. It is our somewhat axiomatic assessment that in order to understand how we should design and develop learning for the future, we need to first take a look at what we already know. Any scientific enterprise that runs forward on only new technology, ignoring the landscape of existing knowledge, will be sub-optimal and likely fail. To build a strong future of digital learning in the academy, we must first take stock of what we know and what has been well researched.

During the process of completing this report, it became clear to us that a society or academic organization is required to facilitate the advancement and adoption of digital learning research. Important areas in need of exploration include faculty development, organizational change, innovative practices and new institutional models, effectiveness of teaching and learning activities, the student experience, increasing success for all students, and state and provincial policies, strategies, and funding models. To address this need, we invite interested academics, administrators, government and industry to contact us to discuss the formation of an organization to advocate for a collaborative and research informed approach to digital learning.

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THE HISTORY AND STATE OF DISTANCE EDUCATION

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ABSTRACT

This report is one of a series of reports describing the historical developments and current state of distance education, online learning, and blended learning. With the intent of informing future research and practice in the emerging discipline of *digital learning*, this tertiary study focuses on the history and state of distance education, and the understanding of the large body of empirical research as captured by secondary studies (i.e., meta-analyses and systematic literature reviews). We conducted an automated search for secondary studies in several online digital libraries, and a manual search through Google Scholar and the ten most relevant academic journals. Our search identified 339 secondary studies in the domains of distance education, online learning, and blended learning. Of those, 37 secondary studies on distance education research and practice met the selection criteria for final inclusion in our study. Based on the analysis of these secondary sources, three main themes emerged: i) comparison of distance education and traditional classroom instruction, ii) identification of important factors of distance education delivery, and iii) factors of institutional adoption of distance education. Our results indicate that distance education, when properly planned, designed, and supported by the appropriate mix of technology and pedagogy, is equivalent to, or in certain scenarios more effective than, traditional face-to-face classroom instruction. This highlights the importance of instructional design and the active role of institutions play in providing support structures for instructors and learners. The implications for future research and practice are discussed.

INTRODUCTION

Although the scope and definition of distance education are ever changing, the major premise remains the same: students and teachers are separated by space, time, or both for the majority or the complete duration of teaching and learning (Moore & Kearsley, 2004). The origins of distance education date back to the mid-19th century (Holmberg, 2005); however, the global shift towards knowledge-based work — ongoing for the last fifty years — has made distance education highly relevant today (Hanna, 2003). The rapid flow of information, the fast decay of knowledge, and the pace of modern societies have placed high demands on today's workers for continuous learning and the enhancement of their own knowledge (Toffler, 1991).

The definition and scope of distance education also changed as new forms of educational technology developed (Moore, Dickson-Deane, & Galyen, 2011). Among many definitions of distance education, one of the more popular and widely used is given by Moore and Kearsley (2004) as "teaching and planned learning in which teaching normally occurs in a different place from learning, requiring communication through technologies as well as special institutional organization" (p. 2). Given this inherent need to transcend physical distance between students and instructors, distance education has always been highly dependent on the current state of technological development (Anderson & Dron, 2010). The biggest shift came with the development of digital computing technology, the Internet, and the World Wide Web, which had an all-encompassing impact on the domain of education. The introduction of various educational software systems dramatically changed the entire process of educational delivery for both distance and on-campus modes of instruction. This trend is likely to continue into the future. According to a recent report (Allen & Seaman, 2011) published by the Sloan Consortium, 6.1 million students took at least one online course in the fall 2010 term, an increase of 10% from the fall 2009 term — far bigger than the 1% increase in the same period for higher education overall. Finally, the recent development of Massive Open Online Courses (MOOCs) has further stressed the need for lifelong, personalized, flexible education (Kovanović, Joksimović, Gašević, Siemens, & Hatala, 2014).

Novel educational software systems, such as Learning Management Systems (LMSs) have not only influenced the practices of distance education. These software have also altered the way traditional universities provide on-campus learning, as well as enabling a mix between the two, which is typically known as *blended learning* (Lust, Juarez Collazo, Elen, & Clarebout, 2012). The introduction of digital technology has also brought a plethora of different terms and abbreviations, such as online learning, web-based learning, blended learning, e-learning, learning management systems (LMS), computer-aided instruction (CAI), computer-supported instruction (CSI), technology-enhanced learning (TEL), Internet-based training (IBT), and virtual learning environments (VLE), which to a large extent all fall under a broad definition of distance education (Moore & Kearsley, 2004). The most recent addition to this group of terms is MOOC (Daniel, 2014; Siemens, 2012). While there is certainly a need for more accurate descriptions of different features of new technology, many of these terms were used without establishing an accepted and authoritative definition and often described several completely different things (Moore et al., 2011).

The ever-growing adoption of educational technology has also sparked debate on the relative importance of instruction and pedagogy versus educational technology and media on the quality of learning. The history of distance education teaches us that the general public will readily assume that the technology alone can transform education (Blin & Munro, 2008). Even today, this position can be seen in reports related to MOOCs and the "disruptive change" of their technologically inspired approach to learning (Kovanović et al., 2014). More than thirty years ago, Clark (1983) expressed his skepticism toward this belief. Clark (1983) argued that different educational technologies and media are "mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition. …the choice of vehicle might influence the cost or extent of distributing instruction, but only the content of the vehicle can influence achievement" (p. 445). Anderson and Dron (2010) express a similar view, recognizing the importance of technology and pedagogy for the success of distance education. According to Anderson and Dron (2010) "the technology sets the beat and creates the music, while the pedagogy defines the moves" (p. 81). What is now needed is a synergetic effect of pedagogies and novel technological approaches.

The purpose of this study

Given the large body of educational research conducted over the past forty years, there is an imperative to collate this accumulated knowledge into a usable form for the development of modern distance education. Distance education has come a long way and can offer useful lessons for the development of the emerging field of digital education. The connection with this previous long-lasting line of research is particularly relevant in light of recent advances in MOOCs. While MOOCs may have been described as a "revolution" of education (Friedman, 2012) they can be considered as a continuation in the long development of distance education (Daniel, 2014). In addition, with many institutions trying to innovate their learning and teaching practices (e.g., flipped classroom, active learning, and clickers), it is important to provide a concise synthesis of the relevant knowledge that can be used to guide these processes of innovation. As such, a first step is to examine what is known from the large body of research in the domains of distance education, online learning, and *blended learning*.

The study presented in this paper provides a systematic overview of relevant meta-analyses and systematic literature reviews in the domain of distance education, while two additional reports cover online and blended learning, respectively. We examined the important dimensions that can be leveraged from a large number of scientifically rigorous reports on the different forms of distance education. More specifically, in this report we focus on the following research questions:

- **RQ1.** *What is the current state of distance education research, as reflected through meta-analyses and systematic reviews?*
- **RQ2.** *What are the key themes in the domain of distance education research?*
- **RQ3.** *Based on available meta-analyses and systematic literature reviews, what is currently known in the field of distance education?*

As most social science studies are not strong enough to provide conclusive evidence, we focused on meta-analyses, which are studies that statistically integrate empirical results of multiple studies on the same topic and thus, provide better characterization of a given phenomena (Glass, 1976; Grant & Booth, 2009; Hedges, 1982). Systematic literature reviews are an important component of educational research (Andrews, 2005; Mulrow, 1994), and include several related types of studies, such as scoping studies, literature mapping and review studies (Rumrill, Fitzgerald, & Merchant, 2010), and rapid reviews and qualitative evidence synthesis studies (Grant & Booth, 2009).

History of Distance Education: From correspondence study to teleconferencing

The origins of modern distance education can be traced back to the early 18th century. In 1728, Bostonian Caleb Phillips, a teacher of a novel shorthand writing method, suggested to the people living outside the city could participate in his learning program by having lessons sent to them each week without diminishing the quality of their instruction (Holmberg, 2005, p. 13). From that period, it is generally considered that distance education has gone through either three (Anderson & Dron, 2010; Bates, 2005; Keegan, 1993) or five generations (Anderson, 2008; Taylor, 2001), depending on whether the focus is on the adopted technology or on the pedagogical approach.

The oldest form of distance education, universally recognized as the first generation, was correspondence study (Anderson, 2008; Bates, 2005; Keegan, 1993; Taylor, 2001). In this form, students received self-directed, paper-based study materials from instructors using the postal service and then, as instructed, returned their written assignments for evaluation, grading, and often written feedback (Holmberg, 2005). The primary drawback of this mode of delivery is that it provided slow, one-to-one communication between instructors and students and did not provide opportunities for interaction among students (Anderson, 2003; Taylor, 2001).

Instead of relying solely on printed media, the next generation of distance education made heavy use of a richer set of media and also enabled simpler and faster delivery of learning materials through broadcasting (Keegan, 1993). Regarding the level of interaction, as with correspondence study, opportunities were still quite limited (Bates, 2005; Garrison, 1985). The broad availability of audio conferencing technology in the mid-1960s, however, enabled distance education with limited student-student interaction (Anderson & Dron, 2010). Unlike audio conferencing, videoconferencing technology was not widely used in practice, primarily due to very high equipment costs (Garrison, 1985). In most cases where video technology was used, only instructors would transmit video to students, while two-way communication was supported only through audio conferencing technology (Garrison, 1985).

In terms of pedagogy, all forms of distance education were characterized by behaviorist and later cognitivist models of learning in which the locus of control is heavily on the teacher and instructional designer (Anderson & Dron, 2010). Students primarily learned individually as the interaction among learners was still limited and not incorporated into learning activities. Those pedagogical models proved very successful and are still in wide use even today, particularly for training purposes in which it is easy to define strict performance criteria (Anderson & Dron, 2010). Given that they are primarily characterized by the purposeful integration of different media and adopt similar pedagogical approaches, some authors (Bates, 2005; Keegan, 1993) consider broadcasting and conferencing to be two forms of the same, second generation of distance education.

Modern Distance Education: Online Learning, Blended Learning, and Beyond

The development of digital computing technology has marked the most significant milestone in the history of distance education (Anderson & Dron, 2010). The use of email, web-based resources, learning management systems, and online discussion boards are some of the primary technologies supporting interactive and flexible forms of distance education (Harasim, 2000). We should emphasize that this is the first form of distance education that truly enabled interaction between students and opened doors to new distance education pedagogies. Novel pedagogical approaches, based on social-constructivist views of learning, were developed (Jonassen, Davidson, Collins, Campbell, & Haag, 1995). Those ideas first pioneered by the likes of Dewey (1897), Piaget (1959), and Vygotsky (1978), view learning as a process of knowledge construction by learners through their social interactions rather than the plain acquisition of facts from instructors (Anderson & Dron, 2010).

Aside from distance education, in more recent times the terms online learning and web-based learning have become more widely used. It is almost universally accepted that they represent special forms of distance education (Clardy, 2009; Harasim, 2000; Mason, 2000; Taylor, 2001) that are the most popular in the 21st century (Anderson, 2009). Another important form of learning that has gained significant research attention is blended learning. This is generally defined as learning that encompasses both traditional classroom and distance delivery (Bonk, Graham, Cross, & Moore, 2005; Spector, Merrill, van Merrienboer, & Driscoll, 2007). It should be noted that mixed-mode learning and hybrid learning are two other terms typically used interchangeably with blended learning (Means, Toyama, Murphy, & Bakia, 2013). Because of the mandatory integration with traditional classroom instruction, blended learning cannot be considered just another form of distance education.

Although it is universally accepted that both types of instruction should be present for learning to be considered blended, there is no clear consensus on their relative percentages. Allen, Seaman, and Garrett (2007), for example, argued that even courses with 30–79% of online instruction should be considered blended. Bernard, Borokhovski, Schmid, Tamim, and Abrami (2014) debated that traditional instruction should represent at least 50% of the course in order to be considered blended. An further view argues that all mixes of online and traditional instruction should be considered blended, even traditional courses that only use LMS for course communication (Bliuc, Goodyear, & Ellis, 2007). In any case, based on this mandatory inclusion of traditional classroom instruction, in this paper we consider blended learning as a special form of learning on its own, that draws from both distance and traditional instruction and provides for their pedagogically sound integration.

METHODOLOGY

Study search method and inclusion criteria

To provide a synthesis of scientifically rigorous knowledge in distance education, we conducted a systematic literature review of published distance education research. Building on the study search method of Means et al. (2013), we searched for published journal articles, conference proceedings, doctoral dissertations, and institutional reports on ERIC[1], PsychINFO[2], PubMed[3], and ProQuest[4] digital libraries. SCOPUS[5] digital library was also included in our search given its comprehensive coverage of many research domains. We also conducted a manual search using Google Scholar[6] for additional reports in our dataset. In terms of the time-span, we did not put any constraint into the search query and considered all studies regardless of their publication date. Similar to Means et al. (2013), we conducted a manual search of all papers published in the following journals: *American Journal of Distance Education, Journal of Distance Education, Distance Education, International Review of Research in Distance and Open Education, Journal of Asynchronous Learning Networks, Journal of Technology and Teacher Education, Career and Technical Education Research, Internet and Higher Education, Journal of Computing in Higher Education*, and *Computers and Education.* We selected these particular journals because in our digital library search these publications contained the highest number of results.

To consider the papers found in the search for inclusion in the study, we examined titles, keywords, and abstracts for the required combination of important domain keywords (i.e., distance education, online learning, web-based learning, blended learning) and important study-type keywords (i.e., meta-analysis, systematic review, tertiary study, scoping study). Figure 1 shows the SCOPUS query used in our search. The actual query syntax depended on the particular search platform, but they all followed the above-mentioned logical structure. We also included several different wordings of our keywords in order to provide more flexible searching criteria.

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1 http://eric.ed.gov

2 http://apa.org/pubs/databases/psycinfo/idex.aspx

3 http://www.ncbi.nim.nih.gov/pubmed

4 http://search.proquest.com

5 http://scopus.com

6 http://scholar.google.com

After the search, three researchers coded the studies for distance education, online learning, or blended learning based on the article title, abstract, and keywords. In cases where a code could not be assigned based on the available information, the full text of the article was consulted. In cases where several publications discussed the same data (e.g., dissertation and journal article) we gave preference to the journal articles, based on the study by Bernard et al. (2014) who found evidence of their superiority in terms of methodological quality over other types of publications. In order to be included in this study, each report had to:

- **i.** *Be published in a peer-reviewed scientific journal, conference paper, doctoral dissertation, or government report,*
- **ii.** *Adopt systematic approach (i.e., systematic literature review or meta-analysis),*
- **iii.** *Focus on distance education,*
- **iv.** *Have a criteria for the inclusion of primary sources, and*
- **v.** *Focus on higher or adult education; studies that focused on K–12 education were included only if they also analyzed higher or adult education.*

Figure 2 illustrates our complete literature search process. The initial search found 306 studies from distance, online, and blended learning. An additional 19 studies were discovered using Google Scholar and 14 more through the manual search of the selected academic journals. In total, we identified 339 unique studies that fit our search criteria. Upon further screening, we were left with 102 studies on distance, online, and blended learning for analysis. Given that this report focuses only on distance education, as a final dataset we included 37 papers that fit our criteria.

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(    TITLE-ABS-KEY("metaanalysis")        OR
     TITLE-ABS-KEY("meta-analysis")       OR
     TITLE-ABS-KEY("meta analysis")       OR
     TITLE-ABS-KEY("metasynthesis")       OR
     TITLE-ABS-KEY("meta synthesis")      OR
     TITLE-ABS-KEY("meta-synthesis")      OR
     TITLE-ABS-KEY("scoping study")       OR
     TITLE-ABS-KEY("systematic review")   OR
     TITLE-ABS-KEY("tertiary study")
) AND (
     TITLE-ABS-KEY("distance learning")   OR
     TITLE-ABS-KEY("distance education")  OR
     TITLE-ABS-KEY("blended education")   OR
     TITLE-ABS-KEY("blended learning")    OR
     TITLE-ABS-KEY("hybrid education")    OR
     TITLE-ABS-KEY("hybrid learning")     OR
     TITLE-ABS-KEY("e-learning")          OR
     TITLE-ABS-KEY("online learning")     OR
     TITLE-ABS-KEY("online education")    OR
     TITLE-ABS-KEY("web-based learning")  OR
     TITLE-ABS-KEY("web-based education") OR
     TITLE-ABS-KEY("web based learning")  OR
     TITLE-ABS-KEY("web based education")
)
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FIGURE 1 Example of SCOPUS search query

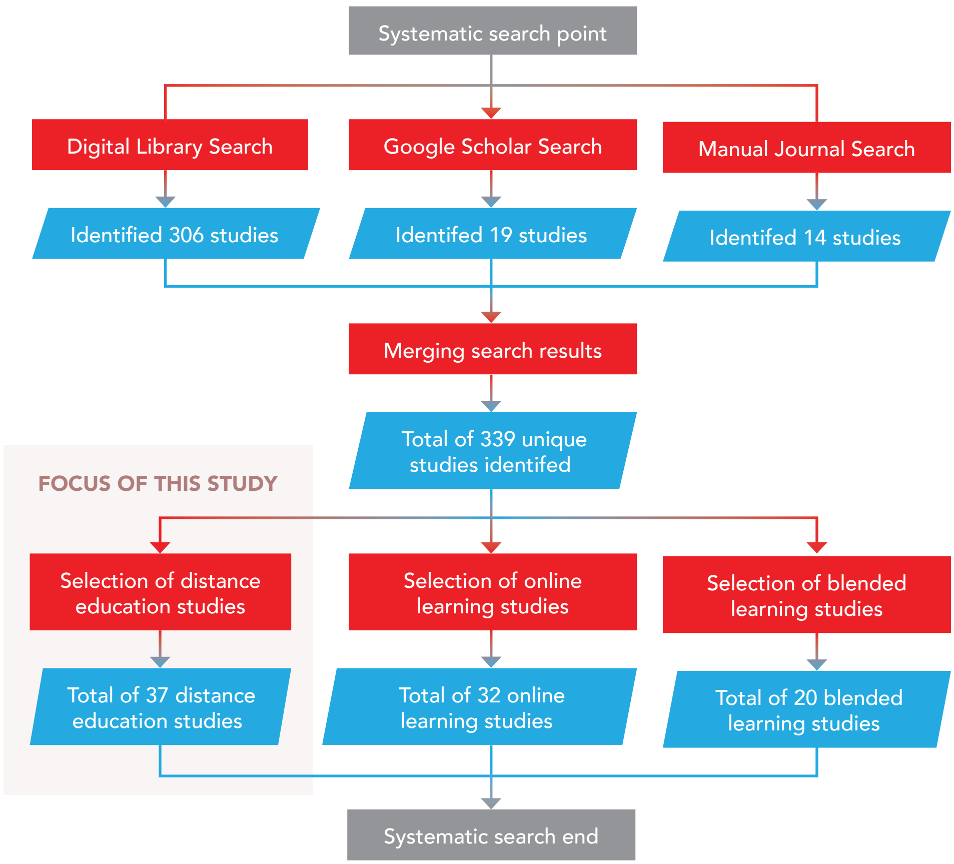


FIGURE 2 Systematic literature search process

OVERVIEW OF DISTANCE EDUCATION STUDIES

An overview of the sources included in the present study is outlined in Figure 3. A complete list of all reports is presented in Table 1. Overall, 37 studies were included comprising 12 meta-analyses and 25 systematic literature reviews. Journal articles were the most represented, with 30 journal publications and only five conference papers and two dissertations (Figure 3). In terms of the number of primary sources, most of the studies were of moderate size, covering between 11 and 50 primary sources (Figure 4). The largest six studies, covering more than 300 sources, were exclusively literature reviews, which is expected given the highly complex statistical calculations involved in conducting meta-analyses and high expectations for the quality of the reported results in the studies (Hedges, 1982).

Regarding the coverage of different levels of education (Figure 5), most of the studies did not focus on any particular level of education, but rather analyzed all the available studies. Focus on higher education, or a combination of higher and adult education, was more common for meta-analyses. What is interesting is that explicit focus on adult learning was only seen in systematic literature reviews, as none of the meta-analyses focused explicitly on this educational segment (Figure 5).

All 37 studies were published between 1998 and 2014, with the largest number of meta-studies (i.e., four meta-studies) published in 2004 (Figure 6). The highest number of systematic literature reviews was published in 2010 (i.e., five studies). The number of published studies seems to be decreasing from 2004 onwards, while the publication of systematic literature reviews seems to be increasing. Recently, systematic literature reviews — probably due to their more qualitative nature — seem to be the preferred way of interpreting existing knowledge in the domain of distance education. Still, those numbers need to be put into perspective of changing terminology, with a large number of studies published in online and web-based learning, which are covered in two separate reports.

As expected, the largest second-order studies, in terms of the number of included primary sources, were almost exclusively described in journal publications (Figure 7). Likewise, the largest second-order studies tend to cover all levels of education, or focus primarily on the higher education domain (Figure 8). The studies focusing on adult learning tended to have fewer than 50 primary sources, likely due to the much smaller number of studies related to this particular form of learning.

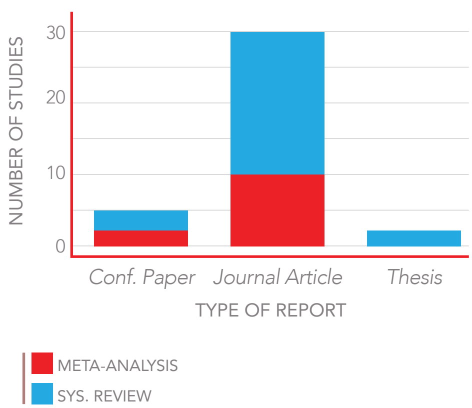


FIGURE 3 Number of meta-analyses and systematic literature reviews published as different types of publications

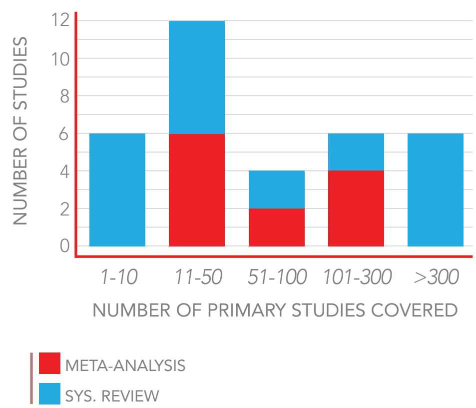
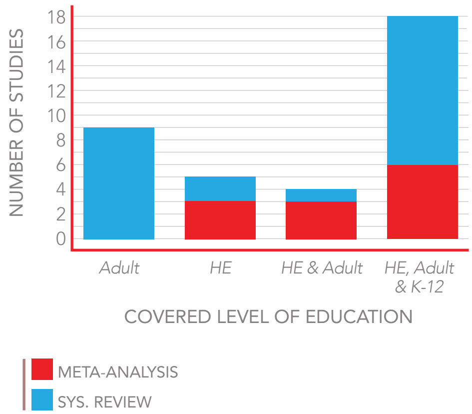


FIGURE 4 Number of meta-analyses and systematic literature reviews covering a given number of primary sources



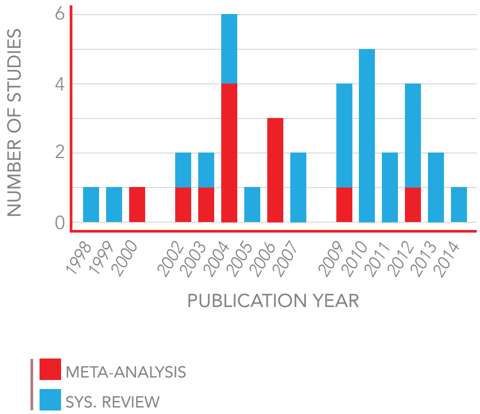
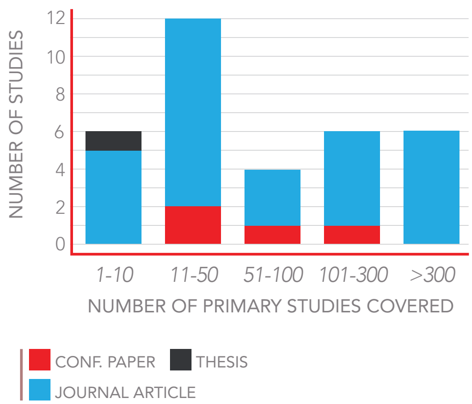


FIGURE 5 Number of meta-analyses and systematic literature reviews covering different levels of education

FIGURE 6 Number of meta-analyses and systematic literature reviews published in different years



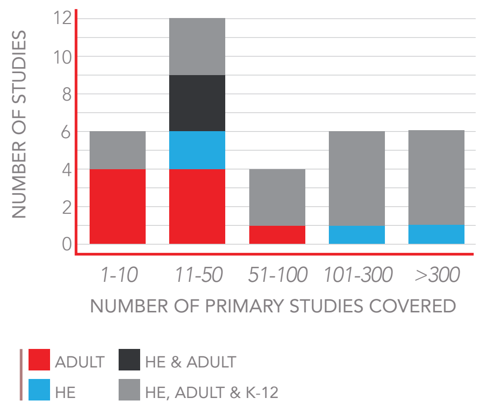


FIGURE 7 Coverage of primary sources by different types of reports

FIGURE 8 Coverage of primary sources about different education levels

TABLE 1 Primary sources included in the study

	Report Title	Report Type	Studies	Years	Level
1	Allen et al. (2002). Comparing student satisfaction with distance education to traditional classrooms in higher education: A meta-analysis. *American Journal of Distance Education, 16*(2), 83–97.	Meta-Analysis Journal	24	1989–1999	HE
2	Allen et al. (2004). Evaluating the effectiveness of distance learning: A comparison using meta-analysis. *Journal of Communication, 54*(3), 402–420.	Meta-Analysis Journal	39	Up to 2003	All
3	Bernard et al. (2004). A methodological morass? How we can improve quantitative research in distance education. *Distance Education, 25*(2), 175–198.	Meta-Analysis Journal	232	1985–2002	All
4	Bernard et al. (2009) A meta-analysis of three types of interaction treatments in distance education. Review of Educational Research, 79(3),1243–1289.	Meta-Analysis Journal	74	1985–2006	All
5	Bernard et al. (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research, 74*(3), 379–439.	Meta-Analysis Journal	232	1985–2002	All

TABLE 1 (Cont.) Primary sources included in the study

	Report Title	Report Type	Studies	Years	Level
6	Bernard et al. (2004). The effects of synchronous and asynchronous distance education: A meta-analytical assessment of Simonson's "equivalency theory." *2004 Annual proceedings of selected research and development papers presented at the national convention of the Association for Educational Communications and Technology.*	Meta-Analysis Conference	232	1985–2002	All
7	Borokhovski et al. (2012). Are contextual and designed student-student interaction treatments equally effective in distance education? *Distance Education, 33*(3), 311–329.	Meta-Analysis Journal	32	1985–2006	HE
8	Lou et al. (2006). Media and pedagogy in undergraduate distance education: A theory-based meta-analysis of empirical literature. *Educational Technology Research and Development, 54*(2), 141–176.	Meta-Analysis Journal	103	1985–2002	HE
9	Machtmes & Asher (2000). A meta-analysis of the effectiveness of telecourses in distance education. *American Journal of Distance Education, 14*(1), 27–46.	Meta-Analysis Journal	19	1943–1997	HE, Adult
10	Shachar & Neumann (2003). Differences between traditional and distance education academic performances: A meta-analytic approach. *The International Review of Research in Open and Distance Learning, 4*(2).	Meta-Analysis Journal	86	1990–2002	All

TABLE 1 (Cont.) Primary sources included in the study

	Report Title	Report Type	Studies	Years	Level
11	Storrings (2006). Attrition in distance education: A meta-analysis. *Annual Proceedings of Selected Research and Development Papers Presented at the National Convention of the Association for Educational Communications and Technology.*	Meta-Analysis Conference	30	1984–2004	HE, Adult
12	Williams (2006). The effectiveness of distance education in allied health science programs: A meta-analysis of outcomes. American Journal of *Distance Education, 20*(3), 127–141.	Meta-Analysis Journal	25	1990–2003	HE, Adult
13	Booth et al. (2009). Applying findings from a systematic review of workplace-based e-learning: Implications for health information professionals. *Health Information & Libraries Journal, 26*(1), 4–21.	Sys. Lit. Rev. Journal	29	1992–2009	Adult
14	Borokhovski et al. (2011). An extended systematic review of Canadian policy documents on e-learning: What we're doing and not doing. *Canadian Journal of Learning and Technology, 37*(3).	Sys. Lit. Rev. Journal	138	2000–2010	All
15	Childs et al. (2005). Effective e-learning for health professionals and students: Barriers and their solutions. A systematic review of the literature: Findings from the HeXL project. *Health Information & LibrariesJournal, 22*, 20–32.	Sys. Lit. Rev. Journal	57	1997–2004	Adult

TABLE 1 (Cont.) Primary sources included in the study

	Report Title	Report Type	Studies	Years	Level
16	Chipps et al. (2012). Videoconference-based education for psychiatry registrars at the University of KwaZulu-Natal, South Africa. *African Journal of Psychiatry, 15*(4).	Sys. Lit. Rev. Journal	7	1998–2009	Adult
17	Chipps et al. (2012). A systematic review of the effectiveness of videoconference-based tele-education for medical and nursing education. *Worldviews on Evidence-Based Nursing, 9*(2), 78–87.	Sys. Lit. Rev. Journal	5	1990–2011	Adult
18	De Freitas (2007). Post-16 e-learning content production: A synthesis of the literature. *British Journal of Educational Technology, 38*(2), 349–364.	Sys. Lit. Rev. Journal	NR	Up to 2006	HE, Adult
19	Hauser (2013). Qualitative research in distance education: An analysis of journal literature 2005–2012. *American Journal of Distance Education,27*(3), 155–164.	Sys. Lit. Rev. Journal	382	2005–2012	All
20	Hrastinski & Keller (2007). Computer-mediated communication ineducation: A review of recent research. *Educational Media International,44*(1), 61–77.	Sys. Lit. Rev. Journal	117	2000–2004	All
21	Lee & McElroy (2012). Telepractice is a new method for providing services to children with *Autism Spectrum Disorder (ASD): This scoping review summarizes existing research and identifies research gaps. Evidence-Based Communication Assessment and Intervention, 6(4), 177–180.*	Sys. Lit. Rev. Journal	9	Up to 2011	Adult

TABLE 1: (Cont.) Primary sources included in the study

	Report Title	Report Type	Studies	Years	Level
22	Lee et al. (2004). The past, present, and future of research in distance education: Results of a content analysis. *American Journal of Distance Education, 18(4), 225–241.*	Sys. Lit. Rev. Journal	383	1997–2002	All
23	Ludlow & Brannan (1999). Distance education programs preparing personnel for rural areas: Current practices, emerging trends, and future directions. *Rural Special Education Quarterly, 18(3), 4–15.*	Sys. Lit. Rev. Journal	32	1985–1999	Adult
24	Mehlenbacher et al. (2010). Reviewing the research on distance education and e-learning. *Proceedings of the 28th ACM International Conference on Design of Communication*, 237–242.	Sys. Lit. Rev. Conference	NR	Up to 2009	All
25	Neto & Santos (2010). Analysis of the methods and research topics in a sample of the Brazilian distance education publications, 1992 to 2007. *American Journal of Distance Education, 24*(3), 119–134.	Sys. Lit. Rev. Journal	983	1987–2007	All
26	Ritzhaupt et al. (2010). An investigation of distance education in North American research literature using co-word analysis. *The International Review of Research in Open and Distance Learning, 11*(1), 37–60.	Sys. Lit. Rev. Journal	517	1987–2005	All

TABLE 1 (Cont.) Primary sources included in the study

	Report Title	Report Type	Studies	Years	Level
27	Simpson (2003). Distance delivery of pre-service teacher education: Lessons for good practice from twenty-one international programs. Doctoral Dissertation.	Sys. Lit. Rev. Thesis	NR	Up to 2003	HE
28	Singh & Hardaker (2014). Barriers and enablers to adoption and diffusion of eLearning. *Education + Training, 56*(2/3), 105–121.	Sys. Lit. Rev. Journal	340	2001–2013	HE
29	Stall-Meadows (1998). Grounded meta-analysis of qualitative case study dissertations in distance education pedagogy. Doctoral Dissertation.	Sys. Lit. Rev. Thesis	4	NR	All
30	Stewart (2010). What's missing? The next step towards universal distance education. *Proceedings of 26th Annual Conference on Distance Teaching & Learning.*	Sys. Lit. Rev. Conference	59	2004–2009	All
31	Tomlinson et al. (2013). How does tele-learning compare with other forms of education delivery? A systematic review of tele-learning educational outcomes for health professionals. *New South Wales Public Health Bulletin, 24*(2), 70–75.	Sys. Lit. Rev. Journal	13	2000–2012	Adult
32	Tuquero (2011). A meta-ethnographic synthesis of support services in distance learning programs. *Journal of Information Technology Education,* 10.	Sys. Lit. Rev. Journal	5	2000–2008	Adult

TABLE 1 (Cont.) Primary sources included in the study

	Report Title	Report Type	Studies	Years	Level
33	Uzuner (2009). Questions of culture in distance learning: A research review. *The International Review of Research in Open and Distance Learning, 10*(3).	Sys. Lit. Rev. Journal	27	Up to 2008	All
34	Waight et al. (2002). Recurrent themes in e-learning: A meta-analysis of major e-learning reports. *Proceedings AHRD 2002 Conference.*	Sys. Lit. Rev. Conference	15	1999–2001	All
35	Wang & Lockee (2010). Virtual worlds in distance education: A content analysis study. *Quarterly Review of Distance Education, 11*(3), 183–186.	Sys. Lit. Rev. Journal	4	2003–2009	All
36	Wutoh et al. (2004). eLearning: A review of Internet-based continuing medical education. *Journal of Continuing Education in the Health Professions, 24*(1), 20–30.	Sys. Lit. Rev. Journal	16	1966–2003	Adult
37	Zawacki-Richter et al. (2009). Review of distance education research (2000 to 2008): Analysis of research areas, methods, and authorship patterns. *The International Review of Research in Open and Distance Learning, 10*(6), 21–50.	Sys. Lit. Rev. Journal	695	2000–2008	All

STATE OF DISTANCE EDUCATION LITERATURE

From the published second-order studies in the domain of distance education, we were able to identify several themes that describe the focus of distance education research. The topics of systematic literature reviews include the following: i) topic analysis of published literature, ii) state of distance education research methods, iii) effectiveness of distance education, and iv) success factors for distance education. Several studies covered more than one of these topics or focused on a specific context in which they are investigated in more detail.

We identified four main topics captured by the meta-analyses included in our study: i) comparison of distance education and traditional face-to-face education, ii) comparison of different modes of distance education delivery, iii) success factors of distance education, and iv) methodological quality of published distance education literature. In the following sections, we report on the most important findings from our systematic review.

Topic analysis of published literature

A number of systematic reviews analyzed significant themes that emerged in the published distance education literature. The most general analysis was done by Lee, Driscoll, and Nelson (2004) who categorized each study using a predefined list of six important topic categories: i) design-related, ii) development-related, iii) management-related, iv) evaluation-related, v) institutional- and operational-related, and vi) theory- and research-related topics. What Lee et al. (2004) found is that studies in distance education focus primarily on two of those topic categories: i) design-related topics, such as course development, organization, and instructional strategy (27% of all publications), and ii) theory and research related topics, such as literature review papers, theory building studies, and research methods (30% of all publications). Similar findings are given by Ritzhaupt, Stewart, Smith, and Barron (2010) who found that the pre-web era was mostly focused on theory development to provide a basis for further pragmatic research efforts. Also, a more recent analysis of almost 700 papers published between 2000 and 2008 by Zawacki-Richter, Baecker, and Vogt (2009) identified a focus on the study of teaching and learning topics, such as learner characteristics, instructional design, interaction, and communication.

In the more concrete domain of workplace learning, Booth, Carroll, Papaioannou, Sutton, and Wong (2009) analyzed 29 studies and identified five emerging topics: i) flexibility, ii) peer communication, iii) support, iv) knowledge validation, and v) course presentation and design. The need for flexibility — although a constant theme in distance education — is increasingly manifested in many different forms, such as a flexible pace of learning, flexible trajectories through course content, and adaptation for the particular context and needs of individual learners (Booth et al., 2009). This need for a flexible pace of learning is closely related to the need for asynchronous peer communication and collaboration, a direct contradiction to the shared learning experience (Booth et al., 2009). Support — either institutional support, peer support, or instructional support — is identified as one of the prerequisites for a successful educational experience. Institutional support also plays an important role in assuring knowledge validation through various means of assessment focused on the particular needs of learners (Booth et al., 2009).

Given that distance education makes use of various technologies and media that enable different modes and levels of interaction, it is important to examine which media and technologies were more investigated by the distance education research community. Looking at 117 studies between 2000 and 2004, Hrastinski and Keller (2007) found the primary focus was on the analysis of asynchronous discussions, while mixed and fully synchronous modes of interaction received much less attention. Also, with respect to three types of interaction (i.e., student-student, student-content, and student-instructor) by Moore (1989), the primary focus was on student-student interaction while other forms received less attention. This particular period (2000–2004) was characterized by the wider adoption of learning management systems and the Hrastinski and Keller (2007) study confirmed the focus on adoption of learning management systems, rather than their development. This also resulted in an extensive investigation of their use in traditional classroom settings and a higher focus on blended rather than distance modes of delivery (Hrastinski & Keller, 2007). These findings are also consistent with those of Ritzhaupt et al. (2010) who, through the analysis of 517 studies published between 1987 and 2005, identified decreasing interest in teleconferencing and a move towards computer-based distance education. Over time, interaction became the central point of investigation, with its scope shifting from instruction to collaboration (Ritzhaupt et al., 2010).

In addition to the thematic analysis of the research literature, Waight, Willging, and Wentling (2002) and Borokhovski et al. (2011) conducted interesting thematic analyses of published government and business reports. In their study of Canadian provincial government reports, Borokhovski et al. (2011) found that the most commonly discussed topic related to the benefits of distance education technology, followed by the support for implementation, and the importance of coordinating efforts in implementing distance education in practice. Similar findings are given by Waight et al. (2002), who also identified the benefits of technology as the main topic of published government, business, and association reports.

Effectiveness of distance education: Comparison with traditional classroom instruction

With the broader acceptance of distance education, the educational research community raised questions about its effectiveness and how it compares to traditional classroom instruction. A large number of empirical studies were conducted in order to provide evidence on these important questions, together with a substantial number of systematic reviews and meta-analyses that tried to aggregate this large body of empirical evidence.

Based on the results of the meta-analyses included in this review, it can be concluded that *distance education is more effective, or at least as effective as traditional classroom instruction.* The meta-analysis by Machtmes and Asher (2000) analyzed 19 true or quasi-experimental studies where a total of 1,426 students showed a non-significant difference in terms of academic performance. Similarly, the meta-analysis by Bernard et al. (2004) looked at 232 studies with more than 57,000 students and found no difference in effect size for student academic performance. Looking at 103 studies of undergraduate distance education, representing 25,320 students, Lou, Bernard, and Abrami (2006) also found similar academic performance, with a non-significant difference in effect sizes. However, results from several meta-analyses give a slight advantage to distance education. The study by Shachar and Neumann (2003) looked at 86 studies with more than 15,000 students and found an overall moderate effect size of Cohen's $d = 0.366$ (Cohen, 1988). The meta-analysis of 39 primary sources with a total of 71,731 students conducted by Allen et al. (2004) also found an average effect size (average $r = 0.048$) favoring distance education in terms of student course grades. Finally, in the context of health education, the meta-analysis by Williams (2006) looked at 25 experimental studies with a total of 2,702 students and found a small overall effect size of Cohen's $d = 0.15$, favoring distance education as a mode of delivery.

The potential of distance education has been acknowledged by Ludlow and Brannan (1999) for training special education and services professionals in rural areas. Similarly, based on the analysis of high quality studies of videoconferencing, tele-learning, and tele-practice use, several studies (Chipps, Ramlall, & Mars, 2012; Chipps, Brysiewicz, & Mars, 2012; Tomlinson et al., 2013) indicated comparable results for distance-education programs and traditional face-to-face programs. The study by Chipps, Ramlall, and Mars (2012) looked at the effectiveness of videoconferencing for doctors and nurses education, based on the analysis of five randomized control trials. They concluded that there is enough evidence to provide moderate evidence-based support for the use of videoconferencing in distance education. Similar findings are reported by Tomlinson et al. (2013) who found — based on the analysis of 13 studies — that tele-learning achieves comparable results to those of traditional face-to-face instruction. In a similar manner, Chipps, Brysiewicz, and Mars (2012) conducted a systematic review of seven published studies on the use of videoconferencing for psychiatric education in Africa. The results of that review show support for videoconferencing for psychiatric education, although they point out that for many educational programs in the developing world, videoconferencing is still out of reach. The systematic review by Wutoh, Boren, and Balas (2004) of 16 primary sources also reported comparable results for Internet-based distance education programs and traditional face-to-face instructional modes. Finally, the systematic review by Lee and McElroy (2012), based on the review of six experimental and two non-experimental studies, concluded that teleconferencing is a promising direction for teaching doctors who work with special-needs children.

While the above mentioned studies showed similar levels of effectiveness, it should be noted that slightly higher satisfaction with traditional modes of instruction is observed. This was reported in the systematic reviews by Chipps, Brysiewicz, and Mars (2012) and Tomlinson et al. (2013) along with the meta-analysis by Allen, Bourhis, Burrell, and Mabry (2002). Based on the meta-analysis of 24 studies with a total of 4,702 students, Allen et al. (2002) found slightly higher student satisfaction with traditional mode of delivery over distance learning (average $r = 0.031$ after the deletion of outliers). Similar results are reported in the meta-analysis by Bernard, Abrami, Wade, Borokhovski, and Lou (2004) who found higher satisfaction with classroom instruction (Hedges' $g = -0.185$ over 83 studies) over synchronous mode of distance education delivery. The difference between asynchronous mode of distance education delivery and traditional classroom instruction was non-significant (Hedges' $g = -0.003$ over 71 studies).

Institutional adoption of distance education

The fourth important set of systematic reviews and meta-analyses focused on institutional adoption of distance education and the various aspects that contribute to or impede its success. Several general, macro-level factors were found to be important for successful adoption of distance education, together with several individual, micro-level factors (Singh & Hardaker, 2014).

Among different macro-level factors, technology infrastructure is seen as an important prerequisite for the adoption of distance education (Childs, Blenkinsopp, Hall, & Walton, 2005; Singh & Hardaker, 2014). The *role of academic management* is essential, as the introduction of new technology requires institutional innovation and change (Childs et al., 2005; Simpson, 2003; Stewart, 2010) and the provision of sufficient resources for program implementation (Childs et al., 2005; Singh & Hardaker, 2014). The coordination and collaboration of different parties involved in the implementation of distance education programs is often necessary (Ludlow & Brannan, 1999; Simpson, 2003). Finally, *support for academic staff* is recognized as having important effects on the adoption of distance education (Childs et al., 2005; Singh & Hardaker, 2014), especially related to the technological aspects of course implementation.

It is equally important to understand different personal and individual factors that affect success in distance education. As Singh and Hardaker (2014) point out, current practices are tailored to more technologically literate academic staff. This brings attention to important issues related to staff development (Childs et al., 2005; Simpson, 2003; Singh & Hardaker, 2014; Stewart, 2010) and allocation of time dedicated to learning new technologies (Childs et al., 2005). When academic staff have *positive views* of distance education, their primary perceived benefit is related to serving students in remote locations (Stall-Meadows, 1998). On the other hand, *negative attitudes* towards a new technology are a major limiting factor for distance education, and they are found to be strongly related to the staff age (Singh & Hardaker, 2014). There is also more *time needed* for the preparation of distance education courses (Childs et al., 2005; Singh & Hardaker, 2014; Stall-Meadows, 1998), and more challenge in keeping students motivated and engaged (Stall-Meadows, 1998). Instructors often use the interactive exchange of information to overcome these limitations (Stall-Meadows, 1998). Sometimes, instructors even visit students in their remote locations, which is associated with improved relationships with students and more positive views of distance education by course instructors (Stall-Meadows, 1998).

Although, in most cases, access to modern technology — such as the Internet — is seen as a major prerequisite for successful distance education, many sources point to a need for high quality *materials* in distance education. As indicated by Moore and Kearsley (2004), "A far bigger problem [than Internet access] is the quality of media produced for distribution via the technology" (p. 8). With this in mind, Simpson (2003) and De Freitas (2007) analyzed the state of distance education in terms of content production. Simpson (2003) showed that the production of quality learning materials, besides being highly valued by the students, was also valued by academic staff, as it enabled a closer examination and refinement of the course structure, and also for maintaining the quality of instruction. A typical medium of content is print, although in many cases interactive forms of content are also included (Simpson, 2003). In the context of workplace learning and adult learning, practitioner-produced content is currently the most popular mode of production; the new mode of learner-produced content is, however, also gaining popularity (De Freitas, 2007). Learner production of content is particularly interesting, as it opens several new possibilities, particularly in terms of adjusting to the needs of learners (De Freitas, 2007). Still, in order for learner-produced content to achieve its full potential, further research — primarily related to the challenges of adopting learner-produced content in formal educational settings — is required (De Freitas, 2007).

Factors in distance education delivery

A large number of studies conducted empirical investigation into the differences between various modes of distance education. These studies aimed at understanding what factors affect the success of students in distance education courses. Machtmes and Asher (2000) looked at second-order studies and found that the effectiveness of distance education was increasing over time. The effect size (expressed as a standard deviation) of –0.09 in favor of traditional instruction was observed during the 1960s, while during the 1990s, an effect of 0.23 in favor of distance education was observed. The likely reason for this is the overall maturation of the distance education field, together with the maturation of distance education pedagogies, modes of instruction, and the introduction of new and more flexible communication technologies.

Domain-related factors

Among the many factors affecting the success of distance education, particular *characteristics* of a given domain are shown to be highly influential. Using a sample of 25 studies with a total population of 2,702 students, a meta-analysis by Williams (2006) found that, despite being overall more effective, distance education was far more effective for *adult professional learners* than for graduate and undergraduate students. With an overall effect size of Cohen's d = 0.74, Williams (2006) showed that adult professional learners had significantly higher academic achievement than students in traditional classrooms. This aligns with the findings of Machtmes and Asher (2000), who showed that the largest significant and positive effects of distance education use were on workplace learning (i.e., 0.53 standard deviation).

In a similar manner, a study by Allen et al. (2004) showed that the effectiveness of distance education is dependent on *course content*, although with slightly conflicting findings. For military-related courses, distance education turned out to be less successful than traditional models, although the sample of three studies with a total of 210 students was rather small to draw any general conclusions. For natural sciences, Allen et al.'s (2004) study found no significant differences between traditional and distance education modes (the aggregated sample of three studies was 833 students), while for social sciences the effect was small (average $r = 0.075$ over nine studies with 680 students). For education courses, the effect was negative, but very close to zero (average $r = -0.021$, over 13 studies totaling 1,828 students). The largest effect in favor of distance education was achieved for foreign language courses (average $r = 0.218$, over the three studies with 2,238 students). The primary reason was that in the distance education mode, students were able to converse regularly with native speakers, which enabled them to achieve better outcomes overall. However, a study by Bernard, Abrami, Lou, et al. (2004) shows different results. According to that study, the best results were achieved in business, military, or computing courses while math, science, and engineering courses benefited more from face-to-face classroom instruction. The likely reasons for the differences across all these second-order studies relate to generally small effect sizes that are hard to estimate reliably over the small number of studies, particularly given the impact of slightly different study contexts and operationalizations.

Instructional factors

One important, extensively analyzed aspect in second-order studies is the *role of communication technology* in the success of distance education courses. Machtmes and Asher's (2000) second-order study shows no significant differences arising from the use of different communication technologies. This finding should be taken cautiously, as technology changed dramatically during the analyzed period. Similar results are reported by Allen et al. (2004), who, using a sample of 39 studies with 71,731 students, found no statistical differences between written and audio communication. This aligns with the findings of Bernard, Abrami, Wade, et al. (2004), who showed that pedagogy, rather than the adopted technology, played a dominant role in the effectiveness of distance education.

It is equally important to understand what role different *modes of course delivery* (i.e., asynchronous, synchronous, or classroom) have on overall student performance. The results are still not conclusive, although it seems likely that asynchronous delivery is superior to traditional classroom delivery, which in turn is more effective than synchronous distance education delivery. Based on a sample of 318 studies totaling 57,775 students, Bernard, Abrami, Lou, et al. (2004) found significantly negative results for synchronous distance education (Hedges' $g = -0.10$ over 92 studies totaling 8,677 students), with significantly positive results (Hedges g =.053 over 174 studies totaling 36,531 students) for asynchronous distance education delivery. Similar results are reported by Lou et al. (2006), who analyzed a sample of 58 studies of synchronous distance education in which the effect size slightly favored traditional classroom instruction (Hedges' $g = -0.023$), while a sample of 122 studies of asynchronous delivery showed an effect size in favor of distance delivery (Hedges' $g = -0.058$). A study by Allen et al. (2004) found slight, but significantly larger effect sizes for both asynchronous (average $r = 0.074$ over 10 studies totaling 1,319 students) and synchronous modes of distance education (average $r = 0.066$ for 27 studies totaling 6,847 students), with the asynchronous mode having a slightly larger effect size. In contrast, based on a sample of 18 synchronous and 12 asynchronous studies, Williams (2006) showed that synchronous distance education had a positive effect (Cohen's $d = 0.24$), while asynchronous distance education showed a negative effect (Cohen's $d = 0.06$).

Based on the current evidence, it seems that both synchronous and asynchronous distance education have the potential to be as effective as traditional classroom instruction (or better). However, this might not be the case in the actual practice of distance education. To improve this situation, Bernard, Abrami, Wade, et al. (2004) suggest including more personalized contact between students and instructors to make synchronous distance education instruction similar to that commonly used in face-to-face education. On the other hand, for the asynchronous mode of distance education, the use of problem-based learning shows positive affects in both achievement and attitude outcomes (Bernard, Abrami, Wade, et al., 2004). The results of the Lou et al. (2006) meta-analysis also indicate that for asynchronous distance education, the use of media to enable collaborative learning among students was the most effective (Hedges' $g = 0.11$), while media that supports individual learning only (e.g., student-content) was not significantly different from classroom instruction.

Alongside the study of different modes of distance education delivery is the investigation of different *types of interactions* (i.e., student-student, student-content, and student-teacher) and the role that different media play in supporting these interactions. Equivalency theory states that different combinations of the three types of interactions can be equally effective for achieving learning outcomes, providing that instructors have the required space to organize their pedagogical approaches according to the needs of a particular situation or student (Miyazoe & Anderson, 2010). The Bernard et al. (2009) meta-analysis found that all three forms of interaction produced positive effect sizes on academic performance, with student-student and student-content interactions having higher effect sizes (Hedges' $g = 0.49$ over 10 studies for student-student and Hedges' $g = 0.46$ over 20 studies for student-content interaction) than student-teacher interactions (Hedges' $g = 0.32$ over 44 studies).

To foster quality interactions between students, an analysis of the role of i*nstructional design and instructional interventions planning* is essential. In this regard, the study by Williams (2006) showed that courses that incorporate three or more components of interaction design (e.g., interaction, integration, innovation, introspection) were associated with larger positive effects (Cohen's d = 0.25 over 22 studies). In contrast, courses with fewer than three components had negative effects (Cohen's d = −0.09 over 12 studies), which is indicative of the importance of proper instructional design on the effectiveness of distance education courses. Similarly, a meta-analysis by Borokhovski, Tamim, Bernard, Abrami, and Sokolovskaya (2012) of 32 studies showed that the planning of interactions is equally important, with designed and planned interactions leading to higher academic performance (Hedges' g = 0.50 across 14 studies) than contextual interactions (Hedges' g = 0.22 across 22 studies).

Likewise, *appropriate academic support* is recognized to have an important effects on student academic success; however, support is often limited to financial and technological services only (Tuquero, 2011). In order to provide sufficient academic support, understanding stakeholder needs is a main prerequisite alongside the understanding of student attrition (Tuquero, 2011). A meta-analysis by Storrings (2006), conducted on 30 primary sources with 9,769 students, found no significant characteristics predictive of attrition in distance education. When compared to traditional classroom courses, Bernard, Abrami, Wade, et al. (2004) showed that asynchronous distance courses had significantly higher attrition rates (Hedges' g = 0.093 over 53 studies), while the difference for synchronous courses was not significant (Hedges' g = 0.005 over 17 studies). Finally, the use of *novel distance education technologies*, such as 3-D virtual worlds, has also been investigated and shows promising results that require more empirical investigation (Wang, & Lockee, 2010).

Limitations

There are several limitations related to this study. First, there is always a possibility that the selected studies are not representative of the whole body of empirical research in the distance education domain. We performed a search across the main digital libraries in the field, and we inspected the studies based on the inclusion criteria, as is commonly done in systematic reviews and meta-analytic studies. However, there is always the possibility that some important studies were not included, which would negatively reflect on the results presented in this report. The second challenge is related to the operationalization of distance education, e-learning, and online learning, as the borderline between them is not clear. Likewise, second-order studies included in this report do not always provide sufficient detail to classify each paper with the absolute certainty. We adopted definitions commonly used in the research literature, but that does not fully eliminate the problem. Finally, given that any tertiary study is limited by the quality of data reported in the secondary sources, this study is dependent on the methodological qualities of those secondary sources. Overall, the quality is very high for most, with only few studies having a noticeably lower quality of reporting.

MODEL OF DISTANCE EDUCATION

Figure 9 shows the conceptual model that concisely synthesizes the findings of the present study. At centre is distance education, which — when properly organized and supported — is associated with reduced costs of education, and an increase in student retention and effectiveness. Primary elements of distance education are learners, content, and instructors. Learning experience is primarily shaped by the interaction of learners with content, other learners, and instructors. In order to successfully engage in interactions, learners are required to possess high levels of digital literacy, to be self-efficient and properly motivated to productively engage in learning activities. Likewise, it is instructors' attitude towards technology use and their levels of digital literacy play an important role in shaping overall learning experience. Instructors should also pay a special attention to planning and designing course interactions, given the evidence of its advantages over contextualized interactions. The quality of learning content is also important, particularly in formal educational settings, where standards of learning quality are of particular importance.

In addition to role of learners, instructors, and content, our findings indicate that other factors — such as academic support, institutional adoption, and course design — play an important moderating role on the final learning experience and achievement of learning objectives. Important course design characteristics that shape learning experience are flexibility, personalization, forms of assessment, use of small group learning and designed interactions, and soundness of adopted mix of pedagogies, technologies, and media. Likewise, factors related to the level of institutional adoption of distance education include the quality of technological infrastructure, support for academic staff, role of academic management, level of coordination between involved parties, and governmental support and policy development. Finally, academic support for students — including technological and financial support — is particularly important for students that do not possess required levels of literacy and self-efficiency, and for understanding the reasons behind student attrition.

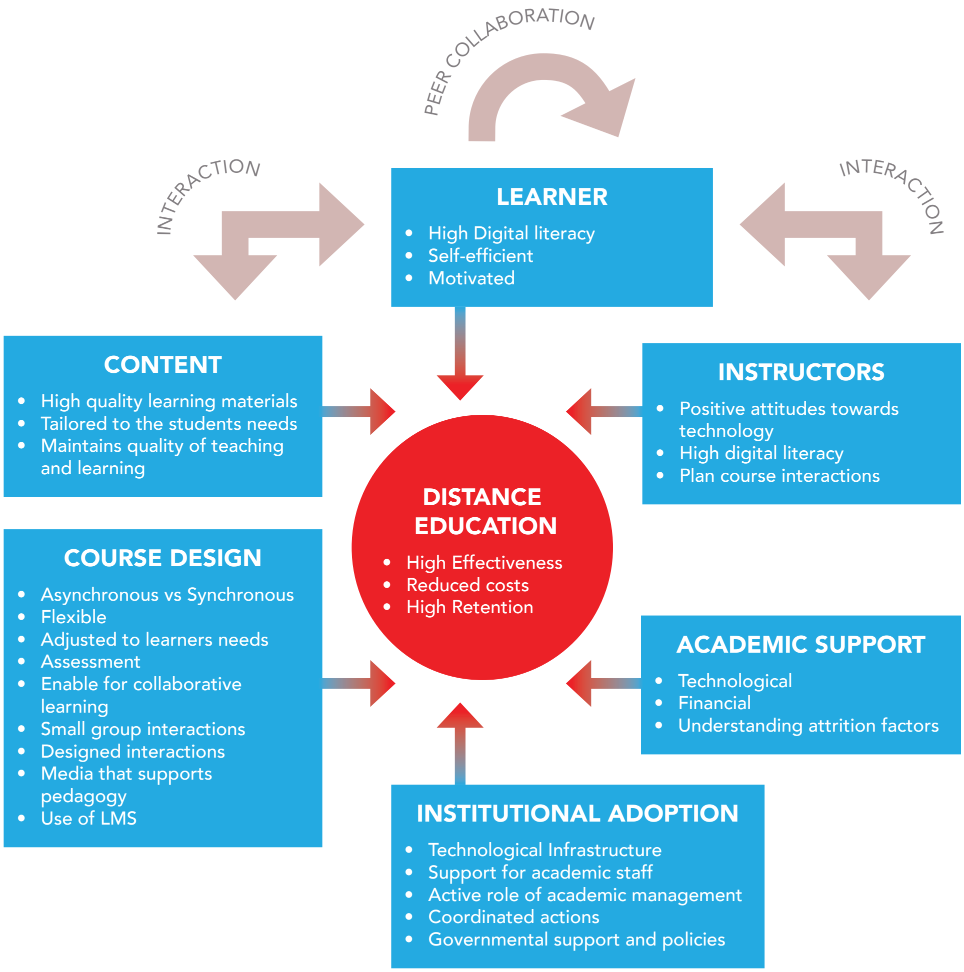


FIGURE 9 Conceptual model of distance education

SUMMARY

This report looked at published systematic literature reviews and meta-analyses in order to provide an overview of the current state of distance education research. The primary goal of this review is to inform the development and operationalization of digital learning as a new construct to capture modern developments in the field of education. Our review showed that:

1. Asynchronous forms of distance education received much more attention than synchronous or mixed modes of education delivery.

2. The primary focus of research is exploratory, with all forms of research design (i.e., quantitative, qualitative, and mixed) being widely used. In terms of particular methodologies, case studies and survey-based research represent some of those more commonly used.

3. There is strong evidence for the effectiveness of distance education, with several studies pointing to the comparable, or better effectiveness of distance education.

4. The early focus on comparing distance and traditional classroom instruction that characterized early reviews made room for a more proactive analysis of different factors of distance education.

5. Student satisfaction with distance education courses depends primarily on the target student population, with professional and adult learners typically being more satisfied with distance education, while undergraduate and graduate students were slightly more satisfied with traditional face-to-face learning.

6. Attrition between modes of instruction is on a comparable level, with synchronous distance education having lower levels of attrition than traditional face-to-face education, while asynchronous distance education has slightly higher levels of attrition than traditional face-to-face education.

7. Institutional adoption of distance education depends on a multitude of macro- and micro-level factors. Among different macro-level factors, the most common include i) technological infrastructure, ii) the role of academic management, and iii) academic and institutional support. Similarly, the most important micro-level factors include i) views on distance education technology use, ii) computing literacy of academic staff, iii) allocation of time for technology-related academic staff training and distance education course development, and iv) quality of learning materials.

8. The success of individual distance education courses is related to many domain and instructional factors such as i) course subject area, ii) target student group (e.g., professional, adult, graduate, undergraduate), iii) conformity between adopted pedagogical approaches and the technologies that enable them, iv) mode of course delivery (i.e., synchronous vs. asynchronous), v) type of interactions supported (i.e., student-student, student-instructor, and student-content), and vi) instructional design and planning.

9. There is much room for improvement in terms of the methodological quality of published distance education literature. There is a lot of missing information in published reports, which makes the synthesis of research findings much more complex and challenging.

With the rising diversity of forms of technology use in modern education, this tertiary study overview presents a synthesis for informing the development of digital learning as a new umbrella term for the 21st-century use of technology in education. While distance education has been the most widely used term, the increasing diversity of educational programs, learning personalization, and modes of assessment merits the development of a more comprehensive and unified construct. The challenges directly targeted include the development of a framework for the successful adoption of novel educational technology and the development of novel educational programs, the identification of successful educational practices for different learning scenarios, the provisions for the further adoption of technology in education, and the development of better connections between educational research and practice. With the rising diversity of forms of learning (e.g., MOOCs or blended training programs), research on digital learning and its main characteristics can be successfully used to advance the current state of education, which is a necessity for coping with the challenges of the future.

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THE HISTORY AND STATE OF BLENDED LEARNING

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ABSTRACT

This report forms one part in a series of articles offering an overview of the state of distance, online, and blended learning, and positioning them in relation to the emerging domain of digital learning. This particular report focuses on *blended learning* (BL), referring to the practices that combine (*or blend*) traditional face-to-face (f2f) learning with online learning (OL). As the concept of BL continues to gain traction in educational settings, researchers are attempting to establish and verify the learning gains it brings. This report seeks to outline the debate regarding BL definitions, pedagogical benefits, and deficiencies that arise in academic studies, and reflect on the future direction for BL. Our critical overview of the state and development of BL is structured to reflect the dominant themes of twenty systematically selected second-order academic studies of BL. This report reviews main findings around such dominant themes as the effectiveness of BL, recommended instructional practices in BL delivery and design, as well as the state of research into BL. The findings suggest that advances in technology have fueled the development of BL from a grassroots practice to an emerging research field. The implementation of BL practices by including both online and f2f modes of delivery positively influence student performance, making BL an attractive educational provision. At present, the field of BL is still dependent on the modes of delivery it is derived from, drawing heavily on OL in both theory and in practice. The field of BL is a dynamically changing area, and much of the critique of the existing research noted here is likely to be rapidly addressed in future work. That being said, a critical overview of the field suggests that it can further mature by adopting a digital learning perspective in its own activities.

INTRODUCTION

In the traditional educational context, *face-to-face* (f2f) classes refer to the cohorts of students able to commit to on-campus instruction presented in conventional brick and mortar classrooms. This model of education requires that students be present for regular in-classroom instruction. As such, the model can be seen as inequitable for those who may have competing demands and priorities that make regularly scheduled on-campus attendance difficult, if not impossible.

In contrast, *distance education* (DE) represents a model that affords students an opportunity to undertake programs of study external to the institution. In essence, this model of education places no requirements on students to be on-campus for course instruction, content, or study. This model is not a recent introduction to the sector; DE has a long history that evolved from specialist colleges and boutique programs and courses (see Kovanović et al. (2015) in this series of papers). Despite a long-established record of offerings, DE has been stymied by the perception that this mode of education delivery is less personal, and primarily caters to working adults or marginal groups separated by both time and space (Moore & Kearsley, 2011). However, the recent growth and sophistication of Internet-based technologies has seen *distance education* or *online learning* (OL) become a staple of post-secondary and secondary instruction. This is well noted by Allen and Seamen (2013), who have been tracking online course enrolment across the United States for over a decade. The authors identified that the percentage growth in enrolment for online learning courses is now increasing faster than for on-campus offerings.

Clearly, the development and adoption of asynchronous and synchronous communication technologies into the learning space has provided an opportunity to leverage the affordances of both education models (DE and f2f classes). At present, courses and programs can be offered with flexibility for access and attendance while retaining opportunities for social engagement and interaction. This report discusses the ongoing juxtaposition of traditional modes of education with distance learning in what has been termed *blended learning* (BL), or *hybrid learning*. We outline the debate regarding *blended learning* definitions, along with the perceived pedagogical benefits and deficiencies that arise through the convergence of technologies with f2f education as documented in the existing research literature.

THE RISE OF EDUCATION TECHNOLOGIES

Over the past decade, technology has increasingly been used to enhance course and content offerings both in the f2f and distance education settings. Technology for learning can be divided into three broad categories: i) information technologies that support the delivery of and access to information; ii) communication and interactive technologies that mediate user interaction; and iii) social software technologies that support group-based activities such as decision-making, planning, and higher order learning activities (C. Allen, 2004; Anderson, 2008; Hulsmann, 2004). While the initial information technologies adopted in education were computer-based and for personal use, educational IT is now predominately located on the web (or cloud) and is more socially oriented. This transition to the web or cloud provides for greater, more diverse access to learning resources and effectively capitalizes on the growth in web-based connectivity for end-users. Communication technologies, initially developed as independent software for synchronous or asynchronous communication, also applied in education, have recently been merged into common software platforms for learning, such as learning management systems (LMS) or virtual learning environments (VLE). Web 2.0 tools and social software technologies (C. Allen, 2004) have enabled two-way communication, as well as sharing, extracting, and organizing knowledge, along with building social relationships (Anderson, 2008). Due to their affordances for interactivity, social software technologies allow distance learners to be exposed to group-based learning activities previously perceived as exclusive to f2f teaching contexts. For example, students can communicate synchronously through video conferencing, synchronous chat, or virtual classrooms without the need for physical co-location (Helms, 2014).

The increased reliance on technology for education delivery and instruction has resulted in changing perceptions of what now constitutes distance. Students can interact in real-time in peer-groups or with instructors and even participate in lectures remotely. As such, the reliance on online technology, alongside the diminishing concept of *distance*, has given rise to the term *online learning* (OL). The adoption of smart devices, the wider use of the Internet, and the gradual lowering cost of technology (Rainie, 2010) have all played a part in redefining learning and teaching practice in the 21st century.

DEFINING BLENDED LEARNING

A positive outcome stemming from the growth in OL has been the capacity for educators to leverage these new technologies for on-campus teaching. This combination of online technologies and f2f instruction has been described in the literature as bl*ended learning, mixed mode, hybrid,* or *online-supplemented*. While *blended learning* is perhaps the most commonly used phrase, essentially all these terms describe the merging of online technologies with f2f teaching.

This report focuses on *blended learning* (BL), specifically the practices that combine (or *blend*) traditional f2f with OL. BL or hybrid practices represent a continual convergence between traditional f2f and distributed, technology-mediated learning environments (Bonk & Graham, 2006; Graham & Dziuban, 2008). Its variance as a changing practice can be located on a continuum between fully f2f to fully online courses (Helms, 2014). Given this broad spectrum, it is not surprising that BL has multiple and varied definitions. For instance, BL can be defined as a version of OL, where 30% – 79% of the content is delivered in an online format (Allen & Seaman, 2003, 2004; Allen, Seaman, & Garrett, 2007; Means, Toyama, Murphy, Bakia, & Jones, 2009; Means, Toyama, Murphy, & Bakia, 2013). Some researchers limit BL practices to those where f2f instruction comprises at least half of all class time (Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014). Others expand BL practices to include web-facilitated classroom instruction where the LMS is used for syllabi and course communication (Bliuc, Goodyear, & Ellis, 2007). In other words, any instructor who employs technology in his/her teaching practice, whether in f2f or through web-based distance education practices in online education (DE/OL), could legitimately refer to such experiences as *blended*.

Although the discussion in the literature regarding the development of an authoritative definition is still open, there are identifiable commonalities in the many attempts to define BL. In all definitions, BL is considered a combination of traditional f2f modes of instruction with online modes of learning (OL), drawing on technology-mediated instruction, where all participants in the learning process are separated by *distance* some of the time. The distinctions between mixed-mode, hybrid, and blended courses are not well articulated, and the terms are often used interchangeably (Graham & Dziuban, 2008; Means et al., 2013). Arguably, hybrid implies that one mode is unused while the other is used; while blended suggests no perceptible difference between modes (McGee & Reis, 2012).

As the concept of BL continues to gain traction in educational settings, researchers are also attempting to establish and verify the touted learning gains and benefits associated with this model of education. Although technology positivists frequently espouse significant learning gains when adopting educational technologies, the realities of such claims are often difficult to measure. This report seeks to highlight the perceived benefits alongside the reported deficiencies or gaps as currently reported in the research.

METHODS

This report provides an overview of the state of evidence-based findings for BL approaches by synthesizing the themes and findings from the meta-analyses and systematic literature reviews on BL. Such a line of inquiry has been framed by the following research questions:

RQ1. *What are the main themes of BL meta-analyses and systematic literature reviews?*
RQ2. *What is the state of BL as reflected through these meta-analyses and systematic literature reviews?*

To identify meta-analyses and systematic literature reviews on BL, a database search was combined with a Google Scholar and journal search (Figure 1). First, a list of 306 studies that included OL, DE, and BL was identified through a search of ERIC, Scopus, PsychINFO, PubMed, and ProQuest databases[1]. An additional 19 studies were retrieved using a Google Scholar search for similar combinations of terms. A journal search yielded a further 14 studies[2]. Hence, the compiled list included some 339 meta-analyses and systematic reviews of DE, OL, and BL. Three researchers scanned titles, keywords, and abstracts to verify the relevance of each extracted article and to assign one or more labels to the list of studies; specifically *distance education*, *online learning*, or *blended learning*. If the coder could not label the study based on the meta-information, the content of the article was reviewed to provide further detail and clarification. During this stage, 67 studies potentially relevant for BL were identified.

1 The database search was conducted using the following criteria: title, abstract, and/or keywords containing at least one of the following terms: *meta-analysis, meta-synthesis, scoping study,* ***OR*** *systematic review*, **AND** title, abstract, and/or keywords containing at least one of the following terms: *distance learning, distance education, blended learning, blended education, hybrid education, hybrid learning, online learning, online education, e-learning, web-based learning,* ***OR*** *web-based education.*

2 The list of the relevant journals was obtained from the most influential meta-analyses in distance and online education, and included *American Journal of Distance Education, Journal of Distance Education, Distance Education, International Review of Research in Distance and Open Education, Journal of Asynchronous Learning Networks, Journal of Technology and Teacher Education, Career and Technical Education Research, Internet and Higher Education, Journal of Computing in Higher Education, and Computers and Education.*

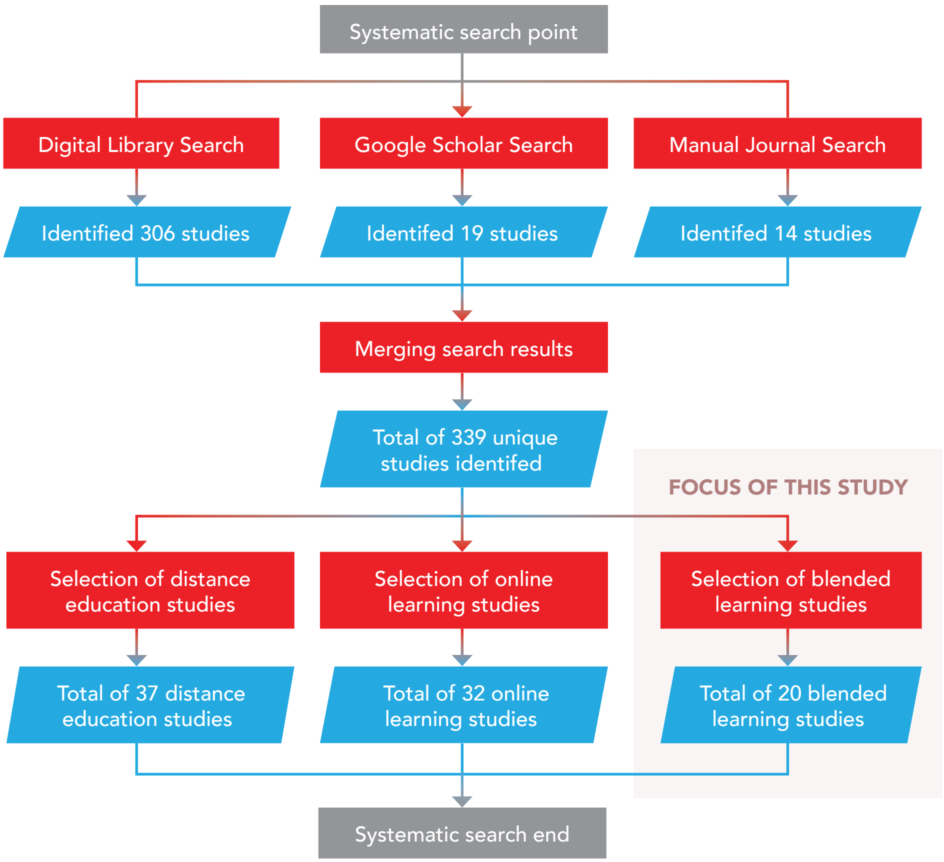

FIGURE 1 The process of systematic literature search

As previously discussed, BL has dual roots in traditional and online modes of learning. This evolution of BL complicated the identification of readily available meta-analyses and systematic reviews for inclusion in this report. For instance, on the one hand, especially in the early 2000s, BL was tied to technology integration into conventional classroom instruction (See Figure 2). The academic literature in this case, connects BL to such keywords as *virtual learning environments, course management systems,* and *computer-aided instruction*, among others. On the other hand, BL largely overlaps with the literature on DE/OL. In this context, the academic literature draws on such keywords as *web-based learning, e-learning, Internet-based learning, online and distance learning/education and distributed learning*. Furthermore, practices of BL are also referred to as *hybrid learning, mixed mode learning*, and more recently the *flipped classroom*.

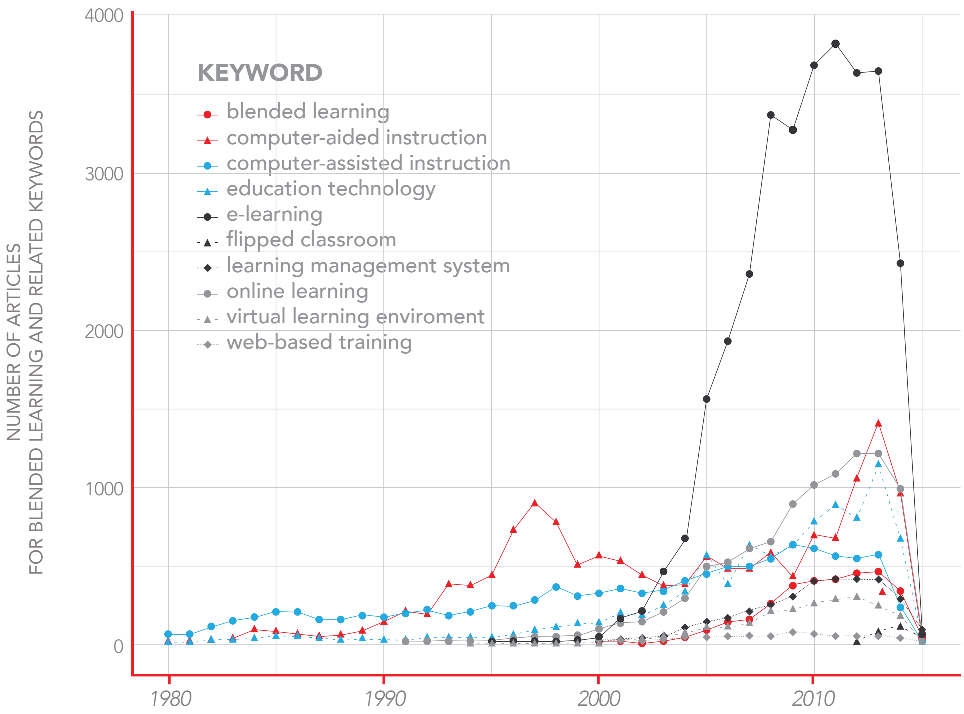

FIGURE 2 Distribution of studies indexed by Scopus as related to BL provisions (query: study's title, abstract and keywords

To be included in the final list for analysis, a study had to meet the following criteria:

- **i.** *the study applied a systematic approach to literature analysis, e.g., meta-analysis, systematic literature review, and meta-synthesis*
- **ii.** *the study identified findings related to blended learning as part of the dataset*
- **iii.** *the study was published in a peer-reviewed journal/conference proceedings or in a dissertation, available in English*
- **iv.** *the study was situated in higher education and professional development contexts, excluding K–12 unless part of a larger dataset embracing higher and/or adult education*

Additionally, OL meta-analyses with a sub-set of BL studies, such as Means et al. (2009) or Bernard et al. (2009), were excluded if the same academic group had conducted a more recent and BL-focused analysis using the dataset of primary studies that overlapped with their prior work.

A list of second-order studies selected for this report comprised 20 meta-analyses and systematic reviews of BL (Table 1, Figure 3)

TABLE 1 Summary of Systematic Analyses and Meta-Analyses of Blended Learning.

	Study	Title	Type	Primary Studies
1	Bernard et al. (2014)	A meta-analysis of blended learning and technology use in higher education: From general to the applied	MA	96
2	Arbaugh, J. (2014)	What might online delivery teach us about blended management education? Prior perspectives and future directions	SLR	60
3	Halverson et al. (2014)	A thematic analysis of the most highly cited scholarship in the first decade of blended learning research	SLR, TA	85
4	Means et al. (2013)	The effectiveness of online and blended learning: A meta-analysis of the empirical literature	MA	45

TABLE 1 (Cont.) Summary of Systematic Analyses and Meta-Analyses of Blended Learning

	Study	Title	Type	Primary Studies
5	Bishop & Verleger (2013)	The flipped classroom: A survey of the research	SLR	24
6	Zhao & Breslow (2013)	Literature review on hybrid/blended learning	SLR	42
7	Drysdale et al. (2013)	An analysis of research trends in dissertations and theses studying blended learning	SLR	205
8	Keengewe & Kang (2013)	A review of empirical research on blended learning in teacher education programs	SLR	23
9	Torrisi-Steel & Drew (2013)	A literature landscape of blended learning in higher education: The need for better understanding of academic blended practice	SLR, TA	827
10	McGee & Reis (2012)	Blended course design: A synthesis of best practices	QMA	67
11	Rowe, Frantz, & Bozalek (2012)	The role of blended learning in the clinical education of healthcare students: A systematic review	MA	14
12	Halverson et al. (2012)	An analysis of high impact scholarship and publication trends in blended learning	SLR	95
13	Gikandi, Morrow, & Davis (2011)	Online formative assessment in higher education: A review of the literature	SLR	8
14	Cook et al. (2010)	What do we know about web-based learning? A systematic review of the variability of interventions	SLR	65
15	Landers (2009)	Traditional, web-based and hybrid instruction: A comparison of training methods	MA	126*

TABLE 1 (Cont.) Summary of Systematic Analyses and Meta-Analyses of Blended Learning

	Study	Title	Type	Primary Studies
16	Bliuc, Goodyear, & Ellis (2007)	Research focus and methodological choices in studies into students' experiences of blended learning in higher education	SLR	Approx. 300
17	Sharpe et al. (2006)	The undergraduate experience of blended e-learning: A review of UK literature and practice	SLR & I	14
18	Sitzmann et al. (2006)	The comparative effectiveness of web-based and classroom instruction: A meta-analysis	MA	96*
19	Zhao et al (2005)	What makes the difference? A practical analysis of research on the effectiveness of distance education	MA	52*
20	Paul (2001)	A meta-analytic review of factors that influence the effectiveness of web-based training within the context of distance education	MA	15

Note: SR: systematic review; MA: meta-analysis; SLR: systematic literature review; TA: thematic analysis; QMA: qualitative meta-analysis; I: interviews. *The sample included both studies with BL and OL instructional interventions

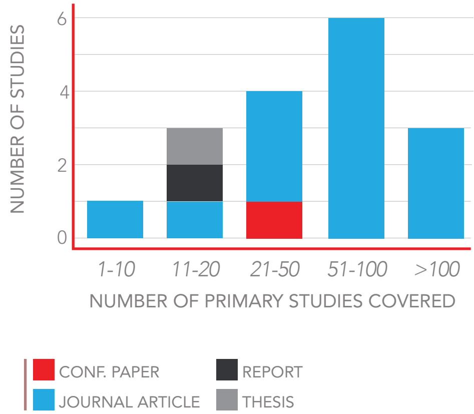

FIGURE 3A Coverage of primary studies by different types of systematic reviews and meta-analyses

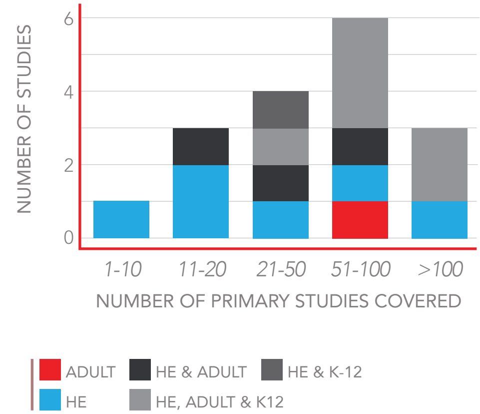

FIGURE 3B Coverage of the domain in primary studies

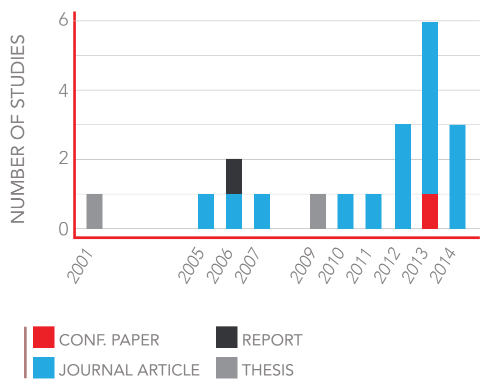

FIGURE 3C Number and type of second order studies published in different years

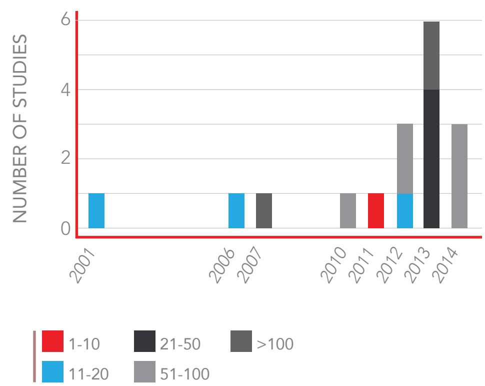

FIGURE 3D Number of primary studies analysed in systematic literature reviews and meta-analyses, published in different years

FIGURE 3 Descriptive Analysis of the Selected Dataset

SYNTHESIS OF SELECTED SCHOLARLY WORK

Analysis of the selected second-order studies revealed the following major themes:

i. *Effectiveness of BL (Bernard et al., 2014; Landers, 2009; Paul, 2001; Rowe, Frantz, & Bozalek, 2012; Zhao & Breslow, 2013; Zhao, Lei, Yan, & Tan, 2005)*
ii. *Review of instructional practices in BL delivery and design (Bishop & Verleger, 2013; Cook et al., 2010; Gikandi, Morrow, & Davis, 2011; Keengwe & Kang, 2013; McGee & Reis, 2012)*
iii. *Review of existing research (Arbaugh, 2014; Bliuc et al., 2007; Drysdale, Graham, Spring, & Halverson, 2013; Halverson, Graham, Spring, & Drysdale, 2012; Halverson, Graham, Spring, Drysdale, & Henrie, 2014; Torrisi-Steele & Drew, 2013)*

A further theme, related to institutional adoption of BL, was included to address one systematic review and to draw attention to the lack of research that effectively systematizes the experiences in the adoption of BL practices as reported by individual universities and organizations.

One obvious limitation of the current synthesis is the challenge of coherence, since the boundaries of what constitutes BL differed across reported studies. Furthermore, it has come to our attention that the themes reflected in the second-order studies do not completely reflect the dominant themes of primary research in the field (cf. Halverson et al., 2014).

Effectiveness of BL

The effectiveness of BL as compared to OL and f2f has been a prominent theme in scholarly work. This research has been of particular interest to policymakers and institutional administrations seeking to understand the potential impact on investment or for further insight into the allocation of future resources. As BL involves an alternate set of costs when compared to other modes of instruction, there is an implicit expectation that this model of learning has to be more cost-effective (Graham, 2013; Means et al., 2009; Twigg, 2003).

From the corpus of literature for the study, six meta-analyses and two systematic literature reviews addressing the effectiveness of BL were identified (Table 2). Following the tradition of DE and educational technology research, these studies approached the effectiveness of BL instruction as an observable increase in *effect sizes*. That is, a greater *effect size* indicates an achievement gain for the treatment (BL) condition over the control condition within the research design (Ross, Morrison, & Lowther, 2010, p. 19).

Essentially, all selected studies concluded that in situations where the students experienced BL instruction, whether it was in an online course with some additional f2f time, or whether it was mostly an f2f course with some online time, student academic achievement was higher than that of students who experienced a fully f2f or fully online learning mode.

TABLE 2 Summary of Systematic Analyses and Meta-Analyses of Blended Learning

	Study	BL Boundaries	Findings	Type of Learning Outcomes Measured	Primary Studies	Type of Study	Years Analyzed
1	Bernard et al. (2014)	f2f = 50%; OL < 50%	BL conditions exceed f2f conditions *(g+=0.334, k=117, p <.001)*	Any measure of academic performance	96	MA	1990–2010
2	Means et al. (2013)	OL = 30%–80%; f2f = 70%–20%	BL outperforms f2f conditions *(g+=0.35, k=23, p=.001)*	Only objective and direct measures of learning, such as standardized scores, scores on researcher-created assessment, grades, or GPA (excluded student/teacher perceptions, satisfaction, retention, attendance, etc.)	45	MA	1996–2008

TABLE 2 (Cont.) Summary of Systematic Analyses and Meta-Analyses of Blended Learning

	Study	BL Boundaries	Findings	Type of Learning Outcomes Measured	Primary Studies	Type of Study	Years Analyzed
3	Zhao & Breslow (2013)	OL = 30%–80%; f2f = 70%–20%	Mixed evidence regarding whether hybrid or BL is more effective	Quantitative indicator of learning, in most cases grades for homework, quizzes, labs, exams, and similar, in some cases combined with student satisfaction scores	42	SLR	1999–2013
4	Rowe, Frantz, & Bozalek (2012)	Meaningful integration	BL shows some measure of improvement, but claims are difficult to make	Pre- and post-tests, interviews, focus groups, surveys, reflective blog posts, etc.	14	SLR	2000–2012
5	Landers (2009)	OL = 30%–80%; f2f = 70%–20%	BL appears superior to traditional courses but examinations of the effect of the degree to which a course is online are difficult due to small cell sizes	Knowledge, observable skills, problem-solving skills, attitudes, perceptions, e.g., multiple-choice tests, computer use tests, self-reported learning outcomes	126	MA	1991–2009
6	Sitzmann et al. (2006)	Mostly f2f with OL enhancement	BL was more effective than f2f. Effect on declarative knowledge: *d*=0.34, *k*=33; Effect on procedural knowledge: *d*= 0.52, *k*=6; Effect on reactions: *d*=–.15, *k*=11	Declarative knowledge, procedural knowledge assessed by either participating in activity or taking a written test	96	MA	1996–2005

TABLE 2 (Cont.) Summary of Systematic Analyses and Meta-Analyses of Blended Learning

	Study	BL Boundaries	Findings	Type of Learning Outcomes Measured	Primary Studies	Type of Study	Years Analyzed
7	Zhao et al. (2005)	As DE with f2f enhancement as moderating variable, or how frequently technology was used	DE mixed with a certain amount of f2f instruction seems to be most effective. Media involvement of 60–80%: $d=0.49, k=18, p<.001$	Grades, quizzes, independent/standardized tests, students satisfaction, faculty satisfaction, dropout rate, student evaluation of learning, student evaluation of the course, external evaluation, and cost effectiveness	52	MA	1966–2002
8	Paul (2001)	Mostly f2f with OL enhancement	f2f with online enhancement was 11% more effective than f2f only; $d=0.27$	Perceptual skills, intellectual skills, motor skills, attitudes, interpersonal skills/ averaged across reactions and learning criteria	15	MA	1980–2000

Despite the near unanimous agreement about the effect of BL, some scholars conclude that the existing evidence is mixed, and that the first-order studies used in meta-analyses lack statistical control for confounding factors (Rowe et al., 2012; Zhao & Breslow, 2013). BL tends to involve additional time, instructional resources, and course elements encouraging interaction among learners, and either of these could serve as a confounding variable explaining why BL conditions have a significantly higher effect on achievement gains (Jaggars & Bailey, 2010; Landers, 2009; Means et al., 2013). In other words, although the effects of BL instruction can be seen, the assignment of causality is far more difficult to ascertain (Rowe et al., 2012).

Generalizability of the findings in BL effectiveness research is problematic due to the lack of consistency across the primary studies from which the datasets for meta-analyses are drawn. First, the primary studies lack consistency in what comprises BL instructional conditions. The commonality between contexts in BL research is the presence of two modes, but such a broad definition embraces practices too diverse and varied in intensity to be replicated without more detailed specifications. Second, the primary research is incongruent in defining what constitutes *academic achievement*. Some meta-analyses and systematic reviews included a diverse set of *academic achievement* measurements, e.g., standardized test scores, researcher-made and teacher-made tests, attitude measures and inventories, expressions of satisfaction, skill evaluations, evaluations of the course as a whole, as well as retention outcomes (e.g., Zhao et al., 2005). Other researchers looking at the primary studies identified whether student learning resulted in declarative or procedural knowledge (Sitzmann, Kraiger, Stewart, & Wisher, 2006), or the learning of facts or problem solving skills (Landers, 2009). Recent meta-analyses and systematic literature reviews tend to settle on exclusively quantitative measures of *academic achievement* (Means et al., 2013), which do not necessarily represent meaningful outcomes (Ross & Morrison, 2014). Since a comparison of *academic achievement* between different instructional conditions is the foundation for demonstrating the positive impact of BL, the diversity of meanings of *academic achievement* further confounds the potential for generalizing the research findings.

To conclude, BL effectiveness studies support the premise that students who learn from the combination of online and f2f modes develop better learning outcomes than their peers exposed to either of the modes exclusively. Although the research speculates that BL combines the "best of two worlds," studies of effectiveness lack consistency in what constitutes BL environments, and what outcomes are being compared. Thus, the research offers limited evidence as to what aspects of BL pedagogy or technology influence learning outcomes (Arbaugh, 2014; Torrisi-Steele & Drew, 2013).

Instructional Practices and Technology that Impact BL

Another prominent theme in the reviewed research focuses on instructional practices perceived as favorable for BL modes. The discussion below is structured to reflect what the research has reported in relation to the following:

- **i.** *Use of technology in BL*
- **ii.** *Pedagogical considerations for instruction within online and f2f modes, as well as across the two*
- **v.** *Design of BL courses*
- **vi.** *Gaps in research on instructional practices*

There is a difference in how the researchers cited in this section have established evidence for "best" practices. For example, some practices have been simply recommended by instructors with their experiences and recommendations summarized in systematic reviews. Alternatively, other evidence has been statistically derived from meta-analyses that identify the value of instructional interventions in relation to academic achievement.

The Use of Technology

It is to be expected that the themes of technology and pedagogy would have a strong presence in the BL research. The tension between technology and pedagogy has a long-standing history, ever since Clark (1983) challenged the notion that technology-as-is has an effect on learning. Clark argued that the instructional practice, not the medium of delivery, ultimately influences the learning process. Research demonstrates that using technology in BL for communication, for presentation, for searching, and so on, has varying effects on academic achievement. More specifically, technology used to provide cognitive support has a much higher moderating effect on achievement in BL *(g+=0.59)* than technology provided for content/presentational support *(g+=0.24)* or technology used to facilitate communication among peers and with the instructor *(g+=0.31)* (Bernard et al., 2014; Schmid et al., 2014). As noted by Bernard et al. (2014), although these findings seem to challenge the neutrality of technology, such conclusions at this stage would be superficial. These results do suggest, however, that technological tools have varying power. Therefore, treating technological tools as the one and only intervention condition in research may lead to over-generalizing the different affordances that have potential to influence student learning. In conclusion, these findings support the standpoint of Clark's opponents who did not necessarily disagree as to the importance of instructional choices in enhancing the learning outcomes in technology-facilitated interventions, but argued for a more inclusive definition of such interventions that would reflect the importance of both the technology choice and the instructional practice (Hannafin & Young, 2008).

In addition to the studies selected for the synthesis, a meta-analysis by Schmid et al. (2014) investigated the impact of how much technology is used within the BL provision. They found that students in f2f classrooms where technology is used at a low or medium intensity level outperform students in a predominantly technology-based classroom (i.e., high intensity). Similarly, Bernard et al. (2014) investigated whether spending a low-to-moderate amount of time in the BL online mode (up to 30% with at least 50% f2f) has an impact on academic achievement when compared to students spending longer periods in the online mode (approaching 50% with 50% f2f). Their results are not statistically significant, and indicate that in courses where at least 50% of the class is f2f mode, students who spend more time in the online mode outperform those whose exposure to the online mode is shorter. A similar trend was noted by Means et al. (2013). That said, the meta-analysis undertaken by Schmid et al. (2014) suggests that differences in the impact of the intensity of technology may be influenced by the subject matter of the course itself. At this point, besides supporting the standpoint that technology is a potent element in the educational setting, such findings are difficult to parlay into well-defined practical implications that can inform the design of BL courses.

BL research perhaps provides only initial insight into the potential impact of specific technological interventions, and solid conclusions are as yet difficult to make. As McGee and Reis (2012) point out in their systematic review of best practices, there is no agreement even when it comes to the question of whether having an LMS is a mandatory component for BL let alone what components of technology or the balance of time allocated for technology-mediated learning will best facilitate student outcomes.

Instructional Practices

Meta-analyses of the effectiveness of BL also include various factors related to instructional practices and their moderating effect on academic achievement. For instance, Means et al. (2013) provide statistically derived evidence that the pedagogical approaches used in BL can have a positive impact on student academic achievement. Their meta-analysis integrated 12 instructional practices as moderating variables[3]. The researchers identified the effects that instructional practices, i.e., instructor-directed (expository), independent (active), and collaborative (interactive), have on academic achievement. From these analyses, the authors demonstrate that effect sizes of collaborative interactive learning *(g+=0.249)*

3 Means et al. (2013) included the following pedagogical practices as moderator variables: pedagogy/learning experience contrasting instructor-directed (expository) with independent (active) and collaborative (interactive); computer-mediated communication with instructor contrasting asynchronous only with a combination of asynchronous and synchronous; treatment duration contrasting less that 1 month with more than 1 month; media features contrasting text-based only with the combination of text and other media; time on task contrasting provisions where students spent longer time online than f2f, with courses where the f2f part of the course was greater than the online part; a condition comparing the presence or absence of one-way video or audio; a condition comparing the presence or absence of computer-based instruction elements; a condition comparing whether the students had an opportunity for f2f time with instructor during the instruction, before or after the instruction, or none at all; a condition that compared whether the students had an opportunity to interact with peers during the instruction, before or after the instruction, or not at all; a condition examining whether the students had an opportunity to practice, or not; and the condition comparing whether the feedback was or was not provided.

and teacher-directed instruction *(g+=0.386)* on academic achievement are higher than the effect of self-paced independent learning *(g+=0.05)* (Means et al., 2013).

Bernard et al. (2014) also integrated instructional-related factors as moderating variables. They focused, however, on the types of interactions students had in BL provisions, and included the three types of interactions — student-student, student-teacher and student-content, as interaction treatments in the meta-analysis of BL effectiveness. Since it was not the focus of the study, they did not establish the impact of the exact combinations of the three interaction types upon student learning outcomes. However, their findings do suggest that the presence of two or three types of interaction yields a higher effect than only one (*g+=0.44* for two types of interaction; *g+=0.47* for three types; *g+=0.26* for one type).

Prior research into OL further adds to our understanding of the combinations of interactions that have more impact on academic achievement in the online modes of BL provision. OL meta-analyses have demonstrated the impact of student-student and student-content interactions, as well as student-teacher and student-content interactions (for further reference, see Joksimović et al. (2015) in this series of papers). Furthermore, the effects of the combinations of interaction types in BL support the interaction equivalency theorem (Anderson, 2003). Anderson's hypothesizes that in OL high levels of more than one type of interaction "will likely provide a more satisfying educational experience, though these experiences may not be as cost or time effective as less interactive learning sequences" (p. 4). This research highlights the close relationship of BL to the dominant pedagogies in OL and DE, where interactions are seen as the means of bridging the psychological distance between the participants in the learning process (Moore, 1989, 1993).

Recommended instructional practices for BL mirror effective practices within f2f and online modes respectively. For example, there has been strong evidence of the essential role that feedback plays in learning from f2f education research (Hattie & Timperley, 2007), as well as DE/OL research (Paul, 2001), and educational technology research (Azevedo, 1993). As expected, prompt feedback is also a suggested practice in BL settings, reflecting OL/DE experiences; recommended practices of BL also include active learning and varied interactivity (McGee & Reis, 2012). Or, in accord with both f2f and OL instructional principles, general recommendations in BL include defining clear course objectives, which are the foundation for the course activities, assignments, and assessments. The design of these learning activities must account for the specificities of f2f and online modes. That being said, literature on BL pedagogy has tied itself more strongly to OL, with far fewer insights taken from f2f education research (Arbaugh, 2014).

Course Design

Clearly, OL and f2f offer a rich heritage for the delivery and design of specific elements in BL provisions. However, there is more to BL design than just mirroring existing practices. The discussion around BL is concerned with thoughtful and meaningful ways of *combining* the two (Garrison & Kanuka, 2004). This part of BL course design is not yet based on sufficient evidence. The challenge of how to mix intensifies when an existing course is re-designed into a blend. For instance, in the study by Graham and Robison (2007), over one-third of faculty reported having taught a BL course. However, in the majority of these instances the teaching and learning practices did not change. Instead the instructors simply added small technology-based enhancements for accessing course content or communication with peers. As such, it is tempting to "translate" a practice that exists within a course into a corresponding technology-based practice (Salomon, 2002), but research provides little assistance as to the types of "translations" that would be meaningful in BL contexts.

Designing activities for BL involves understanding the differences between OL and f2f modes. Research indicates that different modes of learning are best suited for achieving particular learning outcomes. For example, effectively designed OL facilitates the development of factual and declarative knowledge (Landers, 2009; Rowe et al., 2012; Sitzmann et al., 2006), while problem-based f2f learning has a positive effect on skills, and a negative effect on knowledge (Dochy, Segers, Van den Bossche, & Gijbels, 2003; Gijbels, Dochy, Van den Bossche, & Segers, 2005). The premise that different instructional modes are suited for different tasks is further confirmed by studies that show that the same amount of time spent on a task will impact the learning outcome in the OL mode, but will not have a comparable impact in the f2f setting (Means et al., 2013).

Since computer-mediated communication with the instructor and among students asynchronously tends to have higher effect when used in combination with synchronous mode (Bernard et al., 2004), research and practice recommend that students and the instructor carry on their conversations across both the online and f2f modes (Stacey & Gerbic, 2009). Such continuous conversations allow for leveraging the convenience and deeper levels of asynchronous discussion (Bernard et al., 2004; Bonk & Graham, 2006; Hrastinski & Keller, 2007) with the potential for a stronger sense of community in both web-based and f2f synchronous communication (Rovai & Jordan, 2004).

In contrast with recommendations on how to mix student-student and student-instructor interactions, the literature reviewed lacks advice regarding the blending of student-content interactions (Helms, 2014). Here the concept of the *flipped classroom* (FC) becomes relevant. The FC regained popularity as institutions began developing scaled online courses for external non-fee-paying students (e.g., MOOCs). In essence, institutions sought a better way to recoup the costs of such courses through greater integration of the new online resources into the established fee-based course offerings (Bruff, Fisher, McEwen, & Smith, 2013). FC is a specific course design that combines f2f interactive group learning activities with web-based components taught at distance, such as lectures, close-ended quizzes, and practice exercises. A systematic review of FC initiatives by Bishop & Verleger (2013) attempts to evaluate this practice. Their results indicate that most primary studies use single-group study design, providing no point of comparison for learning outcomes. According to Bishop and Verleger (2013), the evidence that FC outperforms the traditional classroom is anecdotal, and little work using controlled experimental or quasi-experimental designs actually investigates what they call *objective learning outcomes*.

McGee and Reis (2012) offer an exhaustive synthesis of best practices reported by BL practitioners in primary studies, including strategies and techniques related to course design, pedagogy, implementation, and assessment. They recommend that BL provisions be designed, rather than redesigned from f2f models, and that course components be aligned, especially regarding assessment practices. They also highlight that although student-student and student-teacher interactions are reported to enhance learning outcomes, in BL provisions, that is not always the expectation, and sometimes instructors are not willing or are incapable of continuous interaction. As a result, the alignment of expectations between instructors and students in BL courses is of utmost importance.

Learner Support

Although student perceptions and perspectives on BL are among the most prominent themes addressed in BL primary research, we were unable to identify a systematized review of this topic. The available meta-analyses suggest differences as to the characteristics of the students who prefer and/or benefit from BL provisions. For instance, Landers (2009) found that older students seem to prefer the OL mode. Students in undergraduate-level BL courses also tend to outperform those at the graduate level (Bernard et al., 2014; Means et al., 2009, 2013). Furthermore, learners oriented towards information and ideas appear to be more satisfied with the online components of BL, while those more people and feelings oriented showed higher satisfaction with f2f components (Akkoyunlu & Yilmaz-Soylu, 2008). Despite these trends being noted in two recent BL meta-analyses, these findings are statistically insignificant.

A common thread across BL studies is that, regardless of the type of learner, extra attention should be paid to developing additional student support to reduce the dependence on the teacher and to assist with self-regulated learning skills (Bernard et al., 2014; Bonk & Graham, 2006; McGee & Reis, 2012; Schmid et al., 2014; Torrisi-Steele & Drew, 2013).

Assessment in BL

Only 2.36% of all articles on BL in higher education, indexed in the Web of Science, addressed the topic of assessment (Torrisi-Steele & Drew, 2013). Consequently, recommendations related to assessment in BL practices are limited. In their synthesis of best practices, McGee and Reis (2012) report that practitioners prefer BL assessment to be conducted online, along with traditional assessments such as quizzes, exams, and essays. They also acknowledge the interest in evaluating projects, threaded discussions, and presentations, as well as assessing groups in collaborative contributions rather than individuals. McGee and Reis (2012) note that if BL assessment is conducted in the f2f format, then it also tends to be traditional, e.g., final exams, term papers, and so on. In conclusion, the authors confirm that the minimal presence of assessment in BL research is puzzling. They also point out that such conservative focus of BL assessment seems to mismatch the diversity of learning activities promoted by BL practitioners.

Instructor's Role in BL

Besides assessment, a further under-represented theme in the research relates to the role of the instructor (or teacher). Two meta-analyses reported the rather obvious fact that the teacher's role has a significant influence on student learning outcomes. For example, in the results of their DE meta-analysis, Zhao et al. (2005) reported that when instructor involvement is low, the outcomes of DE are not as positive as those of fully f2f classes. However, when instructor involvement in DE is at its highest, learning outcomes show a significantly better effect than those of f2f. Similarly, Means et al. (2013) showed the significantly high effect that instructor-directed (expository) instructional practices can have on academic achievement ($g+=0.386$). Although, as pointed out by Graham (2013), neither of these studies actually identified the aspects of instructor involvement that facilitated student learning.

Although the meta-analyses and systematic reviews lack detail on the types of instructor involvement that improve student outcomes, further insight can be gained from primary research studies. For instance, Shea and Bidjerano (2013) demonstrate that students in BL courses report much higher levels of instructional design, facilitation of productive discourse, and direct instruction — all elements of teaching presence (Garrison, Anderson, & Archer, 2001). The authors argue that this student perception may explain the higher effect sizes related to academic performance in BL as compared to those of OL or f2f. Prior OL research has demonstrated that teaching presence can predict levels of social presence and that it influences cognitive presence.

The State of BL Research

A further prominent theme relates to the state of BL research itself. That is, undertaking specific research on how the field is evolving through for example the use of bibliometrics and content analyses. For instance, Halverson et al. (2012) analyzed high-impact scholarship in the field, reviewing the most cited articles, books, authors, and influential journals. Drysdale et al. (2013) also conducted a thematic analysis of doctoral dissertations, as well as a thematic analysis of the high-impact scholarship (Halverson et al., 2014). Torrisi-Steele and Drew (2013) undertook a similar task, reviewing and thematically coding all BL research on higher education indexed by the Web of Science. In addition, Bliuc, Goodyear, and Ellis (2007) conducted a review of methodological choices and research focus in student experiences of BL, while Arbaugh (2014) reviewed academic work on BL in management education.

Several of these systematic reviews report that the majority of primary research on BL can be classified as *how-to* papers related to instructional design or best practices reported through single-case experiences at the course, program, or faculty level of implementing a blended course (Arbaugh, 2014; Halverson et al., 2014; Torrisi-Steele & Drew, 2013). This is consistent with the reported dominant methodologies, i.e., the majority of research has been derived from "teachers as researchers analyzing their own students' experiences of BL" (Bliuc et al., 2007, p. 235). Such a trend illustrates that BL practice has predominately been implemented "bottom-up" by individual teachers in their own classrooms in a desire to improve student learning (Drysdale et al., 2013).

The authors of systematic reviews of the BL research are consistent in their observations regarding the state of that research. There is agreement that the field of BL has matured (Arbaugh, 2014; Drysdale et al., 2013; Halverson et al., 2012) but still has a disconnect between BL practice and theory (Drysdale et al., 2013). To date, BL relies heavily on OL theories (Arbaugh, 2014), as there has been little scholarly work on the development of new theories or modifications to established theory (Halverson et al., 2014). To address this disconnection, there is a need for theories that can better explain the influence of blending practices on student learning (Graham, Henrie, & Gibbons, 2013).

Researchers also highlight significant gaps in the current research. First, the role of the instructor is not sufficiently addressed, nor are the staff or institutional perspectives due to the lack of information on professional development and BL institutional policy and adoption (Drysdale et al., 2013; Halverson et al., 2014; Torrisi-Steele & Drew, 2013). Second, both state-of-the-field reviews and meta-analyses that address the convergence of technology with f2f contexts suggest that future directions for research include investigating blended instructional practices, specifically their relationship to student motivation and engagement, with particular focus on the student characteristics that benefit most from set designs. Finally, suggestions for further research include investigating the role of learner choice and self-regulated learning (Bernard et al., 2014; Drysdale et al., 2013; Graham, 2006; Means et al., 2013).

Institutional Adoption

Only one systematic review on the issue of BL adoption, by Sharpe, Benfield, Roberts, & Francis (2006), was found in our search of the literature. This review does not fully fall under the broad definition of BL adopted for this synthesis, as it deals with the adoption of LMS/VLE-supported f2f classrooms (excluding those combining online and f2f modes). However, the Sharpe et al. study is highly relevant as it highlights the approaches and processes that have promoted BL adoption. More specifically, Sharpe et al. observed that a major advantage of adopting BL has been its ambiguous definition, "which allows staff to negotiate their own meaning" (p. 4). In line with that, Picciano, Dziuban, & Graham (2013) observe that there are no reliable estimates of the number of students enrolled in BL. Essentially, faculty are not fully cognizant of when they are, or are not, teaching in BL format. Furthermore, colleges and universities do not readily keep records of faculty who teach blended courses (Picciano et al., 2013).

Besides the general lack of studies reviewing adoption experiences, no studies were identified that analysed the various reports and models related to the cost-effectiveness of BL. Although, Graham (2013) has recently noted that cost-effectiveness is an obvious rationale driving institutions to adopt BL. He reviewed positive experiences of return on investment reported throughout both corporate (e.g., IBM, Intel) and higher educational contexts (e.g., University of Central Florida). Corporations list such factors as reduction in wait times for training, reduction in training hours and associated salary expenses, and reduction in training costs to be relevant for cost-effectiveness (Graham, 2013).

CONCLUSIONS AND IMPLICATIONS FOR RESEARCH AND PRACTICE

This report presented a synthesis of the themes and findings from some 20 meta-analyses and systematic studies to offer an evidence-based perspective on the practices known as Blended Learning — a combination of f2f and web-based, technology-mediated educational contexts. Studies investigating BL have evolved from grassroots practice into a maturing research field. This is well evidenced in the changing definitions, growing number of doctoral dissertations, and expanding conversations presently taking place in the primary research. This transformation of the BL field has been fueled by rapid advances in technology, facilitating OL instruction that mirrors the properties of f2f contexts, thus enabling the rapid convergence of these instructional modalities.

Despite the development of BL, its current dependence on its "parent" modes of delivery is omnipresent in every theme synthesized in this report. First, findings from the effectiveness studies conclude that combining f2f and online modes of delivery has a higher effect on student academic achievement than either one of the modes independently. However, so far there is limited evidence as to what particular methods of blending impacts academic achievement. Second, recommended instructional practices mirror existing best practices developed within OL and f2f modes, with heavy reliance on OL/DE. Course (re-)design maintains its focus on approaches that help capitalize on the perceived benefits from these separate modes of delivery, e.g., the enhanced social presence and relationship building through f2f modes (Rovai & Jordan, 2004; Shea & Bidjerano, 2013), and the learner control and the flexibility of access through online modes (Graham, 2013). Third, the research field relies heavily on concepts developed in OL/DE while lacking its own theories to address blending itself. Consequently, despite the abundance of individual accounts of blended experiences, there is a lack of empirical research that would feed back to refine the blending-specific theoretical lenses.

Such dependence on the two delivery modes (f2f/OL) from which BL emerged, results in little evidence about the actual *blending* — a diverse set of practices with the potential to overgrow its status of a combined delivery mode to become an effective pedagogical method. While the choices behind pedagogy are highly related to how the process of learning unfolds, there is actually little evidence about *learning* in BL practices. Despite their complex and nuanced research design, recent BL effectiveness studies fall under the category of "surface learning research" (Ross & Morrison, 2014), as they fail to show the effect of various types of learning while maintaining focus on academic achievement and performance. Furthermore, instructional practices barely address student-content interactions, and the role of teacher has been mostly neglected. Finally, research does not undertake theories that synergistically unite the learning that takes place across the physical and the virtual.

BL research has provided some evidence that certain types of technology are more conducive to producing higher measured learning outcomes, which brings the medium back into the conversation about learning and pedagogy (Clark, 1983; Kozma, 1991, 1994). Moreover, the development of technological affordances and technological ubiquity in some parts of the world suggest that technology can help extend informal learning processes, both socially and cognitively. In other words, besides bridging the psychological distance between the separated participants in the learning process, despite their perceived proximity (Thompson, 2007), pedagogical activities mediated by technology need to fit what that technology can afford.

In sum, based on the evidence synthesized in this report, we argue that deeper insights and focus on digital learning — i.e., learning mediated by various technological methods of transcending physical and virtual space — would allow practitioners of BL to make better pedagogical choices. In addition, a more detailed reporting of BL practices, both by administrators and researchers, will aid our understanding of the nuances of BL beyond that of a combined delivery mode. Last, the focus on the interplay between learning-processes and technological affordances would allow researchers of BL to reframe their inquiries in a way that leads to further maturation of the field.

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THE HISTORY AND STATE OF ONLINE LEARNING

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ABSTRACT

This report analyzes findings from research into online learning in order to provide guidelines for further research and practice. Within this tertiary study, we performed a systematic review of thirty-two second-order studies that address issues of teaching and learning in online settings. From the examination of the studies included in the review, four prominent topics emerged: i) comparison of online learning with the traditional classroom, ii) comparison of various instructional practices within two or more online courses, iii) perspectives of students and instructors regarding learning and teaching in online settings, and iv) adoption of online learning in institutions of higher and adult education. Except for showing *no significant difference* in effectiveness of online learning compared to traditional face-to-face settings, the studies within the first theme also provided directions for further research, necessary to better understand what practices work best in online settings. Our findings further indicate that contemporary research into online learning almost univocally agrees that structured online discussions with clear guidelines and expectations, well-designed courses with interactive content and flexible deadlines, and continuous instructor involvement that includes the provision of individualized, timely, and formative feedback are the most promising approaches to fostering learning in online environments. However, this also implies a more complex role for the instructor in online settings, and a need for research on instructional strategies that would allow for the development of student self-regulatory skills. Implications for future research and practice, as well as the position of online learning within the broader aspect of digital learning are further discussed.

INTRODUCTION

From the first offering of a fully online course in 1981 (Harasim, 2000) it was clear that this new model of education had much potential to impact the design and delivery of education at all levels. Initial attempts to offer education online tended to replicate existing distance education practice. As such, online education was text heavy, and mirrored the previous postal packages of handbooks and required readings (Garrison, 2011; Harasim, 2000). However, these early offerings did provide rapid and valuable lessons into what constitutes effective learning in this new mode of education delivery. For instance, long textual lectures were clearly not suitable for the online environment and students did not readily engage in discussion activity (Harasim, 2000). These early insights guided the development of online learning (technical and pedagogical) including the introduction of more collaborative learning activities, such as course discussions.

Online forum discussions have remained an essential component of online education (Harasim, 2000) and even now continue to be central in massive open online courses (MOOCs). The current proliferation of technological affordances and pedagogical developments influence the evolution of online learning and the transformation of teaching and learning in higher and adult education (Clardy, 2009; Garrison, 2011), allowing for broad adoption of distance and online education and incorporation of more interactive approaches to learning (Anderson, 2009).

Although online learning presents a form (i.e., the fifth generation[1]), of distance education (Taylor, 2001), it has its own provenance (Ally, 2004; Garrison, 2011). Online and traditional distance education approaches do share common attributes, including the emphasis on "any time — any place" learning, the assumption that students are at a distance from the instructor (Moore, 1993), and the use of some form of technology to access course materials (Ally, 2004; Garrison, 2011; Harasim, 2000). However, in part due to the interactive nature of online learning, it "is very different from traditional distance education with its [DE] historical focus on content delivery and independent learning [... and] has evolved from a different field of theory and practice" (Garrison, 2011, p. 3). Given that online learning draws from constructivist approaches to learning, it presents a significant shift in comparison to traditional distance education, which is based on "the ideal of autonomy and the industrial production of prepackaged study materials" (Garrison, 2011, p. 3).

Online learning transforms education from instructor-centered (traditional classroom) to student-centered, where students have more responsibility for their learning (Koch, 2014; Peterson, 2008). Given that students are now able to choose what to learn, when to learn, and who to learn with, a certain level of self-directedness is necessary in order to succeed in an online course. On the other hand, the lack of unity of time and place leads to greater interdependence between students and instructors and significantly changes the instructor's role within this "new environment" (Harasim, 2000; Koch, 2014). For example, online asynchronous communication results in new engagement and learning patterns. Peer interaction is high and, unlike more traditional approaches, "there is a multiplicity of voices or perspectives, and students are exposed to a variety of possible interpretations or solutions, rather than just the 'right' or the 'textbook' answer" (Harasim, 2000, p. 16). Instructor participation, on the other hand, is still significant and highly valuable; however,

1 Taylor (2001) identified the following five generations of distance education development: 1) the correspondence model, 2) the multi-media model, 3) the tele-learning model, 4) the flexible learning model, and 5) the intelligent flexible learning model. The fifth generation includes online interactive multimedia, Internet-based access to resources, computer-mediated communication using automated response systems, and campus portal access to institutional processes and resources.

the online environment assumes a "more passive and nondirective role" in teaching and learning in these settings (Koch, 2014, p. 1385). In general terms we would agree with Koch's (2014) view of the instructor's role. However, we would prefer a more inclusive definition that reflects Marks, et al., (2005) earlier perspective. That is, the instructor is not simply passive in this "new" learning environment. The context calls for a more active "supportive and guiding" role (Marks, Sibley, & Arbaugh, 2005, p. 549).

The advances in educational technology and increased interest in asynchronous discussion groups, gave rise to the term *e-learning* in the mid-1990s, which aimed to describe learning delivered *fully* online and learning that combines online with face-to-face components (*blended or hybrid learning*) (Garrison, 2011). With the continued growth and interest in online learning, many researchers aimed to investigate the equivalency of these forms of instruction against traditional on-campus courses. Researchers began to examine: i) whether new technological affordances were more effective than traditional modes of learning (Cook, Levinson, & Garside, 2010; Means, Toyama, Murphy, Bakia, & Jones, 2009; Tallent-Runnels et al., 2006), ii) what best instructional practices foster learning in online settings (Bernard et al., 2009; Borokhovski, Tamim, Bernard, Abrami, & Sokolovskaya, 2012; Darabi, Liang, Suryavanshi, & Yurekli, 2013), and iii) how the roles of instructors and learners evolved within these new educational models (Carroll, Booth, Papaioannou, Sutton, & Wong, 2009; Peterson, 2008; Styer, 2007). Nevertheless, the challenge in obtaining a clear understanding of best practices in online learning settings originates in the "multiplicity of terms used to describe a phenomenon" (Rudestam & Schoenholtz-Read, 2010).

The wide variety of terms used to describe the same or similar learning approaches and the high heterogeneity among the results presented were the main motivations for conducting this study. Thus, the purpose of this report is to summarize findings from contemporary research into online learning in order to understand its current state and to identify potential guidelines for further research and practice.

OPERATIONAL DEFINITIONS:

Changing the Landscape of the Language

One of the challenges for research into online learning is the lack of an authoritative definition of what constitutes this mode of education delivery. As well noted by Clardy (2009), Garrison (2011), and Rudestam and Schoenholtz-Read (2010) (among others), there is a wide diversity of terms used to describe online learning and what activities neatly fit under the umbrella of purely online learning. The most commonly used terms to describe online learning include *web-based learning, e-learning, Internet-based learning, online learning, distance learning, distance education, distributed learning, computer-mediated learning, and computer-assisted learning* (Ally, 2004; Means et al., 2009; Rudestam & Schoenholtz-Read, 2010; Tallent-Runnels et al., 2006). Figure 1 shows the distribution of the most commonly used keywords over years. Online learning is on the other hand, considering that online learning is considered as the "fifth generation" of distance education (Taylor, 2001), as well as the current state of the available technological affordances, it is rather challenging to identify what is considered *pure* online learning. For example, most studies analyzed for this report (Means et al., 2009; Styer, 2007; Tallent-Runnels et al., 2006), defined online learning as a subset of distance education; that is, courses delivered completely online, excluding "print-based correspondence education, broadcast television or radio, videoconferencing, videocassettes, and stand-alone educational software programs" (Means et al., 2009, p. xii). However, it is questionable whether videoconferencing in the forms available today (such as Google Hangouts or Skype) should be a part of distance education only, or perhaps both distance and online education. Therefore, for the purpose of our study, we build further on definitions proposed by Clardy (2009), Gikandi, Morrow, and Davis (2011), Means et al. (2009), Schlosser and Simonson (2006), Styer (2007), and Tallent-Runnels et al. (2006), and we define distance and and online learning as:

> **Distance education** is teaching and planned learning where the teaching occurs in a different place from learning, requiring communication through technologies and special institutional organization[2].

2 For further discussion on distance learning, please refer to the report entitled "The History and State of Distance Education."

Online learning is a form of distance education where technology mediates the learning process, teaching is delivered completely using the Internet, and students and instructors are not required to be available at the same time and place. It does not include more traditional distance education instruction methods, such as print-based correspondence education, broadcast television or radio, videoconferencing in its traditional form, videocassettes/DVDs and stand-alone educational software programs.

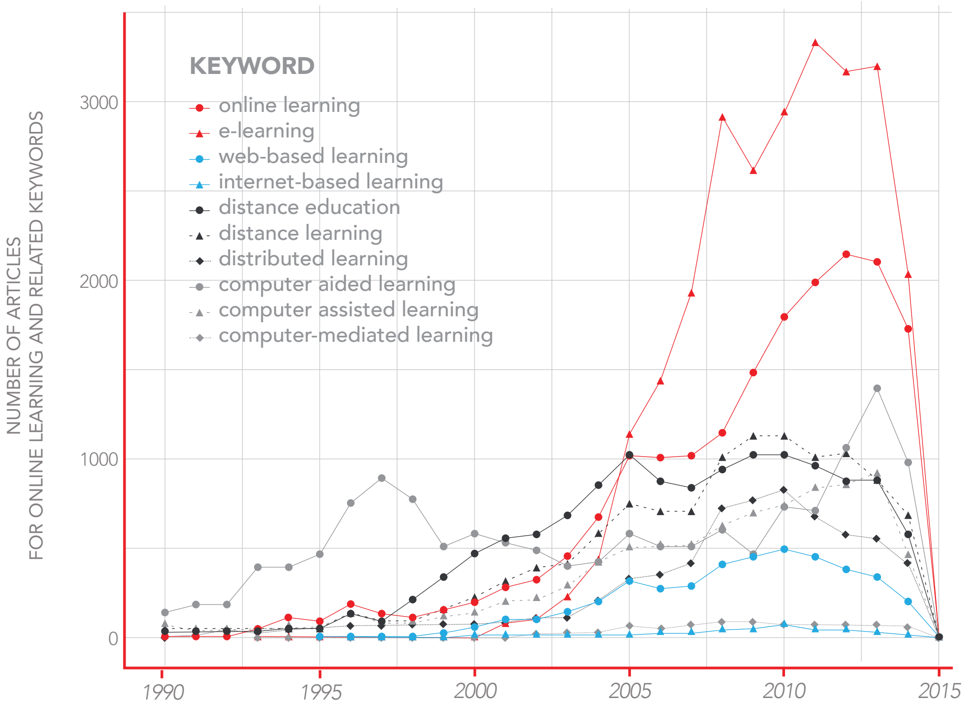

FIGURE 1 Distribution of studies on online learning with the most commonly used keywords used to describe learning delivered online, as indexed by Scopus.

It is interesting to note that terms such as computer-based instruction, web-based instruction, or problem-based learning, have become synonymous with distance (online) and blended learning. As such, a further challenge to synthesizing the findings of research on online learning involves the morphing or aggregation of these terms with online learning. Many studies analyzed learning and teaching in online and blended (hybrid) settings, without a clear distinction between the two approaches. In order to provide a more comprehensive description of the current state of the research and practice of online learning, we will refer to blended learning where appropriate. Therefore, in our study, blended learning is defined as follows:

> **Blended learning** refers to the practices that combine (or blend) traditional face-to-face instruction with online learning[3].

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3 For further discussion on blended learning, please refer to the report entitled "The History and State of Blended Learning."

METHOD

Research questions

The aim of this tertiary study is to identify themes that have framed research into online learning and to summarize the current state of research and practice, as well as to reveal prospective directions for further research and practice. Therefore, we defined the following questions to guide our research:

RQ1. *What are the main topics emerging from the contemporary literature on online learning?*
RQ2. *What is the state of research and practice in online learning, as reflected through meta-studies and systematic literature reviews?*

Literature Search and Inclusion Criteria

We performed a computer-based literature search (with no time limit) through three phases (Figure 2). The first phase included searching the ERIC, Scopus, PsychINFO, PubMed, and ProQuest databases. In order to be included in our analysis, the following search criteria had to be met:

> Title, abstract, and/or keywords must contain at least one of the following terms: *meta-analysis, meta-synthesis, scoping study*, **OR** *systematic review* **AND**
>
> Title, abstract, and/or keywords must contain at least one of the following terms: *distance learning, distance education, blended learning, blended education, hybrid education, hybrid learning, online learning, online education, e-learning, web-based learning*, **OR** *web-based education*.

The initial search resulted in a list of 306 studies, including those on online, blended, and distance learning. Further, we searched Google Scholar for different combinations of the above-mentioned terms. Specifically, we included one of the terms from the first group of concepts (meta-analysis, meta-synthesis, scoping study, and systematic review), and one of the terms from the second group (*distance learning, distance education, blended learning, blended education, hybrid education, hybrid learning, online learning, online education, e-learning, web-based learning, and web-based education*). The second phase resulted in an additional 19 studies that satisfied the search criteria. Finally, we manually searched the following journals: *American Journal of Distance Education, Journal of Distance Education, Distance Education, International Review of Research in Distance and Open Education, Journal of Asynchronous Learning Networks, Journal of Technology and Teacher Education, Career and Technical Education Research, Internet and Higher Education, Journal of Computing in Higher Education, and Computers and Education* to identify relevant studies. The list of relevant journals was obtained from the most influential meta-analyses in distance and online education (Bernard et al., 2009; Means, Toyama, Murphy, & Bakia, 2013). The third search phase resulted in an additional 14 studies, providing a final list of some 339 papers.

After completing the search, three researchers coded the identified studies as distance, online, and/or blended learning. The coding process comprised reading the title, keywords, and abstract for each study and assigning one or more labels, indicating that study predominantly analyzed distance, online, and/or blended learning. In cases where a code could not be assigned based on the available information, the coders examined the article in detail (e.g., reading the Methods section) to identify the most appropriate categorization. The coding process and search yielded a total of 102 second-order studies that satisfied the criteria for inclusion in this review:

- **i.** *the study applied a systematic approach (e.g., meta-analysis, systematic literature review, meta-synthesis) in analyzing studies that addressed any aspect of online learning*
- **ii.** *the study analyzed online along with distance and/or blended learning*
- **iii.** *the study was published in a peer-reviewed journal/conference proceedings or in a dissertation, available in English*
- **iv.** *the study participants in primary studies were non-disabled undergraduate students, graduate students, and/or employees (e.g., teachers and nurses)*
- **v.** *the study analyzed K–12 education along with higher and/or adult education*

After the final screening of the 102 studies, we identified 32 studies that met the above-defined criteria for inclusion. These studies all defined online learning equivalently to the definition provided in this report. We also identified 37 studies related to distance education and 20 second-order studies that analyzed teaching and learning practices in blended learning.

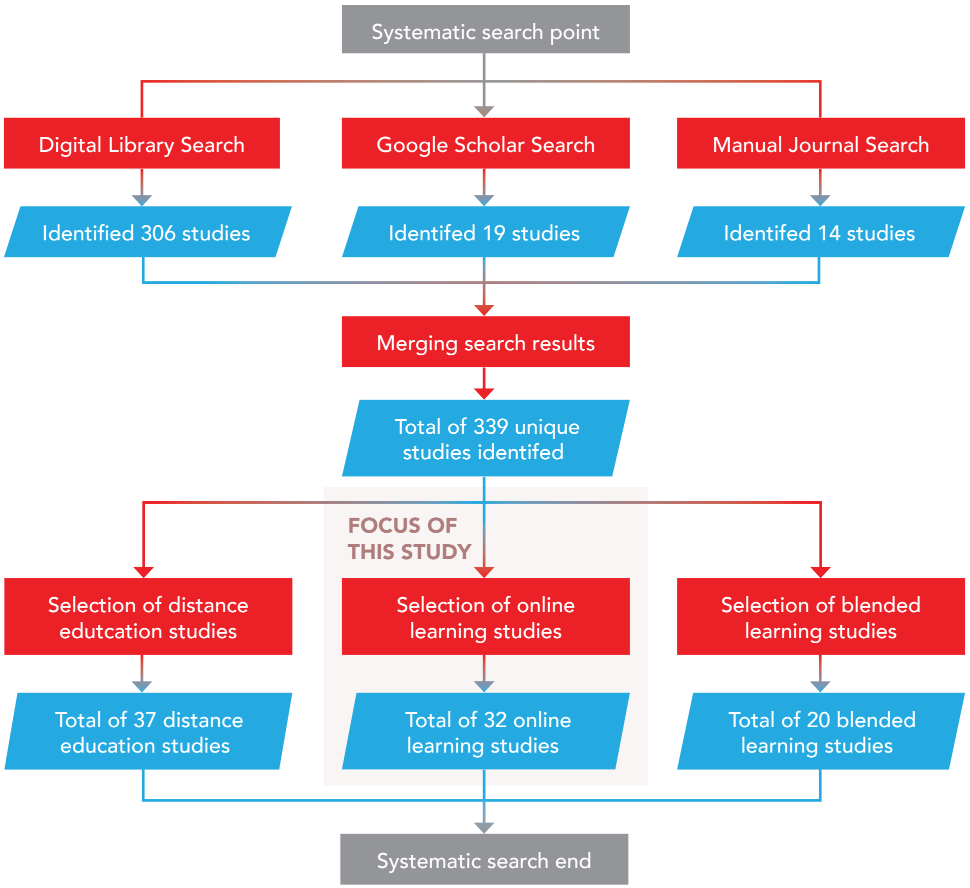

FIGURE 2 The systematic literature search process

Analysis and Data Set

To address the research questions, we performed a synthesis of the systematically selected literature. Given the focus of the study, we aimed to identify the most prominent themes within the second-order studies that satisfied the specified inclusion criteria and to summarize the findings on the state of research and practice in online learning at the time when the studies were conducted or for a set period. Thus, each individual study was coded for the following attributes: *author(s), publication year, publication venue* (the name of the journal/conference), *keywords* (keywords assigned by author), *type of publication venue* (journal, conference, or dissertation), *important definitions* (distance, online, and/or blended learning), *domain* (distance, online, and/or blended), *level of education, type of method applied* (e.g., meta-analysis, scoping study, systematic literature review), *number of primary studies analyzed, years analyzed, research questions, major topics, effect sizes reported* (yes/no), and *main findings, methodology applied in the primary studies*. Coding was performed by the first author only, and further discussed with the co-authors until a consensus was reached.

Table 1 shows the author(s), title, publication year, study type, number of primary studies analyzed, and the number of participants[4] for all the studies included in this report. The vast majority of second-order studies (i.e., 24) were published in journals (Figure 4). We also included five theses, one conference paper, and one report. Figure 3 also shows that literature reviews (including systematic reviews) were the most commonly utilized approach, followed by meta-analyses and a single scoping study.

4 Several studies did not report precise information about the number of participants included, thus we noted "more than" a certain number of participants. For example, Tallent-Runnels et al. (2006) in one case reported "30 undergraduate students," while in the other case it was "Those who successfully completed any of 2,300 college courses over 2-year period (2000–2002)" (p. 44, Appendix).

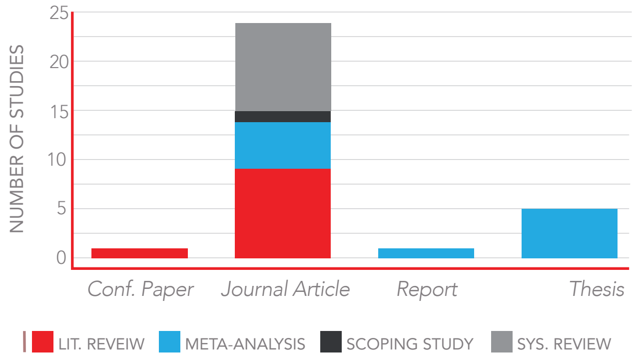

FIGURE 3 Number of studies per type of the publication venue (i.e., conference, journal, report, and thesis), with bars showing the respective number of papers using the method applied (i.e., literature review, meta-analysis, scoping study, and systematic review)

Only four studies included here were published before 2009 (Figure 4). Our search also revealed meta-analyses and literature reviews published before 2006; however, these were primarily focused on distance education rather than specifically on online learning (e.g., Bernard et al., 2004). Given that most of the studies were published during and after 2009, it is no surprise that the majority of those second-order studies analyzed the period between 2000 and 2008 (Figure 5). Finally, the number of primary studies analyzed within the second-order studies varied (Figure 5), whereas the primary focus in meta-analysis, systematic and literature reviews was on the Higher and Adult education (Figure 5).

Thirteen (out of 32) studies reported effect sizes, and those studies focused primarily on the effectiveness of online learning instruction compared to face-to-face learning or to another online course. Three studies (i.e., Jurewitsch, 2012; Beinkowski, Feng, & Means, 2012; Sitzmann, Kraiger, Stewart, & Wisher, 2006) focused solely on experimental and quasi-experimental studies, while only five analyses (Cook, Levinson, Garside, et al., 2010; Cook, Garside, Levinson, Dupras, & Montori, 2010; Cook, Levinson, & Garside, 2010; Du et al., 2013; Wong, Greenhalgh, & Pawson, 2010) included primary studies that used randomized trials (all studied online learning in medical education).

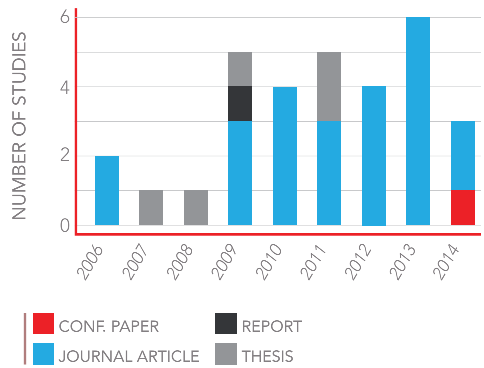

FIGURE 4 The count of second-order studies published with the respective year, with bars showing counts for the publication venue type (i.e., conference, journal, report, or thesis)

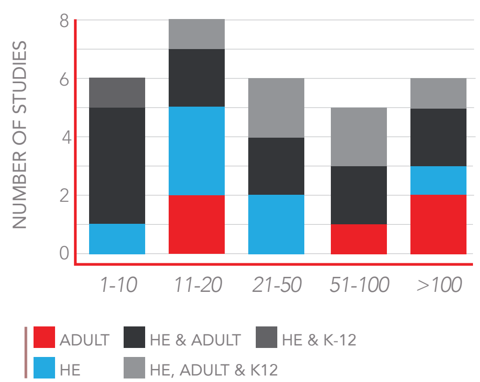

FIGURE 5 Count of primary studies analyzed within the second-order study, with bars showing the counts of second-order studies that addressed a particular level of education

Limitations and Challenges of the Synthesis

The diversity in terms used to describe distance, online, and blended learning provided a substantial challenge for undertaking this systematic review. Researchers frequently defined the three learning approaches in multiple ways. Therefore, the majority of initially obtained second-order studies required a detailed investigation of methods applied and the description of the primary studies included in those reviews. Although we followed the definitions provided in the previous section, inconsistency in the terminology used left a certain level of subjectivity in applying the specified inclusion criteria, leading to potential challenges in internal validity. Moreover, the emergence of new technological affordances and the dearth of second-order studies related to certain themes (e.g., assessment and teaching practices in online education) may limit the generalizability of these findings.

TABLE 1 Second-order studies included in the analysis, with the information about the author(s), title, type of the study, number of primary studies included, number of participants, and publication year

	Study	Title	Type	Num. Studies	Num. Part.
1	Chumley-Jones, Dobbie, & Alford (2002)	Web-based learning: Sound educational method or hype? A review of the evaluation literature	LR	76	>5,471
2	Tallent-Runnels et al. (2006)	Teaching courses online: A review of the research	LR	76	>10,000
3	Sitzmann et al. (2006)	The comparative effectiveness of web-based and classroom instruction: A meta-analysis	MA	96	19,331
4	Styer (2007)	A grounded meta-analysis of adult learner motivation in online learning from the perspective of the learner	MA	14	>4,000
5	Bernard et al. (2009)	A meta-analysis of three types of interaction treatments in distance education	MA	74	NR

TABLE 1 (Cont.) Second-order studies included in the analysis, with the information about the author(s), title, type of the study, number of primary studies included, number of participants, and publication year

	Study	Title	Type	Num. Studies	Num. Part.
6	Carroll et al. (2009)	UK health-care professionals' experience of on-line learning techniques: A systematic review of qualitative data	SR	19	>2,290
7	Means et al. (2009)	Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies	MA	45	>1,635
8	Arbaugh & Benbunan-Fich (2007)	Research in online and blended learning in the business disciplines: Key findings and possible future directions	LR	182	NR
9	Cook, Levinson, & Garside (2010)	Time and learning efficiency in Internet-based learning: A systematic review and meta-analysis	SR	20	1,814
10	Cook, Garside, et al. (2010)	What do we mean by web-based learning? A systematic review of the variability of interventions	SR	266	NR
11	Cook, Levinson, Garside, et al. (2010)	Instructional design variations in internet-based learning for health professions education: A systematic review and meta-analysis	SR	51	8,416
12	Landers (2009)	Traditional, web-based, and hybrid instruction: A comparison of training methods	MA	126	NR
13	Wong et al. (2010)	Internet-based medical education: a realist review of what works, for whom and in what circumstances	SR	249	NR
14	Gikandi et al. (2011)	Online formative assessment in higher education: A review of the literature	SR	18	NR

TABLE 1 (Cont.) Second-order studies included in the analysis, with the information about the author(s), title, type of the study, number of primary studies included, number of participants, and publication year

	Study	Title	Type	Num. Studies	Num. Part.
15	Macon (2011)	Student satisfaction with online courses versus traditional courses: A meta-analysis	MA	13	2,071
16	Šumak, Heričko, & Pušnik (2011)	A meta-analysis of e-learning technology acceptance: The role of user types and e-learning technology types	MA	42	12,986
17	Cohen, Carbone, & Beffa-Negrini (2011)	The design, implementation, and evaluation of online credit nutrition courses: A systematic review	SR	9	1,017
18	Roberts (2011)	Best instructional practices for distance education: A meta-analysis	MA	59	5,779
19	Borokhovski et al. (2012)	Are contextual and designed student-student interaction treatments equally effective in distance education?	SR	32	3,634
20	Jurewitsch (2012)	A meta-analytic and qualitative review of online versus face-to-face problem-based learning	MA	5	291
21	Peterson (2008)	A meta-analytic study of adult self-directed learning and online nursing education: A review of research from 1995 to 2007	MA	9	NR
22	Wolbrink & Burns (2012)	Internet-based learning and applications for critical care medicine	LR	6	NR
23	Ravenna, Foster, & Bishop (2012)	Increasing student interaction online: A review of the literature	LR	19	>2,196
24	Cook & Steinert (2013)	Online learning for faculty development: A review of the literature	LR	20	1,458

TABLE 1 (Cont.) Second-order studies included in the analysis, with the information about the author(s), title, type of the study, number of primary studies included, number of participants, and publication year

	Study	Title	Type	Num. Studies	Num. Part.
25	Darabi et al., 2013	Effectiveness of online discussion strategies: A meta-analysis	MA	8	NR
26	Du et al. (2013)	Web-based distance learning for nurse education: A systematic review	SR	9	1,125
27	Stepanyan, Littlejohn, & Margaryan (2013)	Sustainable e-Learning: Toward a coherent body of knowledge	SR	46	NR
28	Chia-Wen, Pei-Di, & Yi-Chun (2013)	Research trends in meaningful learning research on e-learning and online education environments: A review of studies published in SSCI-indexed journals from 2003 to 2012	LR	38	NR
29	Thomas (2013)	Exploring the use of asynchronous online discussion in health care education: A literature review	LR	14	1,179
30	Jumaat & Tasir (2014)	Instructional scaffolding in online learning environment: A meta-analysis	LR	10	NR
31	Koch (2014)	The nursing educator's role in e-learning: A literature review	LR	40	NR
32	Singh & Hardaker (2014)	Barriers and enablers to adoption and diffusion of eLearning : A systematic review of the literature - A need for an integrative approach	SR	340	NR

Note: SR – systematic review, MA – meta-analysis, SC – scoping study, LR – literature review; NR – not reported.

SYNTHESIS OF SELECTED SCHOLARLY WORK

From the examination of the 32 second-order studies, four prominent themes were identified:

- **vi.** *comparison of online learning with the traditional classroom*
- **vii.** *comparison of instructional treatments within two or more online courses*
- **viii.** *learning and teaching in online settings from the perspective of students and instructors*
- **ix.** *adoption of online learning in institutions of higher and adult education*

Comparison of online learning with the traditional classroom

Soon after online learning emerged as a learning approach, certain advantages became apparent — such as flexibility, alleviation of overcrowded classrooms, increased enrollment, reduced cost, and increased profit (Clardy, 2009; Grandzol & Grandzol, 2006). On the other hand, wide adoption of online learning also revealed various disadvantages of teaching and learning in the online environment — such such as the cost of training instructors, feelings of isolation, and technology gaps. Therefore, recognizing a great opportunity and numerous potential threats with the introduction of a new educational medium, instructors, policymakers, and other relevant stakeholders raised questions about whether instructional technology affects learning and contributes to student achievement (Grandzol & Grandzol, 2006; Means et al., 2009; Ross, Morrison, & Lowther, 2010; Schmid et al., 2014). This resulted in the now well-known "great media debate" (Clark, 1983, 1994; Kozma, 1994) in which many researchers aimed to provide evidence about whether media influence learning or whether pedagogy is "all that matters" (Means et al., 2009; Sitzmann et al., 2006). Thus, the theme attracting the most attention in the existing research on online learning is the effectiveness of learning in online learning practices. Initially, researchers compared online learning with the traditional classroom in order to confirm whether the new learning mode worked. Specifically, those studies compared the two delivery media in terms of effectiveness for improving learning outcome (Cook, Garside, et al., 2010; Cook, Levinson, & Garside, 2010; Landers, 2009; Means et al., 2009; Sitzmann et al., 2006), student satisfaction with online courses (Chumley-Jones, Dobbie, & Alford, 2002; Du et al., 2013; Macon, 2011; Sitzmann et al., 2006), time and learning efficiency (Cook, Levinson, & Garside, 2010), and the effectiveness of problem-based learning (Jurewitsch, 2012). Researchers also analyzed whether contextual or methodological factors moderated the comparison between the two and, if so, which had greater impact. Most studies have demonstrated that online learning is (at least) as effective as face-to-face learning. Hence, existing research (e.g., Bernard, et al., 2009; Cardy 2009) has suggested using an alternate approach to researching online learning and that studies comparing online with classroom practice do not provide the necessary insights into best practices that can effectively inform learning and teaching more broadly. Most second-order studies conducted on the topic of online learning found support for Clark's (1983) view of technology and pedagogy — i.e., pedagogy and instructional method affect learning while "media are mere vehicles that deliver instruction but do not necessarily influence student achievement" (Clark, 1983, p. 445).

Comparison of instructional treatments within two or more online courses

Besides knowing that distance and online education "can be much better and also much worse" (Bernard et al., 2009, p. 5) than traditional learning, the studies that compared two did not reveal much about "what works best" in online learning (Bernard et al., 2009; Clardy, 2009). Roberts (2011) further stated, "media comparison studies have served their purpose in pointing the way to the next generation of studies" (p. 61). Therefore, numerous studies comparing various instructional treatments in distance education in general, and online learning in particular, have emerged. The importance of various interaction treatments (e.g., student-student, student-teacher, student-content interactions) for student achievement (Bernard et al., 2009; Borokhovski et al., 2012), fostering collaboration among students, increasing engagement with content, and supporting interaction with instructors (Darabi et al., 2013; Ravenna, Foster & Bishop, 2012; Thomas, 2013), were some of the most prominent themes in this line of research. The studies tended to indicate that *asynchronous, purposefully structured discussions, with clear guidelines and timely, summative, and individualized feedback from the instructor or peer students are the best instructional strategies to support learning in an online environment* (Borokhovski et al., 2012; Darabi et al., 2013). Means et al. (2009) also showed that *incorporating mechanisms to prompt reflection and self-assessment tend to be more successful than learning in groups. There-*

fore, different practices to support asynchronous online discussions (Thomas, 2013) and various instructional scaffolds — e.g., *metacognitive scaffolding, strategic scaffolding, and question prompts* (Jumaat & Tasir, 2014) — were examined in order to reveal what works best within the online learning paradigm. Furthermore, summarizing research on online teaching and learning, Tallent-Runnels et al. (2006), highlighted the importance of c*reating learning communities, instructor-active participation through scaffolding and timely (formative) feedback, and the promotion of student-instructor and student-student interactions as significant aspects of an online course*. Thus, these second-order studies of instructional practices in online learning tend to agree on several aspects:

- **i.** *online courses should provide good support for student-student and student-content interactions*
- **ii.** *those interactions should include co-operative and collaborative learning*
- **iii.** *the most common approach to fostering interactions within the online learning environment is through structured online discussions*
- **iv.** *the instructor's moderating role in guided discussions is of great importance*
- **v.** *instructors should be able to provide timely, formative feedback on learning progress for every student*
- **vi.** *instructional scaffolds should be wisely considered and applied according to student needs*
- **vii.** *content provided should be visually engaging and interactive*

Considering these general guidelines for organizing online courses, the expected amount of participation in course design and facilitation seems hardly sustainable for instructors (Moallem, 2003). Cook, Levinson, and Garside (2010) showed that instructional strategies that enhance feedback and interactivity tend to prolong learning time in the online learning environment; however, it seems that even more effort is needed from instructors to support learning in online settings than in face-to-face settings. Although Bernard et al. (2009), Borokhovski et al. (2012), and Ravenna et al. (2012) (among others) noticed that the instructor is "not alone" in that process, but rather a member of a team, and that some responsibilities can be delegated to students, the obvious line of further research might be on how to support instructors to teach more effectively.

Perspectives of students and instructors regarding learning and teaching in online settings

Another prominent line of research that emerged examined online learning from the student's perspective. For instance, the factors that motivate students to enroll in an online course (Styer, 2007), aspects that influence student satisfaction with the course and the instructor (Carroll et al., 2009; Tallent-Runnels et al., 2006), and the importance of self-directedness in online students (Peterson, 2008) were the most notable topics aimed at revealing/defining characteristics of the successful student/learner in online environments. Research revealed that students tend to value well-designed, frequently updated courses that incorporate extrinsic motivating factors, with tasks/examples immediately relevant for their practice, a reasonable level of control and flexibility (primarily in terms of deadlines), support to collaborate with their peers, and a high level of instructor involvement in providing summative and timely feedback (Carroll et al., 2009; Styer, 2007).

Despite the fact that most of the research on online learning stressed the importance of the instructor, and clearly the instructor's role within the online learning environment differs from the traditional classroom, there have been very few studies that investigated how teaching has evolved with the new learning paradigm (Koch, 2014). Given that the focus in course design has shifted from an instructor-centered to a student-centered role, where instructors need to take a more passive, non-directive position in leaving students to pace their own learning activities (Koch, 2014), it became clear that instructors need to redistribute their responsibilities among a team of instructors, or by assigning more obligations to students, in order to make their role sustainable.

Assessment is considered an essential component of formal higher education and effective learning (Gikandi et al., 2011). However, there is an evident lack of research on assessment in online education. Based on the 18 studies published between 2000 and 2010, Gikandi et al. (2011) identified validity, reliability, and dishonesty as the key components of assessment. Formative and immediate feedback, engagement with critical processes, and promotion of equitable education were recognized as the main opportunities facilitated by online formative assessment. The main findings of the Gikandi et al. (2011) study suggest that an "effective online formative assessment can foster a learner and assessment centered focus through formative feedback and enhanced learner engagement with valuable learning experiences" (Gikandi et al., 2011, p. 1). Furthermore, online formative assessment requires constant monitoring of student activity, using discussion tools, quizzes, and trace data from the learning management system and in turn fosters student engagement and self-regulation. Assessment still depends on the instructor's "belief" about what should be valued as learning. Therefore, further empirical research is necessary in order to inform effective practice.

Adoption of online learning in institutions of higher and adult education

Current research of institutional and administrative aspects of adoption of online learning showed that individual attitudes towards technology and digital literacy are the main factors influencing online learning adoption (Singh & Hardaker, 2014; Šumak, Heričko, & Pušnik, 2011; Tallent-Runnels et al., 2006). Although most contemporary institutions of higher education have developed policies for online courses, the main challenge is that some institutions still have to develop policies for support, course development, and assessment (Tallent-Runnels et al., 2006). Perhaps, the most comprehensive set of guidelines for adoption of online learning has been provided in Singh and Hardaker's (2014) study. Their findings suggest that:

> In deciding how online learning will be incorporated into current practices, all the interested parties should be included in the decision-making process
>
> A clear, strategic vision should be developed and communicated to all faculties and departments
>
> Such a significant decision for institutional development should not originate from an individual or a small group of top management; rather, policymakers must be aware of the "cultural configuration" within their organization in order for the project to succeed
>
> "Academics' fear" of innovations and loss of control over teaching must be considered by top management; the most prominent approach will consider motivational factors for each individual "and avoid imposing institutional constraints through standardized frameworks that assume a single solution for all eventualities"(p. 13)
>
> Institutional management needs to act as a role model in creating a culture that promotes the adoption of online learning

Cook and Steinert (2013) concluded that online courses were more likely to succeed when the course topic addressed a relevant need; supported collaboration, co-operative work, and social interaction; and provided reasonably flexible timelines to complete all the activities. On the other hand, Wolbrink and Burns (2012) argue that there are still challenges with the implementation of innovative and interactive online resources that would allow students actively to engage and attain hands-on skills (e.g., in critical care medicine). Singh and Hardaker (2014) further concluded that both institutional and individual factors should be considered in conjunction with modeling the adoption and diffusion of online learning. However, most lessons learned are based on anecdotal, descriptive studies that tend to offer insubstantial evidence to permit strong recommendations for online faculty development (Cook & Steinert, 2013), and more critical evidence around the sustainability of online learning is needed for policymakers and vital institutional decisions (Stepanyan, Littlejohn, and Margaryan, 2013).

CONCLUSION AND IMPLICATIONS FOR RESEARCH AND PRACTICE:

Towards a Model of Digital Learning

One of the most significant requirements for further adoption of online learning is the development of *well-designed courses with interactive and engaging content, structured collaboration between peers, flexible deadlines to allow students to pace their learning, continuous monitoring of student progress, and the provision of formative feedback when needed* (Figure 6). Certainly, every aspect of such a design can be interpreted in different ways. For example, a *well-designed course with interactive and engaging content* could have many interpretations, and it is probable that instructors in different settings will have different understandings and expectations as to what constitutes *well-designed* and *engaging*. It is important to note that early second-order studies, such as that by Tallent-Runnels et al. (2006), indicated that instructors requested support in online course development. However, even when such resources were provided, instructors seldom made use of such support services (Tallent-Runnels et al., 2006). Nevertheless, a set of *general guidelines*, related to particular learning contexts, needs to exist as a commencement point for supporting instructors. Here we stress the notion of *general*, since it is highly unlikely that there is a single best course design for any particular context for all instructors.

Research shows that structured asynchronous online discussions are the most prominent approach for supporting collaboration between students and to support learning (Darabi et al., 2013; Macfadyen & Dawson, 2010; Rovai, 2007; Thomas, 2013). Darabi et al. (2013) posit that the greatest impact on student performance is gained through "pedagogically rich strategies" that include instructor participation, interaction with students, and facilitation of student collaboration as well as continuous monitoring and moderating discussions. In order to sustain the instructor's role and provide effective support for the pedagogical features that will foster learning, some of the instructor's roles could be (or need to be) delegated to students (Koch, 2014; Ravenna et al., 2012). A promising approach to developing self-regulatory skills using externally facilitated scaffolds is presented in Gašević, Adescope, Joksimović, & Kovanović's (2014) study. Gašević et al. (2014) argues that meaningful student-student interaction that results in deep learning could be organized without the instructor's direct involvement in discussions. Specifically, the study showed a significant effect of instructional design that provides students with qualitative guidelines on how to discuss rather than setting quantitative expectations only (e.g., number of messages posted) (Gašević et al., 2014; Rovai, 2007).

Provision of formative, timely, and individualized feedback has also been identified as an important challenge in the online learning environment (Barker, 2011; Gikandi et al., 2011; Whitelock, 2010). Azevedo (1993) claimed that "[t]he use of the computer as the deliverer of truly effective feedback will never be attained until it can be programmed to identify the cause of user's mistakes rather than merely verify (e.g., correct or wrong) and explain the correct method" (p. 116). Likewise, more recent studies also highlighted the importance of timely, formative, effective, and individualized feedback in order to efficiently support learning (Gikandi et al., 2011; Tallent-Runnels et al., 2006). To our knowledge, there is no fully automated process for the provision of formative feedback that would allow for more scalable applications of this instructional method in teaching and learning. Such an intervention also requires continuous monitoring of the learning process for every student. Given the current development of learning management systems (Dabbagh, 2007; Macfadyen & Dawson, 2010), collecting data is not an issue nowadays. Nevertheless, this brings numerous ethical and privacy issues, such as who the data belongs to, who is allowed to use the data and for what purposes, and what happens if a student does not allow his or her data to be used to perform analytics. Further research and practice needs to provide clear answers to those and many similar questions.

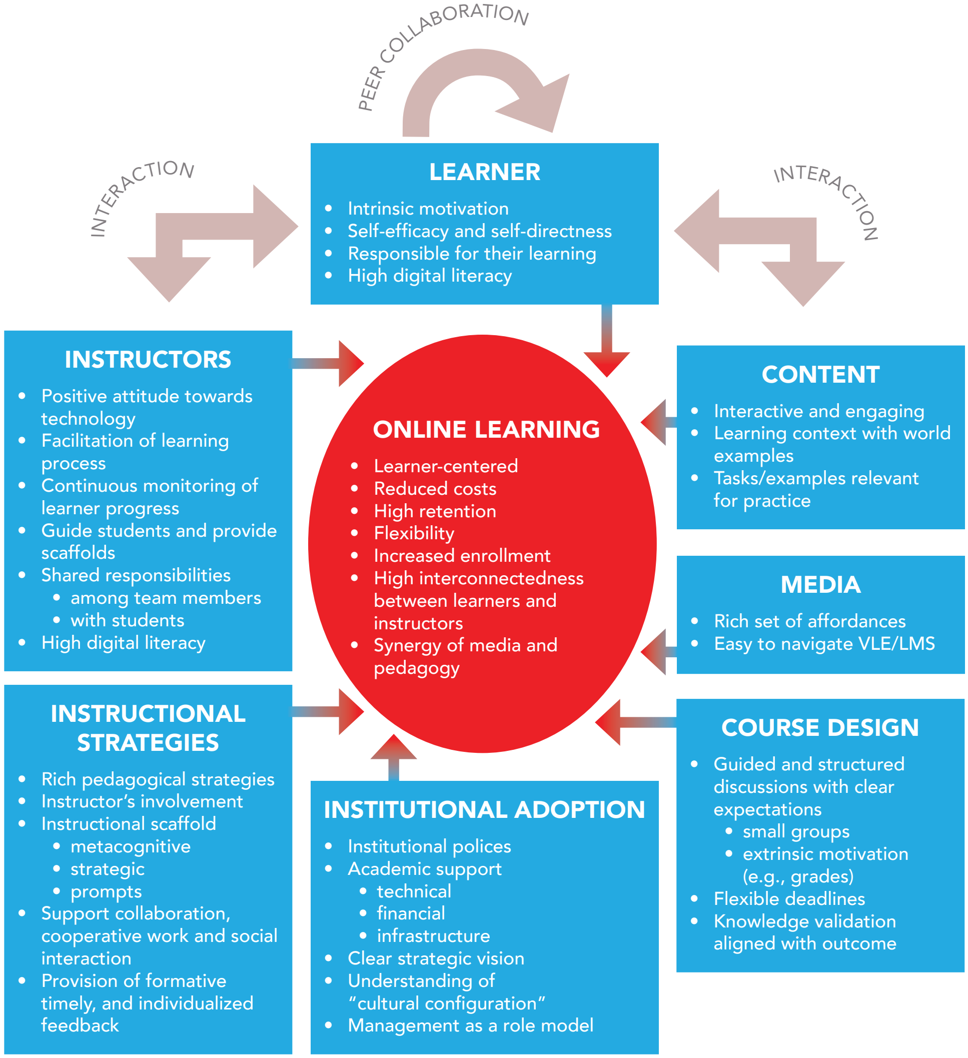

FIGURE 6 A conceptual diagram of the most significant factors that frame educational experience in online learning settings

With the emergence of technological affordances, the landscape of online learning tends to evolve as well. When we defined online learning at the beginning of this paper, we outlined how certain technological advances might change our understanding of what fits under the online, distance, or blended learning umbrella. One of the most obvious examples is the use of video-conferencing, which was originally considered a technology belonging to distance education (Bernard et al., 2009). However, now that videoconferencing is easily available through the Internet, it could be considered part of online learning. With the further development of online education, it seems that both learning paradigms are evolving into a single learning approach — *digital learning*. Building on existing research in distance, online, and blended learning and relying on findings from research in learning sciences, *digital learning* emerges as a new approach to learning using technology (Siemens, 2014b). Digital learning might be structured as formal/informal, self-regulated, structured/unstructured, and "lifelong"; however, the main goal of the new learning approach will be promoting *"research as practice and practice as research mindsets in college and university systems engaged in researching digital learning and teaching"* (Siemens, 2014b).

This report has revealed that initial studies of the effectiveness of online learning support Clark's (2000) view of the role of technology in the *great media debate* (e.g., Means et al., 2009). However, we tend to agree with Ross and Morrison (2014) and Schmi d et al. (2014) that the "synergy" of media and pedagogy is what actually matters. As Schmid et al. (2014) noticed, Clark's (1983) original argument dates back to the era when technology was barely used for presentation purposes, thus not contributing much to the learning process. When technological affordances are used to support meaningful interaction and engage students in collaboration with their peers and instructors, technology plays an important role in the learning process and even in improving pedagogy (Bernard et al., 2009; Schmid et al., 2014). Therefore, *pedagogy* defines collaborative activities but *media* enables such activities to occur (Ross et al., 2010; Ross & Morrison, 2014; Schmid et al., 2014).

Digital technologies and their applications in distance, online, and blended learning has had significant influence on academic research and practice. However, "these technologies have not revolutionized teaching and access to higher education as thoroughly as was predicted by some" (OECD, 2007, p. 21). Within a general tendency to expand access to learning for everyone, an open educational resources (OER) movement emerged with the aim of accelerating the development of formal and informal learning. As a most promising trend in that direction, Massive Open Online Courses (MOOCs) were developed within the OER movement[5] as a new form of online learning that aims at unlimited participation

5 It should be noted that this association of MOOCs with OERs should be considered in the context of the pioneering work on MOOCs (Fini, 2009; Mackness, Mak, & Williams, 2010). The majority of the MOOCs offered since the hype in 2012 however do not build on the principles of OERs.

and open access to learning (and teaching resources) using the Internet (Pappano, 2012; Siemens, 2005). Although recognized as a new trend in online and distance education these large-scale courses required changes in instructional design, given that the majority of widespread, effective instructional practices used in the online learning environment could not scale well to the new massive settings (De Laat, 2006; Fournier, Kop, & Durand, 2014). Therefore, future research should also examine how online learning practices might scale to MOOCs. A recent study of emerging topics in public discourse related to MOOCs, Kovanović, Joksimović, Gašević, Siemens, and Hatala (2014), showed that within the last year a general opinion has developed that MOOCs have failed to fulfill their purpose and their promise. Specifically, Kovanović et al. (2014) showed that public media tend to criticize the "overall MOOC experience" rather than a particular topic and suggest thorough research on every aspect being criticized in order to understand major concerns in MOOC research and adoption. One possible reason for such a trend in the current opinion on MOOCs in the mainstream media might be the lack of the focus on instructional design, as indicated by Margaryan, Bianco, and Littlejohn (2015). The Margaryan et al. study, based on 76 randomly selected MOOCs, showed that course content was well designed and delivered while most courses analyzed showed low-quality instructional design. Further research is required to investigate the possibilities for scaling up instructional methods that have proven successful in online learning in order to address the requirements of learning with MOOCs.

Current research into online learning and MOOCs has provided new evidence for teaching and learning in the digital environment and has raised many questions as well (Siemens, 2014b). As Siemens (2014b) argues, there is great opportunity for further research to examine how (and whether) institutions are redesigning distance and online courses based on the lessons learned from MOOCs. Moreover, another potential line of research might be investigating how universities position online and blended learning with respect to on-campus learning (Siemens, 2014b). Finally, current research and practice also shows that higher education has been primarily focused on content design and curriculum development (Siemens, 2014b). However, in order to move forward and "develop personalized and adaptive learning," the development of personal knowledge graphs and profiles is crucial (Siemens, 2014b). Personalized knowledge graphs present a promising approach for collecting and mapping an individual's knowledge from learning in various settings (e.g., formal, informal, and workplace), and using the accumulated knowledge to bridge the knowledge gaps and provide focused learning materials (Siemens, 2014a, 2014b). On the other hand, some of the main challenges in distance, online, and blended learning relate to developing personalised and adaptive learning pathways and the provision of timely, formative and individualised feedback. Given that personalised and adaptive learning are increasingly being incorporated within the research into a new learning approach — digital learning, it is likely that the future of distance, online and blended learning models will be ultimately subsumed by this new learning approach.

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THE HISTORY AND STATE OF CREDENTIALING AND ASSESSMENT

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ABSTRACT

The complexity of the credentialing landscape has dramatically increased over the last twenty years. For most of the 20th century, the value of a university degree and the path to its attainment was broadly understood and the terms of the agreement between the state, educational institutions, and students were clear. State bodies would accredit higher education institutions with the power to grant degrees and those institutions would develop programs so that students could earn degrees that held meaning for employers. Over the last two decades however, each step in this system has come under question: accreditation, program development, degree earning, and signaling. This new landscape of inquiry and design reveals a tension between the desire to standardize how credentials are measured and an explosion in the possible ways that this standardization could occur. This tension is being played out along two axes with respect to how credentials are defined: 1) whether by a fixed or flexible amount of time and 2) whether based on knowledge or competency. A review of novel credentialing forms follows, classified in these terms.

CREDENTIALING SHIFTS OVER TIME

Despite the long dispute over the role of universities within society, the meaning of their credentials is often considered standard. At least since Kant's *Conflict of the Faculties* (1798) and Cardinal Newman's *The Idea of the University* (1854), a core tension of the university has been between its role as a utilitarian trainer of workers on the one hand and bastion of justice, ideas, and change on the other. In the present day, this tension plays out in the demands of industry to produce more computer science majors while humanities departments and liberal arts colleges seek to preserve their funding and a grander view of education as a central component of democracy and social progress. To some extent, this contest is intensified because the meaning of the credential is seen as standard and monolithic. Whichever becomes the dominant meaning will dictate the future priorities of institutions and the role of institutions within society.

The standard model of the university credential is to some extent a matter of branding. Employers have tended to differentiate between applicants based on the status of their institution rather than the particular assessments that led to the acquisition of the credential (Bordón & Braga, 2013). In this way, credentials act as a value statement about the trustworthiness of institutions generally (universities as an institution are trusted) and in particular (some universities are more trusted than others). But how the credential has been achieved is often overlooked. Policy makers and academics have argued over how best to assess educational outcomes, but the expectations set by governments for assessment are loose and largely have not changed over time (Laitinen, 2012). Generally, universities and colleges were seen to be the best arbiters of how to assess their students' progress, with governments setting broad goals, such as how much time a degree should take and employers paying little attention to the details of assessment (Eaton, 2001). We can look to recent political statements about the urgent need for more graduates, such as the Bradley Report in Australia or the Obama Administration's "American Graduation Initiative." The presumption behind both these plans is that university credentials mean something and that their assessments are sound. Yet, the longstanding global tradition of professional assessment bodies, from the National Board of Medical Examiners in the US to the Honourable Society of King's Inns who administer legal examinations in Ireland, seem to validate the idea that assessment accountability is not part of the role of a university.

Historically, time has been a key component of how governments and colleges have chosen to assess their students. This focus originated with a drive to bring business-style accounting practices to higher education in the late 19th and early 20th centuries. The credit hour — the time requirement for academic credit — emerged and became the major component of degree attainment (Shedd, 2003, p. 5). An easily understood, standardized metric provides a veneer of accountability to the process of teaching and learning. Its growth as a marker of quality completion can be seen in its global spread; agreements between governments and universities generally specify time assignment as the benchmark that students must meet to acquire credentials across countries. For example, a specified number of credit hours in the United States and Canada, 10 hours of work per credit in the UK, or course completion composed of a certain number of hours of on-campus time in Australia, New Zealand, and Hong Kong.

Both the meaning of a degree and its correlated measure of assessment (credit hours) have come under increasing pressure over the last two decades due to several shifting contexts. A major contributor to this pressure revolves around the economic value of a credential. Rising tuition justifiably provokes governments and students to ask what the return on their investment is going to be and this has generated considerable discussion around how to measure that value both in terms of economic returns and in terms of learning (Barrett, 2014). As such, the utility of the credit hour, a metric never intended to measure learning (Learned & Wood, 1938), has come under increased scrutiny. Furthermore, the need for universities to justify the value of their degrees is compounded by globalization through greater study-related migration. A global marketplace for students has forced universities to compete by demonstrating globally recognized credentials, thus feeding into a sense of urgency about how this can be achieved.

In parallel to this economic pressure, there is uncertainty about the role of the university within society. Universities have moved from isolated research and education institutions toward being an essential piece of national economic planning (Duderstadt, 2000). The rise of the "Triple Helix" of innovation, where universities are more integrated with industry and government, requires credentials that serve these new goals to satisfy these stakeholders (Leydesdorff, 1995; Leydesdorff & Etzkowitz, 1996). Besides the demands that industry makes about the content that students should be learning, industry leaders are also questioning the effectiveness of that learning. One industry report claims that managers believe that less than 50% of applicants can "communicate ideas or explain information clearly" (Dua, 2013) — an essential skills for all industries. That industry has an opinion, not only about what content is taught but how effectively it is being taught, is important. It places further pressure on colleges to demonstrate student learning and therefore, the value of the credentials they award. However, institutions have a choice about how they frame their response. They may meet this challenge in the same terms as the problem is posed by industry, by attempting to prove that they produce valuable graduates in economic terms. Conversely, they may broaden the debate by insisting that education is about more than work-readiness and earnings-potential. There are many "bottom lines," including producing citizens who can be morally productive, positioning learning and assessment outside the purview of industry. In either case, the imperative remains: establishing the means for recording and validating learning outcomes.

Finally, the Internet has altered the educational landscape considerably. It has provided new pathways for delivering education to larger numbers of people and measuring both *what* and *whether or not* they have learned. Prior to the developments facilitated by Internet technology, there were few alternative models to the lecture-examination cycle of the traditional university. There are a myriad of ways to both engage students in learning and to measure whether that learning has occurred. For the first time in 200 years, the tools may exist to reformulate the educational process and what constitutes a credential. This has generated both a sense of possibility and uncertainty within higher education as innovations in degree programs continue to develop and, with them, new actors who may challenge the traditional university model.

The shifting educational landscape has brought with it new questions about the traditional credentials that have been assigned meaning and how those credentials should be reassessed to understand that meaning. On the one hand, this inquiry has generated uncertainty for administrators and policy makers, creating urgency around decision-making and committing to re-standardizing the credentialing process. On the other hand, the growth of online computing coupled with society's desire to prepare students for the workforce has meant parallel growth in the ways that credentials could be assessed, increasing the possibility that standardization might not in fact be either possible or desirable. The resulting dilemma essentially pits the desire to validate credentials through standardization against an explosion in the number of possible ways that this standardization could occur.

Standardization

The major initiative to standardize credentialing to date has been the Bologna Process, which began in 1999. Signatories to the Bologna Accords agreed to "harmonize" the structure of European education to create equivalence between degrees across 29 countries. This standardization approach was designed to address some of the tensions described above. Free movement of intellectual capital and the consolidation of research and education within Europe aimed to make the Eurozone more globally competitive within the knowledge economy. This move was intended not only to attract bright students from countries outside the Bologna states but also, by making credential requirements and labels more similar to those in the US, to allow students and employers less friction across the Atlantic.

The success of the Bologna Process and the speed with which standardization was implemented, despite being a voluntary set of recommendations, came as somewhat of a surprise to policy analysts, especially in the United States (Gaston, 2012). The cornerstone of the Process is the European Credit Transfer and Accumulation System (ECTS) — a way for students to transfer credits between the institutions of signatory countries.

In contrast to this growth in standardization in Europe, credentialing in the United States remains fractured between states and among schools. For example, state accreditation bodies have differing requirements for professional accreditation, forcing professionals to retrain if they wish to practice in a different state (Darling-Hammond, 2000, pp. 19–22). Likewise, within a given degree (even in the same state), credits attained at one college are rarely transferable to another (Quaye & Harper, 2014, p. 277). There are clear economic costs to this situation, labor shortages in one state cannot easily be met by people moving from another and degree seekers do not receive recognition for their knowledge and skills and must pay to repeat courses if they change institutions.

The cumulative impact of credentialing issues seems to make the US a particularly fertile place for the development of alternatives. Dissatisfaction with a fractured system, high Internet connectivity and accessibility, and a mismatch between the needs of employers and the skills of graduates have created a flood of alternate pathways to credentials not yet being replicated globally. This growth further complicates the notion that the US will ever achieve standardization in credentialing, either in the manner that Europe has, or even in the manner the US historically had. Further complicating the path to standardization are emerging questions around assessment of student knowledge and learning.

Assessment

The functionality and connectivity afforded by the Internet has enabled alternative forms of credentialing by facilitating new forms of assessment. These alternatives can be categorized into two basic approaches: proficiency testing (also called knowledge or objective testing) and competency-based testing (also called performance assessment). The difference between the two is the focus on "what people know" versus "what people do" (Davey et al., 2000).

Proficiency testing has its roots both in Imperial China (Miyazaki, 1976) and in the rapid growth of psychological methodology at the end of the 19th century. This history has lead to the development of a complex system of methods with strict rules of validity and reliability and to the field of psychometrics. The fundamental idea behind proficiency assessments is that they can attest to what a person knows; the implied utility is that this information can reliably predict future performance. Although more commonly associated with entrance into degree programs, these tests are also used for such professional credentialing as nursing certification (DeVon et al., 2007).

Conversely, competency-based assessment seeks to understand precisely the relevant tasks that people can perform. Competency-based assessments may involve traditional tests but also embrace a wider variety of assessment methods such as portfolios, interviews, presentations, and skill demonstrations. As such, there is no single understanding of what validity looks like within competency-based assessment and no formal manner in which reliability is established (Thomson, Saunders, & Foyster, 2001). Rather, validity and reliability are established by aligning the competence demonstration with the task to be performed; the more similar, the better the assessment (Ten Cate & Scheele, 2007). Ultimately, the Internet and mobile computing enable a wider range of competency-based assessment through the quantification of more contexts and skills. This leads to assessment innovation through the application of data analytics and machine learning methodologies to student data streams (Donkers, Govaerts, Driessen, & Verhoeven, 2008).

Beyond competency, proficiency, and which measures will be applied, questions have also emerged in the domain of assessment regarding how time is treated: is it fixed or flexible? Currently, the vast majority of credentials are dictated by fixed time: the test lasts an hour, a school year is 40 weeks, the degree takes four years. Fixed time standardizes assessment in a convenient way, though it is rigid and its correspondence to learning, knowledge, or skill is neither assured nor obvious (Laitinen, 2012). In contrast, flexible time asks how long it took to complete the task or degree. It provides information about individual capacity and the dynamics of learning but also allows for degree requirements to adjust to students' lives. The ability to work through a degree either faster or slower allows students to accommodate jobs and families, thus increasing accessibility to educational opportunities for a wider range of the population. Frameworks for considering time components are bound to be critical in navigating the new complexities in credentialing.

TAXONOMY OF CREDENTIALS

We can use the distinction between competency/proficiency and flexible/fixed time (Table 1) to understand new forms of credentialing, categorize and discuss historical forms of credentialing, and hypothesize the future of the credentialing debate. In the top left are traditional credentials, such as college and associates degrees. These rely on fixed amounts of time, usually years, and proficiency assessments such as exams and essays to test knowledge. The three other boxes represent combinations of time and assessments suggested and implemented as replacements to the traditional fixed/proficiency model.

TABLE 1 Categories of credentials based on whether they use proficiency or competency assessment and whether they must be acquired over a fixed amount of time or done at a pace determined by the student

TIME		ASSESSMENT: Proficiency	ASSESSMENT: Competency
TIME	Fixed	Demonstrates knowledge	Demonstrates competency
		Uses tests or assignments	Uses a range of assessments
		Occurs within a set timeframe	Occurs within a set timeframe
	Flexible	Demonstrates knowledge	Demonstrates competency
		Uses tests or assignments	Uses a range of assessments
		Student paced	Student paced

Flexible Time, Proficiency-Based Credentials

Flexible time, proficiency-based credentials rose in the late 1990s and early 2000s with the emergence of for-profit online degrees and distance education programs such as those pioneered by the Open University. Distance education largely followed the lead of traditional universities, using proficiency as the basis for assessment (Holmberg, 2005, p. 37). Similarly, online for-profit assessment originally mirrored that of the traditional university, but began to shift over the last four years.

Flexibility and convenience have been major attractions of both online, for-profit credentials and distance education. Online for-profits have flexible course schedules and credit arrangements that do not assign deadlines with respect to degree completion. Online components also allow greater flexibility, allowing students to study at their own pace. In order to increase convenience, the University of Phoenix, for example, also geographically locates their brick and mortar institutions close to the student workplaces, such as within malls and shopping areas. However, this flexibility has been a double-edged sword, as tiered tuition links cost to the speed of student progress. For example, DeVry University has a discounted rate when students take seven or more classes at one time, and all of the for-profit online schools have recurring fees that can further inflate costs for each semester a student enrolls.

Given emerging options, the flexible time, proficiency assessment model may fall by the wayside as innovations in competency-based assessment grow and as flexibility becomes an expectation rather than a novel feature. In fact, the online for-profit sector has been in decline for several years, with enrollment down at the University of Phoenix since 2010 and DeVry since 2013. As such, these schools, along with other online institutions, are currently in a painful reorientation process that includes demonstrating that they are able to provide the types of graduates that industry wants. This includes being able to show that their graduates have particular skills — skills that are best demonstrated and assessed using competency-based assessments. The University of Phoenix, for example, takes content suggestions from various Chambers of Commerce and, having articulation agreements with many corporations that define desirable skills, has now started a competency-based program by partnering with the National Association of Manufacturers. It appears, therefore, that the flexible time, proficiency-based model of credentialing may be on the way out. Providers will either remain traditional fixed time, proficiency models or innovate into remain competitive. However, the flexible time, proficiency-based model may continue within the world of no-work learning.

Learning about the preservation of democracy or the struggle for equity are hopefully life-long pursuits for which a flexible timeline is likely more appropriate. In addition, these are not aspects of society that students should be able to fail, so the ability to continue to work on a skill over a long period, and get credit for that perseverance, is important. Social perspective may take years to learn in any permanent way, and it is difficult to see how it could be credited without the dual structure of flexibility and the demonstration of proficiency (Gehlbach, Young, & Roan, 2012, p. 298).

Fixed Time, Competency-Based Credentials

The fixed time, competency-based credential may seem a strange category, as many people, including the competency-based assessment theorist Malan (2000), define competency-based credentials as those with flexible scheduling. However, it is informative to split these apart, as it is possible to assess student competency while still adhering to a fixed time period within which degree requirements must be met. This category includes Massive Open Online Course (MOOC) providers who offer certificates for single courses — students complete a MOOC course within a specified time to receive a certificate. Often the competency piece of these certificates is a function of the MOOC content: technical and computer science courses ask students to produce artifacts that lend themselves to competency-based assessment. These artifacts require the demonstration of skills in coding and analysis that can readily be converted into a competency measure.

One step more complex than a single certification is the nanodegree. Nanodegrees, launched by Udacity in 2013, attempt to capitalize on the substantial success of certificates, the fastest growing form of credentialing (Carnevale, Rose, & Hanson, 2012, p. 4). In less than a year, these online qualifications are designed to provide specific technical skills for a particular industry. A nanodegree is more than a single MOOC course, but less than a traditional professional qualification and comes with a stamp of legitimacy from a partner company; in Udacity's case, AT&T. Udacity nanodegrees are currently limited to the technology sector, with offerings in web development, app building, and data analytics. Rather than compete with traditional degrees, the nanodegree is explicitly aimed at students unable to attend traditional universities or technical schools. It is mostly marketed at current jobholders, and designed to be pursued after work or on weekends. These degrees are competency based by design and explicitly marketed as bridging the gap between what traditional degree holders know and what skills companies need.

One area of innovation in the fixed time, competency-based model is the recently popular “boot camp” phenomena. Boot camps, such as App Academy, Byte Academy, or Code Core, are short (3 month), intensive, often selective programs that aim to train students in a particular skill set, such as web development, app design, or a particular coding language. Part of their mission is to supply workers for the growing IT sector, particularly development jobs. As such, they tend to have close relationships with particular corporations to whom they intend to send their students for employment. In economic terms, this system seems to be working well, with demand from students high and graduate placements averaging 90% (McGuire, 2014). Students see an immediate return on their investment, allowing boot camps to charge substantial sums, in the region of $1,000 USD a week. The price tag and the residence requirement mean that the pool this model services is small; however, the success of the boot camp model is attracting other sectors to emulate it. A marketing boot camp, Market Campus, opened its doors in Provo, Utah, in 2014. If the boot camp model can be applied to a broader range of industries then it may become a substantial source of credentials in the future. It remains to be seen though how resilient this model is to broader economic forces — will boot camps still exist when the need for developers has subsided?

Flexible Time, Competency-Based Credentials

Over the last decade, there has been rapid growth in the number of credentials that rely on skill demonstrations and flexible time lines. However, the Western Governor’s University (WGU) substantially developed this model of credential in the late 1990s. WGU set out to find a model of college education that could support the growing number of applicants, at a reasonable cost, with a high employability of graduates. Over the last 20 years, they have developed a competency-based model that is time flexible, skill based, and aligned with what employers are looking for in graduates. A key component of the time flexibility in the WGU model is generous crediting of prior experience. If a student can demonstrate their ability because they have worked in the industry related to the degree, they are credited with that competency. This is in contrast to a traditional university course or a fixed time, competency model in which prior experience may be able to substitute for a small part of a degree but is limited to a few credits per year through placement exams. More generous placement credits are available through the University of Wisconsin’s Flex Program but currently, only two universities in the US allow students to “place out” of an entire degree, Excelsior College and Thomas Edison State College. Although students rarely take this option, it signals an institutional belief that people enter formal learning environments with valuable pre-existing knowledge. This philosophy does seem to be gaining traction at other schools. For example, Southern New Hampshire University’s College for America program is marketed as a degree that builds on current skills to align students with employers.

The University of Maryland University College similarly advertises its belief that "learning acquired outside of the classroom is valuable" and SUNY advertises a philosophy "that people deserve credit for college-level learning no matter how it was acquired." Yet even with this philosophy, the organizational structures to value or use that credit remain limited.

MEASURING COMPETENCIES

In terms of measuring competencies, the original competency-based programs still lead the way since competency-based assessment development is both difficult and resource intensive (Kinser, 2007). Spearheading these efforts are universities with strong distance education traditions such as Western Governors University; Southern New Hampshire University; Excelsior College; Chapman University's subsidiary, Brandam University; and the University of Wisconsin.

Western Governor's University has had more than two decades to develop its competency assessments within a flexible time model. Particular innovations include developing difficulty metrics so that students can be awarded credit based on the difficulty of a competency rather than making all competencies equivalent, tracking the use of learning resources and student performance so that resources can be evaluated, and putting all assessments into a single location that can be accessed securely online.

A major hurdle for competency assessment has not been demonstrating competency, but rather how should a failure to demonstrate competency be interpreted. After all, there may be consequences to awarding a degree to a nurse who has demonstrated only eight out of nine competencies. To address this issue, Rush University has developed a three-tiered system for its nursing competencies, consisting of awareness, knowledge, and proficiency (Swider et al., 2006). These competency levels are available to future instructors within the program and appear on transcripts. However, the time and cost of generating these assessments is currently a barrier to expanding them to other courses within the university. Further, competency models require the clear delineation of learning outcomes (Shapiro, 2014), a task that may require considerable time and effort. These difficulties may drive institutions to seek out other flexible time, competency-based options, such as utilizing online functionality or better prior-knowledge assessments. They may be beaten to this goal, of course, by some non-institutional actors — those who see profitability in data such as the College Board's *College Level Examination Program* (CLEP) or the credit-by-examination collaboration between Excelsior College and Pearson, UExcel. In this partnership Pearson provides testing technology to Excelsior students to allow them to gain college credit for learning from other institutions or on-the-job training.

Peer-Based Credentials

Peer-based credentials represent one possible flexible time, competency-based alternative. The essential ingredient is that an assessment is evaluated by a group of peers. Based on a set of loose criteria, peers judge whether or not they believe an individual is competent at a task. They may also judge whether that individual has been active enough within a given period to deserve recognition. In this innovation, peers take over both regulating time and assessment. As such, unlike the tightly defined competencies within a traditional professional accreditation program (such as those in nursing), competencies within a peer-based credentialing environment are socially negotiated and may vary substantially from one community to another.

Both informal and formal peer-based credentials have developed specifically within the software development and online technical communities. We might consider the prototypical examples of each to be the project management platform Github (informal) and the Q&A website Stack Overflow (formal). Github users interact in various ways to understand the work of other users, seek answers to technical questions, and develop possible collaborations. This requires users to become adept at estimating each other's value. Marlow et al. (2013) describe the main metrics used in this appraisal as "history of activity across projects" and "successful collaborations with key, high status projects." This informal peer assessment process informs the value of individuals within the platform — those who can successfully produce work that is deemed high quality and important — advancing their careers both within the platform and in the real world.

The Q&A site Stack Overflow (http://stackoverflow.com/) has demonstrated the power of a more formal system of peer-based reputation credits. Stack Overflow is a question and answer website for programmers, facilitating code and technical problem solving through community-sourced answers. The efficiency of this system is remarkable, with 92% of questions being answered within 11 minutes (median) (Mamykina, Manoim, Mittal, Hripcsak, & Hartmann, 2011). Incentives for both questioners and answer givers seem very well aligned. Questioners get their queries answered while answer givers are rewarded with reputation credits. Actions that elevate reputation credits include getting upvotes on a given answer, getting upvotes for asking a useful question, or having your answer officially accepted by the questioner. Reputation can also be reduced by having your question or answer down voted or when you down vote an answer. These rules are clearly designed not just to provide credentialing information but also to regulate interactions within the community. This illuminates an important aspect of peer-based credentialing — it is a social metric. For peer-based assessment to operate effectively, it must be on some level, an assessment of someone's ability to operate within a given social environment. The ability to play by the social rules is the assessment and is considered an integral part of the knowledge. However, in contrast to traditional proficiency assessment, which is concerned with removing the bias of the assessor, peer-based assessment risks bias and the tyranny of the majority, which still needs to be addressed. One possible remedy may be that the peer metrics not be fully trusted until algorithmic processing can reveal something useful.

The peer-based assessment model can be seen in the endorsement system employed by LinkedIn. Endorsements within LinkedIn have a very low bar, anyone can endorse anyone else for any particular skill and stories abound of people acquiring skills outside their fields. As such, LinkedIn endorsements have been ridiculed as "meaningless," "pointless," and a "waste of time" (Wasserman, 2013). In fact, it has been suggested that the only utility endorsements have is to increase click rates and therefore advertising revenue for the company (Naughton, 2012). Certainly, within a traditional assessment and credentialing framework this would be true, but LinkedIn is not such a tool. Although endorsements clearly provide a very noisy signal, if the signal can be parsed from the noise it may provide a useful metric. Indeed, in October 2013 LinkedIn applied for a patent that utilized endorsements to determine the level of expertise of their members (Work, Blue, & Hoffman, 2013). In this case, validity of the measure has been sacrificed to acquire it. Before the Internet, this would not have happened, as the logistical cost of data collection would have been too high, involving paper surveys and human coders. The cost in this case may be the irritation of its user base, but the implementation of such data collection is almost trivial. This represents a shift methodologically, with a move away from trying to collect perfect data sets toward preferencing data collection itself. This "Big Data" approach represents not just a technical, but also a philosophical shift in credentialing. It puts far less weight on any particular measure and presumes impermanence. It predicts a world in which skills are fluid and everyone must re-skill constantly. In this world, sacrificing time for accuracy no longer makes sense; an accurate but no longer relevant measure is worth less than a less accurate but immediate measure. In future, we may see more credentials developed from noisy data, as relationships between measures are discovered.

Two research fields in particular are poised to take advantage of the growth in educational data: Learning Analytics and Knowledge (LAK) and Educational Data Mining (EDM). The expansion of experimentation in new ways and across large populations would seem to be a great opportunity, though it is unclear what form the pipeline from research to implementation will eventually take. Both fields struggle with common problems around access to data (Siemens, 2012, pp. 5–7), infrastructure limits (Duval, 2011, p. 12), and cultural differences between university researchers and institutional technology departments (Lonn, Aguilar, & Teasley, 2013, p. 238). The next step — from reliable analytic method to scaled implementation for trusted credentials — is even less clear. Even though these fields are young, they have already developed a dizzying number of metrics that test anything from detecting the propensity of students to game a task (Baker, Corbett, Roll, & Koedinger, 2008) to how the type of interaction between students might impact their learning (Schreurs, Teplovs, Ferguson, de Laat, & Buckingham Shum, 2013). In a world where the number of things that can be measured and the number of ways those things can be measured increases, the question about how to organize all this new information becomes more pressing. We are passing from a time when measures were limited and easily controlled to a time when there are many measures and almost anyone can build their own. There are many possible futures: the state may assert control over educational measures, making some measures official and therefore possibly more trustworthy; institutions or corporations may convince the public that particular measures are the most appropriate; or perhaps a technological solution will arise, as Google did, to organize all the measures in a useful way. That said, the role of the human assessor might well change to take on this aspect of the assessment equation. Rather than being a "grader," or being involved in the mechanics of assessment, it will be the role of the teacher — or assessment specialist — to choose the appropriate assessment and data for a particular educational goal or student.

Digital Badges

Another innovation within the flexible time, competency assessment category is the digital badge or micro-credential. Badges draw inspiration from both the Boy/Girl Scout badge system and the way that online games keep track of achievements. They use a digital image to represent skill-related experiences verified through a rich set of associated metadata. Badges seek to address the lack of transferable skill recognition across different educational experiences, allowing people to have a transparent, standardized record across educational courses, work experience, professional development, and self-directed learning. For example, attendance at a professional development workshop may come with a digital badge to designate the skills learned, the provider, the place, and other relevant information to anyone who is interested in the bearer's expertise. In this way, digital badges incorporate features of competency-based models, but within a technological framework that standardizes assessment.

Proponents of digital badges suggest that they have the flexibility required of a 21st-century credential. Unlike a traditional diploma covering a lot of information over a standard period, micro-credentials can be smaller in scope, with no particular time period determined. They also classify knowledge in a very *loose* way (Olneck, 2012), allowing them to draw from many sources concurrently and adapting much faster in response to changes in the job market (Young, 2012). The consequences of a widespread badge system, however, have been contested. The ability of badges to gain critical mass, the technical solutions to badge-fraud, and the impact of badges on the learning process, particularly for younger students, has been questioned (Rughinis, 2013).

Efforts to standardize badges were given a substantial boost in 2011 with the creation of the Mozilla Open Badge Infrastructure or MOBI (openbadges.org). MOBI is the most ambitious badging program to date, but rather than grant badges themselves, Mozilla provides open source code and a technical standard that allows educational vendors to design their own badges. Mozilla also provides the software implementation for individuals to maintain their acquired badges: the digital backpack. The initiative is driven by the same "open web" sentiment that Mozilla brings to its other products. The ultimate goal of the open badge framework is to ensure that all people can "level up" educationally, not just those with access to resources. However, studies of the MOBI framework suggest that the move toward badges will be mediated by how credible the format can appear, which will depend on who is willing to create badges (Gibson, Ostashewski, Flintoff, Grant, & Knight, 2013). This may well be dependent on traditional higher education institutions and credible institutions, such as the Smithsonian, who can lend their brands to the endeavour.

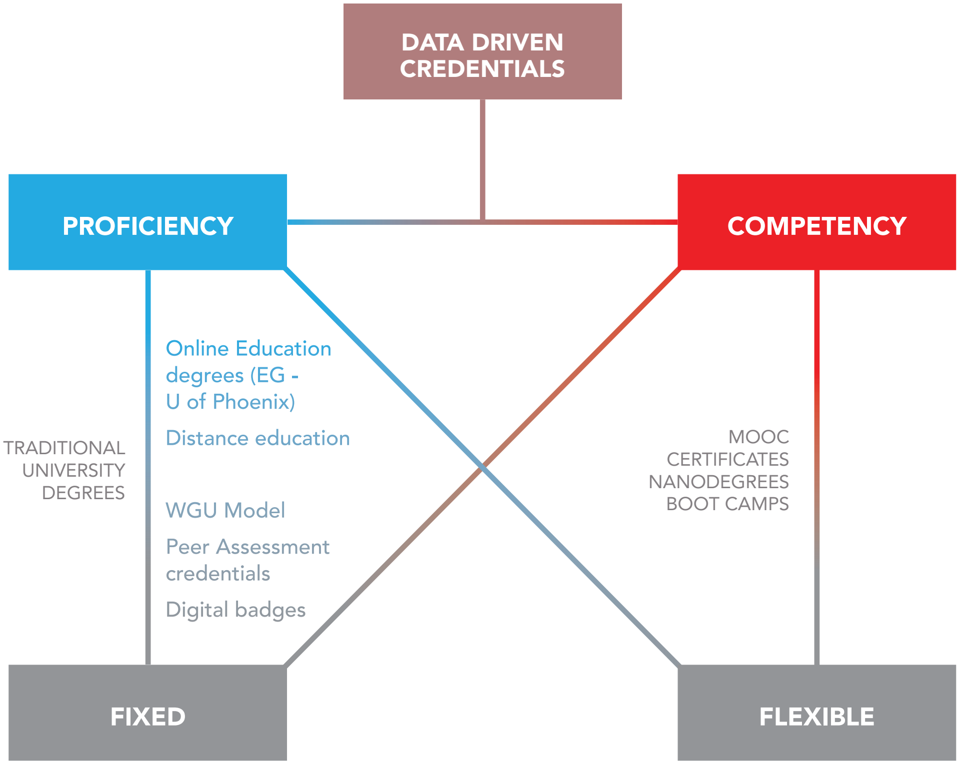

FIGURE 1 Examples of credentials (connections) based on whether they use proficiency or competency assessment, and whether they must be acquired over a fixed amount of time or done at a pace determined by the student (boxes).

THE FUTURE

Badges and endorsement analysis hint at a future where algorithmic processing of online behavior plays a greater role in credentialing. In this way, standardization may occur through technology, bringing proficiency testing and competency-based assessment together. The proficiency goal of creating a general prediction about performance based on quantitative methodology, and the competency goal of providing a prediction about discreet tasks and skills, may merge in the form of a complex data store for each individual.

We can imagine a world where the data associated with a badge is so detailed that it provides the means to make predictions about a person's performance on a particular project. A complex variable store that can be queried to match an individual to a job or educational program, perhaps even to predict the amount of time it will take the person to acquire the skills to tackle a job. So in the future, perhaps time will be neither fixed nor flexible but will itself become an outcome.

The closest example may be the Minerva Project (https://minerva.kgi.edu/), a for-profit residential college/start up in San Francisco. One of Minerva's main points of differentiation from a traditional college is that it revolves around an online platform technologically designed with pedagogical and psychological research in mind. Although located in the same room, students interact with each other and the instructor largely through the online platform, the *Live Interactive Seminar*. This allows easy implementation of various pedagogical techniques, such as flexible grouping and short quizzes. It also tracks student answers, which are then stored as profile data that can be used in a competency-based model or as a traditional milestone. Instructors and program directors receive detailed information and analysis of their students in real time that helps guide instruction, provide feedback for students, and alter course design. It is not mentioned in Minerva publicity materials, but presumably all their student data means that students could graduate with a detailed profile of themselves that could inform their future job searches, demonstrate their skills, or pursue future study.

There are, of course, many barriers to such a future, some technical but many adaptive in nature. Open infrastructure, in particular open competencies, remains elusive but essential if only for reasons of practicality. Progress will be slow if every institution, state, and company has to reinvent their own competencies and tests for all content (Caswell, Henson, Jensen,

& Wiley, 2008). Open frameworks that can be remixed, mashed-up, and built upon would considerably accelerate the process of developing credentials that take advantage of new assessment methods and data sources. Openness has taken large strides with respect to content in the last few years as MOOC providers compete to attract students. Some frameworks, such as the Australian Qualifications Framework (http://www.aqf.edu.au/), seek to establish hierarchically and in detail the competencies required across several domains and job areas. Assessment remains the provision of training organizations, so the connection between assessment and competency is not complete. In fact, assessment remains a highly proprietary area, raising serious questions about whether the current credentialing system can adapt. If anyone can see the inner workings of an assessment, do we need to re-conceptualize education in a more fundamental way? Can a system built on maintaining secrecy about what percentage of course material is on the examination really transform to allow openness of all aspects of a course, including what and how students are assessed?

CONCLUSION

The complexity of the credentialing landscape has dramatically increased over the last decade. The rise of online education and the accompanying changes in the goals of the higher education sector have produced a confusing mix of uncertainty and possibility. Innovation in credentialing is occurring in several areas, both as part of traditional university programming and from outside, for-profit entities as varied as boot camps and MOOCs. This new landscape of inquiry and design reveals a tension between a desire to standardize how credentials are measured and an explosion in the possible ways that this standardization could occur. It has been argued here that this tension is being played out along two axes with respect to how credentials are defined: 1) whether the credential is defined by a fixed or flexible amount of time and 2) whether assessment is based on knowledge or competency. Examination of novel credentialing forms can be classified in these terms to try to come to grips with the possible future of credentialing.

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WHERE IS RESEARCH ON MASSIVE OPEN ONLINE COURSES HEADED?

A data analysis of the MOOC Research Initiative

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ABSTRACT

This paper reports on the results of an analysis of the research proposals submitted to the MOOC Research Initiative (MRI) funded by the Gates Foundation. The goal of MRI was to mobilize researchers to engage into critical interrogation of MOOCs. The submissions — 266 in Phase 1, out of which 78 were recommended for resubmission in the extended form in Phase 2, and finally, 28 funded — were analyzed by applying conventional and automated content analysis methods as well as citation network analysis methods. The results revealed the main research themes that could form a framework of the future MOOC research: i) student engagement and learning success, ii) MOOC design and curriculum, iii) self-regulated learning and social learning, iv) social network analysis and networked learning, and v) motivation, attitude and success criteria. The theme of social learning received the greatest interest and had the highest success in attracting funding. The submissions that planned on using learning analytics methods were more successful. The use of mixed methods was by far the most popular. Design-based research methods were also suggested commonly, but the questions about their applicability arose regarding the feasibility to perform multiple iterations in the MOOC context and rather a limited focus on technological support for interventions. The submissions were dominated by the researchers from the field of education (75% of the accepted proposals). Not only was this a possible cause of a complete lack of success of the educational technology innovation theme, but it could be a worrying sign of the fragmentation in the research community and the need to increased efforts towards enhancing interdisciplinarity.

INTRODUCTION

Massive Open Online Courses (MOOCs) have captured the interest and attention of academics and the public since fall of 2011 (Pappano, 2012). The narrative driving interest in MOOCs, and more broadly calls for change in higher education, is focused on the promise of large systemic change. The narrative of change is some variant of:

> Higher education today faces a range of challenges, including reduced public support in many regions, questions about its role in society, fragmentation of the functions of the university, and concerns about long term costs and system sustainability.

In countries like the UK and Australia, broad reforms have been enacted that will alter post-secondary education dramatically (Cribb & Gewirtz, 2013; Maslen, 2014). In the USA, interest from venture capital raises the prospect of greater privatization of universities (GSV Advisors, 2012). In addition to economic questions around the sustainability of higher education, broader socio-demographic factors also influence the future of higher education and the changing diversity of the student population (OECD Publishing, 2013).

Distance education and online learning have been clearly demonstrated to be an effective option to traditional classroom learning[1]. To date, online learning has largely been the domain of open universities, separate state and provincial university departments, and for-profit universities. Since the first offering of MOOCs by elite universities in the US and the subsequent development of providers edX and Coursera, online learning has now become a topical discussion across many campuses[2]. For change advocates, online learning in the current form of MOOCs has been hailed as transformative, disruptive, and a game changer (Leckart, 2012). This paper is an exploration of MOOCs; what they are, how they are reflected in literature, who is doing research, the types of research being undertaken, and finally, why the hype of MOOCs has not yet been reflected in a meaningful way on campuses around the world. With a clear foundation of the type of research actually happening in MOOCs, based on submissions to the MOOC Research Initiative[3], we are confident that the conversation about how MOOCs and online learning will impact existing higher education can be moved from a hype and hope argument to one that is more empirical and research focused.

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1 For details please refer to the reports on Distance and Online Learning

2 In this paper, we consider MOOCs to belong to the broader field of online education and learning and that their research should be built on and expand the existing body of research knowledge of online education and learning.

3 http://www.moocresearch.com

Massive Open Online Courses (MOOCs)

Massive Open Online Courses (MOOCs) have gained media attention globally since the Stanford MOOC first launched in fall of 2011. The public conversation following this MOOC was unusual for the education field where innovations in teaching and learning are often presented in university press releases or academic journals. MOOCs were prominent in the *NY Times, NPR, Time, ABC News*, and numerous public media sources. Proclamations abounded as to the dramatic and significant impact that MOOCs would have on the future of higher education. In early 2015, the narrative has become more nuanced and researchers and university leaders have begun to explore how digital learning influences on campus learning (Kovanović, Joksimović, Gašević, Siemens, & Hatala, 2015; Selwyn & Bulfin, 2014). While interest in MOOCs appears to be waning from public discourse, interest in online learning continues to increase (Allen & Seaman, 2013). Research communities have also formed around learning at scale[4] suggesting that while the public conversation around MOOCs may be fading, the research community continues to apply lessons learned from MOOCs to educational settings.

MOOCs, in contrast to existing online education which has remained the domain of open universities, for-profit providers, and separate departments of state universities, have been broadly adopted by established academics at top tier universities. As such, there are potential insights to be gained into the trajectory of online learning in general by assessing the citation networks, academic disciplines, and focal points of research into existing MOOCs. Our research addresses how universities are approaching MOOCs (departments, research methods, and goals of offering MOOCs). This results that we share in this article provide insight into how the gap between existing distance and online learning research, dating back several decades, and MOOCs and learning at scale research, can be addressed as large numbers of faculty start experimenting in online environments.

Much of the early research into MOOCs has been in the form of institutional reports by early MOOC projects, which offered many useful insights, but did not have the rigor — methodological and/or theoretical expected for peer-reviewed publication in online learning and education (Belanger & Thornton, 2013; McAuley, Stewart, Siemens, & Cormier, 2010). Recently, some peer reviewed articles have explored the experience of learners (Breslow et al., 2013; Kizilcec, Piech, & Schneider, 2013; Liyanagunawardena, Adams, & Williams, 2013). In order to gain an indication of the direction of MOOC research and representativeness of higher education as a whole, we explored a range of articles and sources. We settled on using the MOOC Research Initiative as our dataset.

4 http://learningatscale.acm.org

MOOC Research Initiative

The MOOC Research Initiative was an $835,000 grant funded by the Bill & Melinda Gates Foundation and administered by Athabasca University. The primary goal of the initiative was to increase the availability and rigor of research around MOOCs. Specific topic areas that the MRI initiative targeted included: i) student experiences and outcomes; ii) cost, performance metrics and learner analytics; iii) MOOCs: policy and systemic impact; and iv) alternative MOOC formats. Grants in the range of $10,000 to $25,000 were offered. An open call was announced in June 2013. The call for submissions ran in two phases: 1. Short overviews of two pages of proposed research including significant citations; 2. Full research submissions, eight pages with influential citations, invited from the first phase. All submissions were peer reviewed and managed in Easy Chair. The timeline for the grants, once awarded, was intentionally short in order to quickly share MOOC research. MRI was not structured to provide a full research cycle as this process runs multiple years. Instead, researchers were selected who had an existing dataset that required resources for proper analysis.

Phase one resulted in 266 submissions. Phase two resulted in 78 submissions. A total of 28 grants were funded. The content of the proposals and the citations included in each of the phases were the data source for the research activities detailed below.

Research Objectives

In this paper, we report the findings of an exploratory study in which we investigated (a) the themes in the MOOC research emerging in the MRI proposals; (b) research methods commonly proposed for use in the proposals submitted to the MRI initiative, (c) demographics (educational background and geographic location) characteristics of the authors who participated in the MRI initiative; (d) most-influential authors and references cited in the proposals submitted in the MRI initiative; and (e) the factors that were associated with the success of proposals that were accepted for funding in the MRI initiative.

METHODS

In order to address the research objectives defined in the previous section, we adopted the Content Analysis and Citation Network Analysis research methods. In the remainder of this section we describe both of these methods.

Content Analysis

To address research objectives (a) and (b), we performed content analysis methods. Specifically, we performed both automated a) and manual b) content analyses. The choice of content analysis was due to the fact that it provides a scientifically sound method for conducting an objective and systematic literature review, thus enabling for the generalizability of the conclusions (Holsti, 1969). Both variations of the method have been used for analysis of large amounts of textual content (e.g., literature) in educational research.

Automated content analysis of research themes and trends

Given that content analysis is a very costly and labor intensive endeavor, the automation of content analysis has been suggested by many authors and this is primarily achieved through the use of scientometric methods (Brent, 1984; Cheng et al., 2014; Hoonlor, Szymanski, & Zaki, 2013; Kinshuk, Huang, Sampson, & Chen, 2013; Li, 2010; Sari, Suharjito, & Widodo, 2012). Automated content analysis assumes the application of the computational methods — grounded in natural language processing and text mining — to identify key topics and themes in a specific textual corpus (e.g., set of documents, research papers, or proposals) of relevance for the study.

For extraction of key concepts from each submission, we selected Alchemy API, a platform for semantic analyses of text that allows for extraction of the informative and relevant set of concepts of importance for addressing research objective (c) as outlined in Table 1. In addition to the list of relevant concepts for each submission, Alchemy API produced the associated relevance coefficient indicating the importance of each concept for a given submission. This allowed us to rank the concepts and select the top 50 ranked concepts for consideration in the study. After the concept extraction, we used the agglomerative hierarchical clustering in order to define N groups of similar submissions that represent the N important research themes and trends in MOOC research, as aimed in research objective (c). Finally, we were able to discover nine clusters in the first phase of the MRI granting process, whereas in the second phase we discovered five clusters.

TABLE 1 Concept Categories for Describing Clusters

Category	Description	Example
Topics	The most frequent keywords that identify topics mentioned in the specific cluster.	Intelligent tutoring systems; Educational technology; Networked contexts
Theory/Approach	Keywords that identify specific theory recognized within documents in each cluster.	Competence-based education; Social constructivist method
Environment	MOOC platform identified within the cluster.	Coursera; edX; MiriadaX
Domain	Keywords that represent a specific domain of a MOOC course.	STEM disciplines; Red Cross; Health Sciences
Data sources	Keywords representing data used for studies within the cluster.	Engagement data; Qualitative data; Study logs
Measures and variables	Keywords representing measures used for studies within the cluster.	Student outcome measures; Early motivation measures;
Analysis techniques	Keywords representing various analysis used for studies within the cluster.	Parallel multi-method analysis; Nonparametric statistical analysis;
Research instruments	Keywords representing various instruments used to collect data for studies within the cluster.	In-depth interviews; Focus group interview; Questionnaire
Use of control group	Identifies whether Control groups are used in at least one study within the cluster.	Control group

To assess the produced clusters and select the key concepts in each cluster, we created a concept-graph consisting of the important concepts from each cluster. The nodes in a graph were concepts discovered in a particular cluster, while the links between them were made based on the co-occurrence of the concepts within the same document. More precisely, the undirected link between two concepts was created in case that both of them were extracted from the same document. To evaluate the relative importance of each concept we used the betweenness centrality measure, as the key concepts are likely the ones with the highest betweenness centrality. Besides the ranking of the concepts in each cluster based on their betweenness centrality, we manually classified all important concepts into one of the several categories that are shown in Table 1. Provided categories represent important dimensions of analysis and we describe each of the clusters based on the provided categories of key concepts. Thus, when we describe a particular cluster, we cover all of the important dimensions to provide the holistic view of the particular research trend that is captured in that cluster.

Content analysis of important characteristics of authors and submissions

A manual content analysis of the research proposals was performed in order to address research objective (b). Specifically, each submission was categorized into one of the four categories in relation to research objective (a):

1. *Qualitative method,* which meant that the proposal used a qualitative research method such as grounded theory.
2. *Quantitative method,* which meant that a proposal followed some of the quantitative research methods on data collected through (Likert-scale based) surveys or digital traces recorded by learning platforms in order to explore different phenomena or test hypotheses.
3. *Mixed-methods,* which reflected a research proposals that applied some combination of qualitative and quantitative research methods.
4. *Other,* which comprised of the research proposals that did not explicitly follow any of these methods, or it was not possible to determine from their content which of the three methods they planned to use.

For all the authors[5] of submitted proposals to the MRI initiative, we collected the information related to their home discipline and the geographic location associated with their affiliation identified in their proposal submissions in order to address research objective (c). Insight into researchers' home discipline was obtained from the information provided with a submission (e.g., if a researcher indicated to be affiliated with a school of education, we assigned education as the home discipline for this research). In cases when such information was not available directly with the proposal submission, we performed a web search, explored institutional websites, and consulted social networking sites such as LinkedIn or Google Scholar.

Citation Analysis and Success Factors

The citation analysis was performed to address research objective (d). It entailed the investigation of the research impact of the authors and papers cited in the proposals submitted to the MRI initiative (Waltman, van Eck, & Wouters, 2013). In doing so, the counts of citations of each reference and author, cited in the MRI proposals, are used as the measures of the impact in the citation analysis. This method was suitable, as it allowed for assessing the influential authors and publications in the space of MOOC research.

Citation network analysis was performed in order to assess the success factor of individual proposals to be accepted for funding in the MRI initiative, as set in research objective (e). This way of gauging the success was a proxy measure of the quality and importance of the proposals. As such, it was appropriate to be used as an indicator of specific topics based on the assessment of the international board of experts who reviewed the submitted proposals.

5 Information about the geographic location as extracted from the application forms submitted by the authors to EasyChair, a software system used for the submission and review process.

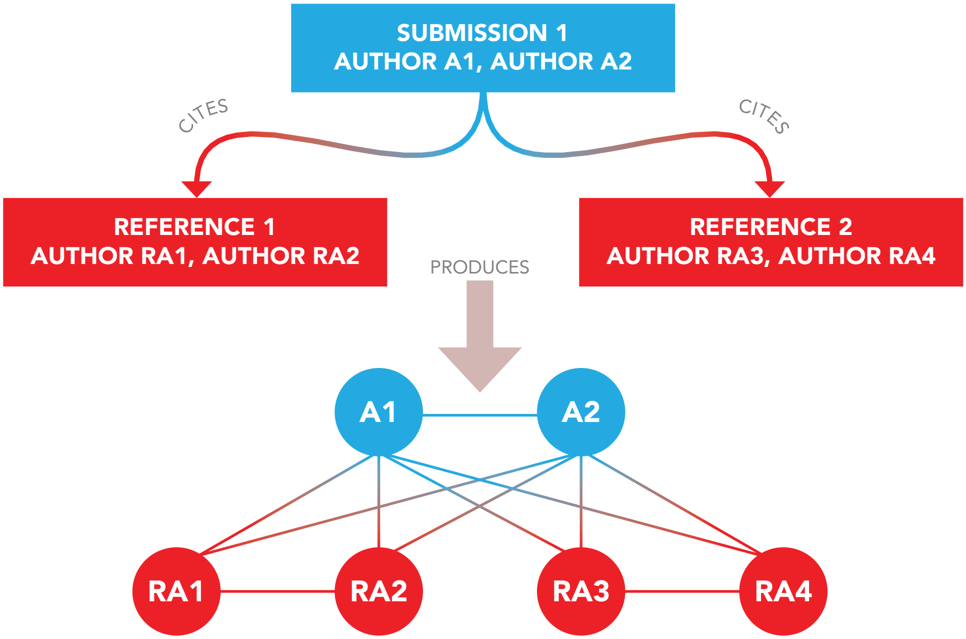

FIGURE 1 The citation networks — connecting the authors of a research proposal (A1 and A2) with the authors of two cited references (RA1, RA2, RA2 and RA4).

Social network analysis was used to address research objective (e). In this study, social networks were created through the links established based on the citation and co-authoring relationships. The use of social network analysis has been shown as an effective way to analyze professional performance, innovation, and creativity (Burt, Kilduff, & Tasselli, 2013; Dawson, Tan, & McWilliam, 2011). Moreover, Centola (2010) showed that the spread of behavior was more effective in networks with higher clustering and larger diameters. Therefore, for research objective (e), we expected to see the association between the larger network diameter and the success in receiving funding.

In this study, we followed a method for citation network analysis suggested by Dawson et al. (2014) in their citation network analysis of the field of learning analytics. Nodes in the network represent the authors of both submissions and cited references, while links are created based on the co-authorship and citing relations. Figure 1 illustrates the rules for creating the citation networks in the simple case when a submission written by the two authors references two sources, each of them with two authors as well.

We created a citation networks for each cluster separately and analyzed them by following three measures commonly used in social network analysis (Bastian, Heymann, & Jacomy, 2009; Freeman, 1978; Wasserman, 1994):

1. *Degree:* the number of edges a node has in a network,
2. *Diameter:* the maximum eccentricity of any node in a network, and
3. *Path:* the average graph-distance between all pairs of nodes in a network.

All social networking measures were computed using the Gephi open source software for social network analysis (Bastian et al., 2009). The social networking measures of each cluster were then correlated (Spearman's ρ) with the acceptance ratio — computed as a ratio of the number of accepted proposals and the number of submitted proposals — for both phases of the MRI initiative.

RESULTS

Phase 1 Results

In order to evaluate the direction of the MOOC related research, we looked at the most important research themes in the submitted proposals. In total, there were nine research themes with similar number of submissions, from 19 (i.e., "MOOC Platforms" research theme) to 40 (i.e., "Communities" and "Social Networks" research themes). Likewise, submissions from all themes had on average slightly more than 2 authors and from 7 to 9 citations. However, in terms of their acceptance rates, more than a half of the papers from the "Social Networks" research theme moved to the second phase and finally 25% of them were accepted for funding, while none of the submissions from the "Education Technology

Improvements" theme was accepted for funding. Other themes within the first phase include "Processes" (7.7% accepted for funding), "Higher Educational Institutions and MOOCs" (4.0%), "Motivational and Behavioral Patterns" (13.8%), "Mobile and Adaptive Learning" (11.4%), "MOOC Platforms" (5.3%), and "Learner Performance" (8.3%). Further, results show that mixed research was the most common research methodology, while the purely qualitative research was the least frequent. Researchers from the field of education (around 53%) were represented by far the biggest group, followed by the researchers from the industry and computer science (both around 20%). Finally, we observed a strong presence of the authors of the proposals from North America (N=305), followed by authors from Europe (N=137) and Asia (N=87). For more details on the extracted themes, most frequent keywords used, and the citation analysis, see Gašević, Kovanović, Joksimović, and Siemens (2014).

We looked at the correlations between the centrality measures of citation networks (for details see Gašević et al., 2014) and the second phase acceptance rates. Spearman's rho revealed that there was a statistically significant correlation between the citation network diameter and number of submissions accepted into the second round ($\rho s = .77$, $n=9$, $p<.05$), a statistically significant correlation between citation network diameter and second round acceptance rate ($\rho s = .70$, $n=9$, $p<.05$), and a statistically significant correlation between citation network path and number of submissions accepted into the second round ($\rho s = .76$, $n=9$, $p<.05$). In addition, a marginally significant correlation between citation network path length and second phase acceptance rate was also found ($\rho s = .68$, $n=9$, $p=0.05032$).

Phase 2 Results

Phase 2 Research Themes

Following the analysis of popular research themes, we applied the same automated content analysis method to the submissions that were accepted into the second phase (78 submissions). We found five research themes (Table 2) that were the focus of an approximately similar number of submissions. In order to give a better insight in the discovered research themes, in the following paragraphs, we provide a description of each of the research themes.

Research theme 1: *engagement and learning success*
The main topics in this cluster are related to learners' participation, engagement, and behavioral patterns in MOOCs. Submissions in this cluster aimed to reveal the most suitable methods and approaches to understanding and increasing retention, often relying on peer

learning and peer assessment. Studies encompassed a wide variety of courses (e.g., biology, mathematics, writing, EEG-enabled courses, art, engineering, mechanical, and engineering) on diverse platforms. However, most of the courses, used in the studies from this cluster, were offered on the Coursera platform.

Research theme 2: *MOOC design and curriculum*
Research proposals in this cluster were mostly concerned with improving learning process and learning quality and with studying students' personal needs and goals. Assessing educational quality, content delivery methods, MOOC design and learning conditions, these studies aimed to discover procedures that would lead to better MOOC design and curriculum, and thus improving learning processes. Moreover, many visualization techniques were suggested for investigation in order to improve learning quality. Courses suggested for the use in the proposed studies from this cluster were usually delivered by using the edX platform and the courses were in the fields of mathematics, physics, electronics and statistics. The cluster was also characterized by a diversity of data types planned for collection — from surveys, demographic data, and grades to engagement patterns and data about brain activity.

Research theme 3: *Self-regulated learning and social learning*
Self-regulated learning, social learning, and social identity were the main topics discussed in the third cluster. Analyzing cognitive (e.g. memory capacity and previous knowledge), learning strategies and motivational factors, the proposals from this cluster aimed to identify potential trajectories that could reveal students at risk. Moreover, this cluster addressed issues of intellectual property and digital literacy. There was no prevalent platform in this cluster, while courses were usually in the fields such as English language, mathematics and physics.

Research theme 4: *SNA and networked learning*
A wide diversity in analysis methods and data sources is one of the defining characteristic of this cluster. Applying networked learning and social network analysis tools and techniques, the proposals aimed to address various topics, such as, identifying central hubs in a course, or improving possibilities for students to gain employment skills. Moreover, learners' interaction profiles were analyzed in order to reveal different patterns of interactions between learners and instructors, among learners, and learners with content and/or underlying technology. Neither specific domain, nor platform was identified as dominant within the fourth cluster.

Research theme 5: *Motivation, attitude and success criteria*
The proposals within the fifth cluster aimed to analyze diverse motivational aspects and correlation between those motivational facets and course completion. Further, research-

ers analyzed various MOOC pedagogies (xMOOC, cMOOCs) and systems for supporting MOOCs (e.g. automated essay scoring), as well as attitudes of higher education institutions toward MOOCs. Another stream of research within this cluster was related to principles and best practices of transformation of traditional courses to MOOCs, as well as exploration of reasons for high dropout rates. The Coursera platform was most commonly referred to as a source for course delivery and data collection.

TABLE 2 Phase 2 Research Themes

Cluster	Theme	Size	Accepted Funding	Authors Avg. (SD)	Citations Avg. (SD)	Major Fields	Qualitative	Mixed	Quantitative
1	Engagement and Learning Success	14	6 (42.9 %)	2.2 (1.3)	15.0 (9.8)	Education (14) Computer Science (4) Engineering (3)	1	3	10
2	MOOC Design and Curriculum	14	2 (14.3 %)	2.9 (2.1)	20.2 (13.7)	Education (19) Computer Science (7) Engineering (4)	3	5	6
3	Self-Regulated Learning and Social Learning	15	6 (40.0 %)	2.3 (0.9)	21.7 (9.2)	Education (25) Computer Science (3)	8	6	1
4	SNA and Networked Learning	19	9 (47.4 %)	2.1 (0.8)	20.7 (15.6)	Education (23) Computer Science (5)	2	12	5
5	Motivation, Attitude and Success Criteria	16	5 (31.2 %)	2.8 (1.1)	23.1 (9.2)	Education (25) Engineering (5) Social Sciences (4)	5	7	4
	Total	78	28 (35.8 %)						

Phase 2 Research Methods

Table 3 indicates that mixed methods was the most common methodological approach followed by purely quantitative research, which was used just slightly more than qualitative research. This suggests that there was no clear “winner” in terms of the adopted methodological approaches, and that all three types are used with a similar frequency. Also, the average number of authors and citations shows that the submissions mixed methods tended to have slightly more authors than quantitative or qualitative submissions, and that quantitative submissions had a significantly lower number of citations than submissions adopting both mixed and qualitative methods.

Table 2 shows that the submissions centered around engagement and peer assessment (i.e., cluster 1) used mainly quantitative research methods, while submissions dealing with self-regulated learning and social learning (i.e., cluster 3) exclusively used qualitative and mixed research methods. Finally, submissions centered around social network analysis (i.e., cluster 4) mostly used mixed methods, while submissions dealing with MOOC design and curriculum (i.e., cluster 2), and ones dealing with motivation, attitude and success criteria (i.e., cluster 5) had an equal adoption of all the three research methods.

TABLE 3 Phase 2 Distribution of Research Methodologies

Methodology	Submissions	Authors Avg. (SD)	Citations Avg. (SD)
Mixed	33 (42.3%)	2.7 (1.5)	21.8 (13.2)
Qualitative	19 (24.4%)	2.1 (0.9)	22.8 (12.10
Quantitative	26 (33.3%)	2.4 (1.2)	16.7 (10.3)
Total	78(100%)	2.5 (1.3)	20.3 (12.3)

TABLE 4 Phase 2 Top 5 Research Fields

Field	Authors
Education	106
Computer Science	21
Engineering	13
Industry	8
Social Sciences	6

TABLE 5 Phase 2 Geographic Distribution of the Authors

Continent	Authors	Authored Proposals	Accepted Proposals
Asia	*17*	4.64	0.14
Australia/NZ	*11*	4.25	1
Europe	*40*	15.66	4
North America	*137*	52.44	22.85
South America	*3*	*1*	*0*

Phase 2 Demographic Characteristics of the Authors

With respect to the primary research areas of the submission authors, Table 4 shows that Education was the primary research field of the large majority of the authors and that Computer Science was the distant second. In terms of the average number of authors, we can see in Table 2 that submissions related to MOOC design and curriculum (i.e., research theme 2) and motivation, attitude and success criteria (i.e., research theme 5) had on average a slightly higher number of authors than the other three research themes. In terms of their number of citations, submissions dealing with the engagement and peer assessment had on average 15 citations, while the submissions about other research themes had a bit higher number of citations ranging from 20 to 23. Similar to Phase 1, in all research themes, the field of education was found to be the main research background of submission authors. This was followed by the submissions authored by computer science and engineering researchers, and in the case of submissions about motivation, attitude and success criteria, by social scientists. Finally, similarly to the Phase 1, we see the strong presence of researchers from North America, followed by the much smaller number of researchers from other parts of the world (Table 5).

TABLE 6 Phase 2 Most Cited Papers

Paper Name	Citation Count
Kizilcec, R. F., Piech, C. and Schneider, E. (2013). *Deconstructing disengagement: analyzing learner subpopulations in massive open online courses.*	15
Liyanagunawardena, T. R., Adams, A. A. and Williams, S. (2013). *MOOCs: a Systematic Study of the Published Literature 2008-2012.*	13
McAuley, A., Stewart, B., Siemens, G. and Cormier, D. (2010). *The MOOC model for digital practice.*	13
Breslow, L. B., Pritchard, D. E., DeBoer, J., Stump, G. S., Ho, A. D. and Seaton, D. T. (2013). *Studying learning in the worldwide classroom: Research into edX's first MOOC.*	13
Siemens, G. (2005). *Connectivism: A Learning Theory for the Digital Age.*	12
Pappano, L. (2012). *The Year of the MOOC.*	10
Yuan L. and Powell S. (2013). *MOOCs and Open Education: Implications for Higher Education.*	9
Jordan, K. (2013). *MOOC Completion Rates : The Data.*	7
Belanger, Y. and Thornton, J. (2013). *Bioelectricity: A Quantitative Approach. Duke University First MOOC.*	7
Long, P. and Siemens, G. (2012). *Penetrating the fog: analytics in learning and education.*	6
Kop, R. (2011). *The Challenges to Connectivist Learning on Open Online Networks: Learning Experiences during a Massive Open Online Course.*	6
Daniel, J. (2012). *Making Sense of MOOCs: Musings in a Maze of Myth, Paradox and Possibility.*	6
Mackness, J., Mak, S. F. J. and Williams, R. (2010). *The Ideals and Reality of Participating in a MOOC.*	5
Means, B., Toyama, Y., Murphy, R., Bakia, M. and Jones, K. (2010). *Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies.*	5

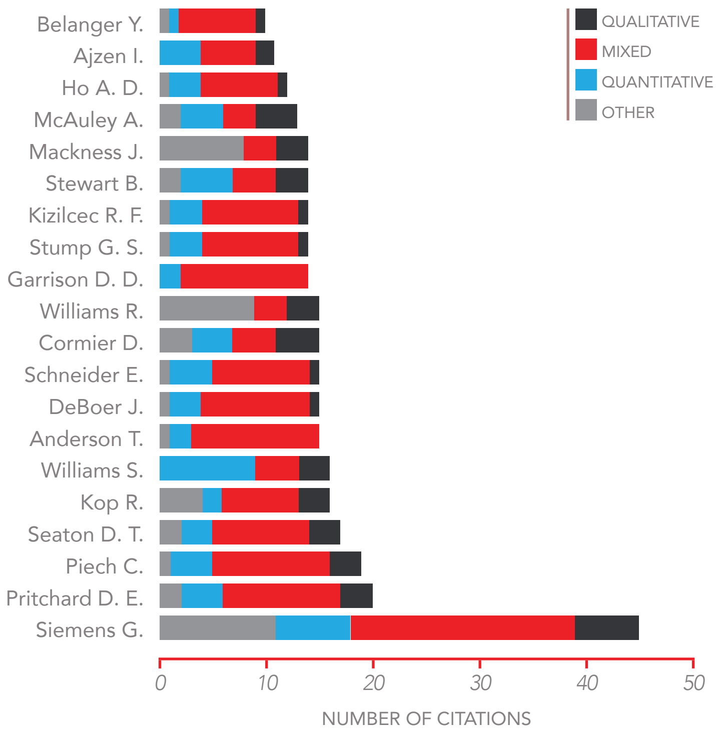

FIGURE 3 Phase 2 most cited authors

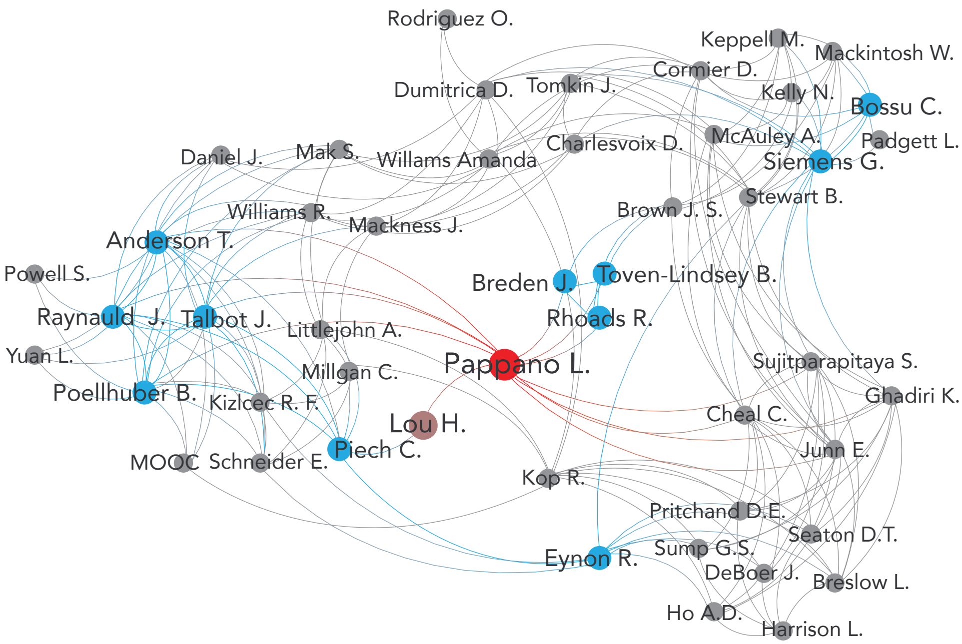

FIGURE 4 Phase 2 citation network.

TABLE 7 Phase 2 Citation Network Metrics

Cluster	Theme	Average Degree (SD)	Diameter	Average Shortest Path (SD)	Density
1	Engagement and Peer Assessment	4.6 (8.4)	8	4.5 (1.6)	0.014
2	MOOC Design and Curriculum	5.3 (10.9)	9	4.3 (1.8)	0.017
3	Learning Characteristics and Social Learning	5.4 (8.7)	7	4.1 (1.3)	0.023
4	SNA and Networked Learning	4.9 (9.6)	8	3.9 (1.4)	0.015
5	Motivation, Attitude and Success Criteria	6.9 (9.0)	8	3.7 (1.5)	0.033
	Total	5.1 (7.3)	11	4.0 (1.3)	0.012

Phase 2 Citation Analysis and Success Factors

We calculated a total number of citations (Table 6) for each publication, and extracted a list of the most cited authors (Figure 3). We can observe that the most cited authors were not necessarily the ones with the highest betweenness centrality, but the ones whose research focus was most relevant from the perspective of the MRI initiative and researchers from different fields and with different research objectives.

We also extracted the citation network graph which is shown on Figure 4. At the centre of the network is L. Pappano, the author of very popular New York Times article *"The Year of the MOOC"*, as the author with the highest betweenness centrality value. The reason for this is that his article was frequently cited by a large number of researchers from variety of academic disciplines, and thus making him essentially a bridge between them, which is clearly visible on the graph.

We also analyzed citation networks for each research theme independently and extracted common network properties such as diameter, average degree, path and density (Table 7). However, further investigation of Phase 2 success factors did not reveal any significant correlation between the citation network centrality measures and the final acceptance rates (Table 7) — i.e., Spearman's rho correlation was not statistically significant correlation at the α=0.05 significance level.

DISCUSSION

Emerging Themes in MOOC Research

The results of the analysis indicated a significant attention of the researchers to the issues related to MOOCs that have received much public (media) attention. Specifically, the issue of low course completion and high degree of student attrition was often pronounced as the key challenge of MOOCs (Jordan, 2013; Koller, Ng, Do, & Chen, 2013). Not only was the topic of engagement and learning success (Cluster 1 in Phase 2) identified as a key theme in the MRI submissions, but it was also identified as a theme that was clearly cross-cutting all other research themes identified in Phase 2, including motivation, attitudes and success criteria in Cluster 5, course design in Cluster 2, and learning strategies, social interaction, and interaction with learning resources in Cluster 3. With the aim to understand the factors affecting student engagement and success in MOOCs, the proposals had suggested a rich set of data collection methods — e.g., surveys, physiological brain activity, knowledge tests, and demographic variables. The theory of planned behavior (TBP) (Ajzen, 1991) was found as the main theoretical foundation for research of student engagement and learning success. While TBP is a well-known framework for studying behavioral change — in this case changing students intention to complete a MOOC and thus, increase their likelihood of course completion — it remains to be seen to what extent a student's intention can be changed if the student did not have an intention to complete a MOOC in the first place. What would be a reason that could motivate a student to change their intention in cases when she/he only enrolled into a MOOC to access information provided without intentions to take any formal assessments? In that sense, in seems necessary first to understand students' intentions for taking a MOOC, before trying to study the effects of interventions (e.g., motivational messages) on the students with different initial intentions.

The results also confirmed that social aspects of learning in MOOCs were the most successful theme in the MRI initiative (see Table 2). Total of 15 out of the 28 accepted proposals (Clusters 3 and 4) were related to different factors of social learning in MOOCs. Not only has it become evident recently that students require socialization in MOOCs through different forms (of self-organization) such as local meet-ups (Coughlan, 2014)[6] and that social factors contribute to attribution in MOOCs (Rosé et al., 2014), but educational research is also very clear about numerous educational benefits of socialization. The Vygotskian approach to learning posits that higher levels of internalization can be achieved through social interaction most effectively (Vygotsky, 1980). These benefits have been shown to lead to deeper approaches to learning and consequently to higher learning outcomes (Akyol & Garrison, 2011). Moreover, students' positions in social networks have been found in the existing literature to have a significant positive effect on many important learning outcomes such as creative potential (Dawson et al., 2011), sense of belonging (Dawson et al., 2011), and academic achievement (Gašević, Zouaq, & Janzen, 2013). Yet, the lack of social interaction can easily lead to the sense of social isolation which is well documented as one of the main barriers in distance and online education (Muilenburg & Berge, 2001; Rovai, 2002). Finally, Tinto's (1997) influential theory recognizes social and academic integration as the most important factors of student retention in higher education.

Research Methods in MOOC Research

The high use of mixed methods is a good indicator of sound research plans that recognized the magnitude of complexity of the issues related to MOOCs (Greene, Caracelli, & Graham, 1989). The common use of design-based research is likely a reflection of MOOC research goals aiming to address practical problems, and at the same time, attempting to build and/or inform theory (Design-Based Research Collective, 2003; Reeves, Herrington, & Oliver, 2005). This assumes that research is performed in purely naturalistic settings of MOOC offering (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003), always involves some intervention (Brown, 1992), and typically has several iterations (Anderson & Shattuck, 2012). According to Anderson and Shattuck (2012), there are two types of interventions — instructional and

6 It is important to acknowledge that the importance of a "face-to-face contact with other students" was found in the Lou et al. meta-analysis (2006) of the literature — published in the period from 1985 to 2002 — about the effects of different aspects of distance and open education on academic success.

technological — commonly applied in online education research. Our results revealed that the focus of the proposals submitted to the MRI initiative were primarily focused on the instructional interventions. However, it is reasonable to demand from MOOC research to study the extent to which different technological affordances, instructional scaffolds and the combinations of the two can affect various aspects of online learning in MOOCs. This objective was set long ago in online learning research, led to the Great Media debate (Clark, 1994; Kozma, 1994), and the empirical evidence that support either position (affordances vs. instruction) of the debate (Bernard et al., 2009; Lou, Bernard, & Abrami, 2006). Given the scale of MOOCs, a wide spectrum of learners' goals, differences in roles of learners, instructors and other stakeholders, and a broad scope of learning outcomes, research of the effects of affordances vs. instruction requires much research attention and should produce numerous important practical and theoretical implications. For example, an important question is related to the effectiveness of the use of centralized learning platforms (commonly used in xMOOCs) to facilitate social interactions among students and formation of learning networks that promote effective flow of information (Thoms & Eryilmaz, 2014).

Our analysis revealed that the issue of the number of iterations in design-based research was not spelled out in the proposals of the MRI initiative (Anderson & Shattuck, 2012). It was probably unrealistic to expect to see proposals with more than one edition of a course offering given the timeline of the MRI initiative. This meant that the MRI proposals, which aimed to follow design-based research, were focused on the next iteration of existing courses. However, given the nature of MOOCs, which are not necessarily offered many times and in regular cycles, what is reasonable to expect from conventional design-based methods that require several iterations? Given the scale of the courses, can the same MOOC afford for testing out several interventions that can be offered to different subpopulations of the enrolled students in order to compensate for the lack of opportunity of several iterations? If so, what are the learning, organizational, and ethical consequences of such an approach and how and whether at all they can be mitigated effectively?

The data collection methods were another important feature of the proposal submissions to the MRI initiative. Our results revealed that most of the proposals planned to use conventional data sources and data collection methods such as grades, surveys on assessments, and interviews. Of course, it was commendable to see many of those proposals being based on the well-established theories and methods. However, it was surprising to see a low number of proposals that had planned to make use of the techniques and methods of learning analytic and educational data mining (LA/EDM) (Baker & Yacef, 2009; Siemens & Gašević, 2012). With the use LA/EDM approaches, the authors of the MRI proposals would be able to analyze trace data about learning activities, which are today commonly collected by MOOC platforms. The use of LA/EDM methods could offer some direct research benefits such as absence and/or reduction of self-selection and being some less unobtrusive, more dynamic, and more reflective of actual learning actives than conventional methods (e.g., surveys) can measure (Winne, 2006; Zhou & Winne, 2012).

Interestingly, the most successful themes (Clusters 3-4 in Phase 2) in the MRI initiative had a higher tendency to use the LA/EDM methods than other themes. Our results indicate that the MRI review panel expressed a strong preference towards the use of the LA/EDM methods. The data types and analysis methods in Clusters 3-4 were also mixed by combining the use of trace data with conventional data sources and collection methods (surveys, interviews, and focus groups). This result provided a strong indicator of the direction in which research methods in the MOOC arena should be going. It will be important however to see the extent to which the use of LA/EDM can be employed to advance understanding of learning and learning environments. For example, it is not clear whether an extensive activity in a MOOC platform is indicative of high motivation, struggling and confusion with the problem under study, or the use of poor study strategies (Clarebout, Elen, Collazo, Lust, & Jiang, 2013; Lust, Juarez Collazo, Elen, & Clarebout, 2012; Zhou & Winne, 2012). Therefore, we recommend a strong alignment of the LA/EDM methods with educational theory in order to obtain meaningful interpretation of the results that can be analyzed across different context and that can be translated to practice of learning and teaching.

Importance of Interdisciplinarity in MOOC Research

The analysis of the research background of the authors who submitted their proposals to the MRI initiative revealed an overwhelmingly low balance between different disciplines. Contrary to the common conceptions of the MOOC phenomena to be driven by computer scientists, our results showed that about 53% in Phase 1, 67% in Phase 2, about 67% of the finally accepted proposals were the authors from the discipline of education. It is not clear the reason for this domination of the authors from the education discipline. Could this be a sign of the networks to which the leaders of the MRI initiative were able to reach out? Or, is this is a sign of fragmentation in the community? Although not conclusive, some signs of fragmentation could be traced. Preliminary and somewhat anecdotal results of the new ACM international conference on learning at scale indicate that the conference was dominated by computer scientists. It is not possible to have a definite answer if the fragmentation is actually happening or not based on only these two events. However, the observed trend is worrying. A fragmentation would be unfortunate for advancing understanding of a phenomenon such as MOOCs in particular and education and learning, in general, which require strong interdisciplinary teams (Dawson et al., 2014).

The positive association observed between the success of individual themes of the MRI submissions and citation network structure (i.e., diameter and average network path) warrants research attention. The significance of this positive correlation indicates that the themes of the submitted proposals, which managed to reach out to a broader and more diverse citation networks, were more likely to be selected for funding in the MRI initiative. Being able to access information in different social networks is already shown to be positively associated with achievement, creativity, and innovation (Burt et al., 2013). Moreover, the increased length of network diameter — as shown in this study — was found to boost spread of behavior (Centola, 2010). In the context of the results of this study, this could mean that the increased diameters of citation networks in successful MRI themes were assessed by the MRI review panel as more likely to spread educational technology innovation in MOOCs. If that is the case, it would be a sound indicator of quality assurance followed by the MRI peer-review process. On the other hand, for the authors of research proposals, this would mean that trying to cite broader networks of authors would increase their chances of success to receive research funding. However, future research in other different situations and domains is needed in order to be able to validate these claims.

CONCLUSIONS AND RECOMMENDATIONS

Research needs to create with theoretical underpinnings that will explain factors related to social aspects in MOOCs that have a completely new context and offer practical guidance of course design and instruction (e.g., Clusters 2, 4, and 5 in Phase 2). The scale of MOOCs does limit the extent to which existing frameworks for social learning proven in (online) education can be applied. For example, the Community of Inquiry (CoI) framework posits that social presence needs to be established and sustained in order for students to build trust that will allowed them to comfortably engage into deeper levels of social knowledge construction and group-based problem solving (Garrison, Anderson, & Archer, 1999; Garrison, 2011). The scale of and (often) shorter duration of MOOCs than in traditional courses limits opportunities for establishing sense of trust between learners, which likely leads to much more utilitarian relationships. Furthermore, teaching presence — established through different scaffolding strategies either embedded into course design, direct instruction, or course facilitation — has been confirmed as an essential antecedent of effective cognitive processing in both communities of inquiry and computer-supported collaborative learning (CSCL) (Fischer, Kollar, Stegmann, & Wecker, 2013; Garrison, Cleveland-Innes, & Fung, 2010; Gašević, Adesope, Joksimović, & Kovanović, 2015). However, some of the pedagogical strategies proven in CoI and CSCL research — such as role assignment — may not fit to the MOOC context due to common assumptions that the collaboration and/or group inquiry will happen in small groups (6-10 students) or smaller class communities (30-40 students) (Anderson & Dron, 2011; De Wever, Keer, Schellens, & Valcke, 2010). When this is combined with different goals with which students enroll into MOOCs compared to those in conventional (online) courses, it becomes clear that novel theoretical and practical frameworks of understanding and organizing social learning in MOOCs are necessary. This research direction has been reflected in the topics identified in Cluster 4 of Phase 2 such as network formulation and peer-to-peer, online, learners and asynchronous interaction. However, novel theoretical goals have not been so clearly voiced in the results of the analyses performed in this study.

The connection with learning theory has also been recognized as another important feature of the research proposals submitted to MRI (e.g., Clusters 3-5 in Phase 2). Likely responding to the criticism often attributed to the MOOC wave throughout 2012 not to be driven by rigorous research and theoretical underpinnings, the researchers submitting to the MRI initiative used frameworks well-established in educational research and the learning sciences. Of special interest were topics related to self-regulated learning (Winne & Hadwin, 1998; Zimmerman & Schunk, 2011; Zimmerman, 2000). Consideration of self-regulated learning in design of online education has been already recognized. To study effectively in online learning environments, learners need to be additionally motivated and have an enhanced level of metacognitive awareness, knowledge and skills (Abrami, Bernard, Bures, Borokhovski, & Tamim, 2011). Such learning conditions may not have the same level of structure and support as students have typically experienced in traditional learning environments. Therefore, understanding of student motivation, metacognitive skills, learning strategies, and attitudes is of paramount importance for research and practice of learning and teaching in MOOCs.

The new educational context of MOOCs triggered research for novel course and curriculum design principles as reflected in Cluster 2 of Phase 2. Through the increased attention to social learning, it becomes clear that MOOC design should incorporate factors of knowledge construction (especially in group activities), authentic learning, and personalized learning experience that is much closer to the connectivist principles underlying cMOOCs (Siemens, 2005), rather than knowledge transmission as commonly associated with xMOOCs (Smith & Eng, 2013). By triggering the growing recognition of online learning in world-wide, MOOCs are also interrogated from the perspective of their place in higher education and how they can influence blended learning strategies of institutions in the post-secondary education sector (Porter, Graham, Spring, & Welch, 2014). Although the notion of flipped classrooms is being adopted by many in the higher education sector (Martin, 2012; Tucker, 2012), the role of MOOCs begs many questions such as those related to effective pedagogical and design principles, copyright, and quality assurance.

Finally, it is important to note that the majority of the authors of the proposals submitted to the MRI were from North America, followed by the authors from Europe, Asia, and Australia. This clearly indicates a strong population bias. However, this was expected given the time when the MRI initiative happened — proposals submitted in mid-2013. At that time, MOOCs were predominately offered by the North-American institutions through the major MOOC provides to a much lesser extent in the rest of the world. Although the MOOC has become a global phenomenon and attracted much mainstream media attention — especially in some regions such as Australia, China and India as reported by Kovanovic et al. (2015) — it seems the first wave of research activities is dominated by researchers from North America. In the future studies, it would be important to investigate whether this trend still holds and to what extent other continents, cultures, and economies are represented in the MOOC research.

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FUTURE TECHNOLOGY INFRASTRUCTURES FOR LEARNING

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ABSTRACT

Technology infrastructure shapes learning and learning opportunities. First generation infrastructure emulated classroom models where the instructor or institution controlled social interaction and content access. With continued development of the internet, mobile devices and apps, as well as the growth of social media and the participative web, explorations of future technology infrastructures are required in order to help higher education prepare for next generation learning opportunities. This paper explores four factors that influence future technologies: who has control, how well are the technologies integrated with other toolsets and the experiences of learners, who has ownership of the data and the technology, and what is the nature of the learning structure in terms of centralization and decentralization. These four factors are then used to explore a range of emerging technologies that provide an indication of the types of learning infrastructures that academics and institutional leaders need to consider in their resource and pedagogical planning.

INTRODUCTION

Though they are far from only the determinants of behavior, enterprise-level technology platforms drive workflow and organizational processes, thus enabling, supporting, and encouraging certain activities and limiting or discouraging others. Nowhere is this truer than with educational technology. Learning has traditionally been a process largely under the control of in-classroom teachers and faculty, albeit acting within the constraints of regulations, norms, standards, policies, schedules, imposed curricula, and the physical and social constraints of classrooms and their facilities. Through the development of online learning and related technologies, such as social media and learning management systems (LMS), administrators and researchers have accessible data trails to evaluate what happened during the learning process. Educational technology, however, also defines the scope and opportunities available to both teachers and learners. In some instances, the trade-off of greater consistency of both the learner and the teacher experience, at the expense of learner options, can be helpful when managing learner enrolment and grading. In other instances, the trade-off impacts both teaching practices and learner activities, limiting options for engagement and creativity.

Technology has received much attention within the education sector over the past several decades as a means for providing more flexible and scalable access alongside its perceived capacity for enhancing student learning outcomes. As noted in earlier articles in this series, the early adoption of distance learning has laid the foundation for the development of computer-based learning, and then online and blended learning. This progression of educational technologies is in part driven by the growing demand and interest in perpetual learning in all aspects of work, society, and life. The so-called knowledge revolution is rapidly transitioning into a learning revolution[1]. In essence, knowledge has become an easily accessible commodity, resulting in greater emphasis on learning opportunities. Workers are required to transition from being knowledgeable to more self-managed learners with the capacities and abilities to recognize their personal learning requirements in order to address organizational problems and challenges. In addition to increasingly sophisticated technologies, the proliferation of data and analytics increase the potential for personalized, adaptive learning. As such, provisioning individuals with the opportunities for relevant and timely education to meet their learning needs is now a critical challenge for companies, universities, and governments alike.

One area that has received limited attention in research and in practice is the role of varying technology infrastructures to address organizational and individual learning needs. While much has been written about learning management systems, enterprise systems, and social media, a nuanced evaluation of how educational technology infrastructures are changing is

1 www.forbes.com/sites/jacobmorgan/2014/12/30/the-death-of-knowledge-work-and-the-rise-of-learning-workers/

required. This paper details the scope of educational technology models and provides some guidance for future transitions and how higher education can prepare for the adoption of the next generation of educational software.

Educational technology has gone through three distinct generations of development and now a fourth is emerging:

Generation 1 — *Basic technology use: Computer-based Training (CBT) and websites*
Generation 2 — *Enterprise systems: learning management systems (LMS) and content management systems (CMS)*
Generation 3 — *Fragmentation and diversification: social media, e-portfolio software and MOOC providers, integrated vendor/publishers*
Generation 4 — *Distributed and digitally shaped technologies: adaptive learning, distributed infrastructures, and competency models*

Each stage represents a complex relationship of factors, including the following[2]:

1. Control between learner and faculty/institution, including structured and unstructured learning activities
2. Ownership of data and content — the learner or the institution
3. Institutional integration — loosely coupled with data exchange happening through APIs and related industry standards or tightly connected with enterprise level systems
4. Structure — centralized and decentralized teaching and learning approaches

These four points — control, integration, ownership, and structure — form the basis of analysis of different technology toolsets and ways in which these toolsets are utilized in higher education.

2 Existing research in learning sciences on distance, online, and blended learning suggests that the learning design approaches primarily, and technology secondarily, determines effective learning. As such, the framework provided here should be considered as a way of understanding how different technologies are experienced by the learner. Important factors, such as scaling a technology for broad adoption or ensuring standard look and feel across courses, or even integrating technologies into system/state-level enterprise systems, require considerations beyond the interest of learners and administrators. Context, resource availability, learning design, regulatory requirements, and other considerations will influence the selection of optimal toolsets in specific courses and institutions.

CBT and basic websites were the norm in higher education institutions during much of the 1990s. These generally consisted of faculty webpages that included contact information, course readings, and (in some cases) discussion forums or links to Usenet News. These faculty webpages were rarely mandated by the university and were generally used to provide profile information of the faculty member, their courses, and their areas of research.

In the late 1990s, Virtual Learning Environments and Learning Management Systems (LMSs) at first in the form of homegrown solutions and later through off-the-shelf toolsets, such as WebCT and Blackboard, emerged as an option to provide more integrated learning options with greater institutional control. An LMS enabled storage of content, tracking of learner activity, integration with institutional systems (such as Student Information Systems), standardized look and feel of courses, and (typically) relatively limited interaction (mainly threaded discussions in early offerings, though many provided blogs, wikis, and other more sophisticated tools). Starting in the early 2000s, the LMS marketplace was dominated by Blackboard as it actively acquired its main competitors, including WebCT and Angel. Open-source LMSs, such as Moodle and Sakai, gained significant market share during much of the 2000s. Desire2Learn, generally a strong competitor in the marketplace, adopted a "build slow and integrated" approach in contrast with Blackboard's acquisition approach. More recently, Instructure — a cloud-based LMS — has overtaken the number two LMS position in terms of learner enrolment, largely due to its "web native" usability.

From the late 1990s into the early 2000s, the growth of social media generated interest within the academy as it offered a learner-controlled approach instead of one that was institutionally controlled. As the concept of Web 2.0 developed in 2004, faculty increasingly adopted blogs, wikis, syndication through RSS, and social bookmarking as teaching tools. While this approach provided learners with opportunities to experience collaborative and knowledge generative learning, the weakly connected toolset sometimes resulted in frustration for institutions as learner data were spread across a range of toolsets, apart from when the tools were integrated into the LMS, which led to limiting compromises, in particular inasmuch as few enabled interaction beyond the course. The learning process enabled by these tools has resulted in a *thinning of classroom walls* where learners are now able to use a range of technologies and interactions with learners and content from around the world (see Figure 1).

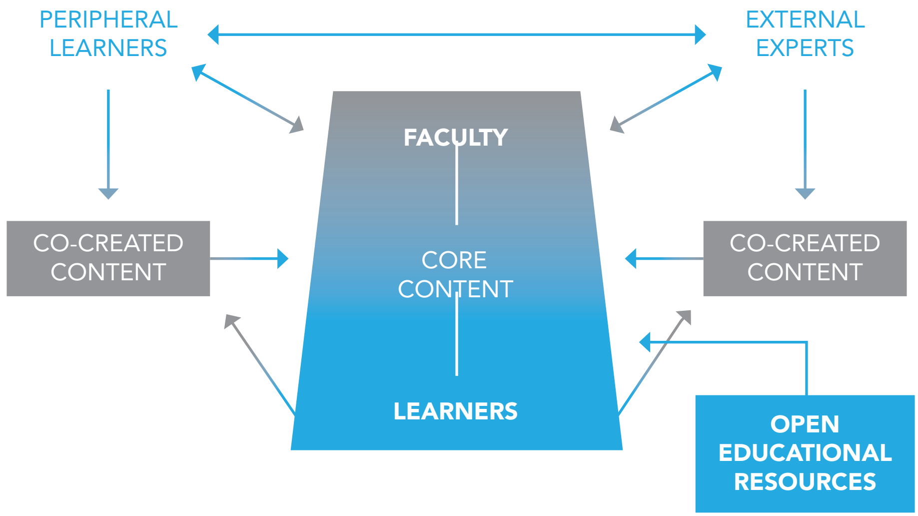

FIGURE 1 The impact of networks on learning

Additionally, the learning experience of students varied significantly based on the technical and pedagogical proficiency of the faculty member and the comfort and skills of learners to use a range of software products instead of a single integrated suite. While RSS aggregation tools and simple approaches like the use of HTML frames allowed some integration, it tended to involve manual effort and skills that, in mainstream teachers, were thinly spread. The uneven experience for students and the lack of institutional control of large parts of the learning process meant that adoption of Web 2.0, and later social media, was limited to technically proficient faculty and learning designers. Institutional adoption of these technologies was limited, even rare. Several notable projects, including the first MOOC in 2008, utilized a collection of social media technologies and placed greater emphasis on the process of "stitching" together distributed interactions (see Figure 2). This approach enabled learners to control the toolsets they personally preferred for learning while still meeting the needs of educators to make sense of distributed interactions. The software, gRSShopper, developed by Stephen Downes, produced a daily email that captured interactions occurring on blogs, Twitter, and even the course LMS if RSS feeds were enabled[3].

3 See here for examples: http://connect.downes.ca/cgi-bin/archive.cgi?page=thedaily.htm

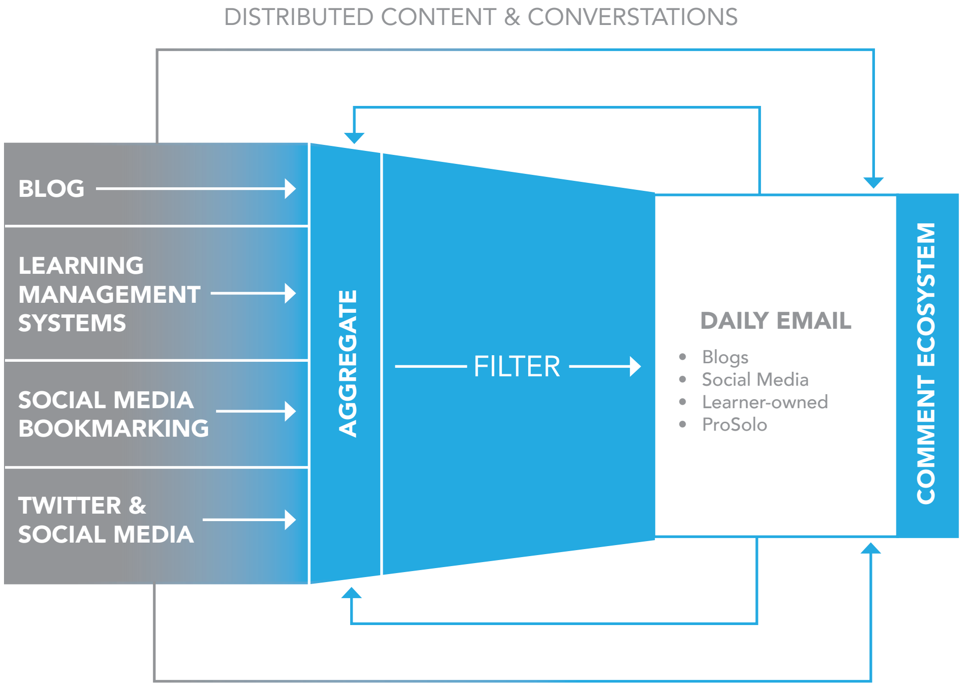

FIGURE 2 Distributed Content

LMS providers, including open source ones, increasingly included more of the functionality of social media in their platforms. Blogs and wikis were made available in closed ("walled garden") environments. Unfortunately, this presented challenges for pushing truly innovative teaching and learning experiences as courses within these contained systems limited interaction outside of a class or cohort. While using blogs and wikis within an LMS reflected participatory pedagogical models, the experience for learners failed to capture interaction with international students and boundary-less classrooms.

More recently, with the promotion of MOOCs by top research and state universities, additional software platforms, notably edX/Open edX and Coursera, have gained interest as delivery platforms. Both edX and Coursera systems are still developing and lack many features of established LMS providers. The major LMS companies now offer some version of open or MOOC courses[4], though the registration in those courses involves significantly fewer learners than those in edX and Coursera (which can include tens of thousands or even hundreds of thousands of learners).

The growing influence of vendors in the educational marketplace is often described in terms of "unbundling." The process of unbundling results in changes to existing power structures of education. Instead of an integrated, end-to-end system of education, the future looks more like a content and technology marketplace, with many vendors offering to take over core university functionality, such as recruitment of students, testing, and even teaching. These changes are providing lucrative opportunities to vendors[5], but also backlash from other stakeholders in education.

Another aspect of third generation educational technology, though it has received less attention than social media and MOOCs, is the growing interest in e-portfolios. Portfolios in the learning process have long been a staple in art or performance fields. Portfolios are particularly useful when combined with some form of Prior Learning Assessment and Recognition (PLAR). This approach, which provides the foundation for current developments in competency-based education, requires learners to produce evidence regarding what they know and are able to do and then to compare that evidence with existing knowledge and skill requirements in a particular subject area. Nursing and education have both seen reasonable adoption of e-portfolios, especially with a growing range of commercial (such as PebblePad or D2L's portfolio offering in their LMS) and open-source products (such as Mahara).

The first three generations of educational technology innovation have resulted in a complex and multifaceted landscape. Product offerings range from integrated suites (such as BrightSpace, Canvas, and Blackboard), to single functionality tools such as Mahara, to social media products like Facebook and Elgg. The technology offerings within LMSs have, to date, largely emulated existing classroom pedagogical models. This is starting to change. More recently, a number of research projects and software products have become available that address competency-based learning, adaptive and personalized learning, and self-regulated (student driven) learning. These software products include Knewton, Smart Sparrow, OLI (now at Stanford and CMU), and LoudCloud.

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4 See https://www.canvas.net/, https://opencourses.desire2learn.com/cat/, and https://openeducation.blackboard.com/mooc-catalog/catalog?tab_tab_group_id=_10_1

5 The stakes and the sources of conflict are reflected in the recent Fortune publication detailing how Pearson is facing mounting criticism for its activity in the education sector: http://fortune.com/2015/01/21/everybody-hates-pearson/

Numerous innovative research projects, often overlooked in favour of commercial vendors, are important to review as they provide insight into how educators and researchers are thinking about restructuring higher education and the learning process. The section that follows introduces a range of projects and software products that we feel provide important insights into future technology infrastructure.

SYSTEMIC-LEVEL INNOVATIONS

Several university systems and multi-system collaborations have been initiated in order to take advantage of scale and elimination of duplicated efforts across multiple institutions. Three examples provide some direction about future systems-level infrastructure: University of Texas System (single institution but multiple universities), Unizin (multiple institutions), and the Apereo Foundation (multiple institutions, multiple international partners). Systems-level innovation attempts to improve end-user experience while reducing operating expenses and frustrations for individual universities.

University of Texas System: TEx[6]

In partnership with numerous educational technology providers, the Institute for Transformational Learning (ITL) is developing TEx, a set of platforms, applications, and services for use across all ITL industry-oriented, competency-based educational initiatives. The acronym TEx derives from the words "Total Education Experience" and will deliver personalized, adaptive educational programming and support services at scale across the system.

6 Thanks to Steven Mintz, Executive Director of the University of Texas System's new Institute for Transformational Learning, for his contributions to this section on TEx

Built around a personal profile, TEx is designed to assist students from the moment they express interest in UT System programs through graduation and entry into their chosen career. It will aggregate information about the student's learning experiences, making it possible for instructors to deliver customized content and learning pathways tailored to individual students' unique needs and interests. TEx will also encourage networking and collaborative experiences among faculty, students, and others.

In addition, TEx will generate data about the student learning experience to support continuous improvement of program and curriculum design, pedagogy, and student services operations. TEx will unify data across traditional SIS, CRM, and LMS systems to drive timely and personalized recommendations and support services tailored to each student's unique set of capabilities, experiences, personal circumstances, and aspirations. Analytics will improve advising, drive continuous improvements in pedagogy, and allow institutions to better assess the effectiveness of their student support programs.

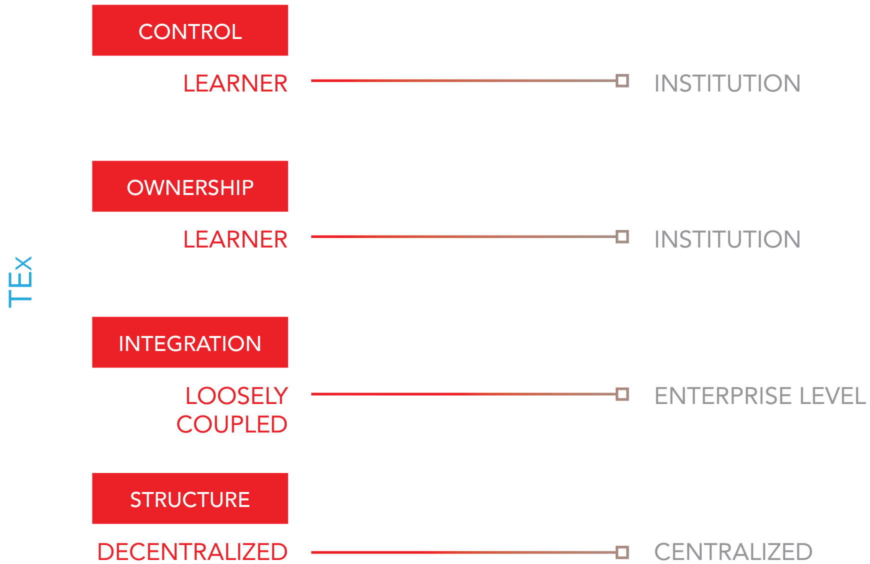

FIGURE 3 TEx

Unizin[7]

In June 2014, four universities announced the formation of Unizin with the stated goal of becoming "the Internet2 of Digital Education" as a member-owned consortium. The metaphorical reference to Internet2 draws on the history of the university-operated infrastructure for advanced digital networks. Internet2 ensures that decisions regarding the use of the network, its privacy policies, ownership, etc. are vested in the hands of its 250+ college and university members. Ownership affords decision rights and influence, and Unizin can ensure that content, privacy, and analytics policies and costs are steered by Unizin's members[8].

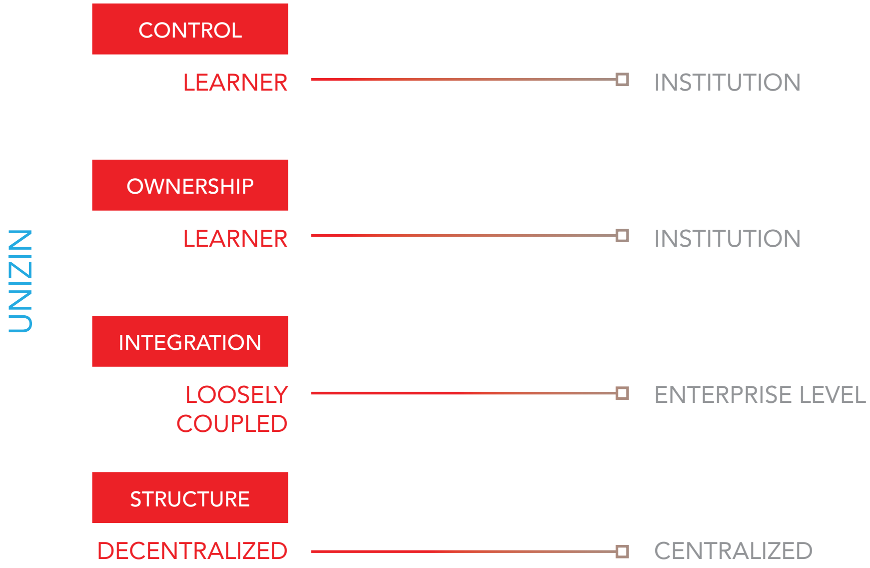

FIGURE 4 Unizin

7 Thanks to Brad Wheeler, Indiana University Vice President for IT & CIO, Dean, and Professor, for his contributions to this section on Unizin.

8 See http://unizin.org/2014/06/why-unizin

Apereo[9]

The Apereo Foundation is a not-for-profit entity supporting the creation and sustenance of open-source software serving the academic mission — learning, teaching, and research. Apereo is a global membership organization with around a hundred higher education and commercial partners on six continents.

Apereo works in close partnership with other organizations with similar or adjacent areas of interest. It has a close partnership with the seventy-institution-strong ESUP consortium in France[10] — creating a network some one hundred and seventy strong. Apereo also has a developing relationship with the Open Source Initiative, Society for Learning Analytics Research, and InCommon.

Since Apereo was formed from the merger of two pioneers of open source in higher education — Jasig and Sakai — in 2012, it has given particular emphasis to creating a framework for developing software project sustainability. This incubation process — a scaffolded process assisting projects on the path from innovation to sustainability — has proved a major success. Apereo currently acts as a legal, licensing, and service umbrella for a dozen projects.

The Sakai environment has served higher education for almost a decade as a collaboration and learning environment. While mainly deployed as a Learning Management System, Sakai has also found a number of adoptions supporting research collaboration. Sakai is designed for campus and above-campus deployment. In addition to considerable visual and tool flexibility, Sakai has played a considerable role in promoting the development and adoption of key educational technology standards, including IMS GLobal Learning Tools Interoperability, and standards supporting learner analytics. Emerging consensus in the Sakai community is driving the environment to provide further, and more effective, integration points for external or alternative tools. This "hollowed out LMS" or "Enterprise Learning Bus" approach will provide the flexibility to fit Sakai more closely to the needs of a greater range of institutions and disciplines. It is highly likely, therefore, that Sakai will continue to play a significant role in education going forward.

9 Thanks to Josh Baron, Assistant Vice President, Information Technology for Digital Education Marist College, and Ian Dolphin, Executive Director, Apereo Foundation, for their contributions to this section on Apereo.

10 https://www.esup-portail.org/

The Apereo Open Academic Environment (OAE) is a next-generation platform for academic collaboration. While OAE can be (and is) used to support formal education effectively, it intentionally breaks with the LMS organizational models of courses and classes, instead resting on more flexible concepts of individuals and groups collaborating around content. In developing OAE, particular emphasis has been placed on user-experience designers working with academic practitioners to provide not only the required functionality, but to provide that functionality in a way that is easy for end-users. OAE is designed from the ground up as a multi-tenant, hosted environment, with optional permeability between tenants. This latter feature enables controlled collaboration between institutions for faculty and students. Apereo OAE currently has around forty adopters, with significant rollouts in the near future in France and Australia.

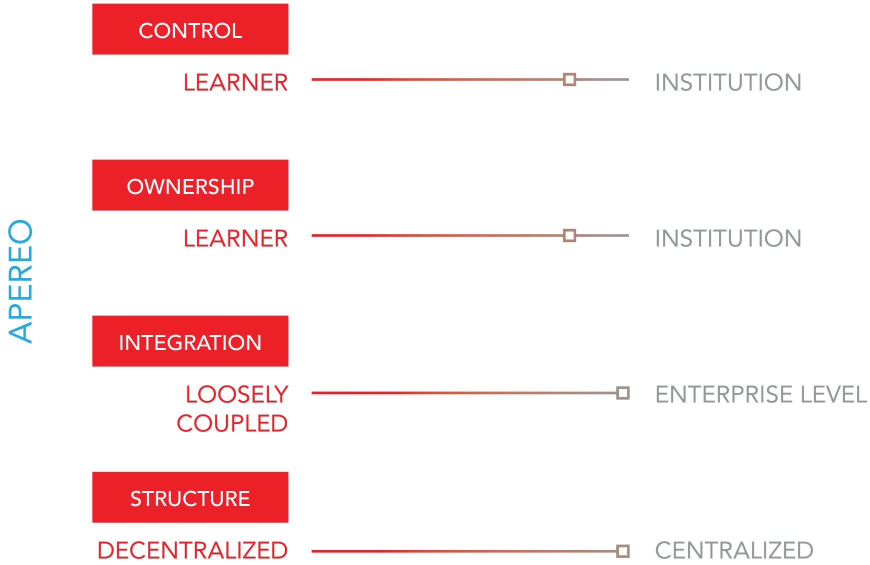

FIGURE 5 Apereo

RESEARCH PROJECTS

The Landing[11]

The Landing[12] is a social site exclusively for members of Athabasca University and a few invited guests. Athabasca University is a publicly funded distance education and research university, with almost all of its undergraduates taking self-paced courses. Numerous master's and doctoral programs are also offered. Like its students, the faculty are also distributed (primarily in Alberta). Although it offers a great deal of freedom and flexibility, the distributed distance model results in a range of challenges caused by isolation for both staff and students. Among other things, this model led to difficulties in communication, an over-emphasis on structured courses and processes, difficulties spreading knowledge across the institution, and problems sustaining motivation. The Landing was created in 2010[13] in response to these unusual conditions using the Elgg social framework. It incorporates blogs, wikis, microblogs, file sharing, social bookmarking, podcasting, photo sharing, and many other read-write tools, all with discretionary access control, from fully private to completely public. It supports social networking as a feature rather than a destination (see Chris Anderson http://www.thelongtail.com/the_long_tail/2007/09/social-networki.html) as well as having facilities for creating more or less open groups that act as containers for focused group working. The site was conceived as a space between the hierarchical, structured space of an LMS and the unstructured, informal, personal free-for-all of email, VOIP, social media, and chat. In many ways, it might be seen as playing the role of similar in-between spaces in traditional physical universities, such as common rooms, hallways, quads, and library working areas, including not just the people but also the artefacts that they create and share with one another. It is a space where other people and their activities are visible and reified. With its large and diverse toolset, it can be shaped to fit a wide range of social and learning needs.

11 Thanks to Jon Dron, Professor, School of Computing and Information Systems, Athabasca University, for his contributions to this section on the Landing

12 http://landing.athabascau.ca/

13 Terry Anderson and Jon Dron are the principal investigators and leads on the Landing. Disclaimer: report author George Siemens was project lead from 2010–2013.

The Landing was deliberately designed and nurtured as a diverse learning commons. Though a lot of use has been made of the system to support formal courses, it has at least equal value as a networking space, a place for ad hoc working groups and committees, a space to share ideas, work in progress, observations, and — sometimes — complaints. With a nod to Jane Jacobs' observations on what makes a city area thrive, it was built so that there should be many reasons one might need or wish to be there, the intent being to keep it lively and filled with visible activity. This has many benefits, not least of which are the opportunities to learn from what others are doing, to make serendipitous encounters, to feel a part of a large and active learning community, and to spread learning within courses beyond the silos that are an inevitable result of the hierarchical role-oriented structure of a learning management system.

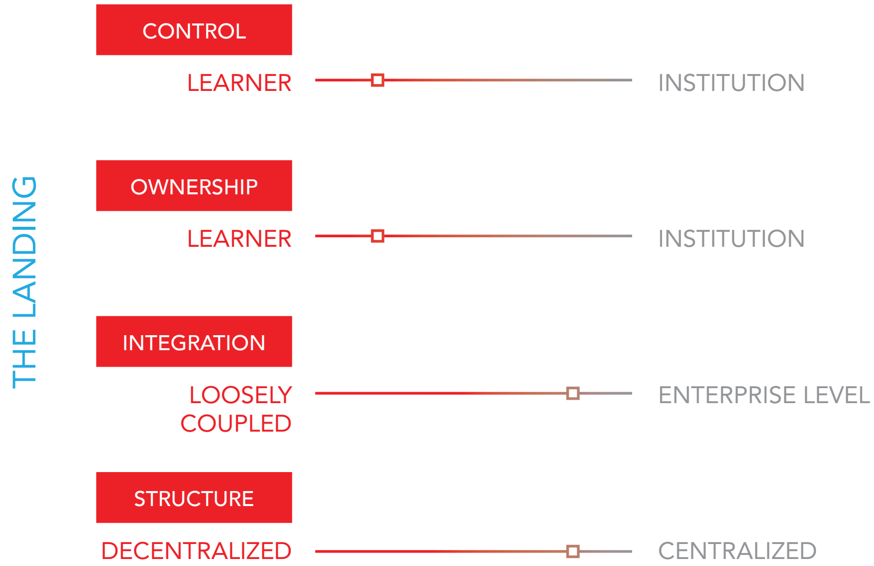

FIGURE 6 The Landing

Federated Wiki[14]

Federated wiki is a new technology developed largely by the inventor of wiki, Ward Cunningham. Like wiki, it encourages revision, reuse, and extension of community ideas. However, it does this not through a centralized site, but through a federation of individually owned wikis that fork text[15], data, formulas, and media from one another. It has been called "Github for Wiki," but is perhaps better explained as a unique mix of blogging and wiki.

With Ward Cunningham's assistance, Mike Caulfield (Washington State University Vancouver) has been investigating the application of the technology to education. Historically, blogging has provided a reflection and communication space for distributed courses. It is hoped that federated wiki could provide a similar space in such courses for loosely coupled collaboration and cooperation around text and data[16]. The "Fedwiki Happening" run in December 2014 explored the use of federated wiki in a distributed learning environment. This experiment was a follow-up to the successful use of federated wiki in a traditional college class.

The results were intriguing. Happening participants were told to explore their academic or professional interests on their own wiki, and to fork and edit elements of other participant wikis if they found them useful to their own learning goals. In the Happening, rather than have them reflect in social space, students were asked to engage in the "mining" of various things they read for ideas, examples, and data that might be applied to other problems (in this way, the wiki borrows from design patterns methodology in software). By abstracting ideas and examples from texts, participants increased their understanding of the texts, and by presenting the results in a modular way, they provided materials through which other students could advance their own investigations. Even with the small number of participants, a surprising number of serendipitous connections occurred.

14 Thanks to Mike Caulfield, Director, blended and networked learning at Washington State University, Vancouver, for his contributions to this section on the Landing

15 Forking refers to the process of taking one resource and essentially copying it to create an additional resource where changes made to the forked version do not impact the first. This allows for personalization, customization, and development opportunities that might advance beyond what the original creators had intended.

16 The process of information flow in a federated system is described here: https://www.youtube.com/watch?v=2Gi9SRsRrE4

Cunningham and other volunteer programmers are currently redesigning the software based on feedback and analysis from the Fedwiki Happening and plan a retooling based on the new educational focus.

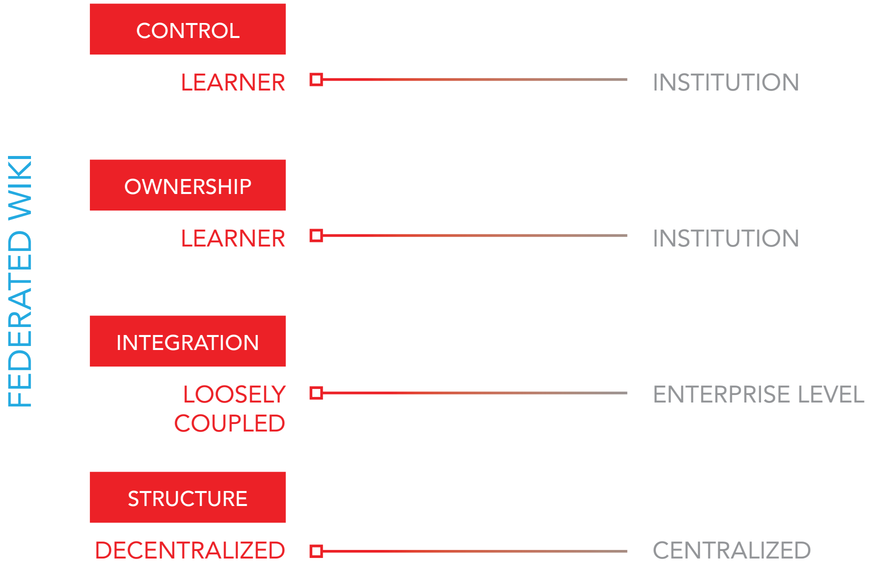

FIGURE 7 Federated Wiki

gRSShopper[17]

Created to facilitate production of the OLDaily newsletter, gRSShopper[18] has evolved into a content management tool that aggregates contents in a variety of formats and facilitates the publication of newsletters and RSS feeds. gRSShopper was used to support the first MOOC, Connectivism and Connective Knowledge, in 2008. Course participants contributed their blog or content site URL and used these, rather than a course-specific discussion board, to contribute comments and resources to the course. gRSShopper aggregated the submissions and prepared a daily summary of contents. gRSShopper also manages event listings, file uploads, and a chat room. gRSShopper is free and open source and available for download, but is a research environment, not production-grade code.

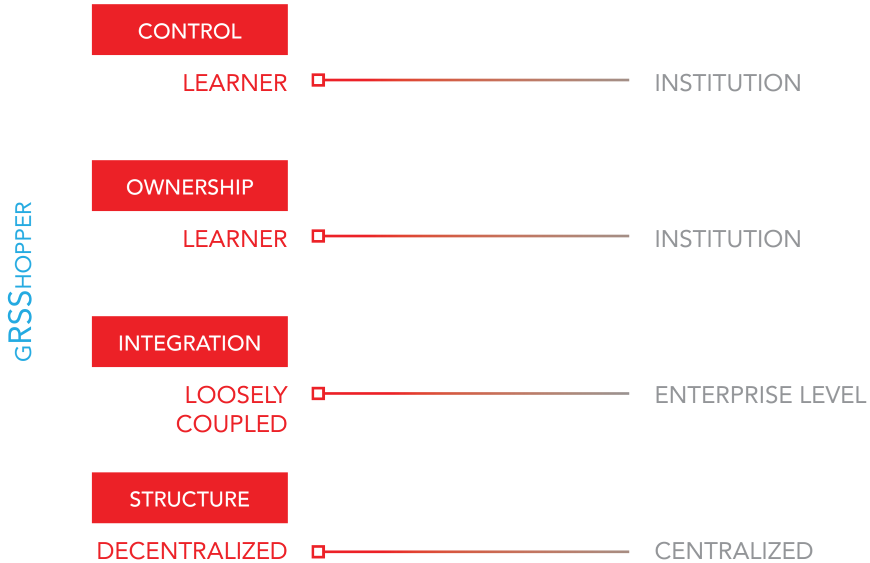

FIGURE 8 gRSShopper

17 Thanks to Stephen Downes, LPSS Program Lead, National Research Council Canada, for his contributions to this section on gRSShopper

18 http://grsshopper.downes.ca/

Learning and Performance Support Systems[19]

LPSS[20] is a personal learning environment being developed by the National Research Council. The project was announced in 2013 and launched as a $19 million, five-year project. Currently offered only as a hosted service and still in pre-Alpha, LPSS will enable learners to manage their learning activities from a single environment while connecting to resources and services offered by multiple vendors. LPSS supports competence-based learning and generates resource recommendations from among a set of personally selected learning providers. The system also supports personal cloud technology for document storage and synchronization, a personal learning record (including badges and an e-portfolio), and a personal learning assistant intended to enable LPSS access through desktop and mobile devices as well as in third-party products and software.

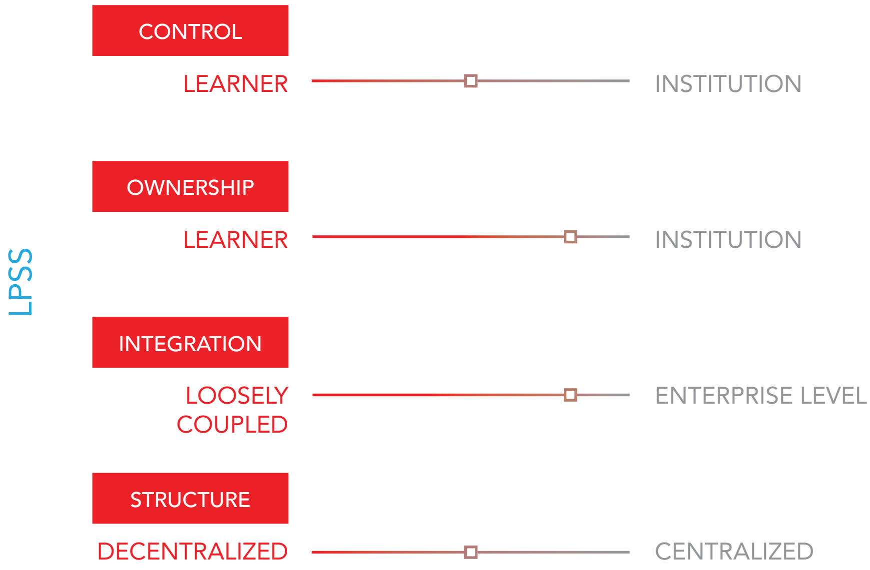

FIGURE 9 LPSS

19 Thanks to Stephen Downes, LPSS Program Lead, National Research Council Canada, for his contributions to this section on Learning and Performance Support Systems

20 http://lpss.me

ProSolo

ProSolo[21] is a platform designed to facilitate self-directed and competency-based learning through social interaction. ProSolo has been developed as a response to the on-going challenges of traditional educational models primarily focused on classroom education and training typically associated with the notion of credit hours as the (only) route towards formal credentials. In contrast, the demands for education are far more diverse, with many individuals now undertaking greater forms of informal learning or professional development and education opportunities within the workplace. The "non-traditional learner" is now the dominant student characteristic in the majority of institutions in higher education[22]. This suggests a need for establishing a greater diversity of learning opportunities. At the same time, institutions recognize a need to innovate educational practices through initiatives such as active learning and flipped classrooms in order for learners to be actively engaged in learning and developing core skills — such as information seeking, critical thinking, creativity, and teamwork — necessary lifelong skills and capacities for productive participation in contemporary society. Therefore, the shift in higher education to more novel learning and instructional models enabled through adaptive and personal technologies are essential.

ProSolo provides users with the ability to unbundle education programs, courses, and units into discrete yet inter-related competencies, allowing learners to construct their education pathway in a manner that better reflects their interests and future career motivations and requirements. ProSolo is developed with the intention of providing learners with opportunities to customize, modify, and personalize their self-directed learning journey. In this way, ProSolo's design and conceptual model captures the essence of personalized learning whereby learners take control over, drive, and make decisions about their learning. ProSolo's mapping of personal goals and experiences directly to the achievement of competencies and granting of credentials provides learners with greater flexibility in their study options, as well as the recognition of alternate learning pathways and prior experience. For education providers, ProSolo maps curriculum activities directly to learner competencies and outcomes, allowing for easy unbundling and reassembling of degree programs and courses. ProSolo unpacks the rigidity of existing programs to cater to alternate educational pathways, providing students with new opportunities to gain recognition for prior learning and achieved credentials and relevant life and work experiences. ProSolo doesn't just break the concept of the credit hour — it totally removes it.

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21 Report authors Shane Dawson, Dragan Gašević, and George Siemens are all involved in the research and development of ProSolo.

22 http://www.census.gov/prod/2013pubs/acsbr11-14.pdf

ProSolo supports the development of skills for self-directed learning by allowing learners to control the planning, learning, and presentation of outcomes associated with their learning (see Figure 2). Learning in ProSolo occurs within a socially rich environment that aggregates learners' information created and shared in their existing online spaces. ProSolo encourages learners to continue using those existing online spaces — such as blogs, YouTube, and SlideShare — and assists them in the aggregation of their personal information to establish their personal and publically shared profiles. The aggregated information can then be used as evidence for competency achievement in the credentialing process. With the possibility of creating and sharing personal profiles, learners also have opportunities to establish a strong social presence that goes beyond a single course offering. This method promotes the creation of communities and peer collaborations. Learners have opportunities to find or be matched with others based on numerous factors, such as shared interests, similarity of their profiles, and proximity of their geographic locations. To validate competencies acquired even through informal and authentic contexts, ProSolo has a robust credentialing pipeline to assess and validate the evidence learners provide in order to demonstrate the achievement of the competencies claimed. The pipeline has its own functionality of supporting instructor and peer assessment, and has integration — through the IMS Learning Tools Interoperability (LTI) standard[23] — with other technologies commonly used in assessment, such as open badging platforms, quizzing engines, or automated essay-scoring technologies.

23 http://www.imsglobal.org/toolsinteroperability2.cfm

FIGURE 10 The conceptual model for self-directed and competency-based learning through social interaction in ProSolo.

The design of ProSolo recognizes that learners may not be prepared for self-directed learning and may require a different form of scaffolding. To support learners with different levels of prior knowledge, study skills, and cultural backgrounds, ProSolo offers features for supporting self-directed learning through three types of scaffolds:

Instructional — enabling promotion and incorporation of the best principles established for instructional design in online and blended learning; this form of scaffold provides instructors with direct involvement and control over the instructional processes. Rather than replacing instructors, ProSolo empowers educators with a technology that creates the possibility for interaction with and instruction of their learners in diverse and authentic contexts.

Social — building on established empirical evidence that asynchronous online discussions among students are one of the most potent instructional strategies. At the same time, the use of social media — embedded in and aggregated by ProSolo — offers seamless communication and information sharing.

Technological — harnessing the power of learning analytics and machine learning, as well as learner modeling, ProSolo provides automatically generated recommendations to assist learners in their learning decisions about plans for future learning and feedback on the ongoing learning.

ProSolo has been successfully used to support an innovative dual-layer instructional design used in the Data, Learning, and Analytics MOOC[24] offered in partnership with edX in late 2014. Presently, ProSolo is piloted on sites of several institutions in the USA and Australia in supporting their transition to competency-based programs and credentialing for continuous career development.

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24 http://www.edx.org/course/utarlingtonx/utarlingtonx-link5-10x-data-analytics-2186 and http://dalmooc.prosolo.ca

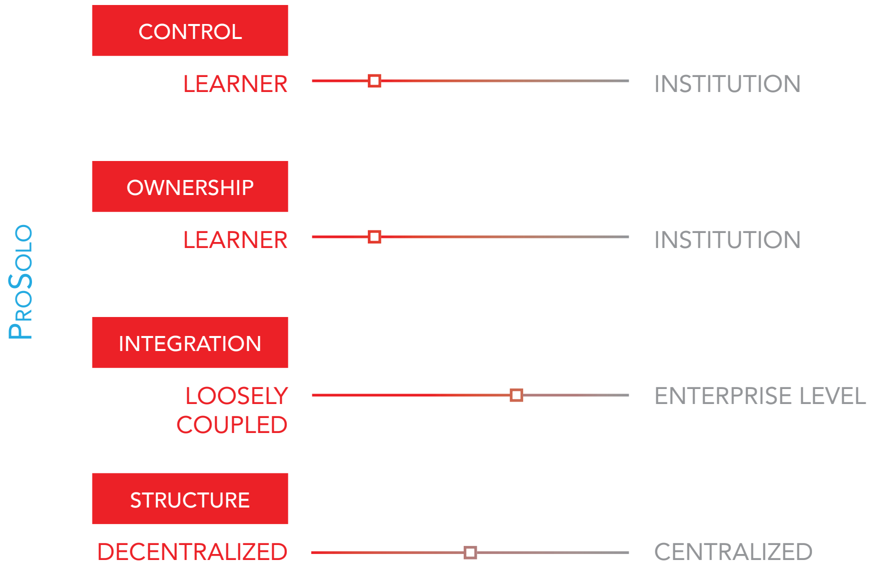

FIGURE 10 ProSolo

Domain of One's Own/Reclaim[25]

Started at the University of Mary Washington in the Fall of 2013, Domain of One's Own (DoOO) provides any interested faculty, students, and staff with their own web hosting and domain. This personal cyber-infrastructure not only enables individuals to manage and control the work they do over the course of their academic career, but also experiment with a wide range of open-source applications from WordPress to Omeka to Moodle to Mahara to Known. So rather than being a single tool provided by central IT, DoOO provides a toolkit for innovation to an entire community.

These personal environments are hosted and supported by the university, providing a platform to start encouraging and scaffolding a deeper understanding of how the web works, and how 21st century learners can fully embrace its possibilities. Most importantly, unlike most proprietary "all-in-one solution systems," the infrastructure behind DoOO is highly affordable, eminently portable, and easily transferable. The community is working

25 Thanks to Jim Groom, Executive Director of the Division of Teaching and Learning Technologies and adjunct professor at the University of Mary Washington, for his contributions to this section on Domain of One's Own on the industry standard, CPanel, which fuels most major hosting sites across the web, i.e., BlueHost, HostGator, etc. So, at the end of their time at university, those interested can seamlessly transition their domain and/or hosting to the domain registrar and web host of their choosing and continue to build and define their digital presence well beyond their time at UMW. This approach to empowering faculty, students, and staff has caught on at numerous universities. Emory University, University of Oklahoma, CSU Channel Islands, Davidson College, and several others have adopted this approach on an institutional level, not to mention the scores of initiatives at the departmental and course level.

Alongside Domain of One's Own, there has been increased focus on reclaiming the work we do online from larger, siloed sites such as Facebook, Twitter, Flickr, Instagram, etc. While not advocating for secession from the social web, this segment of users is concerned with taking greater control over the updates we post, images we upload, bookmarks we save, videos we share, etc. More often than not, we are sharing our work through social media conglomerates that often have unilateral control over the content posted, not to mention limited interest in any long-term preservation (see Blip.tv, posterous, Geocities, del.icio.us, and many, many more). So, a move to personalize infrastructure provides a shift away from social media sites as the sole source of online work. This approach to publishing in one's own space while still sharing widely is one of the tenets of the IndieWeb[26] movement, namely POSSE: publish on your own site and syndicate everywhere. Your domain becomes the hub from which you manage the many forms of work that you do across the web, a concept with implications in every facet of our digital life well beyond education, from managing our digital medical records to property insurance, taxes, etc. The reclaim movement provides an alternative path based on an affordable infrastructure that empowers our communities to take back control of the web.

Reclaim Hosting is a service born out of this vision that currently provides hosting for thousands of students, faculty, and institutions. With so many IT departments either unable or unwilling to support the changing nature of infrastructure to provide such personalized spaces as part of the institutional ecosystem, Reclaim Hosting has become an option for many to explore what this user innovation toolkit might mean on an individual, course, department, or even institutional level. One way to think about Reclaim Hosting is affordable, distributed ed-tech infrastructure for any interested party.

26 indiewebcamp.org

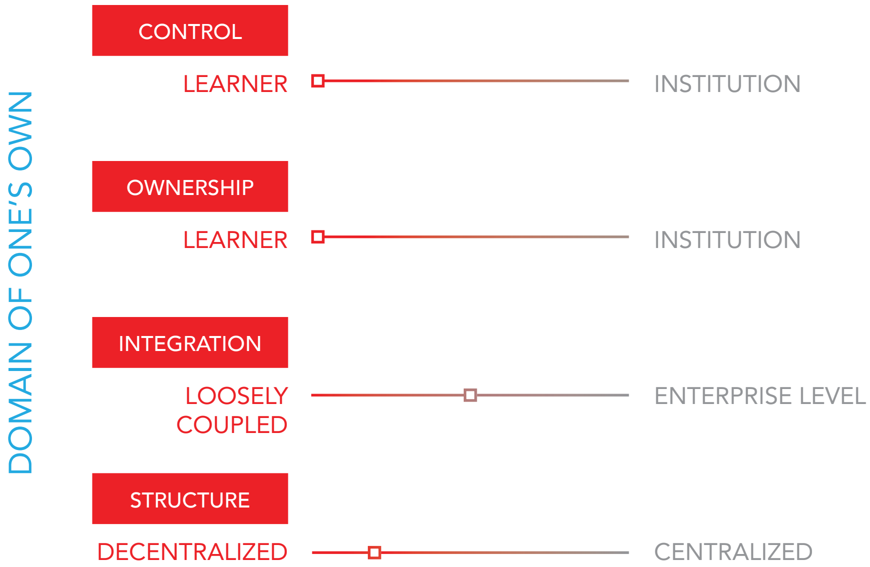

FIGURE 11 DooO

Open Learning Initiative[27]

Carnegie Mellon University's Open Learning Initiative (OLI) leverages learning science and emerging technologies to design, deliver, and improve web-based learning experiences. OLI's methodology is supported by an online platform for developing, delivering, and continuously refining learning materials while driving ongoing research in learning science; in this way, OLI's platform integrates research and practice, providing learners and educators with an experience informed by the best science while advancing our understanding of how humans learn.

The OLI platform is a collection of tools for creating and delivering online instruction that embeds core learning science principles in the system's design, capabilities, and navigation. Content in the system combines traditional expository materials with extensive opportunities for practice, targeted feedback, and robust hints for a complete, supported learning

27 Thanks to Candace Thille, Senior Research Fellow for the Office of the Vice Provost for Online Learning, Stanford University, and Norm Brier, Director of the Open Learning Initiative (OLI) and Core Collaborations at Carnegie Mellon University, for their contributions to this section on Open Learning Initiative

experience. The design of the system has been enhanced by Universal Design for Learning principles to increase flexibility, address learner variability, and allow learners multiple ways to recognize, act on, and engage with knowledge. The system exhaustively captures data on learner interactions; this data is then used to provide meaningful feedback to learners, instructors, and course developers, as well as to support researchers. The system provides a core set of functionality for content, including traditional expository materials (text, examples, images, videos, etc.). The system also provides mechanisms for incorporating other non-core technologies through APIs. Such non-core technologies include standard elements used frequently in courses, including certain types of labs, simulations, and cognitive tutors. These technologies can also include less standard, more experimental elements — as technologies and associated pedagogical approaches become less experimental and better tested, their use becomes more standardized, eventually moving towards integration with the core system.

The system exhaustively captures data on student learning and behaviors, tracking student actions through the course, including questions, responses, feedback, hinting, login, page views, video watching, etc. This data, in association with an underlying cognitive model, drives an analytics dashboard that can provide a real-time view of student learning and performance. The data is used to create various summary reports for improvement and evaluation; it can also be exported to the Pittsburgh Science of Learning Center's DataShop. DataShop provides analytic methods for understanding learning interaction data and provides the infrastructure for sharing these datasets with other researchers. This data capture and use supports continuous course improvement, a scientific approach to course design, and a virtuous cycle that can improve our understandings of human learning.

The OLI system supports semantic tagging of content, associating metadata such as skills and learning objectives with specific pieces of content at various levels of granularity (ranging from pages to individual question parts). The system also strictly enforces a semantic representation of all content, thus supporting design and research. These semantic representations distinguish OLI's approach to learner data capture from other clickstream-based systems, allowing insights into underlying pedagogical intent and learner misconceptions.

The OLI platform is currently provided as a hosted environment; the core platform consists of a Java enterprise application running on Linux using the Apache web server, JBoss application server, and MySQL database software — an open-source development stack. The systems architecture supports open-source application servers that can be run locally, using Red Hat Enterprise Linux or EC2 using Amazon Web Services. Additional technologies are used in the non-core tools. OLI provides support for Basic LTI, integrating with LMS systems as an LTI tool. The OLI system also provides some minimum set of LMS functions — specifically scheduling and a grade book — that are not well integrated into LTI consumers.

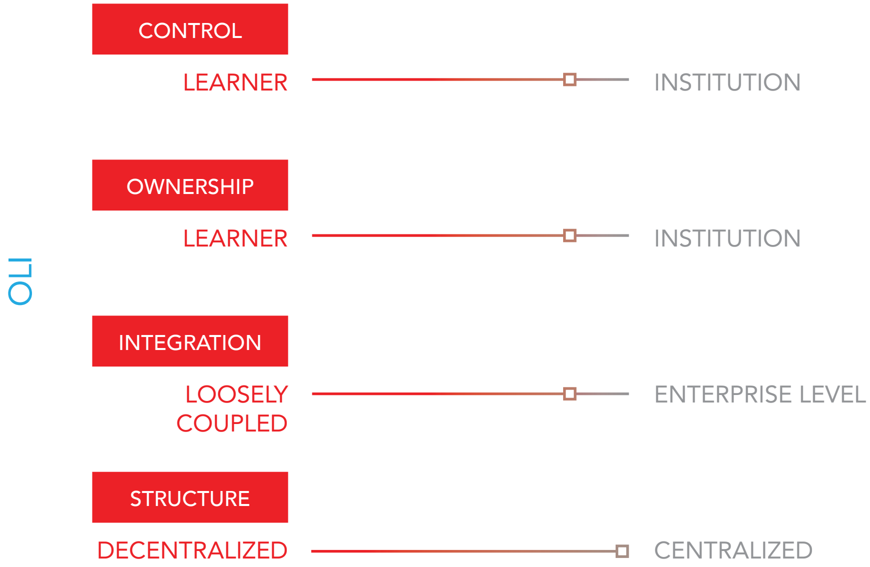

FIGURE 12 OLI

Known[28]
Known is an open-source social publishing platform created by Ben Werdmuller (who previously co-founded Elgg) and Erin Richey. Students publish content to a site that they control and then optionally syndicate it to systems they have less control over, including central course spaces, learning management systems, and social networks like Facebook, Twitter, Flickr, and LinkedIn. Known supports status updates, blog posts, photos, audio, and more. New content types, themes, and syndication integrations can be added easily.

Like Elgg, Known contains granular access permissions and extensive social functionality. However, Known has been developed with today's web in mind; for example, it is fully

28 Thanks to Ben Werdmuller, CEO and co-founder at Known, for his contributions to this section Known

responsive and works well on any mobile device, reflecting the reality that students use these devices to browse the web over 50% of the time.

Unlike Elgg, each student's profile is its own stand-alone site. This means that profiles can easily be moved; for example, when students graduate, they may take their site and content with them. It also allows students and faculty to customize their profiles to their liking, including by radically changing the visual style. Due to this structure, Known users can reply to each other and interact with each other's content in a peer-to-peer manner, wherever their site is hosted.

Known is structured as a start-up, based in San Francisco, California. The company provides a hosted service, as well as consultancy, customization, and development services. A course aggregator and hub software for easier deployment are also available[29]. Jim Groom at the University of Mary Washington, among others, is piloting the software.

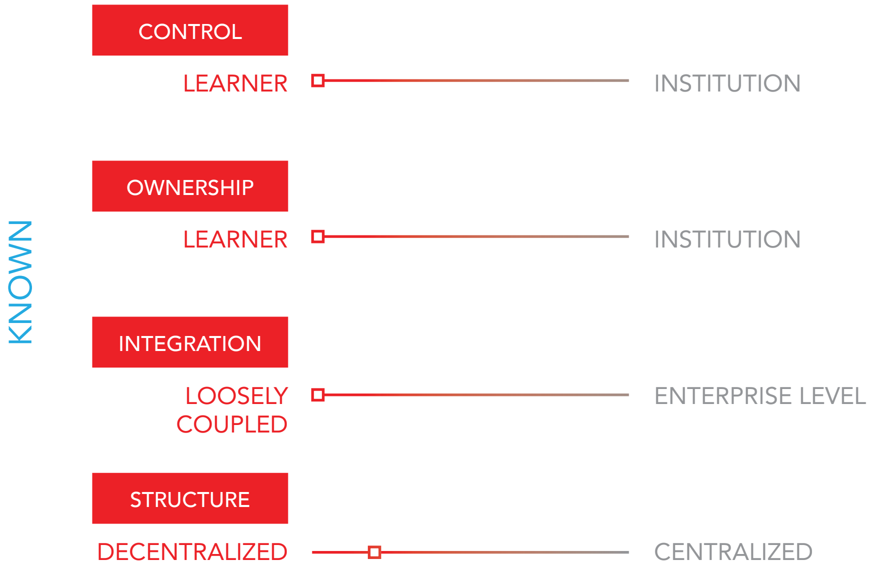

FIGURE 13 Known

29 Further details and open-source software available at https://withknown.com/

CONCLUSION

Higher education is changing. Central to this change is the transition from a physically based learning model to one that makes greater use of digital technologies. A brave, new landscape of toolsets is now emerging, each with various elements of control, integration, ownership, and structure. As leaders, educators, and students begin selecting tools for enterprise deployment, questions of control and ownership become as important as questions of integration and structure. More importantly, the technologies selected will determine the quality of learning, the scope of teaching practices, and ultimately, how well learners are equipped for both employment and engagement in democratic and equitable models of modern global society.