TECHNOLOGY TRANSIENCE AND DISTANCE EDUCATION IN THE SECOND MACHINE AGE

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> "the key building blocks are already in place for digital technologies to be as important and transformational to society and the economy as the steam engine. In short, we are at an infletion point—a point where the curve starts to bend a lot—because of computers. We are entering a second machine age."
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> —Brynjolfsson and McAfee (2014)

In *The Second Machine Age*, Brynjolfsson and McAfee (2014) write that we are "living in a time of astonishing progress with digital technologies," that "the transformations brought about by digital technology will be profoundly beneficial ones," but that "technological progress is going to leave behind some people, perhaps even a lot of people, as it races ahead." (pp. 9–11). The authors go on to explore how technological change is affecting most aspects of our society. In this vein, they note that even though education has historically been more resistant to technological change than other societal sectors, recent advances in distance education, specifically online learning, promise to radically disrupt traditional education (Christensen, Horn, & Johnson, 2008). The articles in this special issue have addressed one aspect of such disruption, technology transience, in the context of distance education.

Technology transience, as noted by Muilenburg and Berge in their article, "refers to the rapid proliferation of technology tools, the frequent update of such tools, and their ever-shortening lifespans" (p. 94). Amirault reminds us that "technology" in this context refers to digital technology—computer and/or computer-driven hardware and software. This is important because it makes the technology in question subject to Moore's Law (Moore, 1965) which states that the amount of computing power one can buy for a set amount of money roughly doubles every year. Moore's prediction was bold at the time, and even Moore expected that his "law" would apply for no more than 10 years following his pronouncement. However, it has held from 1965 to the present. Every 10 years from 1965 until now, digital devices have generally become 500 times more powerful, making today's dig-

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The Quarterly Review of Distance Education, Volume 16(2), 2015, pp. 139–145 ISSN 1528-3518

ital devices over 31 *trillion* times as powerful as they were in 1965.

What does this increase in computations power imply for distance education? To begin with, it has made both online and mobile learning possible, and these two modalities have taken distance education from the periphery of education to the mainstream. Moreover, as Henry Jenkins (2006) reminds us, media are characterized not only by the technologies they employ but by the cultural practices that surround their use. Similarly, what distinguishes online and mobile learning from the distance learning of previous eras is not just the technologies they employ, but, more importantly, the pedagogical approaches they enable. Where distance education was materials- and teacher-centered, online and mobile learning are student-centered; where distance education focused on independent study, online and mobile learning focus on collaboration; where distance education was grounded in behaviorist and cognitive psychology, online and mobile learning are grounded in social constructivist theory.

More importantly, digital technology is expected to continue its exponential increase for at least the next decade (Brynjolfsson & McAfee, 2014), with computing power continuing to double each year during that period. Education in general, and distance education in particular, will similarly evolve and change at a very rapid pace, or, perhaps, even give way to something else. Indeed, in the first article in this special issue, Amirault anticipates the linking of computers to our brains for the transfer of knowledge and skills. The point is that distance educators at all levels—faculty, instructional designers, administrators, policy makers, leaders—are affected by technology transience and must deal with its effects. The articles in this issue are concerned with how they might do so.

Amirault describes the issues generated by technology transcience and situates it in context in "Higher Education's 21st Century Challenge: Technology Transience." He begins with definitions and distinguishes between transient and durable technologies. He argues that durable technologies are often simple, but today's technologies are complex and transient; an interesting idea. It makes one wonder whether increasing complexity leads to increasing transience. Amirault then reviews the history of technology and education, proposing periods distinct from those generally accepted in the areas of either communications or technology, and notes that the periods are becoming shorter. He also reviews models of technology innovation. Amirault concludes by identifying three areas where technology transcience is significantly impacting distance education—instructional design, 21st century skills, and the 21st century university—and examines a sampling of questions technology transcience raises within them.

In discussion technology transience and instructional design, Amirault discusses the great media debate of the early 1990s. Essentially this debate centered on whether or not media (technology) influenced learning, with one side arguing that technologies were just transmission vehicles like trucks bringing food to market (Clark, 1994). What mattered, they argued, was the food the trucks carried, not the trucks themselves. The other side countered that if you are transporting ice cream, the nature of the trucks matters a lot (Kozma, 1991), or as Salomon (1981) argued, media have characteristics that matter, or can be made to matter, in learning. Curiously, Amirault sidesteps these issues.

Westera, however, does not sidestep issues of technology inference in his article, "Reframing the Role of Educational Media Technologies." The true impact of media, he argues, is cognitive; there is a direct connection between media technologies and thought, cognitive processing, memory, perception, and learning. Westera maintains that educators fail to realize this because they misconceive media technologies as transmission media, hence he sees technology transience as a sort of a gift to distance education. "The emergence of the Internet did not imply yet another medium to be included in the media-mix of distance edu-

cation. The all-embracing nature and scale of the Internet produced a new conceptualization of information access, information services, and social connectedness that affected society at large" (p. 23), according to Westera. It is important to realize that Westera is not arguing for technological determinism here, but rather that communication technologies support (and constrain) particular ways of knowing. Because of this, Westera concludes that distance educators may be uniquely positioned to throw off the traditional conservatism of education and explore new pedagogies that take advantage of the particular affordances of Internet technologies. One such affordance Westera highlights is the manner in which Internet users are both *producers* and *consumers* of knowledge—that is, "prosumers." What this might mean in distance education contexts is fascinating to consider. Indeed, one might be able to identify all sorts of evidence that online and mobile learners in particular are already acting as prosumers of knowledge.

In "In a World of Exploding Possibilities in Distance Learning, Don't Forget About the Light Bulb," Bosch, Hartenberger Toby, and Rahman ostensibly caution against throwing off the conservatism of education too quickly. The authors warn of market manipulation of technology transience using the very interesting story of the way a cartel of manufacturers of the light bulb of the title agreed to produce light bulbs with much shorter lifespans than necessary to enrich themselves. Bosch, Hartenberger Toby, and Alkhamsi argue that older (and what Amirault would call more "durable" technologies) often make more sense in third world countries. They then provide two examples—the use of telephone technology to call into webinars and other live Internet-based learning events in Indonesia where the Internet is not always reliable, and the use of radio-based instruction in Liberia during the Ebola crisis. It is thought-provoking to note in these examples that even when institutions and learners were falling back on older technologies, they were doing so in a "prosumer" role. In Indonesia, students were choosing to use their phones to interact with their classmates in webinars that they could not otherwise access and so participate in the creation of knowledge. In Liberia, students separated from their instructors by travel restrictions used radio instruction to become self-directed learners. The authors write, "Distance learning has benefited from innovators and educators trying to find any channel possible that can deliver quality education and interaction to people at a distance" (p. 137). They contend that it is this problem-solving attitude that has produced the more innovative technologies used in distance education. It is worth considering whether or not such concept also applies to innovative pedagogies.

Many of the articles in this special issue address particular aspects of distance education that are critically affected by technology transcience. For example, Beaudoin's "Distance Education Leadership in the Context of Digital Change" explores the most pressing challenges higher education leaders are facing with respect to technology transcience and the particular skills they will need to meet such challenges. Beaudoin argues that distance education is at the forefront of higher education's response to ever more rapidly evolving technologies because all higher education institutions are having to now integrate online learning into their more traditional instruction, and these institutions must plan for a much more integrated technological future. Beaudoin identifies the most important issues facing distance education as managing change (not technology), maintaining meaningful roles for instructors in student-directed learning, maximizing innovation while minimizing disruption, and bridging the digital divide. He argues that to successfully address these issues, distance education leaders should possess or acquire critical competencies in accurately diagnosing problem situations and devising appropriate strategies, creating conditions for innovation, maintaining resilience and perspective in times of glacial or precipitous change, and preparing the next generation of distance educators.

"Designing Instruction in the Face of Technology Transience," by Linder-VanBerschot and Summers, explores the implications of technology transience on instructional design, one of the critical areas identified by Amirault in his introduction. The authors argue that "the impact on quality, currency, and effectiveness in the design of learning experiences needs to be considered in relationship to the ways technology changes the learning environment" (p. 107). They contend that we can cope with the effects of technology transience by applying instructional design principles to our use of new technologies as long as we always keep the learner at the center of design decisions. In particular, they advocate for situating such design decisions in the context of the learners' interactions in technology-enriched environments, identifying a variety of possible interactions, including learner-content, learner-instructor, learner-learner (Moore, 1989), learner-interface (Hillman, Willis, & Gunawardena, 1994), and learner-self (Hirumi, 2002). Linder-VanBerschot and Summers provide three examples of pedagogical approaches that both exploit the characteristics of distance education technologies and keep learner interactions at their center: scenario-based learning, just-in-time learning, and mobile learning. It is perhaps interesting to note that while scenario-based learning is not technology dependent, just-in-time and mobile learning are. The authors conclude by making a case for purposeful design informed by research. We might understand this to be an endorsement of design-based research, which in turn might arguably be an artifact of technology transcience.

Another very important aspect of distance education critically impacted by technology transcience is teacher preparation. Muilenburg and Berge address this area in their article entitled "Revisiting Teacher Preparation: Responding to Technology Transcience in the Educational Setting." They argue that instructors must be prepared to teach effectively in rapidly evolving technology environments and that teacher preparation programs should therefore adjust their curricula to focus more on helping their graduates navigate such challenges. While Muilenburg and Berge are focused on the preparation of K–12 teachers for classroom-based instruction, faculty preparedness is a central issue at the intersection of distance education and technology transcience. The pedagogical strategies they suggest—that is, inculcating a fundamental shift in thinking about technology, building both fluency and adaptability with regard to technological tools, addressing technology knowledge in the context of content knowledge and knowledge about teaching, and employing iterative cycles of learning, application, and reflection in increasingly more complex technological and pedagogical contexts—would apply in either context. Muilenburg and Berge also introduce a variety of technology integration models that could be equally useful in both contexts. These include the Technology Integration Matrix (TIM), the TPACK (Technological, Pedagogical, And Content Knowledge) Model, the Technology Fluency and Integration Model, Universal Design for Instruction, and Learning Activity Types.

Chang and Hannafin's article on "The Uses (and Misuses) of Collaborative Distance Education Technologies" has its feet in both instructional design and faculty preparedness in that it views the efficacious use or misuse of collaborative technologies in distance learning as resulting from both design and implementation issues. In particular, they contend that instructors' lack of knowledge about collaborative learning practices and poorly designed group work results in ineffective instruction regardless of the technologies employed, which can hamper student learning. The authors thus argue that before adapting new emerging technologies to support collaboration in virtual environments, critical instructor and design considerations, including student readiness to use such technologies, should be analyzed. They thus appear to contend that it is not actually instructors' and students' inabilities to deal with technology transcience in the realm of technologies that support collabora-

tion which leads to their misuse, but rather instructors' and students' lack of understanding collaborative processes. Chang and Hanafin support their contentions with findings from design-based research on the use of technology-supported collaborative groups in a large-enrollment science class. Although this research is grounded in a face-to-face environment, which arguably is quite different from a virtual analog, the results still are worth considering.

Similar to Chang and Hannafin's focus on collaborative learning technologies, the final three articles in this special issue focus on the effects of technology transcience on particular technologies—personal learning environments (PLEs), assistive technologies, and big data. In her article, Dennen addresses this latter area, exploring privacy issues related to data affecting online learners, online instructors, and online institutions and offers advice for dealing with such issues in an ever-shifting big data environment. "Technology Transience and Personal Data: Shifting Notions of Privacy in Online Learning" highlights the need to continuously consider and address privacy issues as online learning technologies evolve. Dennen identifies five areas of current concern: cloud computing, social media, mobile technologies, and bring-your-own-device policies, learning analytics (and its more private constituent, *learner* analytics), and data ownership and sharing. She argues that institutions should uphold privacy as both a right and a priority, and provide leadership for both instructors and students within this area. She also maintains that students should be afforded an active place in conversations about privacy in the online environment. Finally, Dennen advises online instructors to consider privacy issues as they plan learning activities, and to include teaching about such issues to students as part of their instructional mandate.

Peterson-Karlan explores assistive technology and technology transience in "Assistive Technology Instruction Within a Continuously Evolving Technology Environment." Assistive technologies are a group of technologies, with various degrees of integration and interaction, which help "increase, maintain or improve the functional capabilities of individuals with disabilities" (p. 62). Interestingly, Peterson-Karlan addresses both technology transience and "technology *intransigence*," which he defines as resistance to "the increasing imperative to recognize and respond to technological transience" (p. 61). Situating his reflections in the context of a blended postsecondary course in assistive technology, he explores technology transcience and intransience as they each relate to assistive technology itself, from the use of assistive technologies in public schools to postsecondary distance education. With regard to assistive technology, Peterson-Karlan notes that the field has benefited greatly from transient advances in connectedness, power, size, memory, and cost reductions, device convergence, app emergence, and availability of universally designed mobile devices. In the schools, however, intransigence tends to dominate, with issues related to technology adoption and replacement and institutional timelines out of step with the state of technology in today's society. Distance education settings have also been relatively intransigent, due in the most part to the accessibility issues of learning management systems (LMSs). The author demonstrates how some of the challenges in this last area can be overcome in a discussion of a course in assistive technology developed at Illinois State University deployed via a variant of the Sakai LMS.

In "Constant Change, The Ever-Evolving Personal Learning Environment," Torres Kompen, Monguet, and Brigos consider the effects of technology transience on the development of personal learning environments (PLEs) which they define as "a group of web technologies, with various degrees of integration and interaction, that helps users and learners manage the flow of information that relates to the learning process, the creation of knowledge and the development of skills" (p. 120). The authors note that because PLEs rely on the availability of Internet applications and ser-

vices that may disappear overnight, they are particularly vulnerable to technology transience. They contend, however, that the negative effects of technology transience on PLEs can be mitigated through instruction. In particular, Torres Kompen, Monguet and Brigos suggest adopting a "learning to learn" approach to introducing PLEs to students, and focus on categories of services (instead of specific tools) to encourage flexibility in building and adapting a PLE. The authors also recommend proposing alternative solutions and uses for tools students are already using, highlighting the fact that change is part of the inherent nature of PLEs, and stressing the importance of building support networks so that responses to change can be collective.

The 10 articles in this special issue are fascinating in themselves, but what commonalities can we glean from them? For one thing, all the authors agree that technology transience is real. I myself still remember when my family got its first TV; in grade school, filmstrips were the apex of innovation; the tools I used to write my first research papers in college were the card catalogue, microfiche, and a typewriter. As an educational technologist, I researched, and have become expert in Logo programming, computer-assisted instruction, interactive videodisc technology, online learning, and learning analytics (in that order). While most of you reading this are not that old, I am sure if you follow a similar train of thought, you will not be able to deny the ubiquity of technology transience and the effects it has had within your lifetime.

Most of the authors in this issue also council flexibility and a focus on the concepts embodied in evolving technologies—their functionalities as opposed to the procedures for their use, heuristics rather than algorithms—when integrating new technologies into distance education. The idea here is simple. Understanding how a category of technologies (e.g., multimedia or databases or social media) can be used to support thinking and learning makes it possible to not only adapt to and make good instructional use of new instantiations of these, but also to know when new technologies offer something useful. For example, because I have explored programming and problem solving, I can evaluate the usefulness of the "new" push to teach all students to code; because I have studied the efficacy of computer-assisted instruction, I have a sense of where (and where not) competency-based learning and adaptive technologies might be most effective; and because I have created interactive multimedia with old media, I understand some of the ways that technology can be used to support learning online.

Many of the authors agree that the significant technological changes we are experiencing also mandate some degree of paradigmatic change with respect to teaching and learning in general, but most especially to distance teaching and learning. In 2001, before the more recent radical breakthroughs in digital technologies, Twigg (2001) remarked that perhaps the biggest obstacle to innovation in online learning was thinking things can or should be done in traditional ways. In 1999, McClintock observed that the rapid acceptance of a variety of new digital technologies had already changed what was pedagogically possible. Some of those pedagogical possibilities include extraordinary access to almost unlimited information, the ability to access, create, and integrate knowledge from a variety of media sources, access to tools that augment our limited computational abilities, and communication and collaboration tools that make it possible to talk to and collaborate with people around the world (Swan, 2009). However, as many of the authors in this issue clearly argue (in my opinion, Bosch, Toby, and Alkhamsi included), our ability to exploit such possibilities is limited by what Peterson-Karlan describes as intransigence, by our imaginations, and by our focus on technological, at the expense of pedagogical, innovation. We are entering a second machine age; digital technologies are rapidly transforming our culture (Brynjolfsson & McAfee, 2014). Distance education and distance educators are well positioned to lead a similar transformation in edu-

cation. We have only to understand and embrace it.

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