Ensuring Quality and Integrity in Online Learning Programs

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Chapter 3

Seven Traits of Personal Learning Environments for Designing Quality Online Learning Programs:
A Systems View of Connectedness

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ABSTRACT

This chapter reports on research findings that illustrate a system view of connectedness across personal, professional, and academic contexts with implications for designing quality online learning programs. Connected learners organically blur the line between formal and informal learning when they call on their social networks and engage in online learning systems towards goals in their personal, professional, and academic lives. The phenomenological study referenced in this chapter is framed by complexity theory and grounded in research on complex adaptive systems applied to educational contexts. Examples of lived experiences illustrate how being connected in a personal learning environment is experienced as immersion in a complex adaptive system. Implications and recommendations for quality online learning programs are discussed.

INTRODUCTION

In a burgeoning area such as online learning, emerging trends continually impact the field. One promising area for quality online programs is the integration of a personal learning environment (PLE) to bridge formal and informal learning. The *Horizon Report* in higher education identified the integration of formal and informal learning as a solvable challenge and indicated the importance for formal educational programs to realize the dominance of online informal learning opportunities (Adams Becker et al., 2017). PLEs can be used to bring about quality higher education online programs by fostering meaningful learning experiences and supporting the transfer of knowledge to real-world settings through the formal-informal learning bridge (Kennedy, 2018). For managers of online programs, designing for the learner experience has the potential to foster a growing network of successful, connected graduates, which would not only point to a quality online program, but also to a flourishing community of practice. This chapter illustrates learners' lived experiences of connectedness in PLEs, which are shown to have characteristics of complex adaptive systems.

According to Martindale and Dowdy (2010), the concept of PLEs grew out of the discontent with institutionally-focused learning management systems that tracked learners, the desire for a more learner-centered approach, and the recognition of the importance of lifelong learning. They described how learners worked independently to gather, filter, and organize content to make meaning while also sharing content and their viewpoints through the social web. A PLE implemented alongside a learning management system integrates both social and learning systems, thereby blending both informal and formal learning experiences, and capitalizing on the affordances and benefits of both systems for personalized learning.

In 2015, Dabbagh, Kitsantas, Al-Freih, and Fake researched how students created PLEs using social web technologies with a focus on self-regulated learning skills. They determined that PLEs "are an emerging pedagogical practice that makes it possible for learners to personalize learning based on their needs, interests, and goals, provided they possess the skills to metacognitively orchestrate their learning experience" (p. 179). PLEs are a promising approach for integrating learner-centric, net-native strategies into formal learning.

In student-centered, adult online learning, the Internet provides access to not only online libraries and open journals, but also the social web, breaking news, and media applications that facilitate connections among learners and information, fostering access to a wide range of diverse perspectives. PLEs align with andragogy principles (Knowles, Holton, & Swanson, 2005) and harness the affordances of the web for learning, which is a key feature of the net-native pedagogy of connectivism (Siemens, 2005). In his seminal work, Siemens (2005) asked, "what is the impact of

networks and complexity theories on learning?" (para. 14). Extending constructivism and situativity learning theories while foregrounding technologies, he described connectivism as "the integration of principles explored by chaos, network, and complexity and self-organization theories" (para. 22). Complexity theory is the study of complex systems with multiple, moving, and interacting parts, which makes it particularly relevant for studying online programs.

The objectives of this chapter are threefold. First, to provide a foundational background on complexity theory in education. Second, to illustrate a systems view of connectedness that bridges formal and informal learning towards personal growth, academic achievement, and professional success. Third, to discuss implications and recommendations for designing quality online programs that foreground the learner experience through the lens of complex adaptive systems.

BACKGROUND

As early as 1973, when Moore wrote about his systems approach for independent learning and teaching, scholars have been drawn to systems theory as a means to make sense of learning at a distance through an electronic medium. In 1994, Saba and Shearer used system dynamics modeling to verify theoretical concepts in Moore's transactional distance theory. In 1996, Moore and Kearsley advocated for scholars to use a systems lens when researching issues in distance education. They believed all facets of the whole system, from teaching and learning to historical and institutional philosophical perspectives, are interrelated subsystems. They advised that researchers, who examined subsystems, should consider the interrelationships of the subsystems and their contextual positions within the whole system.

In 2003, Saba elucidated the interconnectivity of a myriad of factors in nested hierarchical levels of the complex system that is distance education, which includes hardware systems, software systems, telecommunication systems, instructional and learning systems, educational systems, social systems, and global systems. Focused on educational systems, Reigeluth (2004) described features of complexity, which included coevolution, transformation, and self-organization. In 2006, Morrison looked critically at the value added by the central tenets of the theory. He drew on diverse contexts in education to discuss the significance of networking and connectedness. Jakubowicz (2006) examined complexity in online learning and found that, for students of the net generation, learning was often "non-linear, unstructured and explained well by the tenets of complexity theory" (p. 1).

In 2007, Laroche, Nicol, and Mayer-Smith explained that organic learning processes align with "conditions of self-organization, including [a] fluid realm, openness to the information flow, turbulences and changes; freedom within flexible

boundaries, richness of possibilities, interconnectedness of all parts of the system, and collective emergence" (p. 74). They described fluid learning environments as "blurring boundaries between schools, universities, nature, and society" (p. 74). DeWaard et al. (2011), in a case study of a massive open online course (MOOC) that explored social media and mobile learning, examined evidence of chaos, emergence, and complexity to inform new educational environments and frameworks for the Knowledge Age.

In sum, a systems lens has been applied in educational research for 45 years. Most recently, complexity has been used to frame studies in distance education, online learning, and MOOCs. Therefore, a systems lens is particularly relevant for designing quality online programs.

A SYSTEMS VIEW OF CONNECTEDNESS FOR QUALITY ONLINE PROGRAMS

The research referenced in this chapter comes out of a larger phenomenological study on connectedness in the personal learning networks of six doctoral students who were enrolled in a graduate program at a large, public institution in the Midwest (Kennedy, 2018). The participants were selected through purposeful sampling based on their enrollment in the graduate program. This program was identified for purposeful sampling because the students were likely to offer the researcher access to the phenomenon of being connected. Of the 44 students in the program, 13 responded to the call for participation. Of those 13 students, three men and three women completed all three waves of data moments, which included written lived experience descriptions, think-aloud observations, and in-depth semi-structured interviews.

Data were analyzed using a whole-parts-whole approach along with the analytic technique of chasing lines of flight, which is based on the Deleuzo-Guattarian concept of rhizomes. When introducing the concept of nomadic thinking in the rhizome, Deleuze and Guattari (1987) contrasted it with root-tree, representative thought, which is a perpetual reproduction of a state philosophy. They described the characteristics of a rhizome as including principles of connection and heterogeneity, in which all points in the rhizome are connected. Applying Deleuzo-Guattarian nomadic thinking to phenomenology, Vagle (2014) operationalized lines of flight through two analytical noticings. The first noticing calls for the researcher to "actively look for ways that knowledge takes off" (p. 135). The second noticing calls for the researcher to look for binary thinking, certainty, uncertainty, and the tendency towards normative thinking. This methodological data was captured in analytic memos and

a post-reflexive journal, which documented the evolving intentional relationship between the researcher and the phenomenon (Kennedy, 2017).

Vagle's (2014) post-intentional phenomenological philosophy and methodology were useful for analyzing tentative manifestations of a phenomenon in fleeting contexts. Moreover, complexity theory provided a relevant conceptual framework for interpreting the experiential qualities of PLEs, which included immersiveness, emergence, self-organization, adaptive coevolution, self-similarity, dynamic non-linearity, and systemic interconnectedness. Excerpts illustrate the traits of PLEs and how they are experienced in an agent's everyday lifeworld.

Immersiveness

Pervasive computing, the Internet, web technologies, and mobile applications afford systemic interconnectedness that lends itself to experiences of immersiveness. Agents are immersed in their PLEs so that the environment and the technologies become invisible. Ihde (1979) would describe this experience with technology as an *embodied relation* with technology in which the agent no longer has experiences "of" the technology, but rather "through" the technology. The technologies fade into the background and become invisible to the agent who no longer needs to focus energy on how to use technologies, but rather sees only the activities that can be accomplished with the technologies as an *embodied extension* of the self. Ihde's (1979) notion of a technocracy is a technological way of being-in-the-world that influences lived experiences of time, space, body, and relations—the lifeworld. The way the agents communicated and related was mediated largely by technology. For an agent, being connected in their PLE was an immersive experience in a complex adaptive system.

Michelle (all names are pseudonyms) explained how she was "constantly immersed" in her PLE. Jason also described it as an "autonomic" experience—an involuntary or unconscious experience—given the "ubiquitous, omnipresent nature" of his PLE. Andrea's experience illustrated the integral way systemic interconnectedness led to feelings of immersion, "I will check my email like 10 times a minute <laughing>… I use my cell phone a lot and I also use my laptop a lot… every day." Andrea explained that she uses her mobile phone to text classmates to schedule time for research, studying, or projects. She also uses it for email and social applications. Nicole described the feeling of being "glued" to her phone at conferences when she tweeted everything she found interesting or inspiring. She received email digests daily with interesting articles to read. After retelling her lived experiences in her PLE, she reflected, "it sounds like I maybe spend way too much time," but she feels as though she is sucked in to the immersive experience. Nicole described her PLE as a distraction: "I know that it makes me a better employee and

a better learner, but it's hard for me to just engage for five minutes, you get sucked in for an hour."

For managers and instructors of online programs, understanding the learner's experience of immersion is important for thinking about a new paradigm of time on task. In a technocracy, digital citizens rarely unplug. Students are not disconnecting after class. Rather, they continue to make connections through all forms of information and media in their everyday lifeworld. In 1987, Chickering and Gamson proposed time on task as one of seven principles of good practice in undergraduate education. They described a variety of different ways to design time from mastery and contract learning to workshops, weekend programs, and online programs. They explained, "providing students with opportunities to integrate their studies into the rest of their lives helps them use time well" (p. 4). In 1996, Chickering and Ehrmann extended this idea with technology as lever and focused on ways technology could make time spent learning more efficient by accessing course and library information at home or work. The quality of immersiveness means that students organically use mobile and portable devices to stay connected and informed all day, every day. Quality online programs will have 24/7 access to technical support and course systems. Students will want to be able to find information at the moment they are learning, which means access to course-specific frequently asked questions, message boards, and the ability to get an answer to a quick question through text messaging or email. Designing learning experiences that guide students to find relevance and connections between course content and their life will take the most advantage of the quality of immersiveness.

Emergence

An agent's PLE emerges in an organic way born out of natural curiosity and a desire to learn about a personally interesting topic. Patton (2002) noted that emergence occurs when agents pursue their own path. Sparked by agency, a PLE emerged from the connections made through technologies and interactions in pursuit of learning about a topic of interest.

Nicole stated, "when I was first starting I don't think I made a lot of conscious decisions." The connections in a PLE tended to form organically in a natural way through a shared goal or common interest. Jason commented how connections in his PLE "tend to be very organic… I've met somebody through somebody or maybe a couple more degrees of separation than that even." The emergent nature of a PLE may be seen in its invisibility to the agent. Michelle explained, "It's not at the conscious level for me. I feel like it's very second nature so I just do it…. It's kind of like trying to explain how a person breathes, you just do it." A PLE may not emerge in an evident way to the agent until they see value in it to fulfill an immediate need,

which aligns with the principles of andragogy (Knowles et al., 2005), namely that an adult learner is ready to learn when there is an immediate need, and the learning is focused on this need. Furthermore, the adult learner wants to know why it is important to learn, and has a self-concept as a self-directed learner, which creates conditions for intrinsic motivation to learn for the personal payoff. An excerpt from Michelle's lived experience description illustrates emergence:

So, I didn't think about Twitter again till the next semester
when one of the assignments was to sign-up on Twitter
and tweet out something.
I dreaded it.
I didn't want to do anything with it,
but I did the assignment.
That was all I did, nothing more.
Then this year, things started to change.
My school was getting iPads for the whole ninth grade.
That would impact me.
I started looking for resources to help prepare.
I took a class this semester specifically aimed at this.
As part of our assignment, I had to retweet 10 articles out.
Luckily, I remembered I had created an account.
Having to use it more than once made me investigate it a little more.
I started by following people I knew and organizations that interested me;
my interests mainly with interaction design and 1-1 initiatives.
This is when I started to feel more connected.
I started looking for people
who were interested in the same things that I was interested in.
And then look to see who they followed.
I was following people who provided tips
that I could use with my class right away.
I started to see and use Twitter for professional development.

This excerpt illustrates the trait of emergence based on the student's immediate needs. From these examples, informal learning in social systems may begin in an explicit way through guidance in formal learning contexts. In this way, formal and informal learning occur consecutively as students first begin to view social systems as a source of learning.

From a systems perspective, program managers and instructors should make explicit connections between social systems and learning systems. This communication might come through program messaging, class activities, or by guiding students' use of

social systems for finding valid information about personally interesting content topics. As students' use of social systems for learning grows, social and learning systems become concurrent sources of information for creative and critical thinking.

Reigeluth (2004) proposed, "transformation occurs through a process called 'emergence,' by which new processes and structures emerge to replace old ones in a system" (p. 6). While Reigeluth was referring to transformation of an educational system, the idea of transformation could be extended to the agent's experience. A PLE emerges through agency and connectedness. Enacting agency and connectedness in formal learning contexts through learning management systems and online programs means providing learners with choices to fulfill requirements and fostering meaningful connections to classmates and experts by attending to social presence. Moore's (1993) theory of transactional distance highlights the importance of structured choices, learner autonomy, and meaningful dialogue in designing for the learner experience in online programs.

Given agency to pursue one's curiosity and interests, personalized learning has the potential to support transformative learning as theorized by Mezirow (1991). Aligned with andragogy (Knowles et al., 2005), Mezirow (1991) proposed a constructivist theory of adult learning that stipulates a learner's real interests would emerge when given more freedom in an educational context. He elucidated, "the authenticity of a learner's interests is measured by their congruence with the learner's self-concept or concept of the good life. Assessment of learner 'needs' should be broadened to include their real life interests" (p. 226). Scholars have recognized the need for educational change and have theorized about the potential paths towards transformation that involve systems thinking, constructivist approaches, and connected learning. Applied to quality online programs, these potential paths indicate to program managers and instructors the importance of a systems perspective in which learning and the learner are viewed holistically. When online programs make explicit connections between social and learning systems, they guide learners towards authentic, meaningful learning experiences for personal, academic, and professional development in both formal and informal learning contexts.

Self-Organization

Self-organization can be seen in the order that takes shape within an agent's PLE and also in the spontaneous, self-organization of groups within an agent's PLE. Reigeluth (2004) pointed out that a self-organizing system is adaptive and agile. He noted the characteristics of a self-organizing system include having an openness to seek and share information, to self-reference core ideas that give it identity, and to afford freedom for independent decision-making about changes by people in the self-organizing system.

The way an agent organized their PLE was shaped not only by the technological affordances of multiple applications, but also by their own idiosyncratic way of using technologies. For example, Michelle read her Twitter timeline to see tweets from the people that she followed. She marked tweets as "favorites" as a way to catalog ideas for later retrieval. She commented, "I just use it so it works for me." In this way, the design of the technologies in her PLE impacted the possibilities and probabilities of organization through the processes it afforded. When applied to online programs and learning management systems, self-organization takes shape in the unique ways that learners use systems to meet their needs, in the unique ways they retrieve and organize content, and in the unique ways they make connections and share information. For program managers and instructors, having a better understanding of the ways that learners are self-organizing means attending to the affordances of systems and the unique ways students adapt the systems to meet their needs. Self-organization is an agile trait of a system that is perpetually evolving. Andrea's evolving environment of multiple applications illustrates this point well.

Andrea's process of organizing her PLE took shape through a multitude of technologies including the university's online library website, the Mendeley citation manager, the Mac Notes app, and the content folders in Finder, in addition to Google searches, web bookmarks across mobile devices, learning management system course sites, frequently visited websites, and To-Do lists in a Microsoft Word document on the desktop of her laptop. Similar to the environments of other agents, Andrea's PLE was shape-shifting through an adaptive, evolving process of self-organization. It was not static, but rather an evolving process of changes determined by the agent, and influenced by technological designs and affordances from an array of technologies in varied states of ascendance, maturation, and decline. Designers of quality online programs will understand learner's needs for personal knowledge management systems and the emerging technologies that afford efficient processes for students to grow personally, academically, and professionally for lifelong learning. Furthermore, introducing and guiding the use of systems and processes that students can use for efficient personal information management will support their success in all aspects of their lives.

Self-organization was also evident in the order of an agent's PLE, which was shaped to meet personal, professional, and academic needs. The design and affordances of technologies impacted the order and organization in a PLE. The technological affordances of multiple applications meant that Chris could connect with people on all of his devices across multiple platforms. He used a wide range of technologies including Moodle, Flipgrid, Evernote, Zotero, Google Calendar, and Pages. Chris kept his email and calendar open at work because he used them most of the time. In this way, his PLE was shaped and organized by his immediate personal, professional, and academic needs through the design and affordances of

the technologies that he selected. This demonstrated the self-organizing nature of a PLE, in that the technologies that made up the environment in turn shaped the kinds of actions that could be taken, and the way information, ideas, and connections could be organized. It was this influence of the design and affordances of the technologies that pointed to a self-organizing system.

The findings point to three important observations about learner behavior and self-organization. First, learners blur the lines between personal, professional, and academic spaces. Second, students learn and manage information across multiple spaces, devices, and systems. Third, learners do not unplug and disconnect at the end of class. Therefore, the implications of these findings for designing quality online programs would point to the importance of attending to learners' needs and the unique ways they use multiple systems to learn and manage information in all aspects of their lives. In an optimal design, the role of program managers and instructors is to guide students towards meta-cognitive awareness of their own learning processes; seek connections and find relevance across their personal, professional, and academic spaces; and develop self-regulated skills for integrating systems into efficient processes for learning.

Ihde (1979) theorized that technologies were not mere tools, but socially-constructed cultural instruments. The way that the designs and affordances of technologies have the power to shape PLEs and the organizational activities within those environments would support his theory. From the variety of technologies and their unique designs and affordances (as well as the idiosyncratic way agents used technologies and the unique processes they developed to meet their personal, professional, and academic needs), one could observe both order and chaos, which is characteristic of self-organization. The openness to seek and share information, the freedom to make decisions, and the self-referential nature of a PLE pointed to additional characteristics of a self-organizing system.

Adaptive Coevolution

In a reciprocal fashion, an agent both shaped and was shaped by the interacting elements in their PLE in a process of adaptive coevolution. According to Patton (2011), the characteristic of adaptive means, "interacting elements and agents respond and adapt to each other so that what emerges and evolves is a function of ongoing adaptation among both interacting elements and the responsive relationships interacting agents have with their environment" (p. 8). He defined the characteristic of coevolutionary as a process that occurs among interacting agents and the system: "As interacting and adaptive agents self-organize, ongoing connections emerge that become coevolutionary as the agents evolve together (coevolve) within and as part of the whole system, over time" (p. 8). The adaptation and coevolution of an agent and

their PLE was evident in the evolving shape of the environment as the agent adapted, grew, and evolved along with the environment. The affordances and usability of technologies influenced their use in PLEs. For example, while Nicole was intrigued by Periscope, she did not see relevance for her personal use. An agent's PLE is not contingent on one technology, but rather evolves and adapts as technologies ascend, mature, and decline. Quality online programs should be sufficiently agile to adapt to an evolving technological landscape in which individual learners use a variety of applications. Over time, as learners grow and adapt, they draw in new applications to meet their evolving needs. Program managers and instructors can support students' use of emerging technologies by advising on the affordances of various emerging technologies and offering students the freedom to choose which applications best meet their needs at any given time in their learning process.

For Eric, the characteristic of adaptive coevolution was evident in his digital literacy skillset: He adapted as the technologies in his PLE required him to evolve beyond the skills he learned in secondary school because technologies continually evolve at a rapid pace. He explained that the technologies that he learned in middle school were not relevant today, but the way he learned them helped him to adapt to using new technologies in his own PLE and also shaped the way he educated teachers on how to use technologies in his practice. Part of Eric's adaptation process involved gaining a sense of comfort, confidence, and self-efficacy, which propelled him to evolve beyond his comfort zone, try new technologies, and expand his environment in the process. Eric shaped his environment by drawing in trustworthy people. The feedback he received from the people in his environment reciprocally shaped him by the way they challenged him. The people in his environment helped, encouraged, and supported his development.

Michelle described the experience of adaptation as a "branching out" into new areas of interest as she took on a new position at work and explored new academic interests. Again, in a reciprocal fashion, the agent and their PLE coevolved through exposure to new ideas, technologies, and ways of practicing and organizing information. Thus, the implication of adaptive coevolution for online programming is the focus on the processes of learning for lifelong continuous education. In this way, course content is viewed as exposure to new ideas, technologies, and practices that students may assimilate or accommodate into their schemas and environments for lifelong learning. Through a process of adaptation, an agent and their PLE coevolve. This process might take time to find responsive people and could require patience and persistence to find enlightening content, again pointing to the temporal, contextual nature of a PLE.

Self-Similarity

Reigeluth (2004) described fractals as patterns of self-similarity. He explained, "in educational systems, they can be considered 'core ideas' and values or beliefs… that guide or characterize the design of the system" (p. 6). The ideas of an agent were evident in the content that made up their PLE. The content of an agent's PLE was related to the agent's practices and identity. In this way, the agent and the PLE displayed the characteristic of self-similarity.

Given that the participants for this study were recruited from one graduate school program, they shared a common interest in the content of that program. Therefore, the content area of the graduate school program was a thread that ran through the agents' PLEs so that it illuminated the sociocultural context in which they lived and learned. By following the content within a PLE, the characteristic of self-similarity was evident between an agent and their PLE. This self-similarity pointed to how an agent shaped their PLE and was reciprocally shaped by their PLE. Furthermore, it illustrated how an agent's identity was shaped by the sociocultural context in which the agent learned. The characteristic of self-similarity was illustrated in Eric's description of how his PLE was a representation of his identity: "It's a representation of who I am. There's this saying in Spanish…: tell me who you walk with and I'll tell you who you are." The specific content in each agent's PLE could reveal their identity because the environment personified the agent—illustrating the concept of self-similarity. Or conversely, agents embodied their environments.

In their seminal work on the concept of mind-as-rhizome, Duffy and Cunningham (1996) argued for a distributed concept of self that "shifts the activity of learning to the connections one has with communities, to the patterns of participation, and away from efficient internalization of knowledge" (p. 12). They used the thought experiment of looking around one's environment to find something made by nature alone, and everything else would reflect one's self-identity, given one's participation in the process and community in which it was produced. They extended this idea to distributed cognition in which artifacts and interactions in the environment make certain understandings possible and probable. By following the thread of content that ran through an agent's PLE, the characteristic of self-similarity between the agent and environment became evident, along with the sociocultural context of the lived experiences. Quality online programs will foster the trait of self-similarity when they allow students to express their identities by giving them freedom to pursue meaningful interests relevant to their personal, academic, and professional lives. Online program managers and instructors can support students by guiding them to increase their metacognitive awareness of a distributed concept of self and cognition, to use technologies to practice self-regulated learning, to connect with experts and credible sources, and to participate in communities of practice.

Dynamic Non-Linearity

According to Patton (2011), dynamic signifies the interactions among all parts of a system, which are unstable. Dynamic nonlinearity was interpreted in moments of dynamic interactions and in the illustrative descriptions of the PLEs. These descriptions illustrated the continual state of movement an agent experienced in their PLE. Michelle chose a flight map to illustrate the rhizomatous nature of her PLE, whereas Jason chose an atom to describe his PLE.

You've got the nucleus
which is my core learning network,
which would be people I know through [graduate school]
and people I rely on a lot, friends and family…
But then there's this electron cloud…
of stuff moving around
that's always in motion
and always in flux,
whereas the nucleus is fairly stable…
it's more intense out in the electron cloud
because of all the activity…
ya interact with it for a little bit and then
WHOA!
okay, that wasn't what I was looking for,
or expected at all, but man,
I gotta think about that.
and then I withdraw back to the nucleus,
where the interactions tend to be less intense…
and so that's like the comfort zone…
in the electron cloud
things are buzzing around so much,
I have to take a break to process stuff I learn out there,
but it's always so fascinating
that I couldn't possibly stay away from it.

Jason's experience illustrated interactions and elements that were always in motion. Pointing to the transparency of the emergent and immersive nature of a PLE, Nicole chose the concept of a glass bridge to show the connections between formal and informal learning. The implication of dynamic nonlinearity for quality online programs is the understanding that students are in a perpetual state of being connected and making connections both in an out of class. Quality online programs

can support students to find sources of credible information and multiple perspectives for critical and creative thinking. Dynamic nonlinearity signified conditions for unexpected outcomes, which was evident in serendipitous moments that agents described in their lived experiences in being connected.

The dynamic turbulence could feel overwhelming for agents, as Jason explained: "The electron cloud is very intense. I find myself sometimes overwhelmed and sometimes totally off-track, but completely engaged." It could feel like a circuitous route that is "all over the place." The characteristic of dynamic nonlinearity was most notable in the descriptions of a PLE. The implication for quality online programming is understanding students' lived experiences of dynamic nonlinearity while learning, and thus understanding the importance of supporting students needs for personal knowledge management. Program managers and instructors can teach, scaffold, and support ways of exploring emerging technologies, applications, and web resources. Quality online programming will have a focus on students' practice of self-regulation and ability to evaluate technological affordances for access to credible information, along with finding and organizing relevant information for personal, academic, and professional growth.

Systemic Interconnectedness

In 2003, Saba pointed out that the nested hierarchical levels of a complex system included not only hardware, software, and telecommunication systems but also learning, educational, social, and global systems. Systemic interconnectedness could be viewed through the way social systems, educational systems, learning systems, and technological systems (telecommunication, hardware, and software systems) ran through the agents' lived experiences of being connected in their PLEs. Agents used many technologies in tandem that afforded systemic interconnectedness among their personal, academic, and professional interests.

Michelle tended to use Pinterest for cataloguing personal interests, whereas she used Twitter for topics that were more related to professional development. While Michelle had a desire to keep these systems separate, she had collected useful pins on Pinterest that were relevant to her academic and workplace pursuits. Quality online programs can capitalize on systemic interconnectedness by choosing multi-functional technologies with interoperability. In this way, students are able to seamlessly transition among personal, academic, and professional spaces while maintaining access to essential resources, people, and tools.

Systemic interconnectedness took on a literal meaning when technological systems were interconnected. For example, Chris used his university's online library system to download journal articles directly into his Zotero citation manager and he connected with people across all of his devices. Chris also participated in

a synchronous video meeting in which he met his classmates online while in the comfort of his own home. The technology afforded the feeling of comfort and afforded systemic interconnectedness among social and learning systems. In this moment, the technology also afforded motivational drivers of feelings of safety from the structure of a formal class and the sense of freedom and autonomy while participating in his home.

Systemic interconnectedness was also evident in a PLE by the people that the agent drew into the environment. For example, Jason drew on the expertise of professors and colleagues to advance his ideas and projects. The connectedness of formal and informal learning could be seen in the people that Andrea met in formal classes who remained personal friends and colleagues. Andrea perceived formal learning as a narrow experience, whereas she perceived informal learning to encompass broader experiences that she experienced "everyday online" and in her personal life when she socialized with friends from class. At times when socializing with friends from class, they would discuss shared professional interests or plans to take future classes together. In some instances, they remained connected through a collaborative research project or made plans to attend professional conferences together. This affordance of support through systemic interconnectedness of her PLE was important to Andrea, who described her PLE in this way: "I'm surrounded by a lot of awesome people. I can reach out to them no matter if it is online or in person." Whether for a course, research, or a life situation, she could turn to her network for support.

The systemic interconnectedness of social and learning systems—formal and informal—created a supportive PLE. Emotional support and motivation are some of the benefits of blurring the boundary between social and learning systems. Students organically blur this boundary when they navigate between formal and informal spaces in their learning process. When formal online programs take this into consideration, it means that students are emotionally supported by the people in their networks and intrinsically motivated to excel in a trajectory towards meaningful goals. Quality online programs will encourage students to build these emotional and motivational supports and help scaffold their use while learning.

Michelle explained how she used Pinterest in the evening when winding down because it was more relaxing than the professional content she read on Twitter, which required "more brain power." She used Facebook intermittently throughout the day prompted by pop-up notifications on her mobile phone of messages sent from family and close personal friends. She used Schoology for teaching, which was a separate learning system from the technologies connecting her social system. However, one example of a moment of systemic interconnectedness between these social and learning systems could be seen when she serendipitously found memes relevant to her teaching content area while on Pinterest. Another example of serendipity stemming

from systemic interconnectedness occurred when she found a timely news article that illustrated a concept in a way that was relevant to real life for her students.

It's quite interesting when things like that happen
'cause what you don't expect to find,
that piece is the most interesting part is,
when you don't expect to find something specifically for it.
You find it there, and it's like,
WOW, this is really good!
This is really interesting!
And it helps students to make connections
because it's not in the context of a dry
'this is what [this content topic] is like',
but it's like here's how what's being played out in the real world because of this.

For Michelle, systemic interconnectedness ran through formal and informal learning experiences via the thread of content topics in her roles as student, teacher, and colleague. In this way, the systemic interconnectedness of her PLE supported multiple areas of her life including work, professional development, academic coursework, and personal growth. The value that Michelle found through the systemic interconnectedness of her PLE was a motivational driver that propelled continuous development.

Systemic interconnectedness is inherent to being connected in PLEs. This characteristic impacted the unique experiences that were possible and probable in an agent's PLE. Systemic interconnectedness was found running through social and learning systems, formal and informal learning, and technology applications.

Summary and Discussion

To experience being connected in a PLE is to be immersed in a complex adaptive system with the features of emergence, self-organization, adaptive coevolution, self-similarity, dynamic nonlinearity, and systemic interconnectedness. In 2003, Saba advocated for a new paradigm in distance education that could explicate the "contextual crafting of the moment of teaching and learning experience as the instructional-learning process unfolds in time and produces both expected, determinate behavior and general patterns of emergent behavior" (p. 18). The theory of complexity, Ihde's (1979) phenomenological philosophy of technology, and Vagle's (2014) post-intentional phenomenological philosophy and methodology that draws on Deleuze and Guattari's (1987) work are useful for interpreting the fleeting phenomenon of being connected in PLEs. The findings support scholars'

(Jakubowicz, 2006; Morrison, 2006; Siemens, 2005) positions that complexity theory has value for thinking about issues in contemporary learning, particularly for learners immersed in computer-based technologies, the Internet, and mobile applications. Aligning with scholars' (Laroche et al., 2007; Patton, 2011; Reigeluth, 2004; Saba, 2003) descriptions of complex adaptive systems, PLEs exhibited characteristics of emergence, self-organization, adaptive coevolution, dynamic non-linearity, self-similarity, and systemic interconnectedness.

SOLUTIONS AND RECOMMENDATIONS

Everyone has a PLE. The extent to which an individual is aware of their PLE and harnesses its power for development varies. Understanding the lived experiences of students and the traits of PLEs will help program managers and instructors better support the technological needs of learners in online programs. The trait of immersiveness provides a new paradigm for time on task where learners do not unplug and disconnect after class. Digital students require 24/7 technical support and access to learning systems across mobile and portable devices. The emergent feature of complex adaptive systems shows the importance of freedom, autonomy, choice, and dialogue. Systems that foster these technological affordances should be considered for inclusion in quality online programs. The feature of self-organization illustrates the importance of access to interoperable technologies for personal knowledge management across personal, academic, and professional spaces. Adaptive coevolution points to the importance for online programs to be agile and adapt to an evolving technological landscape in which learners use a multitude of applications in conjunction with formal learning management systems.

Influential program managers will recognize and capitalize on the features of complex adaptive systems by incorporating them into the design of their online programs. The feature of self-similarity illustrates how online programs can support students to express their identities in the freedom and choices afforded during their pursuit of meaningful goals. Dynamic nonlinearity shows the organic circuitous path of learning across formal and informal spaces, and points to the ways that quality online programs might focus on scaffolding processes and technologies for personal knowledge management. The feature of systemic interconnectedness indicates the importance of online programs to foster students' use of technologies that offer interoperability with a focus on affordances for learning in multiple contexts including personal, academic, and professional spaces.

While research shows that PLEs are intrinsically motivating (Dabbagh et al., 2015; Kennedy, 2018), program managers can create spaces for online connections with experts, model digital literacies, and scaffold development of self-regulated

learning skills such as setting goals, planning strategies to achieve goals, managing time, and organizing resources. In this way, students will be prepared to capitalize on serendipitous opportunities inherent in PLEs. Moreover, online programs can foster and support the transfer of knowledge and skills to real-world settings in the workplace when applying the features of complex adaptive systems, thereby organically building the program's network and realm of influence in the field through the success of its graduates. Quality online programs support the transfer of knowledge when they build a strong community of practice with program graduates as foundational members. The community of practice, established in cooperation by program managers, instructors, and workplace professionals, becomes a central support for newcomers by welcoming them into the field, providing access to experts and field-specific dialogue, fostering opportunities for authentic practice in workplace settings through sponsored practicums and internships, and introducing them to leading industry organizations, conferences, journals, and seminal works in the field.

While an agent may experience dissonance around using the same technologies and applications for both formal and informal learning (Anderson, 2012), the agent always maintains control of the technologies and content in their PLE. This level of control has the capability to foster a sense of safety and security for agents. Anderson (2012) explained that privacy, persistence of connections beyond the formal learning experience, and support were challenges of integrating social web applications in formal education as learners would likely desire to preserve their connections beyond formal education and would seek PLEs to maintain social capital. Successful program managers will provide user-friendly systems and technologies for agents to use to stay connected during coursework, through practicums and internships, and into the workplace after graduation. These systems will help agents manage information and stay informed on cutting-edge research and developments in their areas of expertise.

Integrating formal education into persistent, personalized contexts of real living is effective for adult learners because it helps them transfer knowledge and supports self-directed lifelong learning. Anderson (2012) explicated, "Web 2.0 applications are built on network organizational models. Networks connecting individuals and learning resources allow for flexible learning that easily extend beyond the class in formal educational contexts" (p. 306). PLEs can be thought of as learner-centric openings in the walled garden that is an institution-centric learning management system. Through these openings, agents have freedom, control, and power to pursue their interests, connect with others, and direct their learning.

In summary, the seven traits originate from agents' lived experiences of connectedness in the context of their PLEs. This context was experienced as immersion in a complex adaptive system in which learning and growth occurred

organically, similar to other living organisms in the natural world. One of the foremost outcomes of this systems view of connectedness is the decentering of formal learning programs and the institutional learning management system. When formal learning is decentered, the learner's perspective takes the fore, and the learner is viewed as the central agent determining their trajectory and navigating their environment for growth. Thus, quality online programs must first know their audience of students. The second step for program managers is to network with professionals and graduates to understand their perspectives, stay abreast of emerging issues in the field, and build a community of practice. The third step is a focus on faculty and cultivating support for learner-centered strategies. Fourth, to build quality online programming, managers must develop an open system of interoperable technologies. An essential part of this open system is the means for students to create a personal portfolio and knowledge management site in which the agent retains control and access for lifelong learning. The fifth and final step is a return to the first step with a focus on the learner and the learning experience, which means providing 24/7 technical support and access to systems for learning, collaborating, and communicating; designing freedom, autonomy, choices, and meaningful dialogue into the curriculum; and teaching students about technological affordances while guiding their use of technologies for personal learning and knowledge management.

FUTURE RESEARCH DIRECTIONS

A goal of this chapter is to be generative in creating new ideas and questions to explore. Potential avenues that could be investigated include pragmatic questions such as the ways PLEs are being utilized in online programs including the specific processes, procedures, technologies, and support that online programs use to facilitate adoption of PLEs in formal learning, along with how they connect to informal and lifelong learning. Several universities have started to implement aspects of PLEs into their programs including Baylor, Penn State, the University of Bolton, the University of Mary Washington, and the University of British Columbia (Educause, 2009). Some examples of their approaches include customized applications for networking; blog spaces for reflecting, writing, collaborating, organizing content, and sharing with others; and web spaces for students to use as a repository in which they maintain access and control after graduation. Methodologically, future research directions might consider the ways PLEs and communities of practice in online programs might be studied through the lens of learning analytics or social network analysis. Additionally, future research might employ design-based research towards the development of a next-generation learning management system that is learner-centric and based on the seven factors of complex adaptive systems. Until then, current online programming

can personalize learning, scaffold self-regulation towards greater meta-cognition, and guide the use of technologies that are interoperable and support personal knowledge management across personal, academic, and professional spaces. Looking towards community-engagement, scholars might explore how implementing aspects of PLEs in online programs might foster greater participation in local communities and communities of practice, and thus lead to increased meaning, relevance, and quality of learning experiences. Finally, with a view towards the workplace after graduation, researchers might examine how PLEs might be leveraged for workplace learning, as well as the connections between PLEs and knowledge management.

CONCLUSION

The seven traits of PLEs are used as a foundation to inform designs of quality online programs. These traits are drawn from phenomenological research that found agents experienced connectedness as immersion in a complex adaptive system. This systems view of connectedness decenters institutional learning management systems and positions the learner in the center. This centrality of the learner is a shift away from traditional paradigms of formal learning.

The trait of immersiveness points to life in a technocracy and the students' technological way of being-in-the-world. For online programs this means that students are constantly connected and making connections. This provides program managers with a new paradigm for thinking about time on task and the importance of providing 24/7 support and access in quality programs. This finding might spur program managers and instructors towards new ways of thinking about how time on task is structured and the level of control given to students to direct their own learning within structured choices; perhaps MOOCs, badges, and gamification are potential strategies for restructuring time on task given the understanding that learners are immersed in a technological world. In PLEs agents are intrinsically motivated to follow their curiosity on a never-ending path that is personally meaningful. Thus, quality online programs should strengthen, support, and build upon learners' natural pathways.

Quality online programs can foster the development of self-regulating skills towards greater meta-cognition, so that learners become more aware of their own PLEs and the power they wield in directing their own learning. When students harness both social and learning systems for access to multiple perspectives for creative and critical thinking, new lines of flight emerge and take off. Program managers and instructors can introduce students to communities of practice, the experts, and the language of the field. Guiding initial participation will help students to flourish

and become contributing members who sustain and grow the community. Thus, the trait of emergence in PLEs can be stimulated through formal learning programs.

Additionally, the technologies that quality online programs utilize makes certain connections and ways of thinking possible and probable based on a distributed concept of self and cognition. Therefore, the design and affordances of multiple technologies impact the order and organization in a PLE. This trait of self-organization is evident in students' unique and idiosyncratic organization that is ever-evolving. Students use social and learning systems in unique ways to meet their needs. Program managers and instructors can integrate, model, and advise on the use of multiple interoperable technologies for personal knowledge management that students can tailor and use in conjunction with the learning management system.

In a reciprocal fashion, an agent both shaped and was shaped by the interacting elements in their PLE in a process of adaptive coevolution. Quality online programs have the power to shape and influence students' PLEs through the technologies, technological affordances, and access to experts and ideas that they offer. When program managers and instructors focus on the processes of learning for continuous lifelong education, then course content is viewed as a means for fostering new ideas for creative and critical thinking, and new practices for greater self-regulation and meta-cognition.

By following the thread of content that ran through an agent's PLE, the characteristic of self-similarity between the agent and environment became evident. In a sense, the agent embodied and personified their own unique PLE. Program managers and instructors can foster and support self-similarity by providing freedom, structured choices, and autonomy. From a systems perspective, quality online programs should provide the technological means for students to express their self-identities through web spaces, portfolio sites, and personal repositories to manage their learning across personal, academic, and professional interests. It will be essential for knowledge transfer and lifelong learning that students maintain access and control over these individual spaces of learning and knowledge management. Moreover, students will require 24/7 access to these spaces for connecting with others, collaborating, communicating, and sharing.

The characteristic of dynamic nonlinearity was most notable through the descriptions of a PLE as continual movement. For quality online programs, the trait of dynamic nonlinearity points to the centrality of the adult learner as an agent in their own learning who comes to the formal space and learning management system with knowledge, skills, experiences, ways of thinking, and processes for studying. Graduates of the program will continue to learn, grow, make connections, engage with professionals, experience the workplace, and practice in the real world. Quality online programs will have a holistic view of the learner in order to meet their needs in personal, academic, and professional spaces for lifelong learning.

Systemic interconnectedness could be viewed through the way social systems, educational systems, learning systems, and technological systems (telecommunication, hardware, and software systems) run through agents' lived experiences of connectedness in their PLEs. A profound benefit of systemic interconnectedness is the amalgamation of positive emotional support and motivation from social systems experienced in tandem with learning systems that create encouragement to stay the course in the trajectory of meaningful goals. Quality online programs will attend to students' affective needs in the process of learning when they support them through a community of practice. From a systems perspective, quality online programs will be sufficiently agile as to adapt to an evolving technological landscape. They will guide students' selection of interoperable technologies with affordances for collaboration, communication, and organization in which students retain access and control after graduation for continuous education in the workplace and lifelong learning.

A systems view of connectedness emboldens program managers and instructors with a new paradigm to design for the learner experience. The seven traits of PLEs guide the practical application of strategies to ensure quality and integrity in online programs. Applying the traits of immersiveness, emergence, self-organization, adaptive coevolution, self-similarity, dynamic non-linearity, and systemic interconnectedness will ensure that the learner is supported holistically, that the community flourishes, and that the online program thrives.

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REFERENCES

Adams Becker, S., Cummins, M., Davis, A., Freeman, A., Hall Giesinger, C., & Ananthanarayanan, V. (2017). *NMC horizon report: 2017 higher education edition*. Austin, TX: The New Media Consortium.

Anderson, T. (2012). Networks, web 2.0, and the connected learner. In R. A. Reiser & J. V. Dempsey (Eds.), *Trends and issues in instructional design and technology* (3rd ed.; pp. 299–308). Boston, MA: Pearson.

Chickering, A. W., & Ehrmann, S. C. (1996). Implementing the seven principles: Technology as lever. *AAHE Bulletin*, *49*(2), 3–6.

Chickering, A. W., & Gamson, Z. F. (1987). Seven principles for good practice in undergraduate education. *AAHE Bulletin*, *39*(7), 3–7.

Dabbagh, N., Kitsantas, A., Al-Freih, M., & Fake, H. (2015). Using social media to develop personal learning environments and self-regulated learning skills: A case study. *International Journal of Social Media and Interactive Learning Environments*, *3*(3), 163–183. doi:10.1504/IJSMILE.2015.072300

Deleuze, G., & Guattari, F. (1987). *A thousand plateaus*. Minneapolis, MN: University of Minnesota Press.

deWaard, I., Abajian, S., Gallagher, M. S., Hogue, R., Keskin, N., Koutropoulos, A., & Rodriguez, O. C. (2011). Using mLearning and MOOCs to understand chaos, emergence, and complexity in education. *International Review of Research in Open and Distance Learning*, *12*(7), 94–115. doi:10.19173/irrodl.v12i7.1046

Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: Implications for the design and delivery of instruction. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 170–198). New York, NY: Simon & Schuster Macmillan.

Educause. (2009). *Seven things you should know about personal learning environments*. Washington, DC: Educause Learning Initiative. Retrieved from https://library.educause.edu/~/media/files/library/2009/5/eli7049-pdf.pdf

Ihde, D. (1979). *Technics and praxis*. Boston, MA: D. Reidel.

Jakubowicz, P. (2006). Complexity theory and online learning. *Proceedings of the Asia-Pacific Education Research Association Conference*.

Kennedy, J. (2017, April). *Bursting toward writing-as-thinking and fluid methodology: Enacting nomadic thinking in post-intentional phenomenology*. Paper presented at the 2017 annual meeting of the American Educational Research Association, San Antonio, TX. Retrieved from http://www.aera.net/Publications/Online-Paper-Repository/AERA-Online-Paper-Repository/Owner/935743

Kennedy, J. (2018). Towards a model of connectedness in personal learning networks. *Journal of Interactive Online Learning*, *15*(3). Retrieved from http://www.ncolr.org/jiol

Knowles, M., Holton, E., & Swanson, R. (2005). *The adult learner: The definitive classic in adult education and human resource development* (6th ed.). San Diego, CA: Elsevier. doi:10.4324/9780080481913

Laroche, L., Nicol, C., & Mayer-Smith, J. (2007). New venues for science teacher education: Self-organizational pedagogy on the edge of chaos. *Complicity: An International Journal of Complexity and Education*, *4*(1), 69–83. doi:10.29173/cmplct8761

Martindale, T., & Dowdy, M. (2010). Personal learning environments. In G. Veletsianos (Ed.), *Emerging technologies in distance education* (pp. 177–193). Edmonton, AB: Athabasca University Press.

Mezirow, J. (1991). *Transformative dimensions of adult learning*. San Francisco, CA: Jossey-Bass.

Moore, M. G. (1973). Towards a theory of independent learning and teaching. *The Journal of Higher Education*, *44*(9), 661–679. doi:10.2307/1980599

Moore, M. G. (1993). Theory of transactional distance. In D. Keegan (Ed.), *Theoretical principles of distance education* (pp. 22–38). London: Routledge.

Moore, M. G., & Kearsley, G. (1996). *Distance education: A systems view*. Belmont, CA: Wadsworth.

Morrison, K. (2006). Complexity theory and education. *Proceedings of the Asia-Pacific Education Research Association Conference*. Retrieved from http://edisdat.ied.edu.hk/pubarch/b15907314/full_paper/SYMPO-000004_Keith%20Morrison.pdf

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage.

Patton, M. Q. (2011). *Developmental evaluation: Applying complexity concepts to enhance innovation and use*. New York, NY: Guilford Press.

Reigeluth, C. M. (2004). *Chaos theory and the sciences of complexity: Foundations for transforming education*. Paper presented at the annual meeting of the American Educational Research Association, San Diego, CA.

Saba, F. (2003). Distance education theory, methodology, and epistemology: A pragmatic paradigm. In M. G. Moore & W. G. Anderson (Eds.), *Handbook of distance education* (pp. 3–20). Mahwah, NJ: L. Erlbaum Associates.

Saba, F., & Shearer, R. L. (1994). Verifying key theoretical concepts in a dynamic model of distance education. *American Journal of Distance Education*, *8*(1), 36–59. doi:10.1080/08923649409526844

Siemens, G. (2005). Connectivism: Learning as network creation. *International Journal of Instructional Technology and Distance Learning*, *2*(1). Retrieved from http://www.itdl.org/journal/jan_05/article01.htm

Vagle, M. D. (2014). *Crafting phenomenological research*. Walnut Creek, CA: Left Coast Press.

ADDITIONAL READING

Anderson, T. (2005). Distance learning: Social software's killer app? In *Proceedings of Open and Distance Learning Association of Australia*. Adelaide, Australia: ODLAA. Retrieved from https://auspace.athabascau.ca/bitstream/handle/2149/2328/distance?sequence=1

Blaschke, L. (2012). Heutagogy and lifelong learning: A review of heutagogical practice and self-determined learning. *The International Review of Research In Open And Distributed Learning*, *13*(1), 56–71. doi:10.19173/irrodl.v13i1.1076

Cronin, C. (2016). Open, networked and connected learning: Bridging the formal/informal learning divide in higher education. In *Proceedings of the 10th International Conference on Networked Learning 2016* (pp. 76–84). Lancaster, UK: Lancaster University; Retrieved from http://eprints.teachingandlearning.ie/4030/1/S3_Paper2.pdf

Dron, J. (2007). *Control and constraint in e-learning: Choosing when to choose*. Hershey, PA: Idea Group. doi:10.4018/978-1-59904-390-6

Michelfelder, D. P., Wellner, G., & Wiltse, H. (2017). Designing differently: Toward a methodology for an ethics of feminist technology design. In S. Hansson (Ed.), *The ethics of technology: Methods and approaches* (pp. 193–218). London, UK: Rowman and Littlefield International.

Paulsen, M. F. (2008). Cooperative online education. *Seminar.Net, 4*(2). Retrieved from https://journals.hioa.no/index.php/seminar/article/download/2482/2381

Price, G. P., & Wright, V. H. (2012). Aligning web-based tools to the research process cycle: A resource for collaborative research projects. *Journal of Interactive Online Learning*, *11*(3).

Timmis, S., & Williams, J. (2016). Transitioning across networked, workplace and educational boundaries: Shifting identities and chronotopic movements. In T. Ryberg, C. Sinclair, S. Bayne, & M. de Laat (Eds.), *Research, boundaries, and policy in networked learning* (pp. 111–124). Switzerland: Springer, Cham. doi:10.1007/978-3-319-31130-2_7

KEY TERMS AND DEFINITIONS

Complex Adaptive System: Grounded in dynamic systems, chaos, and complexity theory, a complex adaptive system consists of the qualities of emergence, self-organization, adaptive coevolution, self-similarity, dynamic non-linearity, and systemic interconnectedness.

Learning Management System: An institution-focused software application for administering, delivering, facilitating, and managing learning in formal contexts. Often referred to simply by the acronym LMS, it is typically integrated with an institution's registration and grading systems.

Personal Learning Environment: A personal learning environment encompasses the technologies, applications, services, organizations, humans, and networks that an agent draws into their world for personally meaningful learning. When implemented in formal learning contexts, it is a net-native pedagogical approach aligned with andragogy principles and situativity theory.

Personal Learning Network: The social component of a personal learning environment, a personal learning network encompasses the people with whom an agent engages to negotiate meaning and socially construct knowledge. Typically, this is through colleagues, teachers, classmates, family, friends, as well as writers and presenters.

Post-Intentional Phenomenology: Conceived by phenomenologist Mark Vagle, post-intentional phenomenology is a philosophy, methodology, and way of being in the world. It is a genre of phenomenology that is influenced by the Deleuzo-Guattarian concept of rhizomes, particularly lines of flight, and foregrounds the multiple and partial ways that fleeting phenomenon tentatively manifest through meaningful interactions in lived experiences.

Post-Phenomenological Philosophy of Technology: Philosopher Don Ihde developed post-phenomenological philosophy of technology as a way of thinking about our experiences of, with, and through technologies. Ihde views human-technology relations through the lens of our lifeworld, which is our lived experiences of space, time, body, and relations, with centrality on the variants in our embodied experiences and relations through technologies.

Social Web: Websites and mobile applications that agent's use to communicate and participate in a digital culture. Agents on the social web often use text, images, and videos as a means of communicating and interacting.