# Bridging the Past and the Future of the Research in Seamless Learning

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**Abstract:** This paper centers on an account of the research foci of MSL according to my recent literature scan and analysis. 83 relevant papers published between 2006 and April 2013 were identified for analysis. However, it is not our intention to compile thick and intentionally accurate statistics, and subsequently offer purely data-driven interpretation of the state of the arts. Rather, we are keen on qualitatively outlining and tracing the evolution of MSL research, particularly in how scholars perceive the roles of technology, pedagogy, learning spaces, and learners in the seamless learning practices. This paper will focus on (1) the (re-)scoping of seamless learning; and (2) the conceptual groundings in the past MSL research. Rise-above discussions on the trends will then ensue in order to provide a synoptic picture of how this line of studies have been advancing over the time. Through the analysis, it is further affirmative that seamless learning is much more than a special form of any other learning method. It is a learning approach at its own right and with its own niche – with '*bridging* of cross-space learning efforts' as its distinctive feature.

**Keywords:** Mobile seamless learning; literature review; conceptual groundings

## 1. Introduction

Seamless learning has two lives – one is in the field of higher education studies and another in technology-enhanced learning (TEL), particularly mobile and ubiquitous learning (m-learning and u-learning). The two 'lives' were 'born' more than a decade apart - in early-1990s and mid-2000s, flourished by the seminal papers, Kuh (1996) and Chan et al. (2006), respectively. Nevertheless, the two 'lives' have barely been 'interacting' with each other (i.e., almost no cross-citation) until 2011 despite bearing an identical name.

The first life of seamless learning began with higher education scholars and leaders' questioning of the gap between the roles of faculty and student affairs professionals (Bloland, Stamatakos, & Rogers, 1994), reflecting two domains of student life – in the classroom and out of the classroom (Kezar, 2003). As a result, they re-examined the need for integration of these roles and advocated a change in the culture of learning from separatist to seamless (e.g., American College Personnel Association, 1994; Knefelkamp, 1991) orientation. Picking up from there, Kuh (1996) elaborated the notion by extending it to involve off-campus experiences, "In seamless learning environments, students are encouraged to take advantage of learning resources that exist both inside and outside of the classroom. Students are asked to use their life experiences to make meaning of material introduced in classes." (p. 136)

With the coming of the 21st century, scholars in the emerging field of m/u-learning has begun to snap to the notion of seamless learning and coin the term in the relevant literature (e.g., Cheng, Sun, Kansen, Huang, & He, 2005; Thomas, Schott, & Kambouri, 2004), with a greater focus on technological innovation to enable specific personalized learning activities across spaces. With the proliferation of 1:1 (one-device-or-more-per-student) setting, an international synthesis of the topic by Chan et al. (2006), saw seamless learning being re-framed in the context of TEL as "… the continuity of the learning experience across different scenarios or contexts, and emerging from the availability of one device or more per student." (p.23)

The paper has virtually launched the 'second life' of seamless learning with follow-up discussions and studies taking place within the community of m/u-learning. This 'second life' is retrospectively known as 'mobile-assisted seamless learning' (MSL) by Wong and Looi (2011) to

differentiate from its 'first life' or the general sense of seamless learning. Although the 'second life' can be seen as a 'cousin' of the first to begin with, it is then aggressively evolving and identifying its own niche, and enriching the meaning of the fundamental notion.

This paper centers on an account of the research foci of MSL (the 'second life') according to our recent literature scan and analysis. The approach in identifying the relevant papers was similar to what was employed by Wong and Looi (2011). We started with rounds of searches on Google Scholar, ERIC, Web of Knowledge and British Education Index, with the Boolean combination of search keywords ["seamless learning" AND ("mobile learning" OR "ubiquitous learning" OR "handheld")]. 83 papers were identified, i.e., an addition of 29 recent publications on top of what were reviewed by Wong and Looi (2011). However, it is not our intention to compile thick and intentionally accurate statistics, and subsequently offer purely data-driven interpretation of the state of the arts. Rather, we are keen on qualitatively outlining and tracing the evolution of MSL research, particularly in how scholars perceive the roles of technology, pedagogy, learning spaces, and learners themselves in the seamless learning practices. Due to the space constraint, this paper will focus on (1) the (re-)scoping of seamless learning; and (2) the conceptual groundings in the past MSL research. In a forthcoming book chapter (Wong, forthcoming), we will further present the MSL-specific theoretical, characterization, ecological, design, methodological and technological frameworks being developed in the past 7 years. Rise-above discussions on the trends will then ensue to provide a synoptic picture of how this line of studies have been evolving and advancing over the time.

## 2. Scoping and Re-scoping Seamless Learning

Despite having rich literature in its 'first life', seamless learning is often seen as a special form of m/u-learning within the TEL community. Some TEL researchers carried a relatively techno-centric perspectives that treated ubiquitous and context-aware technologies as the essential enablers of MSL without being interrupted while learners switch locations or devices (Hwang, Tsai, & Yang, 2008; Yu, Yang, & Cheng, 2009). Others viewed seamless learning and ubiquitous learning as synonyms (Ng & Nicholas, 2007; Wang & Wang, 2008). Wong and Looi (2011) did not concur with both views as u-learning is a relatively techno-oriented notion about how ubiquitous technology supports learners in the right way, in the right place, and at the right time, based on the personal and environmental contexts in the real world (Hwang et al., 2008). To clarify the distinction between u-learning and MSL, it is good to examine some representative 'scoping descriptions' of MSL in the literature, as shown in Table 1.

Table 1: Representative 'scoping descriptions' of MSL in the literature

| **Publication** | **Scoping Description** |
|---|---|
| Chan et al. (2006) | "…marked by continuity of the learning experience across different scenarios or contexts, and emerging from the availability of one device or more per student. By enabling learners to learn whenever they are curious and seamlessly switch between different contexts, such as between formal and informal contexts and between individual and social learning, and by extending the social spaces in which learners interact with each other, these developments, supported by theories of social learning, situated learning, and knowledge-building, will influence the nature, the process and the outcomes of learning." (p. 23) |
| Yang (2006) | "The ubiquitous learning environment can connect, integrate and share learning resources in the right place at the right time by an interoperable, pervasive and seamless learning architecture." (p.188) |
| Ng & Nicholas (2007) | "Sharples, Taylor and Vavoula (forthcoming) *[note: (Sharples, Taylor, & Vavoula, 2007)]* have proposed a model of learning for the mobile age, but we argue that their model omits one important consideration … they have highlighted the physical ubiquity of the technology without adequate consideration of the conditions for seamless learning. In presenting their model, they continue a perhaps unconscious tradition of the mobile learning field to highlight mobility over learning. Our argument is that at least in the mainstream school education context, seamless learning requires planned interactions between mobile and stable technologies." (pp.3-4) |
| Chiu et al. (2008) | "Ubiquitous learning environments enable seamless learning at anywhere and anytime. The learners are allowed to learn without being interrupted while moving from place to place." (p.259) |
| Hwang et al. (2008) | "A context-aware ubiquitous learning environment enables seamless learning from place to place within the predefined area." (p.84) |
| Rogers & | *(Note: This appears to be a synthetic definition for m-learning, u-learning and MSL.)* "Central to |

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|---|---|
| Price (2009) | these notions is the idea that mobile technologies can be designed to enable children to move in and out of overlapping physical, digital and communicative spaces. The mobility can be achieved individually, in pairs, in small groups, or as a whole classroom …" (pp.4-5) |
| Obisat & Hattab (2009) | "The modern e-learning system must be able to offer personalized support and learning solutions in real-time. Such an approach combines real-time assessment, learning, and pedagogical considerations into one seamless learning activity." (p.126) |
| Baloian & Zurita (2012) | "The ubiquitous availability of mobile devices promotes the seamless learning notion that envisages the embodiment of learning into everyday living." (p.7000) |
| Wong (2012) | "There may be episodic learning efforts taking place in different contexts, either externally facilitated (e.g., started from a teacher) or self-initiated. However, such isolated learning gains may later be converged as they may mediate the same learner's learning efforts in the future." (p.E20) |
| Wong (2013) | "We re-conceptualize the nature of 'seamless learning environment' from an individual learner's perspective by adapting Barron's (2006) definition of learning ecology as 'the combination of physical or virtual (living) spaces that a person is situated or encounters in his/her daily life that provides opportunities of learning.'" (p.209)<br>"… to re-conceptualize the nature of seamless learning from an individual learner's perspective, i.e., students' self-generation of learning contexts within and across their living spaces. Students should ultimately become life-long autonomous learners who are able to decide when, where and how to learn with self-identified resources within their learning spaces." (p.210) |
| Milrad et al. (2013) | "… genuine seamless learning is about treating all the learning spaces and resources that learners have access to as ingredients to facilitate their ongoing self- and co-construction of knowledge, rather than believing in knowledge as composed of universal facts that are best learned through didactic teaching." |
| Looi & Wong (in-press-a) | "A more productive view of learning sees learning as happening continuously over time and learning experiences as being enriched when similar or related phenomena are studied or seen from multiple perspectives. In more formal settings, learners may learn canonical knowledge about a subject or topic, while in more informal settings, learners experience the subject or topic in its natural settings or in different contexts, thus achieving more holistic notions of learning and literacy. Learners will almost naturally and continually enhance their knowledge and skills to address problems and participate in a process of continuous learning." |
| Sharples et al. (2012) | "Seamless learning is when a person experiences a continuity of learning across a combination of locations, times, technologies or social settings." (p.24)<br>"Seamless learning may form part of a wider learning journey that spans a person's life transitions, such as from school to university or workplace." (p.24)<br>"Seamless learning can best be seen as an aspiration rather than a bundle of activities, resources and challenges." (p.25) |
| Toh, So, Seow, Chen, and Looi (2013) | "This notion of seamless learning refers to the integrated and synergistic effects of learning in both formal and informal settings, which is distributed across different learning processes (emergent or planned) as well as across different spaces (in or out of class)." |

The expositions of Chiu et al. (2008) and Hwang et al. (2008) seem to be contradictory as the former talks about 'anytime, anywhere learning' while the latter stipulates 'learning within a predefined area'. Hwang et al.'s (2008) exposition is perhaps pertaining to one of the well-studied solutions of u-learning environments that leverage location-based services to tailor learning trails to a specific location or specific objects (e.g., those using RFID or QR tags). Examples of such MSL interventions are also reported in Kurti, Spikol and Milrad (2008), Rogers and Price (2008), and Shih and Tseng (2009). In contrast, the Global Positioning Systems (GPS) or the Geographic Information Systems (GIS) helps the MSL designers and learners in breaking the barrier and affording learning activities to be carried out perhaps in much wider areas. MSL designs that adopted the technologies are accounted in Maldonado and Pea (2010), Ogata et al. (2008), and Sollervall and Milrad (2012), etc.

In a broader view, 'learning anytime, anywhere' was once a 'slogan' for e-learning in general, and later being taken over by m-learning. The question here is that is 'learning anytime, anywhere' equal to 'continuity of learning across multiple spaces'? If so, the seamless learning notion would not have its own niche. Indeed, we see some of the reported interventions were loosely characterized in the literature as seamless learning designs. Yet the learning activities were somewhat repetitive, perhaps in a behaviorist manner, albeit across time and spaces (e.g., Huang et al., 2007; Miyata, Sannomiya, &

Suzuki, 2010; Narayanansamy & Ismail, 2011; Tillman et al., 2012). The way we see such an approach is, however, that it fall back to the 'classic' e-learning construct of 'learning anytime, anywhere' without the consideration of what unique environmental constructs in varied learning spaces including artifacts, tools and/or people could offer to facilitate multifaceted learning tasks – e.g., physical spaces for situated learning and authentic data collection, online platforms for peer discussions, etc.

Subsequent studies then began to accentuate the natures of and the roles that various learning spaces may play in mediating the seamless learning journeys. Both Rogers and Price (2009) and Baloian and Zurita (2012) coined the term 'embodiment' to underscore the importance of mobile and seamless learners' blending into, and interacting and having conversations with, the physical and social worlds (or, 'everyday living'). This marks a departure from the earlier ubiquitous technology-driven interventions which typically treated learners as passive 'consumers' of (perceived static) physical contexts (Whitworth, 2008; Wong, 2013). The arguments are also consistent with what Pea (2009) postulated, "We need to treat the activities and life experiences of the learners throughout the day as our units of learning design, description and explanation."

Whereas 'learning in the right way at the right space and the right time' seems to be the key to general m-learning and situated learning, perhaps the defining feature of seamless learning is 'bridging' the multifaceted learning efforts across learning spaces. Building on the quote from Wong (2012) in Table 1, Wong (in-press) envisaged a spiral-style construct across MSL tasks (or, 'learning cycles' in the paper) where "in the present cycle, the explicit target knowledge to learn, the learning activity types, the skill to learn and apply, the mobile affordances to use, and the student artifacts to reuse and create, are all building on or rising above the previous cycle." Without such an 'organic' bridging of learning experiences and learning gains despite enactments of a variety of learning tasks across spaces, one's learning journey will remain fragmented, if not repetitive.

As observed by Marcelo et al. (2013), "recent studies on seamless learning have been extending from teacher-facilitated classroom or outdoor learning into nurturing autonomous learners." (p.96) Seamless learning is now seen as an aspiration (Sharples et al., 2012), a 'habit-of-mind' (Wong & Looi, 2011), or 'schematized and habitual regulatory strategies' in psychological term (Sha, Looi, Chen, & Zhang, 2012) that should span one's lifetime and make one become a life-long learner. With more and more level- or institution-wide 1:1, 24x7 initiatives being implemented (Bentley, Shegunshi, & Scannell, 2010; Looi & Wong, in-press-b; Ng & Nicholas, 2009; Pegrum, Oakley, & Faulkner, 2013; Vogel, Kennedy, Kuan, Kwok, & Lai, 2007), the fostering of a culture of seamless learning is now on the table.

In a nutshell, the trajectory of evolution of the seamless learning notion probably signifies that the practice of this notion should go beyond the mindset of offering learners the 'logistic convenience' in contextual and cross-contextual learning. The key is to facilitate and nurture genuine transformations of beliefs about and habits of learning among the learners. Ultimately, if a one-statement definition of seamless learning is still desired, perhaps we can adopt and adapt from Sharples et al.'s (2012, p. 24) exposition,

> "Seamless learning is when a person experiences a continuity of learning, *and consciously bridges the multifaceted learning efforts*, across a combination of locations, times, technologies or social settings."

We insert the 'bridging' element into the exposition since 'a continuity of learning' alone does not necessarily encapsulate the stated condition – even the above-stated 'learning anytime, anywhere(, repetitively)' designs may fit this description. With this relatively concise definition (though perhaps requiring further unpacking), the field would not need to always quote the wordy 'scoping description' as put forward by Chan et al. (2006).

## 3. The Conceptual Groundings

Seamless learning or MSL has been loosely referred to by some literature as a learning *theory* (e.g., Fang, Wang, & Huang, 2011; Tsoi & Dekhane, 2011). However, just like inquiry learning and m-learning, seamless learning should instead be seen as a learning notion or a learning approach at least till it is convincingly theorized. To start with, Chan et al. (2006) was meant to be an initial

characterization effort on MSL as a rise above of the co-authors' synoptic and critical analysis of the state-of-the-arts of general m-learning. Over the years, scattered work on modeling, framework building and initial theorization of MSL took place, which will be synoptically presented in our forthcoming book chapter. For now, let's survey existing general learning theories, frameworks and concepts that the MSL researchers have rooted their studies in. This would assist us in making better sense of the nature of seamless learning and shed light on the future research and practical directions of the field.

A summary of the types of conceptual grounding is given in Table 2. Note that papers with brief mentioning of certain conceptual groundings without clear evidences of their actual designs or analysis being informed by the stated concepts are *not* included in the table.

The first set of MSL studies, typically those which are technology innovation-oriented, have exhibited the tendency of associating their intervention designs to numerous TEL concepts or approaches, such as m/u-learning in general, pervasive learning, distance learning, blended learning, personalized learning or Personalized Learning Environment (PLE), and ICT as cognitive tools. Also being rooted for learning designs are context-awareness/sensitivity/ adaptivity, which are more general technological architectures than learning approaches.

The second set of studies was framed by the common characteristic of foregrounding the roles of learning spaces or scenarios in mediating learners' deep learning, such as situated learning, authentic learning, experiential learning, scenario-based learning, and conversation theory. Nonetheless, the theoretical framings assumed by some of these studies appeared to be more orientated towards general m/u-learning than seamless learning. Experiential learning is perhaps the only learning notion among the stated ones that inherently encapsulates the essence of seamless learning. Guided by Kolb's (1984) four-task cyclical model for experiential learning (concrete experience, reflective observation, abstract conceptualization, and testing in new situations), two MSL studies (Lai, Yang, Chen, Ho, & Chan, 2007; Song, Wong, & Looi, 2012) designed learning flows with the four learning tasks being carried out and *bridged* across multiple learning spaces.

Table 2: The conceptual groundings of seamless learning adopted by the literature

| **Category** | **Conceptual Grounding** | **Referencing Literature** |
|---|---|---|
| TEL concepts or approaches | m/u-learning (in general) | Hwang et al. (2008); Ng & Nicholas (2007); Shih, Chu, Hwang & Kinshuk (2010); Wyeth et al. (2008) |
| | Pervasive learning | Bouzeghoub, Garlatti, Do & Pham-Nguyen (2011); Khan & Zia (2007) |
| | Distance learning / blended learning | Bentley et al. (2010) |
| | Personalized learning or PLE | Bentley et al. (2010); Gillot, Garlatti, Rebai & Pham-Nguyen (2012); Looi et al. (2009); Obisat & Hattab (2009); Tabuenca, Ternier & Specht (2012) |
| | ICT as cognitive tools | Seow, Zhang, Chen, Looi, & Tan (2009) |
| | Context-awareness / context-sensitivity / context-adaptivity | Li, Feng, Zhou & Shi (2009); Yu et al. (2009); Zhao & Okamoto (2011) |
| Learning notions that foreground the roles of learning spaces (contexts) | Situated learning | Buzeghoub et al. (2011); Chen, Kinshuk, Wei & Yang (2008); Kurti et al. (2008); Metcalf, Milrad, Cheek, Raasch & Hamilton (2008); So, Tan & Tay (2012); Zurita & Baloian (2012) |
| | Authentic learning | Ogata et al. (2008) |
| | Experiential learning | Lai, Yang, Chen, Ho & Chan (2007); Song, Wong & Looi (2012) |
| | Scenario-based learning | Metcalf et al. (2008) |
| | Conversation theory | Zhao & Okamoto (2011) |
| | Distributed cognition | Looi et al. (2010); Otero et al. (2011); Seow et al. (2009); |

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| | | Song (2013); Wong, Chen & Jan (2012) |
| Pedagogic- or constructivist-inspired notions | Socio-constructivism | Roger & Price (2008); Spikol & Milrad (2008) |
| | Knowledge building | Maldonado & Pea (2010); So et al. (2012) |
| | Knowledge spirals | Zhang & Maesako (2009) |
| | Inquiry learning | Gillot et al. (2012); Maldonado & Pea (2010); Rogers & Price (2008) |
| | Sense/meaning making | Toh et al. (in-press); Wong, Chin, Tan & Liu (2010) |
| | Learner-generated contexts | Wong (2013) |
| | Learning with patterns | Zurita & Baloian (2012) |
| | Cognitive apprenticeship | Zurita & Baloian (2012) |
| | Scaffolding | Lin, Chen & Chen (2008) |
| | Differentiated instructions | Looi et al. (2009) |
| | SECI model | Chang & Chen (2007); Zhang & Maesako (2009); Baloian & Zurita (2012) |
| Autonomous learning approaches | Self-guided exploration | Vogel et al. (2007) |
| | Self-directed learning | El-Bishouty, Ogata, Ayala & Yano (2010); Wong (in-press); Zhang et al. (2010) |
| | Lifelong learning | Tabuenca et al. (2012) |
| | Transformation of participation | Toh et al. (in-press) |

A pertinent notion is distributed cognition (DCog) which has provided the grounding for the second largest set of MSL studies among all the relevant theoretical underpinnings (five of them; after situated learning with seven; see Table 2). DCog is devoted to the study of the representation of knowledge both inside the heads of individuals and in the world, the propagation of knowledge between different individuals and artifacts (broadly defined to include instruments, signs, languages and machines that mediate activities) and the transformations that external structures undergo when operated by individuals and artifacts (Flor & Hutchins, 1991). Combining both social and cognitive aspects, DCog suggests that learning should be perceived as a process distributed across individuals and artifacts (Salomon, 1993). Hutchins (1987) also discussed 'collaborative manipulation', the process in which we leveraged on artifacts designed by others (and ourselves) to share ideas across time and spaces.

All these core assertions of DCog mesh well with the salient characteristics of seamless learning, such as the bridging of individual and social learning, the learners' appropriation of elements (artifacts) available in specific learning spaces to support their learning, and the bridging of cross-space learning efforts mediated by specific artifacts (e.g., the mobile device, or student artifacts created in previous activities). Relating to this perspective, a learning context is not necessarily confined within a specific learning space and a specific time frame. Instead, a learning context may span across time and spaces, and constantly reconstructed through switching of learning tasks. Thus, it is not surprising that scholars tapped on DCog when constructing theoretical or methodological frameworks for seamless learning (e.g., Looi et al., 2010; Otero et al., 2011; Wong, Chen, & Jan, 2012).

The third set of MSL literature placed its emphasis on the pedagogical aspect and/or constructivist affinity of seamless learning and made references to knowledge building, knowledge spirals, inquiry learning, sense making or meaning making, learner-generated contexts, learning with patterns, scaffolding, cognitive apprenticeship, and differentiated instructions. Again, in the eyes of MSL researchers, every knowledge construction process should be extended and bridged, rather than being confined within one single learning session.

In addition, not as a learning concept or pedagogical paradigm but a process framework for knowledge management, the SECI model (Nonoka & Takeuchi, 1995) was adopted by three MSL

studies in developing their respective process frameworks or solutions. The SECI model describes the dynamics of knowledge evolution as a knowledge spiral within a knowledge-creating enterprise, with the process of knowledge creation involving four cyclical stages: Socialization, Externalization, Combination and Internalization – which again should be carried out across time and spaces.

A smaller set of studies associated their designs or analyses with the notions of self-guided exploration, self-directed learning, lifelong learning, and transformation of participation – all can be seen as variations of autonomous learning. Indeed, seamless learning itself can be classified along with this group of notions that aim to promote certain self-regulatory and habitual learning cultures.

Through the analysis of the diverse theoretical underpinnings of seamless learning in this section, the sociocultural perspective of learning consistently stands out as the implicit guiding philosophy for the conceptualization, implementation and interpretation of the notion. Constructivism and socio-constructivism become the common threads that weave together individual or groups of learners' learning efforts and experiences across multiple spaces, (perhaps) with the eventual goal of fostering a sustainable sense of learning ownership in them.

## 4. Conclusion – Bridging the Past and the Future

Looking back the past 7 years, though not a well-modeled or well-theorized learning notion to start with, the 'second life' of seamless learning has continued to show its strong potential and promise, and gradually become a mature line of research and practice. Indeed, it was the 'second life' of the learning notion that has substantially enriched and even re-defined its 'first life'. In this paper, we have attempted to make deeper sense of seamless learning both within and beyond the context of TEL. Through examining the MSL literature, it is further affirmative that seamless learning is much more than a special form of any other learning method. It is indeed a learning approach at its own right and with its own niche – with '*bridging* of cross-space learning efforts' as the defining feature. Indeed, seamless learning is an ever evolving landscape that needs to be constantly refined, re-interpreted and re-contextualized.

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