Chapter 1
The Conceptual Niche of Seamless Learning: An Invitation to Dialogue

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1 Introduction

Over the last few decades, the rise of the student-centred learning movement has rendered a flurry of relevant learning or pedagogical approaches being developed, most of which are underpinned by the sociocultural or cognitivist perspective of learning. Some approaches went on to gain momentum and popularity in both the academic and practical sectors; a few even reached a critical mass to launch their specialised annual conferences and journals. Others have remained in their own niche communities or have relatively low numbers in terms of publications. Seamless learning is one such emerging learning notion that seems to be situated in between the two above-stated statuses, twelve years after it was inducted into the mobile and ubiquitous learning field.

First proposed in the field of higher education studies that advocate systemic reforms in the US colleges by binding together students' academic and non-academic experiences (American College Personnel Association, 1994; Kuh, 1996), and it was later appropriated as the key techno-pedagogical approach underpinned by G1:1, the global community with the aim of promoting research in technology-enhanced learning in 1:1 (one-or-more-device-per-learner) settings (Chan et al., 2006). This 2006 definition is motivated by a new phase in the evolution of technology-enhanced learning, characterised by "seamless learning spaces" and marked by continuity of the learning experience across different scenarios or contexts, and emerging from the availability of one device or more per student ("one-to-one") (Chan et al., 2006). The definition in 2015 views seamless learning as "… 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." (Wong, 2015, p. 10; adapted from: Sharples et al., 2012). Thus, the more recent definitions

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provide an expansive view that goes beyond 1:1 settings and with seamlessness across more multi-dimensions.

Since 2006, the core members of G1:1 spearheaded a series of seamless learning research studies to frame and make better sense of the new (or renewed) learning notion (e.g., Deng, Lin, Kinshuk, & Chan, 2006). Some have developed point-at-able techno-pedagogical models (e.g., Looi et al., 2010). A few other intervention studies were originally rooted in alternative theoretical frameworks and yet the researchers retrospectively associated their techno-pedagogical designs with seamless learning (e.g., Kurti, Spikol, & Milrad, 2008; Maldonado & Pea, 2010; Underwood, Luckin, & Winters, 2010). Since the initial enthusiasm in the G1:1 community, many key members have shifted their research interests to other areas. Subsequently, other researchers took over the baton by making contribution in developing new characterisation or pedagogical frameworks (e.g., Nicholas & Ng, 2015; Uosaki, Ogata, Li, Hou, & Mouri, 2013; Wong & Looi, 2011), research methods (e.g., Toh, So, Seow, Chen, & Looi, 2013; Wong, Chen, & Jan, 2012) and technological environments (e.g., Ogata et al., 2014; Tissenbaum & Slotta, 2015; Zurita & Baloian, 2015) to advance the scholarly understanding and achieve practicality in seamless learning. There were also occasional synthesis efforts such as a special issue on "Seamless, Ubiquitous, and Contextual Learning" in the IEEE Transactions on Learning Technologies (Looi, Wong, & Milrad, 2015) and edited books specialised in technology-enhanced seamless learning (Şad & Ebner, 2017; Wong, Milrad, & Specht, 2015).

As scholars continue to struggle in developing seamless learning into an established learning notion or further spread the practices in formal school settings or in adult learning, the learning notion is still under-theorised to date. The cross-temporal and cross-spatial nature of seamless learning has been posing methodological challenges to researchers, and design, implementation and evaluation challenges to practitioners, as well as self-regulating and cognitive challenges to learners. Even keen adopters might be plagued by curricular rigidity or the lack of technological infrastructure readiness. Thus, beyond the current seamless learning research and expositions, the learning notion may remain obscure to most scholars and educators—even within the mobile learning field.

In the occasions where seamless learning is introduced to a first-time listener, the latter tends to associate the learning approach with similar and more established learning notions that one is familiar with—such as blended learning, self-regulated learning, and lifelong learning. The question now is that whether seamless learning is just a special form of some other learning notion (or any other technology-enhanced learning paradigm—such as that seamless learning had historically been touted as a special form of mobile and ubiquitous learning), or a learning approach at its own right and with its own niche?

Henceforth, this book chapter is intended to be an inquiry on the uniqueness of seamless learning. This will be done by comparing the salient characteristics of seamless learning with the definitions and framing of other relevant learning notions or approaches. Notwithstanding, the endeavour does not treat other learning notions as competing solutions and is not meant for evaluating which solution is better than which. Rather, the intention is to make sense of the similarities and differences of

these learning notions. It is hoped that the new-found understanding will inform cross-fertilisation between seamless learning and other learning notions to inspire and guide the advancement of the relevant research and practice.

Seamless learning has the potential to become a "meta-learning approach" that spans, encapsulates or extend the currently known learning designs. Being a meta-learning approach means that there are sub-approaches, thereby creating some confusion with similar (sub) approaches. This is in the same sense of design-based research being a meta-methodology, therefore overlapping with other sub-methodological approaches.

2 The Key Concept and the Theoretical Basis of Seamless Learning

The intent of seamless learning is to remove the seams so as to enable learners to learn whenever they are curious and seamlessly switching 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. A theoretical basis is needed to explain how the mechanisms and processes behind seamless learning lead to explanations of how learning occurs.

In the literature, researchers have studied cognitive learning processes and theorisations behind each of the seamless learning spaces, such as learning individually, in the group, online learning, face-to-face learning, and through the construction of artefacts mediated by technology. Different affordances in the physical space or virtual space or over time lead to different episodes of learning experiences, each of which may be grounded in some theorisation of learning. However, a theorisation of seamless learning requires a meta-theory, more than an aggregate collection of disparate theories specific to each of the learning spaces.

Thus, the unit of analysis should be the integrated continuous learning processes. In seamed learning, episodes of learning are separated by the seams. The design of learning in online learning is distinguished from the design of learning in the face-to-face settings. Even if both designs are considered together, the linkages may not be brought to the fore in the design. In the seam between individual learning and social learning, theorisation from the computer-supported collaborative learning (CSCL) community takes the form of the transitions of learning via individual cognition versus group cognition.

A key design consideration in seamless learning is to consider and design for removing the seams or planning for the linkages first, that is, planning for the continuous learning at the outset, before elaborating the design in the separate learning spaces. Seamless learning has been explained by the contextualisation or recontextualisation (Wong, Chai, Aw, & King, 2015) of learning. In formal settings, knowledge and skills may be taught in the abstract. The more contexts or settings in which learning a concept or skill takes place, the more powerful is the learning. Con-

text refers to the different situations in which a concept or phenomenon is situated and interpreted. Removing or crossing seams would provide more opportunities for such contextualisation and recontextualisation. In doing so, the thinking and doing practices of learners are drawn to approximate those from the community of practices.

The crossover objects, or the boundary objects in the transitions between these learning spaces, in the form of artefacts, emerge, change and evolve as learners collaborate with peers, teachers and experts or conduct discovery, they acquire and build knowledge.

Seamless learning has been interpreted from a distributed cognition perspective. In the distributed cognition theory proposed by Hollan, Hutchins, and Kirsch (2002), they proposed three principles in which cognitive processes occur: they are distributed across the members of the social group; over time; and the operation of a cognitive system involves coordination between internal and external (material or environmental) structure. Applying these principles to seamless learning, learning takes place through individual learning in private learning spaces, collaborative learning in public learning spaces, and cognitive artefacts created across time and physical or virtual spaces mediated by technology within a context. In our earlier work, we have proposed sets of design principles for enabling seamless learning that supports the cognitive and social processes of learners; and we have recently consolidated and streamlined them into five items, namely designing for connectivity of learning spaces, socio-constructivist inquiry learning, formative assessments with student artefacts, leveraging resources in informal settings and personalised and self-directed learning (Wong, Looi, & Goh, 2017).

3 The Relationships Between Seamless Learning and Other Relevant Learning Approaches

In this section, we make an attempt to "dialogue" with some of the "close neighbours", that is, other learning notions that are often perceived by scholars as being conceptually overlapping with seamless learning. These approaches are chosen based on our understanding and scan of the literature about similarities and alignments in the theorisation or practice-oriented aspects of the approach with seamless learning.

3.1 Blended Learning

In a blended learning course, both online and traditional classroom-based teaching methods are utilised to provide a more effective learning experience for the students (Singh, 2003; Thorne, 2003). Blended learning is any formal education program in which a student learns at least in part through online learning, with some element of student control over time, place, path, and/or pace.

Blended learning can happen at different levels, such as the activity, lesson, course, programme or institutional level (Graham, 2006). It refers to an instructional or organisational arrangement of learning that provides a combination of computer-mediated (online) and face-to-face (offline) learning activities. Blending may be driven by different considerations or a combination of them, such as pedagogical, logistical, time, resources and organisational considerations.

Seamless learning emphasises the crossing of seams, one of which is between online learning and physical learning, to provide the continuity of the learning experiences and the contextualisation and recontextualisation of learning. Thus, it stresses the complementarity of the learning experiences in the different spaces, a principle which may or may not be advocated in the instructional design of blended learning. Researchers from seamless learning have argued for learning across the seams, as exemplified by theorisations of the distributed cognition framework (Otero et al., 2011; Seow, Zhang, Chen, Looi, & Tan, 2009; Wong et al., 2012). However, in blended learning, learning is within or by the seams, with bridging across the seams not foregrounded as learning mechanisms unlike seamless learning.

In self-directed seamless learning, the advocacy is for learners to be self-directed in creating their own continuity of learning experiences, and not as planned or scripted learning episodes as is the case in blended learning.

3.2 Self-Directed Learning (SDL)/Self-Regulated Learning (SRL)

The terms self-directed learning (SDL) and self-regulated learning (SRL) have often been used interchangeably over the past decades. Even their seminal definitions bear a strong resemblance. SDL "describes a process in which individuals take the initiative, with or without the assistance of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (Knowles, 1975, p. 18). On the other hand, "a general working definition of SRL is that it is an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behaviour, guided and constrained by their goals and the contextual features in the environment" (Pintrich, 2000, p. 453).

Despite bearing the obvious commonality, these learning notions belong to two different academic camps which are both instigated in the late 1960s. SDL was originated from the field of adult education outside the mainstream schooling system, while SRL was developed within the field of educational psychology and has been largely studied within K-12 school settings with a greater emphasis on correlating learner autonomy with academic achievements (Loyens, Magda, & Rikers, 2008).

Early SDL research focused primarily on definition and identification of self-directed learner's characteristics (Knowles, 1975). In later decades, cognisant that

self-direction is best viewed as a continuum, new research trends emerged since 1990s where scholars began to study the actual practice of SDL (e.g., Boyer, Artis, Solomon, & Fleming, 2012; Grow, 1991, 1994). In addition, SDL was no longer considered unique to adults but also received some attention in K-12 settings (e.g., Areglado, 1996; Birenbaum, 2002; Van Deur & Murray-Harvey, 2005).

The SRL research, on the contrary, is rooted in cognitive psychology (Cosnefroy & Carré, 2014). Related studies predominantly come with the intentions of developing and validating psychological and metacognitive models of SRL (e.g., Boekaerts, 1988; Efklides, 2011; Järvelä & Hadwin, 2013; Pintrich, 2000; Winne & Hadwin, 1998; Zimmerman, 1989). These models anchor crucial variables that affect learning and at the same time explain their interactions (Panadero, 2017). Informed by such models, other SRL scholars have put in efforts to delineate SRL strategies, or develop and study the effects of SRL skill interventions (e.g., Dignath, Buettner, & Langfeldt, 2008; Hattie, Biggs, & Purdie, 1996).

An important difference between SDL and SRL which has raised our attention in the context of this chapter is that SDL constitutes a tool to examine learning episodes or specific courses as it allows looking at *learning actions* as indicators for SDL. SRL, on the contrary, is often happening on a metacognitive level and therefore is difficult to isolate purely based on self-reported data (De Waard, 2016).

In contrast with SDL and SRL, the notion of seamless learning essentially talks about a special form of *learning experience*—more specifically, continuity of the learning experiences across different scenarios or contexts, perhaps (not mandatorily) mediated by mobile and/or cloud technologies. The key concern of seamless learning researchers is "what it takes" to make seamless learning happens—and the evaluation focus has been on whether seamless learning *actions* do happen and what are their effects. Hence, on the surface, it seems that the original notion of seamless learning is more consonant with SDL than SRL.

Notwithstanding, according to Wong's (2015) critical analysis, there is a gradual shift of the academic foci from technology-enabling perspective (to develop technological infrastructure to facilitate seamless learning) to a pedagogical design perspective to the fostering of a seamless learning culture. The last perspective implies the need to unpack the motivational and metacognitive prerequisites of being a seamless learner. When seamless learning researchers began to reposition seamless learning as an aspiration (Sharples et al., 2012) or a habit-of-mind (Wong & Looi, 2011), rather than merely a persistent learning behaviour, they would recognise the necessity to incorporate cognitive psychological dimensions to advance seamless learning research. Thus, there is potential for prior research on SDL or SRL to assist the seamless learning community in filling the research gaps.

3.3 Lifelong Learning (LLL) and Heutagogy

From Harper Collins Dictionary, lifelong learning (LLL) is "the provision or use of both formal and informal learning opportunities throughout people's lives in order

to foster the continuous development and improvement of the knowledge and skills needed for employment and personal fulfilment". London (2011) sees LLL as "a dynamic process that varies depending on individual skills and motivation for self-regulated, generative learning and life events that impose challenges that sometimes demand incremental/adaptive change and other times require frame-breaking change and transformational learning" (p. 3). Whereas the LLL notion inherently encompasses learning taking place between "cradle" and "grave", the relevant research and practice have been focusing on post-K-16 learning, which comes in the forms of continuing education, workplace learning, older workers' or senior citizen learning (particularly for remediating age-related cognitive decline), intergenerational learning, and interest-driven learning, among others. The key is to empower people to self-determine and self-manage their learning across time and contexts throughout their lifetimes (Bentley, 1998).

More recent literature has been associating LLL with heutagogy (Hase & Kenyon, 2000), a form of self-determined learning which is an extension of andragogy (Knowles, 1970). Luckin et al. (2008) put forward a pedagogy–andragogy–heutagogy (PAH) continuum. In a nutshell, pedagogy refers to K-12 education with instructors determining both the learning goals and approaches for the learners; andragogy refers to tertiary or adult education with instructors setting the goals while the learners are given free hand to choose their approaches; heutagogy means letting the learners decide on both. Luckin et al. (2008) further postulated that the cognition levels of pedagogy, andragogy and heutagogy are "cognitive", "metacognitive" and "epistemic", respectively. Bringing these three learning notions together as a continuum implies a developmental view of learning dispositions and skills.

In a related note, Kenyon and Hase (2001) incorporated double-loop learning (Argyris & Schon, 1978) as a key strategy for implementing heutagogy. What is opposite to double-loop learning is adaptive learning (see Fig. 1). Typically practised within pedagogical and andragogical settings, adaptive learning emphasises on primarily maintaining and repeating existing learning goals and learning approaches (i.e., the "single loop"); adaptation and improvements can be made, based on the track record of learning outcomes. Double-loop learning (also known as generative learning), on the contrary, requires learners to reflect upon and reorient or reshape their learning goals and strategies.

Thus, whereas andragogy is an extended form of structured formal learning, the notion of heutagogy places a greater emphasis on informal learning and learners' self-determination. Some of the salient characteristics of heutagogy are (1) learning how to learn; (2) double-loop learning; (3) leveraging opportunities of incidental learning in one's day-to-day life; (4) nonlinear trajectories of learning; (5) genuine self-directed learning (Hase & Kenyon, 2000; Wong & Chin, 2014).

Indeed, the framings of both LLL and heutagogy are eminently akin to seamless learning. Relevant research in LLL and heutagogy would inform post-college adult seamless learning, a relatively understudied area within the seamless learning field. Nonetheless, whereas the foci of the research in LLL and heutagogy are placed on self-determination and persistence in learning across time, the seamless learning scholars are showing their greater interest in cross-contextual flow of learning. Thus,

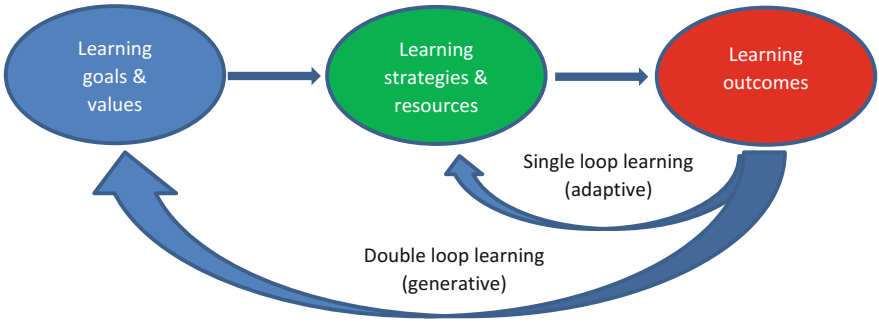

Fig. 1 Single- and double-loop learning

as compared to LLL and heutagogy, the seamless learning field tends to facilitate, study and unpack learning in finer granularity. Notwithstanding, the notion of double-loop learning may imbue seamless learners to consciously look back and cogitate about their previous learning endeavours—a key metacognitive disposition for seamless learning.

3.4 Crossover Learning

The term "crossover learning" was loosely referred to in scattered educational research literature since 1990s (e.g., Appleby & Hamilton, 2005; Bedore, 1992; Edwards, 2008). It was not until 2015 when the annual Innovating Pedagogy Report (Sharples et al., 2015) featured a section that demarcated the learning notion. However, as the report was targeting policymakers and practitioners, the writing was not intended to be an academic treatment to or a theorisation effort on the notion. Thus, "crossover learning" has not yet been developed into a research niche. Instead, it can be regarded as a new practical advocate. Still, it is interesting to examine the relationship between the notion and seamless learning.

According to the above-stated report section, crossover learning refers to "the ways we can connect formal and informal learning experiences, benefiting from the crossover between them" (Sharples et al., 2015, p. 11). Furthermore, the section foregrounds "learning ecosystem" that sees diverse settings and contexts with latent learning opportunities as one. The key exposition of the section is placing on the roles informal and non-academic learning could play in both supplementing learners' pursuance of academic goals and development of traits and skills such as persistence and self-direction. Thus, crossover learning should move towards a competency-based approach rather than on the volume of knowledge gained.

Technology could play an important part in accomplishing crossover learning. The examples raised in the section are using digital badges to track and recognise less formal achievements, and employing social media platforms that allow learners

to gather data/resources and develop transferable skills such as curation, evidence building and reflective commenting.

Panke (2017) extended the explication of crossover learning, though apparently with a focus on the contexts of adult, workplace or professional learning. In the online article, she relates the informal learning components of crossover learning to communities of practice, personal networks, and work-related tasks. Her conceptualisation is congruent with connectivism that sees knowledge as distributed across an information network. However, the renewed explication seems to depart from the "original" framing made by Sharples et al. (2015) as the roles of formal learning are omitted in the article.

Given the above expositions, we argue that crossover learning can be seen as a specific conception of seamless learning. Sharples and colleagues' (2015) exposition focuses on only one dimension of seamless learning, namely connecting formal and informal learning—though it may implicitly encompass the rest of the dimensions derived by Wong and Looi (2011), such as connecting individual–social settings and physical–digital learning realms. Panke's (2017) exposition has instead placed the emphasis on connecting individual–social settings. Building a learning ecology that incorporates multiple learning settings is a common advocate of both learning notions (see: Ng & Nicholas, 2013; Seow, So, Looi, Lim, & Wong, 2008; Song, 2013) and yet further unpacking is needed. There were also attempts of designing seamless learning environments that make use of social media (e.g., Charitonos, Blake, Scanlon, & Jones, 2012; Laru & Järvelä, 2015; So, Seow, & Looi, 2009; Wong, King, Chai, & Liu, 2016) or digital badges (e.g., Boticki, Baksa, Seow, & Looi, 2015) for similar purposes. In particular, Wong, Chai, and Aw (2017) proposed the SMILLA (Social Media as Language Learning Artefacts) Framework that details a theory-rooted mechanism to appropriate social media for both learner community building and language learning purposes—and there is a potential for this framework to be adapted for other subjects, cross-subject or even interest(-group)-driven learning.

3.5 Long-Tail Learning

The phrase "The Long Tail" was first coined by Chris Anderson in an October 2004 Wired magazine article to describe how our culture and economy is increasingly shifting away from a focus on a relatively small number of "hits" (mainstream products and markets) at the head of the demand curve towards a huge number of niches in the tail. This is exemplified by companies such as Amazon or Netflix, that sell a large number of unique items in relatively small quantities (Brown & Adler, 2008).

Long-tail learning comprises at least two facets: (1) learning about exotic topics outside the formal curriculum and (2) the opportunity to communicate with people who share similar niche interests somewhere in the world on a regular basis (Collins, Fischer, Barron, Liu, & Spada, 2009). Long-tail Learning overlaps much with informal learning as learners pursue the opportunity to learn, share and teach at the same time and justify the basis of both (individuals') passion-based, self-motivated learning (Domik & Fischer, 2011) and collaborative learning.

Collins et al. (2009) further discussed how the Web technology may afford the two aforementioned facets of long-tail learning. On the one hand, the Web is both constantly evolving and actively filling up all the long tails of knowledge about every conceivable topic, it can support individual learners' long-tail (passion-based) learning in a way not even the largest physical library in the world can support. On the other hand, the participatory Web 2.0 provides unique possibilities for an educational interpretation of the "Long Tail", thereby creating new feasibility spaces for collaborative learning.

Long-tail learning may be seen as a learning notion that is biased towards participatory learning, given that most of its earliest explications since Chris Anderson's 2004 article was published (Collins et al., 2009; Karrer, 2008; Tynan & Colbran, 2006) had been foregrounding the roles of Web 2.0-enabled learning communities on niche topics. Nevertheless, subsequent relevant literature has instead promulgated the learning notion's consonance with one of the key dimensions of seamless learning—bridging individual and social learning. The establishment of a long-tail learning community must begin with individuals' passion and self-determination in pursuing the relevant topic. Decision-making about connections (with online resources and with a relevant online community) becomes critical in long tail of learning (Klamma, 2010). Novice learners may lurk in long-tail communities to glean relevant ideas and skills for self-enrichment. When learners develop expertise, they can share their (completed or work-in-progress) artefacts or their thoughts to the community and gain feedback to guide their further development. In this sense, individual and social learning are reciprocal.

Du, Wang, Du, and Feng (2012) further unpacked the conceptualisation in the previous paragraph by characterising individual learning as constructivist learning, and social learning as connectionist learning. "A person is no longer able to have all necessary knowledge personally, who has to store it in others or technology" (Du et al., 2012, p. 495). The knowledge formed after constructing is in the head, while the large amount of information is in tail which mainly depends on the connection. Thus, Du et al. (2012) considered long-tail learning as an integration of three kinds of nets—neural networks (self-learning), Internet (online resources) and social networks (either online or real-life learning communities).

In this regard, we see a great potential in the long-tail learning notion in inspiring seamless learning researchers to study the underlying cognitive or sociocultural mechanism of bridging individual and social learning. Cognisant with Du et al.'s (2012) explication, we believe that a learner cannot simply "construct" but not "connect", and neither vice versa.

3.6 Wildfire Activities

Engeström (2004, 2009) put forward the notion of wildfire activities about 15 years ago. He envisioned a form of learning in a decentralised manner, with emerging communities of social or peer production activities across the time and boundaries.

One of the examples he cited was birding (Law & Lynch, 1988), where birders are swarming punctuated by bird movements. They document their sightings and share them through various channels such as social media to fellow bird lovers. Subsequently, they comment on each other's sightings and views and therefore elicit knowledge improvement and perhaps subsequent bird watching activities at the same or other potential sighting locations. Thus, in general sense, wildfire activities are transient in nature, appear or disappear unexpectedly or flare up and expand and may be temporarily extinguished but later reappear.

Apparently, wildfire activities are interest- or hobby-driven in nature, as Engeström (2009) posited that these activities show remarkable sustainability and expansion where the actors (learners) are constantly learning to overcome the constraints and hindrances, often without much centralised effort. According to him, "Transformative learning is not imposed upon the participants, but built into the very operating principles and everyday social textures of these activities" (2009, p. 5).

Two key concepts of wildfire activities are trail and stabilisation. People move around in territories and leave trails, i.e., markings of the environment. In the era of Web 2.0, the trails left by people may come in the form of social media postings pertaining to their experiences in interacting with the environment along their experiential/learning journeys. When multiple trails are marked by different actors (or learners), it forms a network of cognitive trails. The trails are then "stabilised" by the actors through "the imposition of linguistic structure on experiential structure"—which means that the actors learn by (co-)constructing collective concepts that "stabilise" the trails, which may trigger restructuring of the subsequent activities. For example, upon encountering geo-tagged user-generated content while visiting a location, a visitor would feel inspired to offer their response or contribute a new item for someone else to stumble upon in the future (FitzGerald, 2012). Thus, such trails are both material, "in the world", and cognitive, "in the mind" (and being stabilised through generating and improving shareable representations of the trails) (Cussins, 1992).

Engestrom's exposition on wildfire activities may constitute a theoretical basis of a special form of seamless learning, which is situated in the informal end of the formal–informal learning spectrum, and relies heavily on social bonds in informal, largely unstructured but self-organising communities of actors/learners with similar interests, with a key focus on peer production activities. Several techno-pedagogical designs as reported in prior seamless learning literature bear a strong resemblance with such peer production activities, including the highly informal learning-oriented designs (e.g., Charitonos et al., 2012; Ogata et al., 2014; Underwood et al., 2010), or formal learning-driven but with a strong emphasis on student artefact generation activities in informal learning contexts (e.g., Anastopoulou et al., 2012; So et al., 2009; Wong, 2013; Wong et al., 2016).

In particular, from the perspective of seamless learning, the acts of "recording" and stabilisation the trails (i.e., the generation of user/learner artefacts) become the crucial means of mediating and bridging subsequent learning activities, and connecting individual and social learning. Making "bridging" happening is indeed what it takes to invoke, sustain and expand seamless learning—and even "propagate" seamless learning to fellow learners.

3.7 Free-Choice Learning

As its name suggests, free-choice learning is a learning advocate where the learner is given a large degree of freedom in determining when, where, what, why and how to learn. Falk and Dierking (1998) defined free-choice learning as voluntary, self-paced, non-sequential and reflecting learner-perceived choice and control. According to this notion, learning is conceptualised as a cumulative process of the interactions among an individual's ever-changing personal, sociocultural and physical contexts across her/his lifetime. As an effort of unpacking the contextual conditions of free-choice learning experiences, Falk and Dierking (2000, 2004) proposed the contextual model of learning, which encompasses aforementioned contexts with sets of factors under each context,

- Personal context: with the factors of (1) visit motivation and expectations; (2) prior knowledge; (3) prior experiences; (4) prior interests; (5) choice and control.
- Sociocultural context: with the factors of (6) within group social mediation; (7) mediation by others outside the immediate social group.
- Physical context: with the factors of (8) advance organisers; (9) orientation to the physical space; (10) architecture and large-scale environment; (11) design and exposure to exhibits and programs; (12) subsequent reinforcing events and experiences outside the physical space.

The conceptualisation of learning among seamless learning researchers, in particular the concepts of "bridging" and "recontextualisaion", indeed strongly resembles Falk and Dierking's (2000), who argued that "people do not learn things in one moment in time, but over time" (p. 10), and "learning is constructed over time; as the individual moves within his or her sociocultural and physical world … meaning is built up, layer upon layer" (p. 11).

While the notion sounds like yet another variation of (personal or individual) autonomous learning that privileges informal learning, research in free-choice learning has instead been traditionally emphasised on studying groups of learners' perceptions on their episodic visits to non-formal learning settings such as museums, science centres, zoos and botanical gardens (e.g., Tofield, Coll, Vyle, & Bolstad, 2003; Yang & Chen, 2015), or their learning behaviours during the visits (e.g., Bamberger & Tal, 2006; Mortensen & Smart, 2007). Thus, the relevant studies and the implications or recommendations arisen from those seem to be more site—(e.g., how museum learning should be redesigned or reformed) than individual learner-oriented. Furthermore, the potential roles of ICT in facilitating free-choice learning are hardly investigated in free-choice learning research—recent exceptions are explorations of mobile and wireless technologies for in situ free-choice learning (Aguayo & Eames, 2017; Tesoriero, Fardoun, Awada, & Raisinghani, 2018).

Conversely, the research in seamless learning has been more holistic—with studies in both pedagogical (e.g., curricular designs adhering to the notion of facilitated seamless learning (Song, 2014; Wong & Looi, 2018)) and cultural (e.g., case studies on individual seamless learners (Panke, Kohls, & Gaise, 2017; Toh, So, Seow, & Chen, 2017)) perspectives being conducted.

3.8 Third Space Learning

Various earlier publications on education and learning (e.g., Brooke et al., 2005; McLaughlin & Mills, 2008; Skerrett, 2010) coined the term "third space" to describe the learning space where the first (formal school settings) and the second (where informal learning may take place—museums, parks, home, etc.) spaces intersect. Gutiérrez (2008) further postulated third space as a discursive construct involving conversations and interactions among teachers and students during the learning process. Thus, despite of nuances in the positionings among various literature, the term "third spaces" typically refers to social learning settings beyond classroom, either online or physical, to bridge the students' formal and informal learning endeavours.

Lately, Schuck, Kearney and Burden (2017) seek to "build on and expand on this notion of using mobile technologies to support "seamless learning" with the construct of m-learning in the Third Space" (p. 125). They defined the third space as "an emergent shared space, providing an opportunity to develop contemporary learning skills and knowledges, a space that extends beyond traditional, institutional learning with rigid, temporal schedules to also include the spaces of more spontaneous, often incidental learning, unconstrained by classroom walls and set schedules, and sometimes free from teachers and prescribed curricula" (p. 123). The new definition foregrounds extending (not excluding) curriculum-driven activities to learning in informal settings or student-initiated informal learning. The definition seems to depart from the earlier conceptualisation which was social learning-focused—though the key characterisation of the third space is that it is "an emergent shared space", which implies potential social interactions and negotiation of meanings. Notwithstanding, the new conceptualisation seems to see the formal, third and informal spaces as three discrete learning spaces (i.e., an extension of the traditional dichotomous view of formal and informal spaces), which differs from the formal–informal continuum view of seamless learning (Wong & Looi, 2011).

Unlike the more recent reconceptualisation of seamless learning that sees it as a learning notion on its own, with or without (or: in and out of) technological supports Wong (2015), Schuck et al. (2017) considered mobile technologies as the key enabler of third space learning. The technologies afford and mediate the flow of learning, information, ideas and concepts among contexts, resulting in boundary crossing. In addition, Schuck et al. (2017) embraced the notion of learner-generated spaces (as a special form of third space) and called for "recognising opportunities for and even anticipating contexts that may elicit incidental, spontaneous learning interactions; and also planning for pre- and post-episodic asynchronous learning conversations" (p. 128)—an advocate that echoes Wong (2013) and Wong, Chen, and Jan's (2012) postulation of learner-generated contexts within seamless learning settings.

4 Well-Known Learning Approaches Go Seamless

Apart from dialoguing with the conceptual "neighbours", another potentially inspirational aspect on the advancement of seamless learning is to review how seamless learning has been applied to or hybridising with extant learning approaches. The studies in seamless learning in the past decade have manifested the versatility of the learning notion in adapting otherwise predominantly single-context learning designs for greater holisticality and flexibility. In this section, we will focus on examining the mechanisms, the values and (if any) the caveats of such "seamless-ised" learning designs as reported in the existing literature.

4.1 Seamless Flipped Learning

Teaching professionals often have difficulty in distinguishing blended learning, flipped classrooms and flipped learning, as all of them are learning approaches that involve both online and face-to-face learning activities. According to Pappas (2016), in blended learning, both the technology and face-to-face instruction are used alongside and complement each other (e.g., online materials do not take the place of face-to-face instruction); in flipped classroom or flipped learning, there is a clear divide between the technology and face-to-face elements of the learning experience. In particular, in the "orthodox" sense of flipped classrooms (see Bergmann & Sams, 2012), a learner is asked to watch the teacher's video-recorded lecture possibly accompanied with other learning materials before coming to class. That saves the time for in-class content delivery and the teacher may instead facilitate student discussions or practice to apply the knowledge or clarify misconceptions.

Flipped learning constitutes a more sophisticated view of flipped classrooms where the four pillars of F-L-I-P must be incorporated (flexible environment, learning culture, intentional content, professional educator). In particular, the "F" refers to educators' incorporation of a variety of learning modes, rearrangement of physical learning spaces that support either group or independent studies, and accommodation of students' choices of where and when to learn.

Building on the renewed conceptualisation, Hwang, Lai, and Wang (2015) developed a mobile-assisted seamless flipped learning model that makes use of mobile and wireless communication technologies to seamlessly connect learning activities at home, in-class and in-field (Fig. 2). In this model, Hwang et al. (2015) proposed various activity types either taking place within a single context (e.g., in-class peer assessment) or across two contexts (e.g., problem-based learning across the classroom and the field, or issue-quest learning across the classroom and home).

Thus, the seamless flipped learning model (and perhaps flipped learning in general, given its requirement of "flexible environment") marks a significant departure from how the original flipped classroom approach was intended and specified. The original flipped classroom approach bears the nature of teacher-designed learning

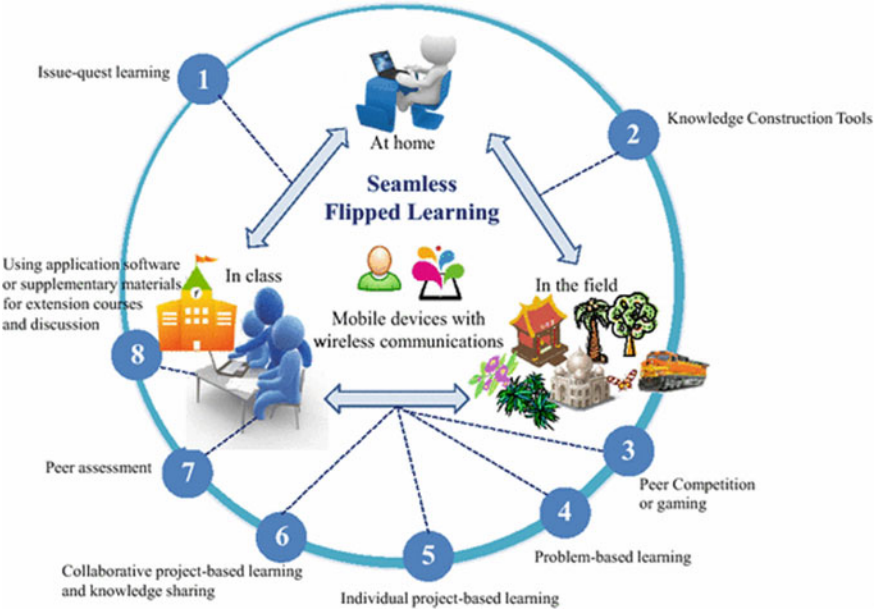

Fig. 2 Seamless flipped learning (*Source* Hwang et al., 2015, p. 456)

trajectory throughout—including the classroom activities which are supposedly student-centred and yet must be designed and facilitated by the teacher (blended learning bears a similar nature). On the contrary, seamless flipped learning allows out-of-school emergent, apart from planned learning. Furthermore, seamless flipped learning advocates the use of technologies across all settings, which defies the flipped classroom prescription of "clear divide between technology and face-to-face elements of the learning experience". Thus, in a sense, seamless flipped learning is conceptually "big seamless" but "small flipped". On the other hand, the model is perhaps a demonstration of how flipped learning may be subsumed into the designs seamless learning journeys, or how the more generic, flexible notion of seamless learning may enrich a flipped learning design.

4.2 Seamless Knowledge Building

Some technology-enhanced learning literature has been using the term "knowledge building" loosely in characterising the general constructivist learning activities involved in the reported techno-pedagogical designs. Instead, the notion of knowledge building (KB) developed by Scardamalia and Bereiter (Scardamalia & Bereiter, 2006) refers to the creation, testing and improvement of conceptual artefacts (or "ideas") (Bereiter & Scardamalia, 2003) within a community of learners. What

distinguishes KB from other constructivist pedagogies is the creation of original, progressive public knowledge, with an "out-in-the-world" character (Burden, 2017). A "genuine" KB learning environment should uphold a Popperian epistemology, namely ideas are improvable by means of a public discourse of scrutiny, testing and modification (Popper, 1972) and implement most of the twelve principles of KB identified by Scardamalia (2002).

Activities within a KB community may either take place solely on online forums, or switch between in-class and online interactions. The latter setting is particularly demonstrating a seamless learning-like element with the bridging of face-to-face and computer-mediated communication (CMC) contexts being ensued. From the perspective of seamless learning, both contexts provide overlapping yet distinct affordances to advance the community's knowledge building "journey" in different ways. For example, Van Aalst and Chan (2012) argued that Knowledge Forum provides a more "seamless knowledge-building environment" (p. 101), which makes linkages between online and offline (in-class) discourse less artificial.

So, Tan and Tay (2012) presented a study that brought together mobile-assisted outdoor learning trails and ongoing KB with on Knowledge Forum (before, during and after the trails). In their design, a majority of student ideas were arisen from the experiential learning activities on Sentosa Island, a tourist attraction in Singapore, for learning of integrated humanities, such as through interpretations of the photos taken, tourist interviews, calculation of gradient of slopes (i.e., to practice geographic and mathematical skills), design thinking of the attractions, accessibility and amenities of Sentosa. Indeed, KB includes the building of knowledge contexts; and such student-generated artefacts offer provisional contexts, which are triggers or bases of idea generation and rise above (Bachmair & Pachler, 2015). According to the analysis in a subsequent publication by the team (So & Tan, 2014), the overall learning experience was very much adhering to the KB principles and at the same time demonstrating the salient features of cross-contextual seamless learning.

4.3 Seamless Task-Based (Language) Learning

Task-based learning (TBL), Willis (1996) is a learning approach specifically for language education. It constitutes a reverse of the traditional language teaching sequence of PPP ((teacher's) Presentation—(student's) Practice—(student's) Production) by enacting meaning-making activities (or "meaningful tasks") *before* form-focused activities (reflecting on and fixing the grammar and vocabulary usage). Skehan (1996) defined tasks as activities which have meaning in their primary focus. The meaningful tasks could be role-playing, telling a story based on a picture, negotiating for a solution to a real-world problem, etc., that utilise the target language for communication.

Willis (1996) developed a framework that defines a three-stage activity sequence—pre-task (to prepare the students for the tasks and equip them with prerequisite linguistic knowledge), task cycle and language focus. "Conventional" TBL lessons that encompass the aforementioned activity sequence are taking place within

classroom. Thus, the authenticity of the tasks (a salient feature of TBL) is indeed "simulated". On the contrary, several mobile-assisted TBL projects have broken the physical and temporal seams that confine the students within classroom lessons and brought the tasks to genuinely authentic contexts. For example, the intervention designs in various studies (e.g., Anderson, Hwang, & Hsieh, 2008; Ogata et al., 2008) that adhere to the three-stage sequence require individual students to leave their classroom and communicate with native speakers in authentic environments such as asking the way, checking the train schedule, or bargaining with a street vendor. They then bring back the audio recordings of the conversations for in-class form-focused reflection activities. Other seamless language learning designs (e.g., Liu & Chen, 2015; Wong et al., 2016) tap on Web 2.0 by facilitating students to create social media pertaining to their day-to-day encounters. Such student artefacts are then constituting the basis for further peer activities including meaning-focused socialisation and form-focused evaluations with the reply feature of the social media. In this regard, Wong, Chai, and Aw (2015) developed a seamless language learning framework that was informed by both second-language acquisition theories and TBL to guide the designs of such language learning interventions.

5 Discussion and Conclusion

In our attempts to draw comparisons with known approaches, epistemic frameworks or theorisations of learning, in the space of a chapter, the descriptions and discussions of each of them will be necessarily brief. Thus, we run this risk of providing imprecise or incomplete renditions of such learning approaches or missing their nuances. We reiterate that it is not our intention to provide superficial comparisons nor be evaluative of other approaches. Really this is an invitation to dialogue to continue the discussion to seek conceptual clarity of each approach and to derive even more insightful understandings or new perspectives if we put similar approaches in juxtapositions with each other.

In articulating the essences of each learning approach and notion, and their interrelationships, we might be able to identify opportunities for further synergistic integration. For example, the synergy between wildfire activities and third space learning implies the need to develop/distil a generic design framework for "third space" in seamless learning. Existing sets of seamless learning design principles may provide some guidance, but there is no framework specifically for this purpose. Examples of third spaces in existing seamless learning environments include the social networking space in MyCLOUD (Wong et al., 2016) and miLexicon (Underwood et al., 2010), the Knowledge Forum for in situ KB activities (So & Tan, 2014), SCROLL (Ogata et al., 2011) and Personal Inquiry platform (Anastopoulou et al., 2012).

As another example, wildfire activities and long-tail learning are conceptually overlapping with their mutual interest in advocating and studying learners' reaching out to the niche (and typically self-organised without centralised control) community of people of the same learning areas to advance their own learning. Nonetheless,

wildfire activities are well-theorised, placing a greater focus on situated learning and interacting with the living spaces, and introducing "trail" and "stabilisation" as alternative means of social learning. This is apart from explicit, intentional communication and sharing through social media contributions and discussions, in which certain seamless learning designs, have incorporated. The concepts of "trail" and "stabilisation" may also underpin the ant colony optimisation algorithms (Steels, 1991) in computer science in which the "roads" (learning pathways) more "travelled" by many learners, with good learning outcomes are identified and recommended to future learners (e.g., Pushpa, 2012; Rastegarmoghadam & Ziarati, 2017; Wong & Looi, 2009).

During the last fifty years, continuous educational and technological innovation has had profound effects on how learning is understood. Although we are trying to position seamless learning as a learning notion on its own, we must recognise that technology is a key stimulus for seamless learning to prevail. SDL, SRL and free-choice learning are learning notions/activities that are not necessarily involving technologies, but technologies are essentially playing an "enhancer" role. Blended learning and third space learning are very much the technology-driven learning notions; technology is essentially seen as "enablers". Wildfire activities and crossover learning lie somewhere in between the two types of notions in which technology has not only extended the existing learning spaces, but also afforded new learning spaces, or new layers of learning spaces to bridge existing learning spaces.

In this chapter, we also share three models of hybridising seamless learning with the approaches of flipped learning, knowledge-building and task-based language learning. Other "seamless-ised" learning approaches that were reported in the literature include seamless inquiry learning (e.g., Sharples et al., 2015; Song, 2014; Wong & Looi, 2018), seamless situated learning (e.g., Bozkurt, 2017; Zurita & Baloian, 2015), seamless experiential learning (e.g., Lai, Yang, Chen, Ho, & Chan, 2007; Song, Wong, & Looi, 2012), seamless learning in massive online open courses (MOOCs) (e.g., De Waard, Keskin, & Koutropoulos, 2014; Sharples, Delgado Kloos, Dimitriadis, Garlatti, & Specht, 2015) and seamless knowledge management underpinned by the SECI (Socialisation, Externalisation, Combination, Internalisation) model (Baloian & Zurita, 2012; Zhang & Maesako, 2009), among others.

The inclusion of seamless learning design principles brings in considerations of extending the spaces and time durations of such original learning designs. The arguments laid out in this chapter can point to seamless learning becoming a "meta-learning approach" that spans, encapsulates or extends the currently known learning approaches. From the perspective of operationalisation, we see such a meta-learning approach as a set of "heuristics", which comes in the form of seamless pedagogical design principles for guiding practitioners, or in the form of metacognitive skills for seamless learners to intentionally bridging their learning efforts across different contexts as well as self-identifying opportunities to learn within individual contexts.

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