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# What seams do we remove in mobile-assisted seamless learning? A critical review of the literature

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## ABSTRACT

Seamless learning refers to the seamless integration of the learning experiences across various dimensions including formal and informal learning contexts, individual and social learning, and physical world and cyberspace. Inspired by the exposition by Chan et al. (2006) on the seamless learning model supported by the setting of one or more mobile device per learner, this paper aims to further investigate the meaning of seamless learning and the potential ways to put it in practice. Through a thorough review of recent academic papers on mobile-assisted seamless learning (MSL), we identify ten dimensions that characterize MSL. We believe that such a framework allows us to identify research gaps in the stated area. A practitioner interested in adopting an MSL design or doing a new design can use our analysis to situate the dimensional space where the constraints or parameters of his or her design problem lie, and look at relevant design and research-based evidence of other related MSL systems to refine her own design.

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## 1. Introduction

Since the notion of seamless learning supported by 1:1 (one-mobile-device-per-learner) setting has been expounded in Chan et al. (2006), a major international synthesis of the topic, there has been a flurry of subsequent relevant discussions within the research community of mobile and ubiquitous learning. Dozens of subsequent academic papers produced by the community cited the notion, though not all of them put it into actual research studies. Chan et al. (2006) define seamless learning as a learning model where a student can learn whenever they are curious in a variety of scenarios and in which they can switch from one scenario or context (such as formal and informal learning, personal and social learning, etc.) to another easily and quickly using the personal device as a mediator. The mobile devices carried by the seamless learners could function as a “learning hub” (Looi et al., 2009) or the technological interface between learners and their learning environments (Bentley, Shegunshi, & Scannell, 2010) for experiencing or enacting seamless learning. In this paper, we refer to seamless learning mediated by 1:1 setting as *mobile-assisted seamless learning (MSL)*.

The initial notion of 1:1 refers to the ratio of one computer or one computing device to one student. According to the G1:1 (<http://www.g1to1.org/>) website, “in one-to-one (1:1) technology enhanced learning (TEL), every learner has a personal computing device that is mobile, wirelessly connected, and enables multimedia input and output.” With the availability of several computing devices within access of a student, we broaden it to mean one or more device per learner. The pervasive use of mobile devices means it is feasible to have a “1:1, 24x7” setting that provides anytime access to a learner.

The ubiquitous availability of 1:1 promotes the seamless learning notion that advocates the embodiment of learning into everyday living. The notion of seamless learning advocates, “learning anytime, anywhere” and not “learning everytime, everywhere.” We do not mean that seamless learners are *always* doing tasks and pursuing learning especially outside of school. Rather, the goal is to empower and support them to learn wherever and whenever they are stimulated to learn, and not to require them to learn every single second when they are awake.

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In this paper, after sharing our thorough review of recent academic papers on mobile-assisted seamless learning (MSL), we identify and unpack ten dimensions that characterize MSL. In turn, we will rise above these “seams to be removed” to discuss how it may inform future MSL researchers or practitioners in refining their learning designs. In short, this paper aims to unpack the connotation and the features of such a learning model, and unravel the potential ways of enacting MSL from research studies.

## 2. “Seamless learning” before Chan et al. (2006)

The term “seamless learning” did not originate from Chan et al. (2006), and it was initially used without any consideration of technology as an essential component. American College Personnel Association (1994) stresses the importance of linking students’ in-class and out-of-class (but still in-campus) experiences to create seamless learning and academic success. Kuh (1996) further elaborates the notion by extending it to involve off-campus experiences:

“The word seamless suggests that what was once believed to be separate, distinct parts (e.g., in-class and out-of-class, academic and non-academic; curricular and co-curricular, or on-campus and off-campus experiences) are now of one piece, bound together so as to appear whole or continuous. 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)

Focusing on integrating formal and informal learning, Kuh’s (1996) exposition stimulated further discussions (e.g., Bell, 2000; Seifert et al., 2008) and inspired further relevant studies (e.g., Smith & Northrop, 1998) on this learning model, though with varied emphasis. Other researchers added the dimension of learning community (e.g., MacGregor, Tinto, & Lindbald, 2001; Tinto, 1998) and the intertwining of individual and collaborative learning (e.g., Kazmer, 2005; Skop, 2008) into the notion. A common characteristic of this group of literature is that almost all of them pertain to tertiary education in context. Seamless learning for K-12 students was seriously underexplored.

## 3. Seamless learning meets WMUTE – 1:1 technology-enhanced learning (TEL)

With research in WMUTE ongoing for a decade and through rapid evolution, there is great diversity in the scholars’ and educators’ conceptual understanding and approaches to harnessing mobile and ubiquitous computing. From the literature on classifications of mobile learning, we observe a variety of classification frameworks being developed – from technical-oriented (Roschelle, 2003; Song, 2007) to learning theory-based (Naismith, Lonsdale, Vavoula, & Sharples, 2004) to that of a hybrid techno-pedagogical construct (Patten, Arnedillo-Sánchez, & Tangney, 2006).

Yu (2007) combs the development of three generations of mobile learning: the first generation focuses on transferring learning content onto mobile devices (transfer of information and behaviorism); the second generation focuses on pedagogical design (cognitivism and constructivism); and the third generation is characterized by 1:1 setting and the use of context-aware technology. Barbosa & Geyer’s (2005) view summarizes the essence of the third generation mobile learning well – it “is about increasing a learner’s capability to physically move their own learning environment as they move.” This would transform students into genuine “nomadic learners” (Brodersen, Christensen, Grønbaek, Dindler, & Sundararajah, 2005). Hence, while the first and second generation mobile learning tend to confine the learners in the formal learning (teacher- or expert-planned learning materials or activities) context, third generation mobile learning is creating the impact of stitching the learners’ formal and informal learning contexts together to lead towards seamless learning and making their learning experiences more personalized.

Indeed, ready-to-hand, perhaps  $24 \times 7$  access of light-weight mobile devices creates the potential for a new phase in the evolution of technology-enhanced learning (TEL). Chan et al. (2006) posit:

“... (The evolution) is characterized 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. 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)

Thus seamless learning could simply be characterized as “seamless flow of learning across contexts.” The basic rationale is that it is not feasible to equip students with all the skills and knowledge they need for lifelong learning solely through formal learning. Henceforth, student learning should move beyond the acquisition of content knowledge to develop the capacity to learn seamlessly (W. Chen, Seow, So, Toh, & Looi, 2010). Leung and Chan (2003), however, argue that mobile learning should become a part of the learning culture than an adjunct to it. We believe that genuine mobile-assisted seamless learning could not be taken for granted simply by assigning each learner a mobile device or by designing and enacting one-off mobile learning activities in which the designed learning processes do not go beyond the planned learning hours and venues. Learners need to be engaged in an enculturation process to transform their existing epistemological beliefs, attitudes, and methods of learning. Therefore, at the early stage of learners’ engagement in mobile devices, teachers need to model the seamless learning process by gradually and systematically incorporating mobile learning activities into the formal curriculum. In addition, teachers should encourage learners to extend their learning into the informal, out-of-school context by picking up incidentally learned knowledge, applying their knowledge in real-life, and relating back or questioning the knowledge that they learned in the formal curriculum (Wong, Chen, Looi, & Zhang, 2010).

We advocate the marriage of WMUTE and seamless learning (mediated by  $24 \times 7$  access of 1:1 setting) as mobile seamless learning or MSL in short (to distinguish it from Kuh’s (1996) more general notion of seamless learning). Subsequent literature on WMUTE learning cite different aspects of Chan et al. (2006), offer somewhat diversified and loose (re-)definitions of seamless learning (MSL in particular), and

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