Chapter 2
Mindfulness in Mobile and Ubiquitous Learning: Harnessing the Power of Attention

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Abstract Mobile and other digital technologies facilitate ubiquitous learning that offers unprecedented benefits. With mobile learners being able to "squeeze in" learning in-between other daily activities, they face contesting demands on their attention and their brain. Their learning experience might be hindered by multi-tasking, distraction, mind wandering, and even problematic dependence on digital devices. These influences are addressed in the chapter, and recommendations are presented on how to promote higher levels of attention and engagement in m-learning events. Based on the latest empirical evidence, mindfulness strategies can aid in attention regulation and cultivation of "healthier" learning habits, thus alleviating these problems amongst mobile learners. Recent discoveries in neuroscience and the renewed understanding of brain plasticity are bridging the science and practice of mindfulness. Combined with 35 years of scientific research in mindfulness, more recent exploration of the applications of mindfulness in education has demonstrated that learners can train their mind to respond to stimuli in a purposeful controlled manner leading to more successful learning. Incremental mindfulness practice tunes up our nervous system and strengthens the neuro-components that help us connect with our intentional attention capabilities. It is hence the purpose of this exploration and the resulting chapter to identify such learner-centered strategies to promote the development of mindfulness practice leading to enhanced intentional attention in mobile learning. Mobile technologies can be used to provide scaffolds for learners to engage and persist in mindful learning and practice of mindfulness. The author presents a variety of proven mindfulness practices and techniques that can be adapted in the m-learning design. She concludes with a call for more interdisciplinary studies and rigorous explorations of the intersection of mobile learning, education, instructional design, contemplative practices, cognitive science, and neuroscience to attain a better understanding of how to harness attention in mobile and ubiquitous learning.

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2.1 Introduction

With m-learning expanding beyond the use of handheld devices, and the presence
of digital information and communication becoming pervasive wherever we are
(e.g., the "Internet of Things" where things and objects, such as tags, sensors, and
mobile phones, are able to interact with one another and exchange information), it is
vital to consider how the learner can actually benefit from this ubiquitous presence
of information, and go beyond simply accessing content and successfully activate
more persistent cognitive effects to attain deeper learning. As noted by Goleman
(2013), "[w]e learn best with focused attention" (p. 16).

Mobile learning, particularly contextual m-learning, varies greatly in the context
of use, extent and time of interaction with content, ergonomics of the experience
(user posture, lighting, and background noise), social and physical context, and,
consequently, demands on users' attention (Sharples, Arnedillo-Sánchez, Milrad, &
Vavoula, 2009). Moreover, cognitive load, which has been identified as a key issue
in successful instructional design (Ozcinar, 2009), is yet another aspect that is
impacted by the content, delivery, and setting of mobile learning. In fact, envi-
ronmental interferences can lead to a learner's cognitive system being overloaded
when performing an m-learning task, thus hindering learning. Two extraneous load
inducing factors that are highly relevant to the design of mobile learning envi-
ronments are the need to *split* attention between multiple sources of information and
"the need to *pay* attention to multiple sources of information that are self-contained
and can be used without reference to each other (Liu, Lin, Tsai, & Paas, 2012;
emphasis added). Other related influences that impact the quality of learning are
multitasking, distraction, mind wandering, and problematic dependence on mobile
devices leading to potential addiction to those devices. These concepts are
explained in the chapter based on current research, and recommendations are
offered on how to promote higher levels of engagement in m-learning and increase
learner attention during m-learning events. The common theme for these behavioral
issues triggered by digital devices is the contesting demands on attention and the
brain. With mobile learners being able to "squeeze in" learning in-between other
daily activities of their busy lives, the hindrance of distracted attention may be
aggravated. Based on the latest empirical evidence, mindfulness strategies can aid
in attention regulation and cultivation of "healthier" learning habits, thus alleviating
these problems amongst mobile learners. It is hence the purpose of this exploration
to identify learner-centered strategies to promote the development of mindfulness
practice leading to enhanced intentional attention in mobile learning. Mindfulness is
viewed hereby as a continuum of attention-based self-regulatory practices culti-
vated to develop a capacity to focus intentionally on what is happening *now*.

Latest discoveries in neuroscience and the renewed understanding of brain plasticity are bridging the science and practice of mindfulness. Combined with 35 years of scientific research in mindfulness, more recent exploration of the applications of mindfulness in education has demonstrated that learners can train their mind to respond to stimuli in a purposeful controlled manner leading to more successful learning. Incremental mindfulness practice tunes up our nervous system and strengthens the neuro-components that help us connect with our intentional attention capabilities (Siegel, 2016). It helps us cultivate our presence in the moment through intention, attention (focus and monitoring), and attitude promoting self-regulation and co-regulation in our mobile learning efforts. Mobile technologies can be used to provide scaffolds for learners to engage and persist in mindful learning and practice of mindfulness. In the world filled with distractions, learners should come off their autopilot and skillfully decide when, what, and how to learn.

Drawing on research and her own mindfulness practice,[1] the author suggests strategies to improve learners' attention, active awareness, engagement, and ensuing completion of learning tasks that require sustained and undivided attention. Improved task accuracy and being more "on-task" can be achieved through mindfulness practice that reduces mind wandering and helps to stabilize and focus attention on one's present moment experience in the service of effective learning. It can help a mobile learner to focus on a task at hand even if the task setting makes the learner performance susceptible to distractions. Moreover, these mindfulness strategies can be worked into the design of mobile learning to help learners notice when they are not focused (hence not engaged cognitively) and redirect selective attention back to the current learning task.

The author introduces some evidence-grounded m-learning design recommendations and mindfulness techniques, reflecting the state of mobile learner habits and the latest technology advancements, which can be applied in future m-learning practice and research. Mobile and other digital technologies facilitate ubiquitous learning that offers unprecedented benefits. It is of utmost importance that the m-learning community provides guidelines and strategies to use these powerful tools to the benefit of the mobile learner.

2.2 Mobile and Ubiquitous Learning: Harnessing the Power of Mobile Technologies

Mobile and ubiquitous learning has proven to be able to deliver education to learners of all ages, cultures, backgrounds, and geographical location. Mobile device users can tap into most of the information collected over centuries with new

resources being added every day, including free-access courses by world leading universities, such as Harvard and MIT, so anybody can learn from the best international experts. Mobile devices are the gateway to networks and information that a decade ago was accessible merely to the privileged and only a fraction of which was available digitally. Digital resources and tools have now reached learners in formal face-to-face and online classrooms across the world as well as in informal contexts in which people communicate with others, access information, and acquire knowledge as part of their daily life.

Informal learning, i.e., "intentional or tacit learning in which we engage either individually or collectively without direct reliance on a teacher or externally organized curriculum" (Livingstone, 2006, p. 204), is an integral part of our life and for millions of underprivileged people—the only available form of learning. For many, learning with mobile devices opens doors to equity and welfare through mobile access to resources, advice, aid, and supports that never used to be available prior to the mobile learning era (Palalas, 2017). Mobile and ubiquitous learning has reached the most remote corners of the globe to offer people "transformational change founded on personal, vocational, cultural, economic, social, and civic improvement of individuals and groups" (Palalas, 2017).

The relationships between formal and informal learning, face-to-face and distance learning, tethered and mobile-technology-enabled learning have been now more dynamic than ever. The pervasive digital technologies crossed many physical and cultural barriers that were impenetrable to other educational technologies. Not only did they democratize learning but they also gave a new meaning to situated learning contextualized in authentic meaningful settings and across a variety of contexts. This unprecedented ability to move learning out of the traditional static classroom into a real, virtual, or augmented reality conducive to the target learning outcomes has been recognized as one of the key drivers of the m-learning pedagogical shift.

Mobility and flexibility of mobile learning open new possibilities of choice and personalization of learning—the learner, especially adult learner, can decide how, when, and where to connect to digital resources and how long to stay "on." At the same time, this autonomy comes with requirements of self-regulation and enhanced agency. Personal mobile technologies offer tools to adjust when to engage in learning activities and when to disconnect and enjoy a moment of silence. How do we navigate that opportunity to personalize the time and place of learning? How do we optimize our time, brain, and mind capabilities to deal with all the challenges and information that we encounter? This often requires guidance from teachers, experts, instructional designers, or policies and regulations that facilitate learning and prevent unfavorable side effects of too much choice and "noise." Digital literacy skills are essential to an effective ubiquitous learning experience, so is "attention literacy."

The magnitude of the positive aspects of mobile and ubiquitous learning is sometimes underestimated, so are the possible detrimental effects on people and their well-being. Digital technologies, including mobile technologies, upset the balance between personal and public space, private time and "open" time when we make ourselves accessible. The lines between our work, family, and "me time" become blurred. Traxler (2016) observes that "digital conversation now intrudes

into physical conversation, and cyberspace and phonespace now intrude into physical space, forcing new social practices and transformed etiquettes into our lives as we all attempt to manage our changed communities and the conversations within them" (pp. I–II). Our digital habits and behaviors have fundamentally changed how we interact with others and how and when we transition from our personal space to interactional space. Ironically, the very same devices that were invented to connect us can make us feel less connected and less present in the moment and with the people around us. Technological advancements, like many other inventions, can be double-edged swords that, on the one hand, solve problems and, on the other, create new ones. Fortunately, solid digital literacy and "attention literacy" skills can help the mobile learner steer away from most of the detrimental consequences of the overwhelming digital noise.

2.3 "Digitally Overwhelmed"

A study led by Nottingham Trent University (Andrews, Ellis, Shaw, & Piwek, 2015) estimated that the average person (age 18 to 33) checks their device 85 times a day with a total of five hours browsing the web and using apps, which equates to around a third of a person's waking time. Moreover, the actual mobile device usage is twice as much as the participants self-reported. Statista (2015) recorded even a higher number with users checking their phone on average more than 150 times a day. In 2015, the number of emails sent and received daily totaled over 205 billion; this figure is expected to increase to over 246 billion by the end of 2019 (The Radicati Group, Inc., 2015). People who check their email repetitively throughout the day tend to access their email via mobile devices. The constant inflow of emails, updates, and information can distract and overwhelm us. With mobile access to an endless choice of entertainment, communication, and information resources, the temptation to check in with the virtual space is unceasing. All that information at our fingertips can make it difficult for us to concentrate. For mobile learners, who can connect to their learning materials and networks at any time, it can lead to stressful and unproductive learning habits unless they employ strategic, purposeful, and meaningful learning practices.

Cultivating mindful digital habits would include being able to select when to turn the device off. If incessantly plugged-in, one might not be spending sufficient time in the physical company of other people and himself or herself. We are rarely alone with just our thoughts and when we are, thoughts rush through our head jumping from judgments about past actions to planning for future tasks. When we drive, walk, sit on the bus, wait in a lineup, or even "enjoy" a family dinner, hardly ever are we present and fully engaged in the moment. Instead, feeling overwhelmed by the pace and responsibilities of daily life, we plan next steps or reach for the mobile to send off yet another email in an attempt to shorten the to-do list. People now experience much higher levels of stress, which is yet another reason why mindfulness, the practice of being aware of one's thoughts, physical sensations, and

surroundings, has been progressively becoming a very popular movement in the western world (Wallace, 2006).

Before considering these mindfulness strategies, the next four sections take a closer look at the need to leverage self-regulation skills to extract valid and useful information.

2.4 Information Overload

The sheer amount of information we are exposed to may hinder our ability to select and process any of those resources. This may cause stress and an inability to choose valid information and make decisions. This is not a new dilemma, though. According to Weinberger (2014), the concept of information overload was first introduced to the general public by Alvin Toffler in his 1970 book *Future Shock* citing research demonstrating that too much information can hurt the ability to think. When the brain is buffeted by information, appropriate filtering strategies should be applied to distill what is valid, useful, and relevant to us (Weinberger, 2014).

These sentiments can be traced back further. Ever since the introduction of Gutenberg's printing press in the mid-fifteenth century, people have been complaining about information overload. In the Renaissance, as a result of the growing popularity of technology of printing and an ever-increasing number of recovered texts of ancient authors as well as works of modern authors, "there was an over-abundance of works to be read and referred to in the cycle of textual commentary across all fields of study" (Blair, 2000, p. 69), causing objections to the consequential information overload. In 1685, French scholar Adrien Baillet lamented:

> We have reason to fear that the multitude of books which grows every day in a prodigious fashion will make the following centuries fall into a state as barbarous as that of the centuries that followed the fall of the Roman Empire. Unless we try to prevent this danger by separating those books that which we must throw or leave in oblivion from those that one should save and, within the latter, between the parts that are useful and those which are not. (Blair, 2000, p. 70)

Nowadays, due to the digital revolution, this problem is exponentially larger. Hence, the ability to distill what information is valid and worthwhile is more critical. In 2010, former Google CEO, Eric Schmidt, pointed out that we created as much information in two days in 2010 as we did from the dawn of man through 2003 (Siegler, 2010). Six years later, in 2016, according to IBM (2016), 2.5 quintillion bytes of data are generated every day with 90% of the data in the world today being created in the last two years alone. These data come from everywhere, including posts to social media sites, digital pictures and videos, purchase transaction records, cell phone GPS signals, and communication records just to name a few. Hilbert and López (2011) reported that we received five times as much information every day as we did in 1986. The capacity to process all this information with computers has doubled every 18 months and with telecommunication devices—every two years. While we are far from the saturation point and nowhere

near the mind-boggling amount of information contained in the natural world, natural world remains fairly constant; "in contrast to natural information processing, the world's technological information processing capacities are quickly growing at clearly exponential rates" (Hilbert & López, 2011, p. 64). We should be spending less time-consuming information, often irrelevant facts and fake news, and more time creating new understanding, new skills, and new knowledge. Devoid of "attention literacy" skills, learners are exposed to a range of distractions as highlighted in the next section.

2.5 Distraction

Distraction and chronic distractibility, splitting our focus between digital information and the real-life context we are in, and between the present moment and thoughts about the next one, have become the norm in the twenty-first century (Goleman, 2006). Distraction can be internal or external, habitual or unanticipated, frustrating or welcomed. Distraction might be appealing as it activates the brain and draws on the brain's attraction to novelty (Bunzeck & Düzel, 2006; Willis, 2006). It also feeds into our misconception that, when we are involved in more than one action simultaneously, we "cover more ground" and get more done, or at least more checked off our to-do list. When we are switching between the article we are reading on our iPad, a Facebook page opened in the background to add a "Like," and an email notification that popped up, we might be deceived by the erroneous perception of autonomy, freedom of choice, and control that the device offers. In fact, we might not be aware of the havoc that this behavior plays with our brain and our cognitive capabilities. The constant distraction an agitation of the mind leads to exhaustion and brain burnout (Willis, 2006). We cannot focus enough to produce any in-depth reflection, creative ideas, or engagement in learning. Lack of attention and mind wandering can interfere with learning and academic success (Morrison, Goolsarran, Rogers, & Jha, 2014). Mind wandering and off-task thinking are linked to diminished cognitive performance (McVay & Kane, 2012; Smallwood, Fishman, & Schooler, 2007). Mind wandering or "stimulus-independent thought," albeit the brain's default mode of operation (Killingsworth & Gilbert, 2010), can be particularly problematic in contexts where sustained attention to content and interaction are hindered by external information and distractors, as well as internal thoughts and emotions. We have to find solutions to the distractions, avoiding mindless and passive entertainment.

The mobile learner needs to engage in active learning activities with awareness and skills that have not previously been appreciated or associated with m-learning. Mindfulness and meaning are key to learning with focus, self-control, presence, engagement, intention, and patience so that one can harness the cognitive, processing, and creative powers of the brain. Learners should cultivate the qualities of self-awareness and self-regulation so that they can manage their mobile device usage leading to ubiquitous learning that is controlled by the learner and not by the compulsion to check in with the digital space.

The irony is that many companies creating the hardware and software that are gateways to the digital distraction are actively involved in practices of mindfulness that, amongst other benefits, aim at quieting the mind. Representatives from Google, Facebook, Apple, Twitter, eBay, and many Silicon Valley companies engage in individual and professional mindfulness practices (e.g., mindfulness training for approximately 5200 employees at Google) on a daily basis to introduce and maintain a healthy balance between the personal and digital space in our lives. One can meet them, for instance, at Wisdom 2.0, the international conference that aims to tackle the challenge of the twenty-first century to "not only live connected to one another through technology, but to do so in ways that are beneficial to our own well-being, effective in our work, and useful to the world" (Wisdom 2.0, 2016). Thanks to the ever-growing interest in the well-being of the digital technology user, more empirical studies are available to inform the mobile educational landscape. Some relevant studies on multitasking are presented below.

2.6 Multitasking and Continuous Partial Attention

Closely related to the issue of distraction and lack of focus on the task at hand is the tendency to multitask. It is the overcommitted schedules of learners that frequently drive much of their multitasking. Multitasking is also emotionally gratifying as is checking our Facebook status (Houlihan & Brewer, 2016; Wang & Tchernev, 2012). There is scientific evidence that multitasking, performing certain tasks simultaneously, is problematic (Bowman, Levine, Waite, & Gendron, 2010; Wallace, 2006). Accordingly, the brain is not capable of performing more than one task at a time and it switches back and forth between the tasks at hand. The more tasks we are trying to embrace, the faster the brain jumps between them (Jackson, 2012)—it is rapidly toggling between tasks rather than simultaneous processing them or multiprocessing. What might appear as multitasking is actually task switching with great rapidity which stresses our brain and makes it difficult to properly complete any single task. The brain requires time to switch back to the suspended task and refocus on it. In short, multitasking is ineffective as the quality of awareness allocated to each task is reduced. The consequential "experience of attending to multiple things at once is an illusion" (Wallace, 2006, p. 38).

Wallace (2006) in his exploration of how meditation can deepen the human capacity for sustained concentration aptly concludes that:

> The practice of focused attention is essentially "non-multi-tasking". It's learning how to channel the stream of awareness where we wish, for as long as we wish, without it compulsively becoming fragmented and thrown into disarray. (p. 38)

Likewise, related studies in the educational setting show that in order to achieve high performance, creative work, and effectiveness in learning, it is recommended to focus on a single task instead of feeding into our distractibility through multitasking. According to Fried (2008), frequent multitaskers reported paying less

attention to lectures and their academic performance was inferior to other students in the class. Moreover, Bowman et al. (2010) cited multiple cognitive studies and research of attention (e.g., Broadbent, 1958; Deutsch & Deutsch, 1963; Kahneman, 1973; Pashler, Johnston, & Ruthruff, 2001; Treisman, 1960) and concluded that competing cognitive tasks affected performance and that "attentional capacities are limited and that dividing attention among one or more different tasks leads to decrements in performance" (p. 928). While the mechanism of multitasking, task switching, and the degree of distraction depend on the type of activities, researchers agree that paying attention to more than one learning task interferes with academic performance and "multitasking has been found to interfere with both length of time needed to complete a task and comprehension and memory for material learned" (p. 928). Students may think they accomplish more by multitasking; however, the findings by Bowman et al. (2010) suggest that the multitasking students, in fact, need more time to achieve the same level of performance on an academic task. Chen and Yan (2016), in their extensive review of literature on the influence of mobile phone multitasking on academic performance, conclude that further research is needed to fully understand the mobile phone multitasking phenomenon and to help learners develop skills necessary to prevent potential distractions.

This discussion would not be complete without reference to the notion of continuous partial attention (CPA), a phrase coined in 1998 by Linda Stone, a former manager of Apple and Microsoft. CPA refers to a behavioral approach to managing information when interacting with digital technologies and interfaces (Stone, 2006). Johnson (2004) posits that CPA "involves synthesizing superficially the data obtained, collecting the related information and going on with the following data flow" (p. 59). Similarly, Firat (2013a, 2013b) views CPA as constant fragmented attention motivated not by productivity but by the desire to be connected. He interprets CPA as "trying to follow and deal with everything while, in fact, failing to focus on anything." Stone (2006) further commented that our attention patterns shift in order to stay on top of everything and to superficially scan everything for opportunities to move our attention to some activity or person that could be potentially more important or make us feel more alive; but ironically, the selected object is not going to receive our full attention either. Stone posed fundamental questions of how people pay attention to things, to each other, and how the new technologies have affected our attention. She concluded that "In a world of interconnected communities and constant background noise, the overriding question is: what do we really need, and what do we need to pay attention to?"

There is a growing body of research examining what types of discrete tasks can be completed simultaneously and how to combine them to enhance learning, for instance, by not mixing attentional modes, i.e., reading an article while listening to a conversation. If we can drive a car and listen to the music at the same time and we can stroll in the park and listen to a podcast, why can we not switch between tasks in a skillful way in the m-learning context? Could learners be using their divided attention productively to look up information on their mobiles during a class lecture or to engage in a back-channel discussion about the lecture via Twitter? These and

similar questions still need to be researched to inform our understanding of what comprises the "attention literacy" skills.

Concluding, our attentional capacities are not infinite. Although we may not have to always being narrowly focused on one task, we should not try to use attention concurrently for two incompatible tasks. More importantly, we should never let our digital devices control when and to what we dedicate our time, emotional, social, and cognitive resources. These learning strategy decisions should be mindful actions promoted by a trained attentive mind.

2.7 Addiction to Cell Phone

The results of a study with 2000 participants, sponsored by Microsoft Canada (2015), revealed the new adult attention span to be in 2013, on average, eight seconds compared to 12-second attention span in 2000. The more people reported reliance on their electronic devices, the less they were able to sustain their attention. Dependence on their smartphones negatively affected their cognitive load and their ability to concentrate.

The brain can be addicted to the cell phone the same way it becomes dependent on substances. The same reward pathways are observed in dependence on the mobile phone as in any other addiction (Houlihan & Brewer, 2016). According to the authors, neuroscience and the increasing understanding of brain function have "partially illuminated what common neurological features underlie seemingly disparate behaviors such as cocaine use, romantic infatuation, … posting selfies to Facebook," and checking one's cell phone when they become objects of addiction (p. 192). Dopamine can be released whenever new information or a "Like" on Facebook and Twitter is received, following the same addiction processes in our brain as when under the influence of drugs. The inherent drive of the human brain to be connected and receive new information (Siegel, 2016) fuels our tendencies to regularly check our phones in the fear that we are going to miss out on something important. That fear residing in the back of our mind can lead to anxiety and unnecessary preoccupation with the device in our pocket and with the information it can deliver (often trivial and invalid data). Much too frequently, such behavior may cause distraction, restlessness, and even compulsive habits.

Leung and Liang (2015) examined the literature pertaining to problematic use of mobile phones (including the often interchangeable concepts of mobile phone addiction, mobile phone dependency, and pathological or maladaptive mobile phone use) and possible behavioral health issues related to it. They observed that "adolescents and young users are becoming increasingly dependent, or "addicted," to this technology, not only for interpersonal communication but also as a way of "seeking gratification, searching for information, entertainment, relaxation, passing time, picture and video taking, and expressing status and identity…" (p. 640). The authors provided an overview of the existing models for assessing mobile phone addiction and observed that these were similar to other technological addiction

scales derived from empirical studies. They listed common predictors of mobile phone addiction emphasizing the relationship between personality traits and problematic mobile phone use. Accordingly, the most prominent of those predictors are the following psychosocial factors: self-esteem, loneliness, shyness, leisure boredom (too much time, too little to do), and self-control. The authors offered a definition of mobile phone addiction: "addictive mobile phone use can be considered an impulse control disorder that does not involve intoxicants and is similar to pathological gambling" (p. 642) and cautioned the reader to distinguish between the addicted mobile phone user and habitual or heavy user. They continued that based on a study by Bianchi and Phillips (2005) the following are key signs of mobile phone addiction suffered by millions of mobile phone addicts:

– over-preoccupation with the phone (e.g., becoming worried when out of cellular range for a period of time);
– a need to use the phone for increasing amounts of time to achieve satisfaction;
– repeated and unsuccessful attempts to control, reduce, or stop using the phone;
– feeling lost, agitated, moody, irritable, or depressed, when attempting to decrease mobile phone use;
– staying on the mobile longer than initially intended;
– hiding from family, friends, and others to conceal the extent of the mobile device use;
– using the mobile phone as an escape from problems and dysphoric moods (e.g., feelings of isolation, anxiety, loneliness, and depression).

There is a debate about how increased mobile phone use may negatively impact student academic performance, mental health, and even well-being and happiness. Some studies suggest that excessive and inappropriate cell phone use may negatively influence users' health and behavior. For instance, Lepp, Barkley, and Karpinski (2014) observed that in a large sample of college students, cell phone use/texting was "negatively related to GPA and positively related to anxiety" (p. 343). These corroborate the findings discussed in the previous section and highlight the necessity to cultivate digital and attention skills which will help learners self-regulate how they distribute their attentional resources.

2.8 Attention Literacy Strategies

Wallace (2006) observes that the mind is prone to attention deficit and hyperactivity leading to imbalances in our mind and little control over attention. He continues that the ability to voluntarily sustain attention on a chosen topic, activity, or object is indispensable and that the faculty of attention can be trained. Drawing from the discussion of potential culprits challenging mobile learners and research on mindfulness in education, guidelines for the development of the essential "attention literacy" skills are proposed. This discussion is a mere prelude to a much broader

conversation that is needed amongst mobile learning researchers and other related fields of science.

Mobile learners of the digital era have to be able to self-regulate their ubiquitous learning habits, and they have to pay attention to learning tasks consistently and mindfully, even when on-the-go, and often for stretched periods of time. While ubiquitous learning may rely on chunked-up information and learning tasks spread over multiple episodes and activities, occasionally the learner needs to concentrate on one task for a lengthier period of time. In many cases, that information that could be delivered in smaller chunks eventually has to be synthesized and critically reflected on for new knowledge to be effectively constructed. How long the learner needs to spend interacting with the mobile device depends on many factors, but it could be as brief as merely looking up a date in a performance support event or a two-hour location-based biology scavenger hunt activity in a grade 5 science field trip. In case of training new skills, sustained practice, persistence, and engagement are also indispensable elements; hence, dedicated temporal and location prerequisites need to be worked into the design of learning. It is a fallacy, then, that mobile learning equates to squeezing short episodes of information lookup whenever and wherever the learner happens to be. Mobile learning, particularly formal m-learning, like any other approach to learning, requires rigorous planning, strategy, and careful instructional design underpinned by sound pedagogy and methodology. The following section offers an example of how one aspect of ubiquitous learning, namely contextual learning can be enhanced with elements of attentional strategies.

2.8.1 Contextual Mobile and Ubiquitous Learning— Harnessing the Context

The untethered context in which learners find themselves—a key unique feature of ubiquitous learning, can serve as an enabler and supporter of learning or a distractor that contributes to the learner's feeling of being lost in the avalanche of stimuli and overwhelmed by the noise of information. The context of learning contributes to the learning process and outcomes on more than one level. Mobile technologies can be leveraged to situate learning in specific meaningful settings "at this time, in this place" (Parsons, 2014, p. 219) to offer contextualized or situated learning. In the resulting location-dependent m-learning tasks, for instance, a science scavenger hunt, it is the information embedded in the environment that is an indispensable learning resource with which students have to interact in order to create new understanding. In location-independent learning events, on the other hand, the time and place of learning may be entirely flexible (e.g., reading or posting comments in an online discussion). However, the time, place, and the circumstance of the context are never inconsequential to the learning activity at hand. Can the learner benefit from listening to a Chinese language pronunciation podcast while in a noisy

marketplace? Can she fully engage with her classmates' posts and formulate an insightful reply when the iPad she is using bombards her every two minutes with notifications of Facebook posts and work emails? Can the learner dictate his notes through the mobile phone recorder in the midst of a face-to-face lecture as he would while reading an article at home? The answers to these questions are multifaceted and go beyond what is appropriate and conducive to learning.

The world around us is "knowledgeable" and, if we are paying attention and engaging with the selected valid information, each moment can bring new input for learning. When mobile learners interact with the environment around them in an attentive manner, they can more effectively notice and process information.

Hoven and Palalas (2016) posit, in their discussion of Ecological Constructivism, "that *humans learn from both* perceiving, interpreting, reacting to and acting upon affordances in the environment, *as well as* using these same processes in learning from and through interactions with others, in mutually inter-dependent and co-creative ways" (pp. 126–127). The authors continue that perception is the first step the learner must take to act upon an affordance in the environment. The learner then becomes aware of the presence of the affordance—notices it (step 2). He or she can respond to it initially through senses, then emotionally, cognitively, socially, or spiritually.[2] When the learner becomes aware of some usefulness of the element in the context to learning (step 3: awareness), she or he can react to it by taking action (step 4), such as acting upon it, integrating it into their schema of knowledge of the world, or even ignoring it.

For the first step of perceiving to occur, one has to pay full attention and be ready to engage with the information offered by the location, people, and other sources, not excluding digital technology. While in pre-planned location-dependent learning episodes, learners can be directed and pointed to the source using QR codes, reminders, and questions, in more ad hoc learnable moments, when learners spontaneously reach for the support of their m-learning device, their learning can be scaffolded by reminders to pause, take a breath and notice or reflect on their prior knowledge (discussed in more detail later).

Mobile learners often use their devices to connect to the source of information (e.g., communicate with peers, listen to podcasts, look up the meaning of a word), to capture data for future reference (e.g., record a video of a procedure, take notes, snap a photo of rare species), as well as to share information, artifacts, and ideas (e.g., share, through Twitter, resources related to a lecture in which they are participating or comment on a research article in an online class discussion). Regardless of whether they use their devices for immediate feedback or delayed spaced learning, ubiquitous learners should be reminded by external (facilitators or built-in supports) and internal (attention and awareness skills) guidelines to create

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[2]"Spiritually" refers here to "human responses at a deep level, when elements of the environment resonate with a person's beliefs, values, or experience and their *sense of being* in the environment. This is not based on any religious worldview (though it may be), but rather on their perception of who they are and their capacities, capabilities, responsibilities, and potential within the world around them, and in which they move, live, and learn. " (Hoven & Palalas, 2016, p. 124).

m-learning contexts conducive to learning. Context is "continually created by people in interaction with other people, with their surroundings and with everyday tools" (Kukulska-Hulme, Sharples, Milrad, Arnedillo-Sánchez, & Giasemi, 2011, p. 159). This interaction has to connect learners' internal and external worlds as they intentionally and knowingly transition from their own sensory, emotional, cognitive, and spiritual reflexive spaces to the external world of communication and interaction with others and with information. Being able to connect with oneself, with others, and the surroundings in a meaningful way is one of many benefits observed in research on mindfulness in education as discussed next.

2.8.2   Mindfulness in Education

According to Morrison et al. (2014), "Mindfulness is a mental mode characterized by attention to present moment experience without conceptual elaboration or reactivity." Definitions vary, but essentially, mindfulness is about awareness and giving full attention to the present moment, on purpose, non-judgmentally (Kabat-Zinn, 1994). It means approaching each moment with openness and presence in a way that allows one to pay attention to what is unfolding both internally and in the environment. Wallace (2006) defines mindfulness as "attending continuously to a familiar object, without forgetfulness or distraction" (p. 13). Rechtschaffen (2014), when discussing mindful education, observes that "Mindfulness invites us back to the preciousness of the present moment" (p. 7). David and Sheth (2009), in her book on mindful teaching, concludes that mindfulness promotes a learning community "in which students flourish academically, emotionally, and socially (p. 1)."

Mindfulness falls under the umbrella of contemplative science—the study of the mind–brain connection through techniques such as art, dance, meditation, prayer, yoga, and walking in nature. The unifying goal of these contemplative practices is to develop awareness of present moment experience—to have one's mind present with one's body rather than in a future or past state (Miller, 2013). Contemplative practices, such as meditation and yoga, "train skills by placing some constraint or imposing some discipline on a normally unregulated mental or physical habit" (Davidson et al., 2012, p. 147) and effect psychological functions, such as attention and emotion regulation, which overtime alter neuronal processes and result in structural and functional changes in the brain displayed by measurable behavioral outcomes. Such contemplative teaching and learning practices may include deep listening, storytelling, dialogue, establishing a personal space, quieting the mind, centering, visualization, and many other techniques presented, for instance, in books by Barbezat and Bush (2014) as well as David and Sheth (2009).

Mindfulness is an essential practice for education as it "opens the mind and gives space for new understanding" (Barbezat & Bush, 2014, p. 98). Mindfulness can be cultivated through meditation, the practice of paying attention to the present moment, in combination with other self-regulation techniques. Meditative inquiry traditions, which stem from classical Eastern contemplative heritage, have made

unique advances in the area of attentional development (Wallace, 2006) and how to adopt them into the twenty-first-century life. Attention and awareness are dynamic; therefore, one can develop them overtime through systematic practice (David & Sheth, 2009). One can cultivate the ability to remain focused, notice when the mind wanders, and refocus at will after an interruption or distraction. Attentional training methods based on meditation, for instance, are accessible to anybody and can benefit those who engage in them through regular drills, repetition, and habituation (Wallace, 2006, p. 4). While mindfulness is an ancient practice with roots in different philosophies and traditions, it has now been adopted globally and is a widely used contemplative exercise. Importantly for educators, it has been extensively researched and is backed by over two decades of empirical evidence with more pertinent scientific research emerging every day.

While mindfulness might be readily criticized, the science supporting it is quite persuasive. Individuals who engage in mindfulness practice demonstrate reduced anxiety and depression (Hofmann, Sawyer, Witt, & Oh, 2010; Hölzel et al., 2013), lower stress (Baer, 2003; Creswell et al., 2016), richer and more positive personal relationships (Carson, Carson, Gil, & Baucom, 2004; Coatsworth, Duncan, Greenberg, & Nix, 2010), and increased self-regulation (Tang et al., 2007). Most importantly, benefits of cultivating mindfulness also include improved attention skills (Becerra, Dandrade, & Harms, 2016; Jha, Krompinger, & Baime, 2007; Sedlmeier et al., 2012), adults' ability to regulate attention and executive function (mental operations that involve attentional and cognitive control, planning, and working memory), including "orienting attention and monitoring conflict (Jha, Krompinger, & Baime, 2007) and inhibiting emotionally charged but irrelevant information (Ortner, Kilner, & Zelazo, 2007)" (Davidson et al., 2012, p. 148). Recently, there has been a growing body of evidence that students who engage in mindfulness practice perform better academically, even in mathematics (Schonert-Reichl et al., 2015). David and Sheth (2009) compiled a list of ten key benefits of mindfulness for students, including the following: mindfulness promotes (1) readiness to learn, (2) academic performance, (3) attentions and concentration, (4) self-reflection and self-calming, (5) social and emotional learning, (6) pro-social behaviors and healthy relationships, (7) holistic well-being; it also (8) reduces anxiety before testing, (9) provides tools to reduce stress, and (10) improves participation by promoting impulse control (p. 9).

Research has, indeed, demonstrated that mindfulness practice can be transformative not only to our health and well-being but also to our educational system. Mindfulness practice can alter the function of the brain of the learner and actually help train the mind to, amongst other skills, pay attention in a selective and purposeful way, not get distracted by the abundance of information, and not fall victim to the problematic mobile device habits. Just like we can train our bodies through daily exercise in the gym or regular Tai Chi practice, we can train our minds to be aware and focused. Cultivating mindfulness by learning and practicing brief simple mental training techniques enhances both teaching and learning process and outcomes (David & Sheth, 2009). It is essential for learners to train their brain so it does not stray or strain.

2.8.3   Mindfulness Strategies in Mobile Learning

Regular mindfulness practice and techniques, incorporated directly into the m-learning design, can create more conducive learning environments by giving students tools for paying attention, self-regulation, learning how to learn and eliminate distractions. This section presents some key mindfulness techniques that have been scientifically proven to enhance learning across various educational contexts. Recommendations are offered on how to adopt them through mindfulness micro-moments conjoined into a larger process of mobile learner evolving into a more mindful learner.

2.8.3.1   Focusing Attention on Intention

Mindfulness is a practice of intentionally paying attention. While our attention might be pulled away from us, through our intention, we have a choice to cast it a specific direction. Where attention goes, neural firing occurs, and new connections can be made overtime shaping our brain (Siegel, 2007). Siegel (2007) observers, that "Intentions create an integrated state of priming, a gearing up of our neural system to be in the mode of that specific intention: we can be readying to receive, to sense, to focus, to behave in a certain manner" (p. 177). Intentions are rooted internally and in the now, yet they have long-term effects. They promote clarity, motivation, and more purposeful engagement. To briefly define the concept, *intention* is a mental, emotional, or attitudinal model that positions one's mind to hold a particular orientation; intention focuses attention (David & Sheth, 2009). Intentions have no expectations or evaluation attached to them. An intention can be a purpose or attitude the learner chose to actualize—a statement of how learners want to be, think, feel, engage in their learning or with others, e.g., "I want to be fully present," "I'm here to enjoy this learning activity," or "I want to complete this activity without feeling stressed or rushed."

Intentions can be incorporated into the learning design so that learners know why they are doing what they are doing and thus commit to bringing focused mind to the activity. With help of intentions, learners can uncover what motivates them, which in turn aids them in strategizing attention and applying purpose to the learning in which they are engaged. This also furthers learners' feelings of agency and ownership.

It is essential to differentiate intentions from learning goals which focus on future outcomes and expectations. Setting intentions can be achieved through simple messages prompting learners to formulate and type in their intentions or select from a list of those that learners have previously personalized, and even share their intentions with others to create gentle accountability to them. Such messages and notifications also serve as basic reminders for students to reflect, engage, and self-regulate. Another technique would be to culminate a learning event with reflection questions, as simple as "How did your intention work for you?" or, if the

intention was to stay focused on the task at hand, "Did you check any messages or emails when you were listening to the podcast?". It is through such self-reflection that students may gradually evolve into self-regulated autonomous learners. Metacognitive skills of attention and intention are the building blocks of one's mindfulness practice.

2.8.3.2 Self-regulation through Self-awareness and Reflection

The relational nature of our mind (Siegel, 2007, 2016) should be also considered in the design of learning. Related to the concept of self-regulation, which is dependent on integration in the brain (Siegel, 2016), is the need for learners to both self-regulate and co-regulate their "emotions, thoughts, attention, behavior, and relationships" (p. 82). According to Siegel (2016), studies on mindfulness provide evidence that mindfulness training integrates the brain resulting in enhanced self-regulation. Consequently, regular mindfulness practice should be combined with m-learning scaffolds that promote understanding of learners' own individual needs and preferences as well as those of others in the context of collective learning. In view of that, the increasingly popular social emotional learning (SEL) approach, which has been shown to promote emotional regulation, social competency, resiliency as well as academic performance (Rechtschaffen, 2014), should be considered in m-learning solutions. SEL supports students in developing the following five competencies: self-awareness, self-management, social awareness, relationship skills, and responsible decision making (David & Sheth, 2009; Rechtschaffen, 2014).

Drawing from the review of contemplative educational practices presented by Barbezat and Bush (2014), self-awareness, self-monitoring, and other metacognitive strategies complement holistic student development and emotional regulation leading to intellectual and experiential gains. Another significant dimension of mindfulness practice is that of meta-awareness which involves monitoring of experience including "an *introspective*, inward turn of attention and a *background* awareness of features of experience outside the current focus of attention (Lutz, Jha, Dunne, & Saron, 2015, p. 640; *emphasis added*). On a macro-level, attention to the present moment, to preferred ways of learning, coupled with the awareness of the bigger educational landscape (including larger personal and collective goals) is crucial for meaningful well-managed learning. Hence, alongside regular mindfulness-cultivating practices, learners should be encouraged to reflect on their learning through journaling; notes to themselves; opportunities to rank their preferred methods of learning, communication, and resources; or tools to block sources of distraction that they identified as their barriers to focused learning (examples of such tools are listed below). Chunking information in such a way that allows students to sort, organize, and reflect on concepts and smaller bits of information can also help them observe what elements work best for them. Another strategy would be reading reflections when learners are asked to not only extract meaning form the reading but also evaluate the reading for its relevance to their own interests and needs. Similarly, assignment reflective evaluations could facilitate

self-regulation by asking learners to consider the strategies they used for an assignment, its results, and their experience, before they reflect on what works for them and what might need adjustments. These are only a few examples of self-regulation tactics, which combined into a holistic solution, would overtime lead to heightened attention and self-regulation skills that contribute to the "attention literacy" skill set.

2.8.3.3 Meditation

The systematic mindfulness practice, referred to in the previous section, would ideally include regular meditation—the process of getting to know oneself, ones' emotions, thought patterns, and how we experience the world. Meditation is also defined as practice of intentionally paying attention to the present moment without judgment and taking control of one's mind (Kabat-Zinn, 1994). Richard Davidson (2012), based on the numerous studies he conducted on meditation and its effects on the brain and attention, observed that meditation strengthens the ability to focus. The practice of meditation has been recurrently proven to promote changes in brain activity and improve attentive and focus capacities, owing to the state of mind cultivated through the practice (Barbezat & Bush, 2014; Miller, 2013; Rechtschaffen, 2014). It increases gray matter in brain regions that handle attention, compassion, and empathy. It also alleviates a variety of medical conditions, strengthens the immune system, and improves psychological functioning (Hanson, 2009). All in all, meditation supports the development of mental, cognitive, and emotional skills that can lead to improved learning.

Numerous educational programs incorporate brief meditation practice in their design and have observed its positive effect on learning (Miller, 2013). Mobile learning solutions can easily draw on the many meditation mobile apps and online guided meditation sources available to anybody at a click of a button. Examples of meditation mobile apps identified by the author as appropriate for m-learning include Headspace[3] and Mediation Studio.[4] They offer a range of meditations and mindfulness breaks, ranging from two minutes to an hour. Learners can choose from awareness, anxiety, stress, performance, confidence, and many more focuses. These brief practices and breaks can be built into any mobile learning design. Customized guided mediations can also be designed by mindfulness practitioners for specific m-learning content and contexts. Focusing on one's breath is a good starting point for such meditation practice.

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[3]Headspace is available at https://www.headspace.com/.

[4]Meditation Studio is available at http://www.meditationstudioapp.com/.

2.8.3.4 Breath Awareness

Awareness of the breath helps to focus attention on intention. Taking pause to be aware of one's breath and reflect inward prepares learners for intentional learning. Regular practice, for only 10 min a day, can promote the development of a self-observational ability (Siegel, 2007) that results in improved self-regulation. Breath can serve as the anchor whenever one gets distracted (Rechtschaffen, 2014; Siegel, 2007) and "returning awareness gently to the breath when attention has wandered strengthens the hub and initiates the reflexive capacity to become aware of awareness" (Siegel, 2007, p. 295). The awareness of breathing can bring us into the here-and-now and ground our experience (Miller, 2013).

In an m-learning context, mindful breathing can be used to stay centered and calm amid the distracting thoughts and feelings (Rechtschaffen, 2014). Pausing to take a breath or a short Take 5: Mindful Breathing exercise[5] can help to slow down, notice, and redirect the energy of the learner (David & Sheth, 2009). Breath awareness pauses can be incorporated into podcasts, readings, m-learning activities, and even assessments by means of audio or written reminders and guided mindfulness moments.

2.8.3.5 Mindful Language and Emotional Climate

It is imperative to create a safe learning environment, based on trust and stress-free emotional climate. Stress, threat, and fear can activate affective filters in the brain that hinder information processing, patterning, and memory circuits (Willis, 2006). This requires a combination of elements and strategies and can be fostered by attitudes and messages of support, gratitude, and compassion, constructive rather than destructive feedback, as well as mindful, respectful, and relational language. Such encouraging m-learning messages may be conveyed, for instance, through communications from facilitator containing words of encouragement and guidance on mindful strategies. When discussing attention, it is beneficial to use language that inspires students and points them toward self-discovery and the subsequent development of attention skills (Rechtschaffen, 2014). With many contemplative exercises being introduced through verbal instruction, clear guidance should be offered by using language that is familiar and transparent (Barbezat & Bush, 2014). It is recommended to keep it kind, simple and concise.

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[5]Described in detail in Appendix 2 of David and Sheth's (2009) book amongst many other mindfulness activities for students and teachers.

2.8.3.6   Other Mindfulness Techniques

There are many other mindful learning strategies, discussion of which deserves a separate volume. For the sake of brevity, only some of them are summarized below.

– Incorporate a step to activate prior knowledge (Willis, 2006), connect to what has been done before, for instance, by way of mindful memory games, such as a two-minute concentration (word-matching) game at the start of a podcast to activate learners' prior knowledge of terms and concepts, and to promote attention practice.
– Promote students' readiness to learn and transition into a learning event by means of riddles and brief quizzes before embarking onto an activity (David & Sheth, 2009, p. 51).
– Remind the learner where they are in context-dependent activities and encouraged them to connect with the setting around them by using mindful seeing techniques, such as an observation technique described by David and Sheth (2009, p. 63), which also contributes to the improvement of short-term memory. Directions, guiding questions, and pointers can also be employed to support noticing and connecting to contextual affordances.
– Use "mindful moment" techniques to help learners shift their attention away from learning and toward other aspects of their present experience to calm and re-center their minds; for instance, introduce thirty seconds of silence in the middle of an activity; ask students to listen to ambient sound around them for 30 S, build in a one-minute clip of calming and inspiring music (David & Sheth, 2009).
– Prompt the learner to ensure that the conditions are conducive to learning. Reminders and directions to apply mindful listening, speaking, reading, and writing techniques[6] should be incorporated.
– Integrate music as it supports contemplative practice (Miller, 2013); well-selected music (e.g., soothing sounds and classical music) offers a calming effect as well as an opportunity to practice focus through the awareness of the sound (Barbezat & Bush, 2014). Music can also be used to inject an element of novelty and surprise (Willis, 2006).
– Incorporate tools that help block distracting sites and apps for a customized period of time and those that track and measure when the learner is doing meaningful work.

This is by no means a complete list but rather ideas to guide m-learning designers in the creation of solutions appropriate for their educational contexts. Examples of specific software and tools mentioned above are listed in the following section.

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[6]Examples and explanations of these techniques are widely available on the Internet and can also be obtained by contacting the author.

2.8.4 Harnessing Learner's Attention—Tools

As already discussed in this chapter, attention is a skill that must be learned and practiced and it will evolve overtime. There is an array of tools that can be employed to help control the digital space and promote more on-task focus. The following are examples of such applications.

– http://www.teamviz.com/pricing-plan/ (TeamViz) and https://www.focusboosterapp.com/ (focus booster)—Focus on the task and divide it into manageable working intervals with short breaks in-between.
– https://freedom.to/ (Freedom)—Block distracting sites on the Internet, social media, and apps blocker.
– https://selfcontrolapp.com/ (SelfControl)—Block your own access to distracting websites, your mail servers, or anything else on the Internet; identify what your distraction triggers are.
– https://gottcode.org/focuswriter/ (FocusWriter)—Enjoy a distraction-free writing environment by utilizing a hide-away interface.
– http://antisocial.80pct.com/ (Anti-Social)—Target and block any distracting website to be more productive.
– http://www.one-tab.com/ (*One*Tab)—Use only one tab at a time when browsing, convert your tabs to a list for future reference.
– https://www.rescuetime.com/ (RescueTime)—Understand your daily habits so you can focus and be more productive. Obtain detailed reports and data based on your activity.
– Use apps like Twitter, Flipboard, Pulse, and Zite to save artifacts directly from the browser for future read or reference offline and to minimize destruction.
– Set the buzzer on your phone to remind you to take breaks.
– Track your own phone habits with apps like Checky (http://www.checkyapp.com/) and Momentum (https://inthemoment.io/).

These and similar applications promote the development of self-regulation and self-control skills. They may be used to support the practice of "attention literacy" on the way to becoming a mindful mobile learner.

2.9 Conclusion

Smartphones and other digital devices might be viewed as technologies used to control the flow of information and our social networks or technologies of escape that tap into our need for withdrawal into a personal space. Inherently, they are neither good nor bad; they are merely tools which, if used properly, can empower and help learn and, when misused, can lead to cognitive and emotional exhaustion and even addiction. They can be a gateway to the abundance of information that functions either as noise or as invaluable input for learning. They can be a source of

distraction or, on the contrary, tools used to tame unhealthy habits of absent-mindedness and partial attention. Digital tools and online resources can be also utilized to train attention and teach mindfulness albeit without personal presence (Barbezat & Bush, 2014). As learners, we have the autonomy and choice to do the right thing. As m-learning designers, it is our responsibility to consider what attention promoting strategies to incorporate into the ubiquitous learning designs.

As demonstrated in this chapter, m-learning design can adopt simple attentional practices and mindfulness strategies that have been proven through scientific studies to support the metacognitive process of self-monitoring and self-regulation (Rechtschaffen, 2014). Mindfulness strategies, which bring about numerous other benefits for both teachers and students, can also help cultivate self-awareness and confidence, emotional intelligence and resilience in the face of stress rooted in a wide range of pressures to perform and produce in a fast-paced environment.

In conclusion, there might be nothing wrong with our minds wandering or our attention being diverted occasionally, provided that this does not turn into a habit of constant partial attention and digital interface hopping. Given the demonstrated influence of multitasking, hindered attention, and problematic dependence on digital devices, juxtaposed with the benefits of undistracted attention and mental training in learning, more interdisciplinary research should be conducted to discern what m-learning design practices can have impact on the development of "attention literacy" in ubiquitous learning. Methodologically rigorous explorations and evaluations of the intersection of mobile learning, education, instructional design, contemplative practices, cognitive science, and neuroscience may offer a clearer picture of how to harness attention in mobile and ubiquitous learning.

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