Situated Learning and Mobile Technologies: Connecting Theory to Design

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Abstract: In recent years, mobile devices have become ubiquitous across our everyday lives and are seeping into informal and formal educational settings. As a response, scholars, educators, and game designers alike have begun to explore mobile platforms as educational tools. In this paper, we hope to provide a vocabulary and framework for this exploration. Our goals are twofold: 1) to consider the design of mobile activities in terms of theories of learning, mapping mechanics on a theoretical platform, and 2) offer a framework to inform future learning design with mobile technologies. We hope this paper adds to the discussion around mobile learning in providing a broad theoretically-driven survey of the landscape.

Introduction

In recent years, mobile devices have become ubiquitous across our everyday lives and are seeping into informal and formal educational settings. Mobile technology has gained traction in education settings due to both its ubiquity and its unique affordances; its mobility allows learning to happen in more situated contexts and its portability brings digital technologies to students in classroom in a different way than desktop computers. In this paper, we explore the distinctive affordances of mobile technologies, particularly in the context of education and learning. Our goals are twofold: 1) to consider the design of mobile activities in terms of theories of learning, mapping mechanics on a theoretical platform, and 2) offer a framework to inform future learning design with mobile technologies.

Mobile learning has largely emerged from a grassroots movement in education as a reaction to the rising ubiquity of mobile technologies. As a result, there are many practical illustrations of how mobile has been used in educational settings, yet there is still a deep need to connect these cases with theory. We turn to learning sciences, sociology, anthropology, design studies, game studies, cognitive sciences, and a variety of other fields to begin to build a theoretical vocabulary around mobile technologies. Additionally, in this paper, we put forth a working framework of mobile learning to help frame understanding and design of mobile projects and activities.

Situated Learning

We take up a *situated* perspective toward mobile learning and technologies. Thus, our assumption is that - in terms of learning - the overarching virtue of mobile is its situative nature. Brown, Collins, and Duguid (1989) make a seminal argument that knowledge is inherently situated, being in part a product of the activity, context, and culture in which it is developed and used. Building on this notion, Lave and Wenger (1991) propose *situated learning,* which identifies the person (or learner), activity, knowledge, and the social world as means through which meaning making happens. From this perspective, the person is transformed into a practitioner whose changing knowledge, skill, and discourse are part of a developing identity - in short, a member of a community of practice. Collectively, these theorists move from a paradigm of abstracting principles to designing concrete learning environments in which learners can build knowledge and make meaning.

By getting learners out into the real world, mobile technologies can ground knowledge real-world contexts and situations. Specifically, place, embodiment, and design are three core dimensions of mobile that can be intentionally manipulated to situate learners in specific contexts - we will discuss these further in later sections of this paper. Squire (2006) refers to these types learning environments as designed experiences; however, we focus here on designed experiences that are possible on mobile platforms from a situated learning perspective.

While situated learning defines our general approach to mobile, it also lends itself to more pragmatic design uses. For instance, we argue that in a given mobile activity or experience the problem or task with which learners engage can land on a continuum from abstract to concrete (see Figure 1). The more concrete the problem, the more accurately it mirrors real-world problems, and thus, the more conducive it is to participation in valuable meaning making practices. From these experiences, learners can then abstract and apply only to return to concrete settings. The fundamental assumption here is that learning happens in situated contexts, so centering activities and experiences around authentic, contextualized problems is vital.

Place in Learning

Naturally, *place* emerges as a core dimension in understanding mobile learning and technologies. The value in mobile is that it *is* mobile and portable, and this transforms learning in distinct ways. Scholars attribute a wide set of meanings to place; thus, there is a lot to untangle when considering the roles of place and space in mobile experiences. In this section, we highlight a core property of place that must be considered in any mobile game design or implementation. Additionally, we identify three general approaches mobile game designers and educators can take up to connect place and learning.

A core property that we must consider in mobile learning is the extent to which the activity is dependent on place. Here we use the term place to mean a physical location. This is particularly important in designing, implementing, and understanding mobile experiences, because it asks: how connected is the activity with the location in which it is happening? We map this relationship onto a continuum with *location agnostic* anchoring one end and *location dependent* anchoring the other (see Figure 1, below).

Figure 1: Place continuum.

One the one side, a truly location agnostic mobile activity is one in where the experience can happen anywhere, regardless of physical location. For example, Angry Birds or DragonBox are mobile games, yet are not tied to a physical location in anyway - they can be played anywhere. On the other side, a truly location dependent mobile experience is one in which the activity is inextricably tied to a physical location. For instance, Foursquare or Belly require users to be in a physical location in order to participate. Using these constructs as anchors, we position other genres of mobile activities along the continuum; field research games that require learners to collect real-world data and situated documentaries that present historical narratives in the context they actually occurred expand the range of how connected mobile experiences are with physical locations. The big takeaway here is that mobile affords learning to happen in a variety of locations, which has fundamentally revolutionized the way in which we understanding education and learning.

Furthermore, designers of mobile games and learning environments must also consider: in what ways can learners connect with place? Here we use the term place as a cultural, social construct. We propose that, in terms of mobile learning, there are three types of connection learners can with place: locational, personal, or critical. More broadly, we extract these styles of connection from three general approaches that function as a framework for understanding how learners can engage with place in mobile activities.

At the most basic level, we see place as a gateway to experiential learning about all subjects. For instance, the creek at the local pond teaches about biology and the neighborhood baseball field demonstrates physics. This view of place gives Dewey's laboratory school its edge, and leads to all forms of situated learning practice. With mobile technologies, we can situate content locatively in the place in which the information is relative. In other words, using mobile devices, we can bring the biology content to the pond or physics to the baseball field. This is the most natural and intrinsic connection mobile technologies have with place - a *locational* connection.

Next, Smith and Sobel (2010) describe as place being a shared thing inextricably intertwined with the idea of community. With this perspective of place, it is impossible to separate a location from a community. To really connect with place, not only means to learn from it (e.g. its history, values, vocabulary, art), but also to begin to take part in its creation. One of Smith and Sobel's (2010) core convictions is that young people should be taught how to become contributors to their communities. From this perspective, mobile technologies are not just used as a tool to get learners out in the world, but also to actively participate in the community that surrounds them. This does not always require that learners venture out to a specific location or place, however, it is still often the case. With a community-based approach to place, mobile technologies afford a *personal* connection with place in the form of community education and involvement.

Lastly, designers of mobile learning environments and experiences can take up a more critical perspective of the connection between place and learning. Particularly, Gruenewald (2003a, 2003b) introduces an unapologetic locative social criticism. He begs us to ponder questions such as: Who holds the most power over the use of a place? Who benefits from a place being understood a certain way? What systems are influencing the design of a place? In this view, not only does the place hold meaning and learners become agents, but the systems of power are explicitly examined. Gruenewald (2003a, 2003b) also asks us to analyze the elements of the community that need to be preserved, transformed, restored and created. With this perspective of place, mobile offers a unique medium through which learners can critically engage with place. This combines both the practical and affective characteristics previously discussed, but identifies a deeper *critical* connection mobile can potentially have with place.

In sum, adopting this connection-based framework of place highlights the flexibility of place as a fundamental dimension of mobile learning. It is important to note that these approaches are not necessarily mutually exclusive, but that designers and educators of mobile learning must intentionally decide which style of connection best suits design goals and learning objectives. Mobile technologies have drastically altered the way in which we relate with place both in terms of physical location and sociocultural, historical communities.

Embodiment in Learning

Place and location are not the only aspects of the physical world that serve to situate our learning and cognition. There is mounting evidence that our entire sensorimotor system affects cognition and learning in complex ways (Wilson, 2002; Barsalou, 2009). According to theories of embodied cognition, our body's interaction in the world shapes how we think and learn, and even abstract conceptual understanding is grounded in our perception and action in the world (Goldstone, Landy & Son, 2008; Barsalou, 2009). Perceptual features of an environment can influence how children perform and understand mathematics, for example, and actions can influence problem solving and spatial reasoning, categorization of objects, and reading comprehension and memory (Landy & Goldstone, 2007; Thomas & Lleras, 2009; Smith, 2005; Glenberg et al., 2004). Because of this, some researchers recommend that, rather than focusing solely on "abstract" knowledge as often occurs in classrooms, learners should be offered opportunities to co-opt perceptual processes to aid in tasks that require abstract reasoning (Goldstone, Landy & Son, 2008).

Because of this deep interaction between perceptual and conceptual processes, it is important to understand mobile's unique affordances of perception and action and how mobile technologies may uniquely provided embodied experiences that ground learners' conceptual understanding in the real world. One useful place to start is with Milgram et al.'s (1994) virtuality continuum (see Figure 2). When real-world environments are paired with digital media, one important dimension to consider is *how much* of the real vs. virtual environment the user is encountering. On the one end of the continuum, the the environment the user encounters is primarily real, on the other end primarily virtual. Anything in the space between entirely real and entirely virtual is considered to be *mixed reality*, while environments that are primarily virtual are considered *virtual reality* and those that are primarily real are considered *augmented reality* (Milgram et al., 1994). Many current mobile games fall into the space of augmented reality. Even within this space, it is sometimes helpful to consider how heavily the real-world is augmented with digital media (Klopfer, 2008). For example, camera-based augmented reality game where digital media is constantly overlayed on top of the real world would be more heavily augmented than a location-based AR game in which digital information appears at a only appears at a location under certain conditions. Mobile technologies allow for some unique designs that incorporate aspects of the physical world; built-in gps systems allow for location to be incorporated into designs, cameras allow for image detection and the overlaying of digital information onto a real-time view of the world, and gyroscopes allow for movement tracking.

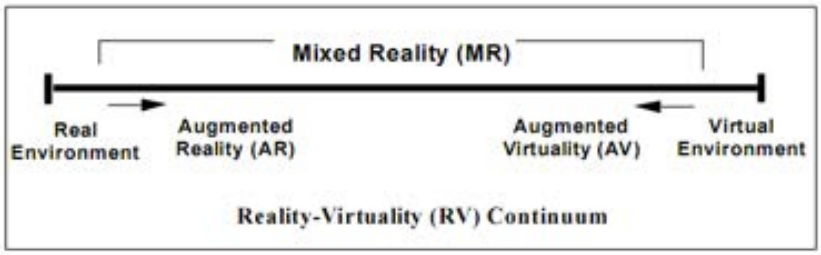

Figure 2: Reality-Virtuality continuum, from Milgram, Takemura, Utsumi, & Kishino (1994).

Though thinking about how much of the real world is incorporated into a mobile game can help us to categorize different technologies and designs, it does not tell us much about the user's experience, and what the affordances of the technology are for situating learning. For this, we should consider *what aspects of perception and action* are incorporated into the player's experience with the game, particularly what perceptual modalities and and specific types of action are utilized in the game and how that may shape experience and learning. The perceptual properties of representations used in mixed reality environments can greatly affect the user's interaction experience (Manches, O'Malley & Benford, 2009). Mobile devices support different types of interactions across the visual, auditory and tactile sensory modalities. Of these, most mobile games currently focus on the visual modality, requiring the player to view the screen to interact with the game. Other games, however, are primarily auditory, where the user is given audio feedback based on their interactions with the world. For example, in the fitness game "Zombies, Run!" (see Figure 3), players jog while being chased by virtual zombies who they can hear through their headphones. Most mobile devices have limited tactile feedback (generally only a vibration), so current mobile games may incorporate tactile feedback but generally don't focus on it.

Figure 3: "Zombies, Run!" mobile augmented reality game.

Mobile games can also incorporate a player's physical action into the game design in ways that are unavailable with other technologies. Through the GPS and compass, mobile devices can detect a player's movement in space, and with the gyroscope and accelerometer can detect body movements as well.

Finally, we should pay attention to *how* the combinations of physical and digital elements across multiple sensory modalities and forms of action occur in mobile activities. The precise couplings of elements of the real world with digital information affects the player's experience and may shape learning. Some researchers stress the importance of the relative *locations* of the physical and digital representations in mixed reality environments. For example, Price, Falcão, Sheridan & Roussos (2008) list three levels of different spatial locations of digital representations in relation to real-world objects and actions triggering the digital effect: *discrete*, in which the digital representation is located separately from the input device; *co-located*, when the input and output are contiguous and the digital effect is directly adjacent to the artifact or action; and *embedded*, when the digital effect occurs within the object itself. In augmented reality games, this locational property can often be described as the player either looking *at* the device, separate from the real-world (discrete), or *through* the device to see the real-world with digital information overlaid on top of it (co-located). For example, in the game Dow Day, a situated documentary where players act as reporters to understand an important historical event on campus, portions of the game include a map that is discrete from and a video that's co-located with the real-world space (see Figure 4). The relative locations of digital representations to real-world objects, actions and environments can shape the way learners' understand the relationship between the the digital representations and the real world as well as their interactions with each other in the environment (Falcão, Sheridan & Roussos, 2009).

In addition to *locational* relationships, *representational* relationships may be an important consideration as well. For example, how abstract or concrete are real-world places represented visually on a map? Finally, how the relationships between physical and digital elements may stay constant or change *over time* may be important to consider. A design where the same actions in the same places lead to different results at different times (based on experience or objects collected) may lead to a more compelling and engaging activity.

Figure 4: Map and video view from mobile, situated documentary "Dow Day".

Design

Papert (1980) explains that this working out of ideas through the creation of external, shareable artifacts is a particularly meaningful, situative style of learning. Thus, mobile experiences designed by learners themselves offer a remix of traditional conceptualizations of learning environment. Open source, easy-to-use design platforms have opened the door to practically engaging learners in making the same types of decisions game designs have made.

Given the inextricable connections mobile has with place and the physical body, crafting these activities can be particularly powerful and offer opportunities for learners to reflect on their own learning in ways other technologies do not afford. For instance, Mathews (2010) had his students design their own mobile games to engage with contested places in their city. This means with which students were able to engage afforded a unique platform for students to connect personally with their local community. Another example of how designing with mobile transforms learning is through the use of primary sources to (re)create historical narratives and events, so that they can be experienced in the place that they actually occurred (see Dow Day above as an example of this type of mobile activity). Both of these examples point to important affective and intellectual connections that learners can make through the design process.

Implications

Ellsworth (2005) argues that experience comes prior to and is crucial for building understanding, and that, "the qualities of an *experience* of learning are crucial to *what* is learned." (Ellsworth, 2005, pp. 18). Thus, in order to design learning environments in which learners actually *learn*, we must intentionally craft designed experiences (Squire, 2006) of quality. Additionally, the *what* that we want learners to understand mutually informs the way in which we design the learning experience.

Given the mobility and portability of mobile, integrating it into learning environments brings to light several design implications that are not present with many other media. There are unique affordances mobile offers learning, and the frameworks we presented above shed light on many of the decisions designers of mobile learning environments must make. Specifically, both the content and learning goals should drive the design of mobile learning environments. For instance, when building a mobile tour of a university campus, the designers must address questions like: do we want users to have to physically walk through the campus (location dependent)?or do we want users to have access to the tour remotely (less locationally dependent)? Taking up the frameworks we have put forth here, affords a vocabulary with which to talk about these decisions, but more importantly a lens through which to manage and organize design decisions specific to mobile.

Though there is a good deal of research emerging from the different theoretical traditions we draw from in considering mobile learning (i.e. situated learning, place-based learning, and embodied cognition), research on how these theoretical traditions translate into mobile learning designs and how those design decisions affect learners' experience and understanding is only beginning. We hope this framework adds to the discussion in providing a survey of the landscape.

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