Augmented Learning

Research and Design of Mobile Educational Games

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Preface

For as long as there has been formal education, there have been calls for education reform. Sometimes those calls arise from emerging pedagogies. Sometimes they emerge from fundamental social and political change. And sometimes they come out of necessity. We are currently in a transition of necessity. Technological advances, globalization, and the shift from an industrial to an information economy are forcing our hand and demanding change. The rapid pace of change, on the order of years instead of decades, further demands that education and training cannot end after high school or college, but must become a lifelong pursuit.

This wave of change has brought with it a demand for new tools and approaches that can address the new learning demands of elementary, secondary, university, and lifelong education. E-learning has emerged as a serious contender to help support the learning needs of individuals across this spectrum of levels. E-learning itself can mean many things to many people and at its core simply means electronically supported learning, which can be online, on desktop PCs, or even on mobile devices (though the latter is sometimes referred to as m-learning). In practice e-learning often means delivery of information and content to learners through online hypertext, accompanied by images, audio, and video. But e-learning can mean much more, as evidenced by the recent surge of interest in using video games to teach everything from basic math skills for young learners to advanced communication skills for adults.

Researchers have shown that the potential of video games in education resonates with researchers, teachers, and students alike. There is growing interest in utilizing games as educational tools (Prensky 2001; Gee 2003). People are seeing the value of games as models of pedagogically rich, highly motivating learning environments. Commercial games possess many of the

elements we look for in learning environments—collaboration, problem solving, higher-order thinking skills, and so on. While some ''edutainment'' games such as SimCity are being repurposed for the classroom, another set of ''serious games'' is being developed expressly for learning.

Yet the introduction of video games into the classroom, or even education more broadly, has yielded mixed results at best. Researchers worry that the skills learned in video games may be difficult to transfer to the real world. Developers of games lament the skyrocketing production costs and questionable market. Teachers fret about the practical difficulties of implementing games in the classroom. Students resent drill-and-practice activities disguised as games. The potential of video games for learning is real, but so are the difficulties in realizing this potential.

Enter mobile learning games. The mobile games market (encompassing cell phone games and handheld console games like the Sony PSP and Nintendo DS) is the fastest growing gaming sector in the world. Commercial industry trends, while well ahead of the educational sphere, demonstrate tremendous growth in the area of portable, handheld games. Nintendo Game Boy, Nintendo DS, Sony PSP, and many cell phone games are quickly becoming the fastest growing sector in games (Reuters July 28, 2005). While some of these games are merely translations of ''big screen'' games resized for smaller display screens, some of the most successful handheld games are written to take advantage of the unique aspects of these platforms. Mario Kart allows players to form ad hoc races with players standing nearby, while Nintendogs, a wildly popular game in Japan that is a more sophisticated version of virtual pets, requires players to ''pet'' their dogs using the Nintendo DS touch screen.

Handheld games are accessible to many more people than PC or console games, and can be developed without the astronomical production costs associated with blockbuster games. With more devices in the hands of potential players, a platform more amenable to casual play, and no need for expensive 3D high-definition graphics, this is a fast-moving sector. Yet the potential of handheld devices as a platform for learning games has gone essentially untapped. Handheld computers have incredible potential for aiding learning in a time when people must tackle complex problems and acquire information in ''just-in-time'' fashion. These portable connected computers can provide just the information necessary when it is needed and where it is needed. Their design, size, and mobility also make them an

ideal platform for learning games. Rather than cramming desktop applications onto these small devices, such games play to the strengths of this platform—its portability, context sensitivity, connectivity, and ubiquity. Well-designed mobile games can use the physical and social context of the player as integral components to the game, creating a rich playing and learning environment.

This book describes the educational and gaming landscapes that place mobile learning games in the unique position to make a substantial impact on education. It starts by exploring the past and present of education, educational technology, edutainment, and mobile games, and then delves into case studies of a number of mobile educational games that have been designed, developed, and implemented in recent years. These case studies detail the history, uses, and design principles primarily of two categories of mobile educational games: participatory (requiring interactions with other players) and augmented reality (responding to player location) handheld simulation games. These games can place learners in real-world contexts that promote transfer of learning from one context to another. They can be produced at much lower costs, using social dynamics and real-world contexts to enhance game play. They can be integrated into the natural flow of instruction much more seamlessly than their big-screen counterparts. And they can create compelling and fun educational environments for learners. All of these factors combine to position mobile games in a unique and powerful position within the educational technology space.

Why Mobility Matters: Theory and Practice

There is an adage in the field of learning sciences that we should define a problem first and then seek the most suitable technology to fix that problem, rather than seek a problem to fix with a particular technology. I'd be lying if I said that this was strictly how we conduct our work in the research and development of mobile learning games, here in the MIT Teacher Education Program or in the work to which I have contributed in the Education Arcade. To be honest, most research (including ours) is much more a hybrid of the two approaches. Surely one can find value in not strictly limiting the genesis of innovations to addressing an existing problem or challenge. Similarly, science is not conducted by the linear process of sitting down in a chair and coming up with a hypothesis to test, then designing

and carrying out experiments and analyzing results; but rather by a messy and nonlinear process of tinkering with experimental systems, then iteratively designing, testing, and modifying those systems. The design of learning technologies is more often composed of iterative cycles of designing, modifying, and testing the technologies in parallel with a series of problems to which the technologies relate.

In the case of mobile learning games that we have developed, on the technology strand we have examples that are firmly grounded in connecting people with each other or with their surroundings or both as core components of the games. This design approach arose from early experience with mobile games, informed by theories of learning. In parallel, we have goals of creating experiences that promote the new set of skills demanded by the twenty-first century while meeting the realistic constraints of classrooms, schools, and other learning environments.

What ties the goals (twenty-first-century learning) and tools (mobile games) together are two underlying learning theories that guide much of our work—*constructivism* and *situated learning*.

Constructivist theory (Piaget 1977; Bruner 1986; von Glasersfeld 1995) states that people learn by constructing their own understanding of principles and phenomena. They build that understanding based upon past experiences and beliefs, integrated with current experiences. That is, according to constructivist theory, learning is an iterative process of updating existing understanding with new information acquired through activity. Educational activities informed by constructivist theory recognize that learners enter these activities with preexisting knowledge, and shape that knowledge through the experiences of those activities. Thus constructivist activities are characterized by wide open spaces to explore, room for learning through both success and failure, feedback that learners can use to adjust their own understanding, and multiple possible outcomes. Constructivist activities often take the form of problems that learners are motivated to solve in unique and active ways.

Situated learning (Lave and Wenger 1991; Lave and Chaiklin 1993; Wenger 1998) is a theory that describes the process of learning as highly social, embedded in the lives of learners, and can be complementary to constructivism. Much of the theory of situated learning centers on the notion of *communities of practice*: dynamic groups that are present throughout

our lives in which we participate in various ways. Such groups exist in schools, workplaces, social organizations, and families. Each of these groups has a set of practices that members learn over time. While this training may sometimes be formalized (such as joining an outdoor group to learn rock climbing), it is often much more tacit (such as spending time with a group of friends and learning what they enjoy). In addition to the set of skills and knowledge one might learn by participating in such a community, the cultural and social practices are also part of what is learned.

Learning activities that draw on the principles of situated learning and communities of practice share many characteristics with constructivist activities. They are also often problem-based, and draw upon previous experience in the learner's life. These problems usually are inherently meaningful and motivating to the people involved. But situated learning also explicitly draws upon the real-world context in which the problems are set and the community that is either developed or appropriated around the activity. Social activity and connections to the real, physical world are important characteristics of situated learning.

The synthesis of the constructivist and situated learning paradigms lead us to design activities that are inherently social, authentic and meaningful, connected to the real world, open-ended so they contain multiple pathways, intrinsically motivating, and filled with feedback. While many technologies can foster some of these design elements, mobile learning games are particularly well suited to supporting them all:

Social Mobile games draw upon existing social relationships and means of communication when situated in social environments that participants already know how to negotiate. Many technologies require developing new means of communication and of fostering social relationships. Mobile games do not need to reinvent these systems, as they draw upon preexisting ones—whether those be face-to-face, through other modern means like instant messaging, or even phone calls. This real-time connectivity can increase the building of real social relationships among group members.

Authentic and Meaningful Situating mobile games in real contexts connects them to actual people, places, and events. While the specifics of these games may be fictionalized, basing them in the reality of physical places—through which the players must physically navigate—deeply connects the players to the problem and place at hand.

Connected to the Real World While PC and console video games strive for high-fidelity graphics and game-play experiences, mobile games that are already set in the real world get 100 percent real-world fidelity for free. Many intangibles of the physical world get incorporated in mobile games without being explicitly designed into the games.

Open-Ended/Contain Multiple Pathways Like real-world problems, the problems designed into my group's mobile games are significant and characterized by the lack of one clear answer. Navigating large geographic and information spaces makes knowing all of the information impossible, and players must constantly redefine their own goals—in the end defending their answers and the means that they used to define that answer.

Intrinsically Motivating Mobile gaming not only is the fastest growing gaming sector, but also has the broadest appeal across genders, ages, and interests. Drawing upon some of the design principles that have brought about the broad success of this platform, we can make learning games that are equally broad in their appeal.

Filled with Feedback Feedback in mobile games can come in many forms. The most obvious is directly by electronic means. As players physically move around in the real world and interact they are provided with virtual feedback based on their actions, preprogrammed outcomes, and underlying models. But feedback can also come from other players. As players encounter each other, by design and serendipity, they exchange information and ideas, providing useful feedback to each other. Finally, new means of feedback can be discovered by players as they appropriate information from their physical reality with the information provided to them by the games.

These characteristics fit well with the twenty-first-century skills we are trying to build because they provide the appropriate context for students to develop these complex abilities. Thus mobile learning games may be uniquely poised to address these skills in schools, in the workplace, and in life.

Who Should Read This Book?

The focus of this book is on the research and design of mobile learning games. In order to effectively design such games, they need to be set properly in the context of schools and learning, games and education, and mo-

bile games. The first half of the book lays out the history and current state of each of these areas. Chapter 1 is about schools and education reform, and how technology fits into the academic world. Chapters 2 and 3 are about educational games, both historically and by design. Chapters 4 and 5 are about mobile games in general and applied to education in particular. The remaining chapters (6 to 12) offer case studies in the design, implementation, and research of mobile learning games.

I'd like to think that the book can be read through the lens of anyone interested in schools, learning, educational games, or mobile games, and that there should be lessons and stories pertinent to any and all of these realms. Even the case studies that straddle intersections of these topics can be teased apart to provide insights for people with interests in one or more fields. Thus teachers, trainers, technologists, administrators, instructional designers, educational and game studies researchers, and game designers should all find stories of interest to them. For teachers and other educators, this book provides a new perspective on how educational technologies can make a difference in (and out) of the classroom. Even if mobile learning games are not specifically feasible or desirable, it is useful to understand the salient characteristics and practices that make computer technologies powerful and feasible classroom learning tools. For trainers who provide professional development and just-in-time or on-demand learning for the workplace, this book introduces new tools and approaches that should be considered when looking to enhance the knowledge, skills, and performance of a diversity of workplace learners. Training adults to enhance their job-related expertise (everything from first responders dealing with a crisis to managers working with teams) is a challenging task, and these technologies may prove effective in reaching this audience. Educational technologists can similarly benefit from understanding what makes mobile learning games effective tools, and using these principles when evaluating new learning technologies. Administrators may look to the lessons of implementing mobile learning games when planning their own technology infrastructure, both for what should be in their plans, as well as what not to invest in. Beyond technologies, the material covered in this book also speaks to the design of classroom and learning activities more generally, from which instructional designers could benefit. Parents can begin to understand more deeply what their kids are doing and learning when playing mobile games, and gain some insights that might help guide

decision making when it comes to choosing video games. Researchers in educational technologies and game studies can get a primer in a segment of the video game space that has received little attention from either field, and see the possibilities for research and development. And game designers may look at their work differently and push into a relatively untapped portion of the market, as they better understand the growth potential and interesting design challenges and opportunities of mobile games.