MAKING DIGITAL GAME-BASED LEARNING WORK: DOMAIN KNOWLEDGE TRANSPARENCY

By

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ABSTRACT

During the past two decades, the popularity of computer and video games has prompted games to be a source of study for educational applications (Dickey, 2007). The most distinguishing characteristic of games is their capability to engage and motivate their players (Kiili, 2005). Educators started to explore game-based learning by testing commercial off-the-shelf (COTS) games in the classrooms directly and by developing educational games through mimicking the constructions of some popular massive multiplayer online games (MMOGs). These educational explorations of games, however, all tended to highlight their educational purposes and content, which unintentionally diminished their ability to engage and motivate players. This paper suggests the concept of domain knowledge transparency (DKT). This concept indicates that instead of emphasizing the educational content and purposes, domain knowledge should be integrated into games naturally and invisibly to keep the nature of games fun and playful. In addition, the technologies used in modern games have pushed many computer games beyond the boundaries of game genres. Therefore, this article suggests the replacement of game genres with a feature list to identify a game. Finally, this article uses a popular Chinese game, Mai-fang-zi, to illustrate these two ideas.

Keywords: Domain Knowledge Transparency, Game-based Learning, Game Feature List.

INTRODUCTION

The use of games for educational purposes can be traced to the use of war games in the 1600s (Gredler, 1996; Langton, Addinall, Ellington, & Percival, 1980). With the advent of advanced computing and network technologies, computer games have become one of the most popular entertainment forms today. Consequently, modern computer games have brought their educational applications back to the educators' attention in the past two decades (Dickey, 2007). Digital game-based learning (DGBL) is the product of this educational trend.

Research involving commercial off-the-shelf (COTS) computer games has been a popular approach to investigate the effects of games on learning. COTs are computer or video games that are created entirely for entertainment purposes (Charsky & Mims, 2008). While some researchers have tested COTS games in classrooms directly due to its relatively low costs (de Freitas, 2007); others have tried to mimic the construction of some of the most popular massive multiplayer online games (MMOGs) to create educational versions of the originals. No matter which approach was taken, however, researchers and educators tended to highlight the educational purposes and content in their work. Although different players may have different reasons for playing games, it is often the case that people want to escape from their real life stress and problems by immersing in the game world (Lazzaro, 2004; Sweetser & Wyeth, 2006; Yee, 2006a, 2006b). When the educational purposes and features stand out, students may not be able to enjoy the games as much as they enjoy other games where there has not insertion of "something good for you", which can overshadow the inherent, fun nature of those games. Since player enjoyment is the single most important goal of computer gamers (Sweetser & Wyeth, 2006), and while content learning is the most important consideration for educators, "exploring games and education is inherently controversial" (Oblinger, 2006, p. 6).

This paper introduces a new concept domain knowledge transparency (DKT) to DGBL. The term "transparency" is borrowed from computer science, in which it indicates the idea that computing technology should be seamlessly embedded into the environment and make the delivery of computation "transparent" (Ishii & Ullmer, 1997). This paper suggests that in order to keep the motivating factors of computer games, domain knowledge should be integrated into games in a transparent way. Therefore, the game players can pick up knowledge naturally without ruining the fun of game play. This paper also suggests the replacement of game genres with a game feature list. Since modern games tend to integrate multiple features, which often cross the border of different game genres rendering the genre labels useless. Three most promising educational features of computer games are introduced and discussed in this paper as well. This paper starts with the introduction of DGBL, the concept of DKT, technological features that make modern online games educationally appealing, and then uses a Chinese online computer game, *Mai-fang-zi*, to illustrate the three promising educational game features and the DKT concept.

Game-Based Learning

Generally, the supporters of DGBL accept one or more of three assumptions. The first assumption is that digital games can provide learners with opportunities for exploration and manipulation, conversation and collaboration, and interactive challenges (Dickey, 2007). These opportunities lead to the development of skills that are expected by today's employers (Carstens & Beck, 2005; Federation of American Scientists, 2006). The second assumption is that today's children are "digital natives" (Prensky, 2001) and "game generation" (Carstens & Beck, 2005) who grow up with interactive digital tools (Oblinger, 2003) and online games (Annetta, Klesath, & Holmes, 2008). Games, to some extent, shape their beliefs of self, how the world works, and how people related to each other (Carstens & Beck, 2005). Matching the learning styles, habits, and interests of the game generation with appropriate instructional strategies is very important to produce effective learning outcomes (Prensky, 2001). In other words, today's children are especially prone to take advantage of educational games (Federation of American Scientists, 2006). The third assumption is the belief in the "transferability" of the aspects that are inherent in gaming and game strategies. Educators believe that the attributes of digital games, such as strong motivation effects (Ang & Rao, 2008; Kiili, 2005; Sedig, 2008), contextual bridging (Gee, 2007; Gredler, 1996), collaboration, and personalization of learning pace (Carstens & Beck, 2005), can contribute greatly to education. For these reasons, games may also be able to achieve a wide range of educational objectives (Percival, 1976). For example, some games can serve as "hands-on" tools for teaching practical and technical skills ranged from automotive repair to heart surgery (Federation of American Scientists, 2006). The most distinguishing advantage of games, however, is its promise of engaging and motivating players (Kiili, 2005). Researchers believe that games can be designed to help children learn subject matter in an enjoyable and motivating way (Sedig, 2008). To this end, researchers have claimed that "the study of games and learning is ready to come of age"(Squire, 2007, p. 167)

Domain Knowledge Transparency

Strong beliefs in the educational benefits of computer games have led researchers in two directions of DGBL explorations. On one hand, many researchers have tested COTS games in classrooms in order to keep costs low, which resulted in some opposing findings (Bragg, 2007; Foti & Hannafin, 2008; e. g. Stevens, Satwlcz, & McCarthy, 2007). When a game is designed without educational purposes in mind, it is predicable that these games will not thrill educators for their educational possibilities. On the other hand, some researchers believed that "a good game's design is inherently connected to designing good learning for players" (Gee, 2007, p. 21). They tended to use game design to develop educational programs. Consequently, many educational games and game-based projects were designed and evaluated. For example, Sung Chang, and Lee (2008) explored designing games for concept development. Sedig (2008) explored how specifically designed mathematical games can be used to teach mathematic concepts. Dempsey and his colleagues (2002) evaluated 40 simple computer games for their possible instructional applications. These relatively small games yielded comparatively positive results; however, since they are small programs running on individual computers, their participants and impact on learning are limited. In addition, they still keep the original look and feel of children's software started a few decades ago (Ito, 2007) without catching up with the development of modern computer games. These educational games are, at best, repetitive efforts at drill and practices (Atkinson, 2009).

Imagine six million devoted users of World of Warcraft (de Freitas, 2007) are learners who are so involved in learning that they lose their sense of self consciousness and time (Csikszentmihalyi, 1990; Csikszentmihalyi & LeFevre, 1989; Wan & Chiou, 2006). Researchers and educators cannot resist this temptation. For that reason, millions of dollars have been invested to develop educational games with the construction of some of the most popular MMOGs, such as World of Warcraft, into educational programs. Projects such as Harvard University's River City program, Indiana University's Quest Atlantis, and North Carolina State University's WolfDen virtual campus are cases in point. Researchers expected that those educational programs would be just as popular as their original games in attracting and maintaining learners' attention. A common feature integrated into these projects is a three-dimensional virtual environment.

Whether these projects worked or not, there are some inherent problems with these lines of research and logic. First of all, some of these projects tend to equate virtual environments to computer games. However, as Ang and Rao (2008) pointed out, a virtual environment is not a game by itself, because a game must have a narrative or a storyline embedded as well as challenges or goals to achieve. Therefore, when equating virtual environments to games, learners, especially new learners, may be found wandering in the programs and having nothing to do. In addition, learners may be caught up by some distractive activities such as changing avatars (Annetta, Klesath, et al., 2008; Annetta, Murray, Laird, Bohr, & Park, 2008) at the very beginning. This begs the question: When the technological innovation fades (Reiser, 2001), are the game features still left that can maintain learners' interests in this way of learning? Third, a frequent reason for playing games for many gamers is to escape from their real life stress and problems by immersing themselves in the game world (Lazzaro, 2004; Sweetser & Wyeth, 2006; Yee, 2006a, 2006b). When the educational purposes are highlighted and presented to students, do learners still have a place to escape? Last but not least, game development costs are staggering commonly reported in the tens of millions of dollars (Oblinger, 2006). Should and could educators spend millions to develop educational games with the high failure rate as commercial games?

This paper holds that the term "educational game" should be thrown away. Games should keep their original fun and playful features, so all the benefits that educators believe games possess will not be affected. The fun of game should not be ruined, so people can still venture into game worlds to release their stress, feel competent, and fulfill the dreams that have not come true in their real lives. The developing cost should be paid by the game development companies instead of academic institutes. How about education? Should we just forget about educational usage of games? The answer is no. This article proposes a concept of domain knowledge transparency (DKT) for commercial game design. The term "transparency" first came from the field of computer science in reference to the idea of pushing the computers into the background and to make the delivery of computation "transparent" (Ishii & Ullmer, 1997). On the educational side, researchers use the term to emphasize the importance of integrating instructional technologies naturally and invisibly to the instructional process (Meira, 1998; Sabena, 2004). In addition to the technology transparency, this paper suggests making the learning content transparent in the DGBL. In other words, domain knowledge should be integrated into games so naturally that the players will pick up the knowledge without noticing. The transparency of a game is closely related to several modern game features: virtual player interaction environments, role playing, and simulation. These features by themselves are not games; however, they can contribute greatly to the DKT when being integrated appropriately into computer games. Moreover, merely embedding these features in games cannot guarantee the occurrence of learning or the DKT of games either.

Game Genres or Game Feature

As Oblinger (2006) pointed out, games are not all alike, different games incorporate different features to attract different audiences (Oblinger, 2006). Therefore, games have been categorized differently by different researchers based on different criteria. For example, Oblinger (2006) categorized games into six common genres: adventure games, puzzle games, role-playing games, strategy games, sports games, and first person shooter games. Squire (2007) categorized games into four different genres: targeted games, linear games, open-ended and sandbox games, and persistent worlds. Salen (2008) believed that there were four different kinds of games: sandbox, alternate reality games, online casual games, and virtual worlds/environment. Ito (2007) used three genres to categorize children's games: academic, entertainment, and construction. However, modern computer games, especially, some MMOGs cut across the lines between genres to include simulation, sandbox, role-playing, and virtual worlds into one game to make games more attractive. In addition, the borders between academic, entertainment, and construction games are also vague. Overall, game genres may no longer work for many of today's games. Instead of using genres to categorize games, a feature list is more appropriate to describe today's computer games.

Looking into some of the current computer games, especially MMOGs, three features stand out and make them especially appealing to educational explorations: virtual player interaction environments, role playing, and simulation.

Virtual worlds, such as Second Life, are a kind of virtual player interaction environment. A virtual world is a three-dimensional interactive artificial environment that can be visited simultaneously by many people via networked computers. Virtual worlds are used commonly in MMOGs, such as World of Warcraft, Paradise, and Counter Striker. However, a virtual world is not a game by itself. A game is bound by rules, and it must have a narrative or a storyline embedded, as well as specified challenges, some aspect of competition, and goals to achieve (Akinsola & Animasahun, 2007; Ang & Rao, 2008; Dempsey, et al., 2002). When integrating virtual worlds into a computer game, the interactive and collaborative features of a virtual world make a computer game more attractive. Educators have seen the potential of the MMOGs for new ways of collaborative learning, knowledge building, and academic performance (Gee, 2007). The collaborative learning environment creates the circumstance for learners to help each other (Hardy, Lawrence, & Grant, 2005). Instead of developing its own player interaction environment, some games are developed from existing online social utilities such as Facebook and Windows Live Messenger. The Facebook game, Farm Town, is a case in point.

Role-playing games situate learners in certain roles in the process of solving complex problems. Role-playing is often combined with MMOGs to make massively multiplayer online role-playing games (MMORPGs). MMOGs games such as World of Warcraft, Paradise, and Counter Striker are also MMORPGs. These games offer an intriguing mix of socio-cultural and constructivist learning theories (Squire, 2007). Role-playing is also a fundamental element of simulations, in which people adapt roles in a mockup of selected aspects of a real-life situation (Akinsola & Animasahun, 2007).

Simulations have been used to provide learner interactions in situations that are too costly or hazardous to provide in a real-world setting, such as diagnostic testing (Gredler, 1996). As defined by Gredler (1996), simulations are open-ended evolving situations with many interacting variables. The goals for participants include taking a particular role, addressing the issues, threats, or problems that arise in the situation, and experiencing the effects of their decision. Although, by themselves, simulations are not games either, simulations are often integrated into games in which players are provided with a simulated environment in which to play (Akinsola & Animasahun, 2007). Simulations and games differ in their purposes, the types of roles taken on by individuals, the nature of decisions, and the nature of feedbacks (Gredler, 1996). Games that contain embedded simulation techniques are called simulation games. Researchers believe that simulation games can bridge the gap between the classroom and the real world by providing authentic learning experiences (Gredler, 1996). Consequently, simulation games contribute to the improvement of achievement and positive attitude towards learning, for example, mathematical learning (Akinsola & Animasahun, 2007).

Computer games that combine features such as virtual player interaction environment, role playing, and simulation make them promising learning tools in educational settings (Sardone & Devlin-Scherer, 2008). These features increase the possibility of DKT in games. These features alone, however, cannot guarantee the occurrence of learning or DKT. The following is a sample game that embeds these features effectively to make DKT in the game.

Mai-fang-zi

This study explored one sub-game of a Chinese massive multiplayer online game named Kaixin (happy) Net. The Kaixin Net game consists of many two dimensional sub-games. This study investigated one sub-game in the Kaixin Net, *Mai-fang-zi* (purchasing a house) game, which is a little bit like the Farm Town game in Facebook. The Purchasing a House game integrates Facebook's familiar, virtual interaction environment, quasi-simulation, and role-playing features. The reason we use the term "quasi-simulation" in this paper is that in this game, the images of the plants are not identical to the real world plants, but they are the images quite often used in students' learning books. They are cartoonish, but capture the important features of the real things.

The storyline of this game is about buying houses through farming. The goal of the game is to make money to buy residential properties and decorate them. The challenges of the game that epitomize the competitive elements of the game include: levels of farms, levels of plants, upgrading houses, decorating houses, and upgrading cars and so on.

Mai-fang-zi integrates multiple-disciplinary domain knowledge that can contribute to students' knowledge development in agriculture, food science, interior decoration, and real-estate. Most importantly, the domain knowledge is integrated into the game so naturally that a player may pick up the knowledge without even noticing. This game embedded the Facebook's familiar, virtual interaction environment so that players can create a game-based community to interact with each other to enlarge their personal network online. In other words, this game embodies the concept of the DKT.

The player starts as a homeless poor man/woman with empty fields and an empty barn yard in the game world as shown in Figure 1. In order to make money, the player needs to farm. Here is where the agricultural knowledge fits in. The digital plants grow up in the virtual fields. The game shows the plants' different growing stages that are consistent with how the plants look in the real world. In other words, the game runs the simulation of various plants' growing processes. A player can even enlarge the screen to see the details of a plant. Figure 2 shows a description of the growing stages of a cucumber and the look of the cucumber in that stage. This game simulation makes the observation of a plant's growing process possible. The lead author of this article never saw a pineapple plant in real life, only the fruit in the grocery store. She was always curious about how a pineapple looks as a plant. Does it look like an apple in an apple tree? Is it too heavy to grow up in a tree? The lead author of the article learned about the pineapple plant through playing this game. In addition, in the game setting, when a plant is harvested, if the owner does not pick it and take it to the storehouse quickly enough, other

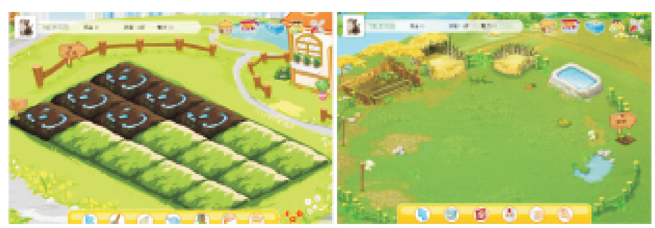

Figure 1. The field and the barn yard.

Figure 2. The growing stage of the cucumber plant.

players can "steal" the crop and sell it themselves to make money. Therefore, in order to make more money, players gradually learn the look of different plants in their different growing stages, so they can quickly pick and steal the full-grown and more valuable crops. Each player is constrained by his/her game level as to the types of plants and the number of the fields that the player can farm. This setting is one of the challenging designs of the game, it also gives the player a certain amount of time to learn and digest knowledge instead of being overwhelmed by a flood of information.

The food science knowledge is also integrated into the game naturally, when the player needs to make decisions about what plants they want to grow in their fields. When going to the virtual store to buy plant seeds, players can make informed purchases by reading plant descriptions provided by the game. For example, the cucumber description includes the medical benefits of cucumbers, foods that are good or should not to be eaten with cucumbers, and the warning that people with certain health conditions must not eat cucumbers.

When the time comes to make the decision of buying a residential property, information related to the city, the living area, the living complex, the size of a property, and the price is mostly based on real data. By playing the game, players get to build up their real-estate domain knowledge without really being aware of it. For example, a player may learn a certain type of housing is more expensive in Hangzhou than in Beijing by looking around different cities to buy a property within his/her limited budget.

After a player buys a virtual residential property, such as a condo, the interior decoration is like a sandbox. The player can paint the walls; choose the floor, furniture, and every detail of the decorative items for a room from scratch. The player can also test different designs again and again until he/she feels satisfied. The virtual furniture, appliances, and decorations are also those that people can normally find in real-world stores such as IKEA. Figure 3 shows the living room of the lead author's virtual condo. The right side of the figure shows the corresponding building in the real world.

Conclusion

While computer games are catching more and more

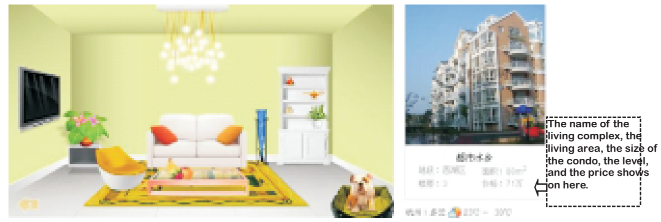

Figure 3. The Virtual Home.

attention from educators today, the explorations on DGBL also reaches its unprecedented prevalence. Ways of investigating DGBL might be various; however, they all unanimously tended to emphasize the educational purposes and content of these games to game players or students. This article claims that the emphasis on computer games' educational features casts a shadow on games' motivating and engaging capabilities, thus decreasing the learning-facilitating effects of computer games. A computer game should accentuate its fun and playfulness, while the domain knowledge should be integrated into games naturally. Therefore, players can pick up knowledge embedded in games without paying special attention to it or even being aware of its existence. To this end, this article proposes the concept of DKT for the design and development of games with educational purposes. In addition, the development of the computer games outgrows the capabilities of game genres for categorizing and describing today's games. This article suggests that the game genre should be replaced by a game feature list. This article concludes three distinguishing features of modern computer games that increase the possibility of DKT and make computer games more promising to be used in educational settings: virtual player interaction environment, role playing, and simulation. At last this article uses a popular Chinese online computer game, *Mai-fang-zi*, to illustrate these three game features and the DKT concept.

Note

This article has no intention to advertise the *Mai-fang-zi* game or claim it has ideal DKT. This article only uses this game to represent the concept of DKT. This game does appear to have many possibilities to embed more domain knowledge transparently such as adding the calculation of a mortgage into home buying, showing the real price of the furniture and so on. If games developers can keep the DKT in mind, it will definitely reduce the controversy of DGBL and make DGBL integrate into school education more naturally without ruining the fun of playing games.

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