Constructivist Learning through Computer Gaming

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Abstract: Apart from the ability of computer games to make learning more interesting, a number of researchers and educators have been exploring other educational potentials of computer games. In parallel with the advancement of computer and information technology and the advocacy of constructivism in education, the issue of harnessing computer games to create new constructivist learning opportunities has received attention in both education and game research domains. This chapter is aimed at giving an introduction to computer game-based learning. Besides discussing computer games' intrinsic educational traits favouring constructivist learning from different perspectives, the authors also review a number of instances of two recent foci in the game-based learning domain. The first one is *education in games* that involves the adoption of existing recreational games in the commercial market for educational use. The second is games *in education* that entails designing and developing educational games articulated with different constructivist learning paradigms or pedagogical approaches.

Keywords: computer game-based learning, educational games, constructivist learning

1. INTRODUCTION

Computer games have become an important part of the leisure lives of young generation (Kirriemuir & McFarlane, 2004; Newman, 2004). This attention has been one of the common premises of various research on harnessing games[i] in education for these decades (e.g., Adam, 1998; Betz, 1995; Bowman, 1982; Buckingham & Burn, 2007; Cameron, 2008; Egenfeldt-Nielsen, 2007; Gredler, 2004; Jong, Shang, Lee & Lee, 2006, 2007; Lee, Lee & Lau, 2006; Malone, 1980, 1981; Mason & Moutahir, 2006; Squire, 2003, 2005; Shaffer, 2006).

Along with the advancement of multimedia, gaming, and Internet technology, as well as the pervasive promotion of student-centredness in education, the focus of game-based learning has been shifting from its original purpose of "sugaring" the process of learning onto today's purpose of offering students constructivist learning experiences. A number of contemporary game-based learning researchers have been endeavouring to investigate how to employ the

intrinsic educational traits of games for exploiting new constructivist learning environments. In general, their work can be categorized into two main research foci, namely, (1) *education in games*, and (2) *games in education*. The former adopts existing recreational games in the commercial market for educational use, while the latter designs and develops educational games articulated with different constructivist learning paradigms or pedagogical approaches.

In this chapter, firstly, we discuss what and how the intrinsic traits of games can promote constructivist learning. After that, we review a number of instances of the recent research foci in the game-based learning domain. Further, we give an introduction to our recent game-in-education work, before our concluding remarks are given.

2. INTRINSIC EDUCATIONAL TRAITS OF GAMES

The discussion of utilizing games for learning and teaching has started since the widespread popularity of Pac-Man in the early 1980s (Squire, 2003). Without doubt, the "games" discussed in most of today's game-based learning research are quite different from the ones that were used in education in the last few decades. The differences are not only in games' technical enhancement (e.g., more sophisticated 3D user interfaces, dynamic synchronous players' interaction, etc.) brought by the advancement of technology, but also their underpinning learning philosophy, shifting from behaviourism (Rachlin, 1991; Skinner, 1938) to constructivism (Bruner, 1960; Papert, 1993; Piaget, 1964, 1970). In direct contrast to behaviourist education, constructivist education emphasizes that students should construct knowledge on their own. Students' learning is not imposed simply by conditioning and reinforcement, but rather a cognitive and socio-cultural interaction in an engaging and authentic learning environment (Otting & Zwaal, 2007).

Initiating and sustaining students' learning motives through gaming has been one of the significant research areas of game-based learning (e.g., Bowman, 1982; Cordova & Lepper, 1996; Malone, 1980, 1981; Martens, Gulikers & Bastiaens, 2004). More recently, researchers in the domain (e.g., Aylett, 2005; Gee, 2003, 2005; Kirriemuir & McFarlane, 2004; Mason & Moutahir, 2006; Prensky, 2001, 2006; Shaffer, 2006; Squire, 2005) have also argued that the underlying cognitive and socio-cultural features of games can offer various "educative" opportunities to students. In the following, we will discuss games' intrinsic educational traits that promote constructivist learning from the *motivational*, *cognitive* and *socio-cultural* perspectives.

Motivational Perspective

Constructivist learning theorists (e.g., Papert, 1993; Piaget, 1964, 1970) realize that game-like activities can foster students' deep learning. It is because, in those activities, students are willing to spend more time and effort on learning. They also feel better about what they learn, and will try to apply the acquired knowledge and skills in the future.

There have been a number of game-based learning studies focusing on investigating what, why, and how gaming can make students more motivated during the process of learning. Based on a series of surveys, observations and interviews with gamers, Malone (1980, 1981) put forward a motivation theory, which asserts that *challenge*, *fantasy*, *control*, *curiosity*, *cooperation*, *recognition*, and *competition* are the most significant elements that make gaming fun and engaging, and sustain gamers' continual motives. Malone advocated that schools

should try to integrate gaming elements into curricula so as to arouse students' intrinsic motives in learning. Apart from that, Bowman (1982) tied his study on learning through gaming with Csikszentmihalyi's (1975, 1990) psychological conception of *flow*. Flow is a state of experience of "*intense concentration and enjoyment*." Under the flow state, a person will engage in a complex, goal-directed challenge not for external rewards, but simply for the exhilaration of dealing with the challenge. Bowman believed that learning through gaming is a spontaneous way to bring students to the flow state of learning. Although Bowman's work was done more than two decades ago, recent empirical evidence (e.g., DeLisi & Wolford, 2002) still accords with his assertion.

Fun and enjoyment are essential elements in the process of learning as students can be more relaxed and motivated to learn (Bisson & Luncker, 1996; Cordova & Lepper, 1996). Gamers always undergo hard but engaging, challenging but pleasurable, and risk-taking but rewarding experiences in gaming (Prensky, 2001). All these are the experiences of fun and enjoyment. From both theoretical and empirical points of view, it is expected that students are more motivated to participate in educational activities if these activities take place in a form of gaming.

Cognitive Perspective

The traditional school curricula are often fragmented into small and unconnected pieces (Papert, 1993). The original intention is for making learning easier, but this usually ends up neglecting the rationale behind the knowledge itself, creating unrealistic learning contexts, and rendering the whole learning process boring. Without chunking or turning learning content into a series of split-screens, a well-designed game does well in presenting near real-life context for students to acquire knowledge and skills unintentionally rather than deliberately (Gee 2003). This sort of learning experience coincides with Lave and Wenger's (1991) conception of *situated learning*.

When discussing games' educational potential from the cognitive perspective, we should first classify today's games into *mini-games* or *complex-games* (Prensky, 2006). In general, playing mini-games takes around several minutes to an hour. Usually, these games contain simple challenges and content, with neither ethical dilemma nor human gamers' interaction. In contrast to mini-games, complex-games require gamers' dozens of hours (or even more) of concentrated attention to master. Most tasks therein are generative and open-ended without prescribed gaming strategies. Gamers engaged in complex gaming cannot be passive (Antonacci & Modaress, 2008). They have to analyze the perceived information and context in the games proactively, and then apply their existing knowledge and skills to formulate strategies, make decisions, and then examine results. It is also necessary for them to acquire new and multiple skills, and interact (compete, cooperate or collaborate) with other human gamers or NPCs (non-player characters) inside the games (Gee, 2003; Mason & Moutahir, 2006).

Complex games offer the prospect of user-defined learning environments (Halverson, 2005) in which individuals can try out and get feedback on their assumptions and strategies. This is a new cognitive way for learners to acquire knowledge and skills in a constructivist fashion (Shaffer, Squire, Halverson & Gee, 2005).

Socio-cultural Perspective

How to educate students is not seen as how to build representations in each of their heads, but how to engage them in social practices (Lave & Wenger, 1991). Knowledge itself arises from social needs, fulfills social functions, and is tied inherently with cultural conditions (Cole, 1996). Thus, learning is not just a process of mastering facts, or even doing complex tasks, but rather, participating in socio-cultural practices. This requires learners to develop their own identity in relation to others.

Most of today's gaming activities are situated socially and culturally (Gee, 2003), entwining practice, participation, community, and identity (Wenger, 1998). The gamer generation prefers human competitors and/or collaborators rather than purely artificial intelligence (AI) (Prensky, 2001). Gamers meet online and form teams to discuss challenges, complete quests, and solve puzzles. Moreover, nearly every prevalent game does not simply appear alone as a game itself, but exists logically as a *game system* (Prensky, 2006). In each of these systems, besides a complex game concatenating with a built-in real-time chat console, it also entails gamers' self-initiated components, such as online discussion forums, fans' sites, blogs, etc. All these components enable and encourage individuals to share, discuss, evaluate and apply the community knowledge co-constructed by the community members.

In didactic schooling approaches, learning takes place through teaching and testing (Gee, 2005), and students can merely gain standardized learning experiences (Halverson, 2005). Compared to those traditional approaches, game-based learning can create a more social and cultural world that helps individuals learn by integrating thinking and social interactions (Shaffer et al., 2005). Moreover, the whole learning process does not necessarily need to be face-to-face and take place at school.

3. CONTEMPORARY GAME-BASED LEARNING STRATEGIES

When the idea of "learning through gaming" was first introduced into education, most of the so-called "educational games" were designed mainly based on the drill-and-practice learning principle (Egenfeldt-Nielsen, 2007). Usually, those games had a clear reward structure that was used as a way to push students' learning forwards. It was assumed that students could be put in front of computers, and then learned the designated content and skills through drills and practice, without teachers' help or involvement. For example, in *Math Blaster!*[ii], students have to shoot down the right answer to the mathematics question shown on the screen. On each success, the player's balloon will move towards a needle. A student who can pop his/her balloon eventually will win the game.

Squire (2003) observed that drill-and practice games are still popular in today's education. It is because they can be integrated easily into ordinary school curricula as enrichment exercises for students to reinforce their exiting knowledge or skills during their independent study time. However, a number of educators and researchers (e.g., Card, 1995; Gredler, 2004; Kirriemuir & McFarlane, 2004; Papert, 1993; Prensky, 2001) have been criticizing that drill-and-practice games lack integration of learning experience into gaming experience, and promote rote memorization. "Parrot-like" learning will result in weak transfer and application of knowledge and skills (Gee, 2003; Jonassen & Howland, 2003).

Contemporary game-based learning researchers (e.g., Adam, 1998; Aylett, 2005; Cameron, 2008; Gee, 2003, 2005; Ip, Luk, Cheung, Lee & Lee, 2007; Johnson, 2005; Jong et al., 2006, 2007; Lee et al., 2006; Shaffer, 2006; Squire 2005) believe learning through gaming can be much

more than drilling and practicing. The ability of today's games to sustain spontaneous gamers' engagement, offer gamers near real-life experiences, and exploit proactive gamers' communities makes gaming another possible means to realize constructivist education. In the following, we will review and discuss a number of constructivist game-based learning instances in the domain. In general, they can be categorized into two research foci, namely, *education in games*, and *games in education*.

Education in Games

Gee (2003) has been advocating the exploration of the possibility of adopting recreational games in the commercial market for educational use. He argued that many bestselling recreational games (e.g., *Full Spectrum Warrior*[iii]) are already state-of-the-art learning games as they are hard but fun, time-consuming but enjoyable, and complex but "learnable." As an education-in-game proponent, Adam (1998) adopted a prevalent recreational game, SimCtiy 2000[iv], into a university-level introductory urban geography class for the students to acquire urban planning concepts through playing the game in a self-directed manner. SimCity 2000 is a "city-building" simulation game. The game cannot only approximate near real-world conditions and phenomena of designing and building a city, but can also demonstrate the potentially successful or disastrous consequences of complex decision making in urban planning. Prior to the adoption, Adam analyzed SimCity 2000, and set up a number of learning objectives related to urban planning that they expected students could achieve after playing the game. Further, he conducted a number of learning experiments to verify quantitatively whether those gaming experiences would yield the expected students' learning outcomes. The research results revealed that, in terms of students' knowledge acquisition (urban planning concepts) and their perceptions of "learning through gaming," the game-based learning adoption in Adam's study yielded positive outcomes.

Another education-in-game proponent, Squire (2005), investigated the possibility of integrating another prevalent recreational game, *Civilization III*[v], into a US high-school classroom for teaching the formal world-history curriculum. Civilization III allows players to lead a civilization from 4000 BC to the present, with a mission to compete for political, scientific, military, cultural, and economic victories. In this game, each player has to seek geographical resources, manage economics, plan the growth of his/her own civilization, and engage in diplomacy with other players competitively and collaboratively. In the study, although Squire concluded that the students could develop more understanding and interest in historical knowledge, he remarked that it was difficult to align the "educative" content in the game with what was required in the subject curriculum. In fact, this remark, to a certain extent, coincided with some other similar arguments made by other game-based learning researchers. Mishra and Foster (2007) realized that it is hard to integrate existing recreational games into existing school curricula, as those games are designed originally for entertainment purpose, rather than education purpose. It is difficult for teachers to identify what and how a particular part of a recreational game is relevant to a particular part of a subject curriculum. On top of that, the authenticity and accuracy of the "educative" content of recreational games are another cause for concern over the integration of recreational games into formal schooling (Kirriemuir & McFarlane, 2004).

More recently, there has been literature (e.g., Gee, 2005; Prensky, 2006; Reese, 2007; Salen, 2007), from a more theoretical perspective, discussing recreational games' potential for

preparing youngsters to become the skilled workforce in the twenty-first century. Nevertheless, some critics (e.g., Egenfeldt-Nielsen, 2007; Mishra & Foster, 2007) have been arguing that those claims lack empirical evidence, and most ideas therein still remain philosophical arguments.

Games in Education

Instead of adopting existing recreational games in the commercial market, a number of game-based learning researchers design and develop educational games articulated with different constructivist learning paradigms. For example, *distributed authentic professionalism* (Gee, 2005) is the underlying learning paradigm of Shaffer's (2006) educational games. Distributed authentic professionalism refers to the distribution of authentic professional expertise between NPCs (non-player characters) and gamers' avatars while gamers are engaged in specific activities during gaming. Professional knowledge and practice are embodied through the interactions between NPCs and gamers. Thus, gamers can gain first-hand experiences on how members of these professions think, behave, and solve problems. The whole cognitive process is situated both socially and culturally. Shaffer (2006) gave a more detailed account of Gee's (2005) idea of distributed authentic professionalism. He realized that members of a profession have an *epistemic frame*—a particular way of thinking and working, i.e., a grammar of a particular culture. In other words, epistemic frames are the conventions of participation that learners become internalized and acculturated. Thus, developing students to be members of a particular profession is a matter of equipping them with a right epistemic frame. To accomplish this, Shaffer and his colleagues developed a number of *epistemic games* which allow students to participate in simulations of various professional communities that they might someday inhabit. The communities include, for example, biomechanical engineers in **Digital Zoo**[vi], ecological thinkers in **Urban Science**[vii], journalists in **Journalism.Net**[viii], etc.

Lee et al. (2006) proposed a constructivist learning paradigm for designing educational games, namely, *Folklore-based learning*. This paradigm suggests that learning takes place in an interactive adventure highlighted by problem-solving tasks which are situated in a folklore-based story plot. It is not only aimed at enabling students to learn in an authentic environment, but also offering interesting story episodes as a motivating agent for less initiated students. As prototype work, Lee et al. developed a game to realize this learning paradigm, namely, *Tong Pak Fu and Chou Heung*[ix], based on the topic of probability in Mathematics education. This game is composed of several gaming stages, from sample space construction in the first stage, to simple probability, to conditional probability, and eventually to the *Monty Hall Problem* (Fowler, 1996) in the last stage. In each stage, students are presented a problematic scenario and required to solve the problems therein in order to proceed to the next stage.

Emergent narrative is the underlying constructivist learning paradigm of Aylett's (2005) narrative games. This paradigm suggests learning through role-playing in an improvised, rather than scripted digital story. The plot of the story in a narrative game emerges from the interactions between players' avatars and NPCs therein. If necessary, a teacher can participate in the game to intervene the emerging story so as to facilitate his/her students' learning. FearNot! (Aylett, Figueiredo, Louchart, Dias & Paiva, 2006) is an instance of narrative games. It was designed to educate children against bullying behaviour at school. Students in this game act as counselors to give advice to victims (the NPCs in the game) who are being bullied at school. Their advice will influence the proceedings about the victims in the next episode. Thus, students can observe the consequence of the actions taken by the victims in accordance

with their prior advice. This game offers a safe environment for students to witness bullying incidences and reflect on how they have to cope with these incidences in real life.

4. OUR GAME-IN-EDUCATION WORK

In this section, we will introduce two pieces of our recent game-in-education work. The first one is *Learning Villages*[x] (Ip et al., 2007; Jong, Tse, Zhou, Chen, Lee and Lee, 2008)—a massively multi-player online game to support collaborative learning. The second is *Virtual Interactive Student-Oriented Learning Environment* (Jong et al., 2006, 2007)—a constructivist pedagogical approach to game-based learning.

Learning Villages

CSCL (Computer-Supported Collaborate Learning) refers to the process of a group of students engaging in discussing their perspectives on a problem with the goal of knowledge acquisition through a computer-based communicative platform (Weinberger & Fischer, 2005). Success of a group is attributed to all group members rather than merely the group leader (Scardamalia & Bereiter, 2003). Each member is responsible for knowing what needs to be known, and ensuring others to know the same.

Learning Villages *(LV)* is a game-based CSCL platform that operates in a form of massively multi-player online gaming, in which each student can design his/her own virtual character (an avatar) to participate in this virtual world. There are various entertaining elements in LV. For example, students can earn the *passion value* and upgrade their own *symbolic status* through playing a range of mini-games. Furthermore, there are various "hangout places" for students to meet one another. The interactions include real-time chat, making funny gestures and showing funny emotional icons to draw others' attention, etc. Figure 1 shows one of the hangout places in LV. Besides the entertainment, LV facilitates students' 2-tier issue-based discussion for collaborative learning. The first-tier is "village-level discussion," while the second-tier is "house-level discussion."

Figure 1. A hangout place in LV

Both levels of discussion can take place concurrently. Each *village* in LV represents a

discussion issue. A student can create a village, taking the role of *Chieftain* by initiating an issue for discussion. Any other students in LV who are interested in that issue, can become *Villagers* by building *houses* in that village. They can use houses to elaborate, for example, their perspectives, arguments or some related concepts with respect to the issue. In addition, students can build *roads* between the houses to interconnect different perspectives, arguments or concepts delineated in the village. They can make use of different types of roads, namely, *Explanation*, *Evidence*, *Problem*, *My Reply*, *Solve This First*, *Another View*, *Compare With*, and *Others* to reflect the different relationships between the elaborations represented by those houses. This is called village-level *(the first-tier)* discussion. An example is shown in Figure 2.

In the village, every house is "enterable," and it functions as an individual forum to facilitate discussion on a specific perspective, argument or concept raised in the village-level discussion. In LV, the term "*postings*" is used to represent the discussion threads inside houses (see Figure 3). This is called house-level *(the second-tier)* discussion. The more postings there are in a house, the larger its size and the higher its modernity level will be. The advantage of the 2-tier design in LV is that, major perspectives, arguments and related concepts, as well as their relationships with respect to a discussion issue can be arranged neatly in the form of mind mapping at the village level. However, it is still handy for students to review the details of a particular perspective, argument, or concept discussed at the house level.

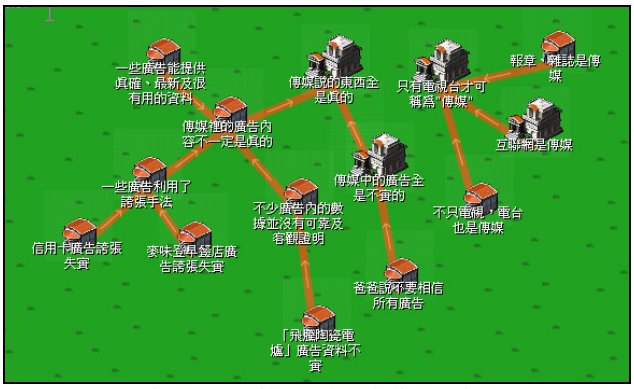

Figure 2. Village-level discussion

Figure 3. House-level discussion

In order to encourage students to participate in quality issue-based discussions, the invest-and-reward mechanism is one of the strategies adopted in LV for the purpose. Every time when a student creates a village, or builds a house in villages created by others, he or she has to pay "donuts" *(the virtual money in LV)*. Nevertheless, when the number of quality houses and postings in the villages *(that he or she has "invested" in)* reaches a certain amount, the village will be upgraded by either the LV system administrator or their learning facilitators *(usually their teachers)*. Benefits brought about by the upgrade include donut reward, higher social status conferment for enjoying extra privileges in LV, etc.

Virtual Interactive Student-Oriented Learning Environment

Virtual Interactive Student-Oriented Learning Environment *(VISOLE)* is a constructivist pedagogical approach to empower game-based learning. This approach encompasses the creation of a near real-life online interactive world modeled upon a set of multi-disciplinary

domains, in which each student plays a role in this "virtual world" and shapes its development. In VISOLE, we adopt a game-pedagogy co-design strategy in which we emphasize the importance of teachers and their roles therein. Upon the theoretical foundation[xi] of *intrinsic motivation* (Malone, 1980, 1981), *situated learning* (Lave & Wenger, 1991), *scaffolding* (Vygotsky, 1978), and *debriefing* (Thiagarajan, 1998), VISOLE is framed into three operable pedagogical phases, namely *Multi-disciplinary Scaffolding* (Phase 1*), Game-based Situated Learning* (Phase 2), and *Reflection and Debriefing* (Phase 3), as diagrammatically shown in Figure 4. Please note that Phase 2 and Phase 3 take place in an interlacing fashion, but Phase 2 starts a bit earlier than Phase 3.

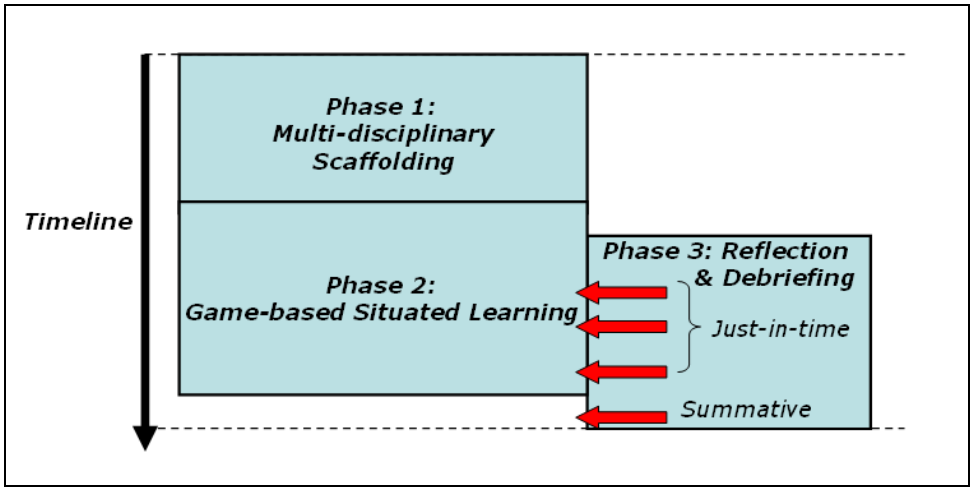

Figure 4. Three pedagogical phases of VISOLE

Phase 1: Multi-disciplinary Scaffolding. VISOLE teachers act as cognitive coaches to activate VISOLE students' learning motive, and assist them in gaining some preliminary high-level abstract knowledge (prior knowledge) based upon a selected multi-disciplinary framework. In this phase, students are equipped with "just enough" knowledge, and given only some initial "knowledge pointers." They have to acquire the necessitated knowledge and skills on their own in the next learning phase, not only from the designated learning resources but also a wider repertoire of non-designated learning resources, such as the Internet.

Phase 2: Game-based Situated Learning. This phase deploys an online multi-player interactive game portraying a virtual world. The scenarios therein become the dominant motivator driving students to go on to pursue the inter-related understandings of the multi-disciplinary abstractions encountered in Phase 1. The game encompasses the creation of a virtual interactive world in which each student plays a role to shape the development of this world for a period of time. The missions, tasks and problems therein are generative, and there is no prescribed solution. Since every single action can affect the whole virtual world, students have to take account of the overall effects associated with their strategies and decisions on others contextually and socio-culturally. "Being situated" in this virtual world, not only do students have to acquire the subject-specific knowledge in a multi-disciplinary fashion, but they also need the generic skills of problem analysis, strategy composition, decision making, etc.

Phase 3: Reflection and Debriefing. This phase interlaces with the activities in Phase 2. After each gaming session, students are required to write their own reflective journal to internalize their learning experience in the virtual world in a just-in-time fashion. Moreover, at

the end of this phase, they are required to write their own report in a summative fashion to reflect on their overall learning experience. In addition, teachers monitor closely the progress of students' development of the virtual world at the backend, and look for and try to act on "debriefable" moments to "lift" students out of particular situations in the game. Respectively during the course and at the end of this phase, teachers extract problematic and critical scenarios arising in the virtual world, and then conduct just-in-time and summative case studies with their students in face-to-face debriefing classes.

FARMTASIA (Cheung, Jong, Lee, Lee, Luk, Shang & Wong, 2008) is the first online game following the pedagogical paradigm of VISOLE. It involves the subject areas of geography (natural environment and hazards, as well as environmental problems), biology, economics (including government, and production system) and technology. The "virtual world" of FARMTASIA consists of interacting farming systems, covering the domains of cultivation, horticulture, and pasturage. In the game, every student acts as a *farm manager* to run a farm which is composed of a cropland, an orchard, and a rangeland. Each student competes for *financial gain* and *reputation* with three other farm managers who are also at the same time running their own farm somewhere nearby in the same virtual world. Throughout the gaming period, students have to formulate various investment and operational strategies to yield both quality and abundant farm products to the market for making profit. Nevertheless, the richest may not be the final winner. Students' final reputation in the virtual world is another crucial judging criterion, which is determined by their practices on sustainable development and environmental protection. "Wise Genie," who is one of the game characters, will appear in the virtual world for giving advice or hints to students in some critical moments.

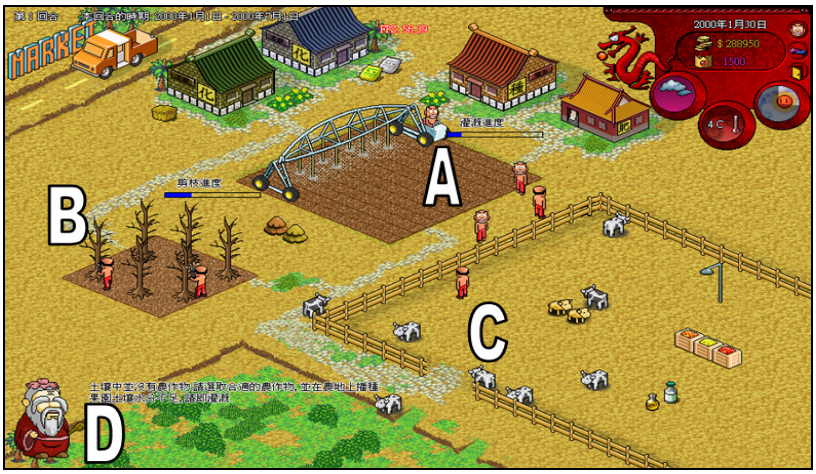

Figure 5. The gaming interface of FARMTASIA
(A) Cropland, (B) Orchard, (C) Rangeland, & (D) Wise Genie

In order to enable teachers to review students' performance in the game, a "record-and-replay" system is implemented in FARMTASIA. While students run their own farm in the virtual world, the system logs their every single gaming action. Teachers can make use of the teacher console to re-transform the logging stored in the game server into students' gaming proceedings, and then replay the proceedings in a form of "video" playback. With the record-and-replay system, teachers can look for and extract interesting, problematic, or critical scenarios taking place in the virtual world to conduct just-in-time and summative case studies

with their students. Since all these scenarios come from students' actual gaming experiences, it is easier for them to recognize, empathize, and understand the constructive and destructive occurrences therein, and the corresponding enhancement and corrective actions.

5. CONCLUSION

In this chapter, we have introduced briefly the background of game-based learning, from the early 1980s' drill-and-practice learning paradigm to the recent constructivist learning paradigm, and from its original purpose of "sugaring the pills" to today's purpose of sustaining learners' intrinsic engagement and exploiting cognitive and socio-cultural learning environments. Besides elaborating on a number of intrinsic educational traits of today's games that favor constructivist learning, we have also reviewed two recent research foci in the game-based learning domain, namely, education in games, and games in education.

Education-in-game researchers (e.g., Adam, 1998; Gee, 2003; Squire, 2005) have focused on investigating the possibility of a direct transformation of entertainment into edutainment. Nevertheless, some game-based learning commentators (e.g., Rice, 2007) realize that the education-in-game approach is more suitable to support students' after school informal learning, rather than formal schooling. On the other hand, instead of adopting existing recreational games in the commercial market, game-in-education researchers (e.g., Aylett, 2005; Ip et al., 2007; Jong et al., 2006, 2007; Lee et al., 2006; Shaffer, 2006) have focused on designing and developing educational games articulated with different constructivist learning paradigms or pedagogical approaches.

We have no intention to argue that all learning should be via gaming. However, we believe that game-based learning could be an integral part of our education systems allowing a variety of contemporary pedagogical approaches to co-exist and interplay. Some researchers argued that today's educational environment is still not flexible enough to accommodate game-based learning in place (e.g., Squire, 2005), and the real integration of games into formal schooling has not yet been explored systematically (e.g., Halverson, 2005). Apart from discussing how to design and develop the best games for the educational use, the actual adoption, implementation, and evaluation of game-based learning within school and institution settings are issues which need to be addressed.

We hope our discussion in this chapter can generate a flash of inspiration for game-based learning researchers, educators, school teachers, game designers, as well as game companies, when reflecting on the questions of what, why, how, and when gaming can be educational. More mature and comprehensive frameworks for the educational use of games (*either the education-in-games approach or games-in-education approach)* will emerge soon, provided that we continue to pursue open discussion and conversation within multiple fields and disciplines.

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[i] Unless otherwise specified, the terms "game(s)" and "gaming" refer to "computer game(s)" and "computer gaming."

[ii] *Math Blaster* is an educational game for children aged 6-9 to assist them in learning the criteria for Key Stage 1 and 2 mathematics skills. http://www.smartkidssoftware.com/nddav31.htm (Retrieved on January 15, 2009)

[iii] http://www.fullspectrumwarrior.com/ (Retrieved on January 15, 2009)

[iv] http://www.sc3000.com/sc2000/ (Retrieved on January 15, 2009)

[v] http://www.civ3.com/ (Retrieved on January 15, 2009)

[vi] http://epistemicgames.org/eg/?cat=15 (Retrieved on January 15, 2009)

[vii] http://epistemicgames.org/eg/?cat=14 (Retrieved on January 15, 2009)

[viii] http://epistemicgames.org/eg/?category_name=journalism-game (Retrieved on January 15, 2009)

[ix] http://www.cse.cuhk.edu.hk/~mhp/ (Retrieved on January 15, 2009)

[x] http://www.learningvillages.com (Retrieved on January 15, 2009)

[xi] For the details of the theoretical foundation of VISOLE, please refer to the work of Jong et al. (2006, 2007).