A Conceptual Design of Teacher-Learner Framework for Educational Serious Games

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Abstract

This paper introduces a conceptual Teacher-Learner framework for collaborative learning with serious games. An initial study identified 12 attributes of educational serious games that can be used to support effective learning. These attributes can be applied to the development of a conceptual framework for games to support learning. A considerable number of serious games have been developed over the 10 years, with varying degrees of success. Due to a lack of clear standards and guidelines for game developers, it is difficult to justify claims that a specific game meets the learners' requirements and/ or expectations. This paper provides an account of a conceptual framework for serious games that will guide their designs and the measurement of achievements in meeting the learners' requirements.

Keywords conceptual framework, model, serious games, teacher-learner

INTRODUCTION

Currently, a majority of teaching and learning activities are focusing on examinations, thus burdening students with unnecessary workload. Furthermore, students can get easily bored, which makes them less attentive. Another major problem with traditional teaching is that the ratio of learners to teacher keeps increasing. As a result, learners are getting fewer contact hours and, as the class size is getting bigger, they are given less guidance on how to progress in their studies. These problems, if left unattended, can push students to unhealthy activities as a means to escape from boredom and neglect. For instance, the Malaysian Education Ministry reported that in 2011 there were over 11,000 students or 2% of the student population who had been cautioned with several disciplinary warnings nationwide. Even though the percentage is currently small, the number of cases is alarming given the students' age, which

is relatively young. More efforts are needed to minimize these problems by, for example, making students more interested to go to school. Therefore, the aim of this paper is to find a benchmark learning framework for the young learners that can be adapted to current schools using immersive learning materials with games, which are widely accepted to be fun and entertaining. More profoundly, this learning framework based on serious games can help create learning environments that can attract and motivate learners to learn and to keep them engaged, leading to the attainment of the learning objectives. Moreover, the proposed learning framework is needed as existing standards and guidelines have been criticized for their lack of efficacy in meeting learner's requirements or expectations. One of the criticisms is that most of the available games for learning have been created without the involvement of language or pedagogy experts (Verdugo & Belmonte, 2007). To address the needs for better standards, this paper highlights a conceptual framework for collaborative learning with serious games based on the contemporary learning theory. The use of the learning theory is vital to guide game designers in developing serious games that can stimulate effective learning.

A CONCEPTUAL FRAMEWORK FOR COLLABORATIVE LEARNING

This section discusses the development of a new learning game framework because existing applications of games in learning have been found to be not highly effective. One of the reasons is that the tasks in the games have been poorly designed to support effective learning (Kirriemuir & McFarlane, 2004). To make learning through games more effective, Prensky (2001b) claims that the ideal framework for serious games for learning is to have an equal proportion of engagement and learning. In essence, he states that by introducing enjoyment within the game, the learner becomes more engaged in learning. Some studies have proposed several serious games frameworks; however, their effectiveness in creating meaningful learning through serious games is still not clear. The Input-Process-Outcome game model framework by Garris (2002) focuses on a repetitive loop that requires learners to constantly re-engage in the learning process; however, given its repetitive nature, this model will not be able to foster higher, active learning (Westera, et al., 2008). On the other hand, Charles (2009) presented a model that illustrates the relationship between computer games and learners, which is based on three layers for a useful game. The first layer deals with game mechanics that needs to be observed by the learner. The second layer is the dynamic link between the learner and the game, and the third layer is the aesthetic design of the game, which will create the learner experience in the game. However, this model seems suitable only for developing computer games that support generic learning – the model does not offer any detailed design for optimal learning. De Freitas and Oliver (2006) introduced a framework for supporting tutors' evaluation of education games and simulations. However, this framework

only focuses on the game evaluation, not on their design (Westera, et al., 2008). Hu (2008) proposed a game framework that is based on classroom teachings called Eduventure game framework, which uses an adventure game for learning. Still, this model is too confined to a textbook style and does not offer any freedom for exploratory learning. Meanwhile, Amory (2007) proposed Game object model II that focuses on identifying interface requirements for a game, challenges and social space. Again, this model is not portent enough (Westera, et al., 2008) to guide the design of serious games because it does not take into consideration the gameplay and flow theory (Kiili, 2005). Westera et al. (2008) proposed a framework based on the expansion of basic architecture of scenario-based game development. The framework is strongly linked to customised software called Emergo (2008). However, this framework is still in the theoretical stage, and it does not offer any design solutions to work with other game design tools. Kiili (2005) proposed a learning game framework based on the four stages of experiential learning by Kolb (1979), which needs to be implemented in a game. This framework uses a challenge as a problem solving activity to keep the learner engaged. Even though this framework helps to integrate learning with games, it still lacks other important pedagogical elements, such as reinforcement (e.g., rewards), built into the game.

To guide the game designer in developing serious games for optimal learning will entail a framework that is conceptualized from a series of perspectives, namely learning, pedagogy, and games. Therefore, to address the above problems and to improve the game design that will make games become more effective for learning, the authors propose a new framework as shown in Figure 1. This framework represents a structure of serious games that will be used as a conceptual framework for serious games. Essentially, the framework was conceptualized based on research of learning theories, teaching pedagogy, and real games construction of earlier frameworks (Garris, et al., 2002; Gilbert & Gale, 2008b; Thompson, Berbank-Green, & Cusworth, 2007a).

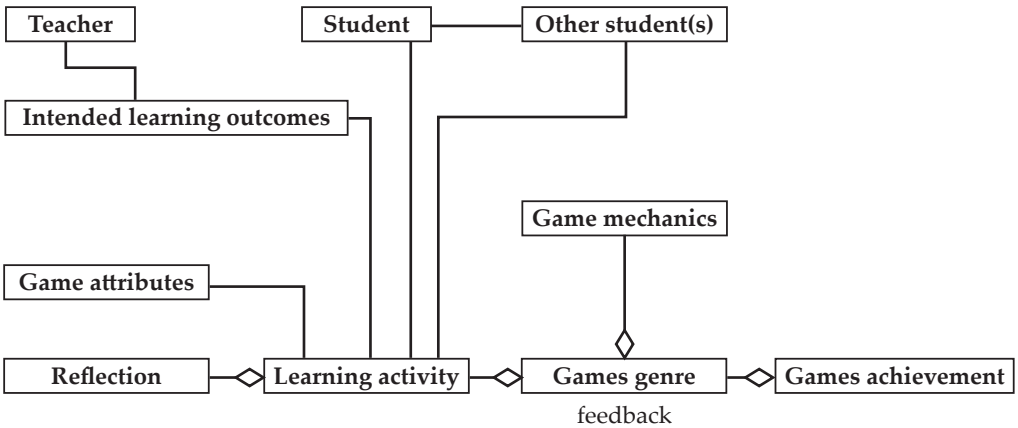

Figure 1 Conceptual Framework for Collaborative Learning shown as a Structural Class diagram

TEACHER

Teachers can play the role of a facilitator and help guide the students to achieve the objectives or intended learning outcomes. The educational perspectives suggest that the learner constructs their own knowledge, and their understanding is generated from negotiation within their community or peers. While peer-to-peer learning involves learners acquiring knowledge from others to navigate a game world, mastery of knowledge has to come from their learning experience as well as from collaboration with their peers (Langer, 2009; Sauvé, 2009). Learning is not necessarily restricted to the classroom or tied to a curriculum. Instead, learners may be viewed as a producer or a contributor to their knowledge, and they can be autonomous in their learning (Kafai & Fields, 2009; Steinkuehler & Squire, 2009). The development of knowledge by the learners can be achieved from active exploration within the game (Conati & Manske, 2009). Looking for clues for the game's obstacles and searching for answers within the game is a way in which this might work. To gain mastery in certain skills within a game requires two things. First, to solve certain problems within the game, the learner has to perform certain steps that invoke critical thinking. Secondly, to progress to the next level of the games entails the ability to transfer previously learnt skill (i.e., reusing existing skills to gain new skills). In other words, during playing, the learner draws upon his or her real-life experiences and blend these with newly-acquired skills to accomplish a learning task.

Self-efficacy is a construct that reflects the players' behaviour, which can be measured by the amount of time spent in a game. Longer time spent in playing games usually means that the learners are doing well and their confidence is high. Offering help and support (i.e., scaffolding) and reinforcement (i.e., learning feedback) in games will increase the learners' self-efficacy (Yates, 2005). To ensure that learners can cope by themselves or be able to apply the learning skills on their own, serious game developers must know when to provide, or not to provide, the features to the learners before the responsibility is shifted to the learners.

The instructional content delivery can be done by carefully designing the game activities. Learners can be informed of their progress by adequate feedback during these activities. In addition, from the perspective of self-paced learning, serious game designers can adjust the learning activities according to learners' performances by allowing them to spend sufficient time to acquire the skills as intended. However, problems will arise in trying to adapt the educational perspectives based on a single method. This situation poses several important questions. If learners are allowed to control their own learning, will they know how to learn and plan their own activity? If learning is based on learners' own experiences, how can standards be set in order to assess whether meaningful learning has taken place? Do learners know that the knowledge gained is the 'correct' knowledge that they are supposed to learn? Addressing these questions requires a multi-method approach as deemed critical from the teacher's perspective.

STUDENT AND OTHER STUDENT(S)

Learners can acquire new skills from their own learning experience by having sufficient time to practice. This resembles a learner exploring on his own and picking up skills (experience) within the game in order to continue to the next level at their own pace. Rogers developed the theory of facilitative learning or the humanist approach (Rogers & Freiberg, 1994; Zimring, 1994). He suggests that learning will take place where the teacher acts as a facilitator, and the learners feel comfortable exploring new ideas on their own and charting their own learning path. In this study, the researchers have developed a framework based on the constructivist perspective, which posits learning takes place as learners collaborate with each other through sharing and cooperation in finding an answer to a given problem . For example, a learner can build up his/her knowledge or try to complete his/her learning by sharing and asking information from other learners. In the end, these students will attain the same level of knowledge through mutual collaboration that shortens the learning process. The teaching materials and instructional contents given to the students will have to be based on their capability to maximize learning effectiveness. In this regard, capability refers to the cognitive, psychomotor, and (possibly) affective skills that learners develop as a result of playing games, and these three domains of skills are attributed to Bloom (1956), Dave (2003), and Krathwohl (2001), respectively.

INSTRUCTIONAL CONTENT

The instructional content is the subject matter that it is intended for learners to learn. The details of the actual subject matter to learn, or the types of contents that learners learn, could be an exhaustive list. Gilbert and Gale (2008) illustrate the classification of contents based on four types: facts, procedures, concepts, and principles.

INTENDED LEARNING OUTCOMES

Learning outcomes are the goals to be achieved from playing serious games. An intended learning outcome is a particular combination of capability and subject matter. For example, learners should be able to recall the date of a particular Indian War or to analyse whether a particular bird is a raptor. Typical examples of learning outcomes are based on taxonomies of educational objectives where learners' capabilities are measured according to the psychomotor, cognitive, and affective domains (Gilbert & Gale, 2008). For example, pilots can undertake rigorous training in both the classroom and aircraft cockpit. A study showed that playing aviation computer games for a number of hours had resulted in pilots performing better in test flights (Connolly, Johnson, & Lexa, 1998).

Game attributes are those aspects of a game which support learning and engagement. The game attributes, as listed in Table 1, are deemed important based on the critical review of related literature concerning behaviourist,

cognitive, constructivist, educationist, and neuroscience perspectives (Yusoff, et al., 2009). The game attributes include:

1. Incremental learning provides the learning materials and introduces the learning activities incrementally. Intended learning outcomes are addressed one by one and not all at once.
2. Linearity is the extent to which the learning activities are sequenced by the game (and would suit a serial learning style), and the extent to which an active learner may be able to construct their own sequences.
3. Attention span concerns the cognitive processing and short-term memory loads placed upon the learner by the game. These loads need to be carefully calibrated to the target learner.
4. Scaffolding is the support and help given by the game during the learning activities.
5. Transfer of learned skills is the support provided by the game to enhance the application of previously learned knowledge to other game levels.
6. Interaction is the extent to which the game activities require responses and engagement from the learner.
7. Learner control is the extent to which the learner can direct their learning activities within the game, providing self-study and self-exploration to suit their own pace and experience.
8. Practice and drills provide repetitive learning activities with increasingly harder tasks for better achievement of the intended learning outcomes.
9. Intermittent feedback is the extent to which every game interaction receives feedback, or whether feedback is provided less frequently.
10. Rewards are arrangements in the game to encourage the learner and to keep their motivation high.
11. Situated and authentic learning involves the provision of a gaming environment or world where the learner can relate their learning to their needs and interests in the outside world.
12. Accommodating to the learner's styles refers to the game's ability to suit and to reach out to different learner styles by offering variation in game play.

LEARNING ACTIVITY

Learning activity is the activity designed to keep learners engaged and learning in the game world. The deep involvement or immersion by the learner depends on the effective design of these activities. Gilbert and Gale (2008a) recommended a number of methods for constructing learning activities to support given intended learning outcomes. For example, if a learner needs to be able to recall a concept, the learning activities would include showing an example of the concept and asking the learner for the concept's name, followed by feedback for the given answer. Activities should involve learning materials

that are appropriate and challenging for the target learners seeking competency at a level slightly above that of their current competency (Gee, 2007). To cater for this need, the majority of game designers spend considerable time in perfecting this area of "game play" in order to make the game successful.

Table 1 Serious Games Attributes

Attributes for Serious Games	Values for Learning and Education
Incremental learning	Learning material is delivered incrementally. Additional new knowledge is delivered and not done all at once. It will have a proper start and end section. Learner feels and learns in a natural way and less complex.
Linearity	Learning will be in sequence. This will suit the sequential learner. However, due to the games flexibility, active learner can skip chapters.
Attention span	This concerns with the cognitive processing and short-term memory loads placed upon the learner by the game. These loads need to be carefully calibrated to the target learner Not to be overwhelmed and too long in the learning process.
Scaffolding	Support and help during learning in the games.
Transfer of learnt skills	Learnt knowledge to apply to other skills in the next level.
Interaction	Higher engagement, higher learning.
Learner control	Active learning, self study and self exploration based on individual pace and experience.
Practice and drills	Repeating for harder task, better knowledge retention and can have plenty of game activities for drills.
Intermittent feedback	Learner to reflect on what has been achieved so far and motivated for higher score (higher learning). Also using just in time feedback for learning.
Reward	Encourage learners and keep them motivated. Negative reward as punishment in the game may also contribute to learning.
Situated and authentic learning	Learning in which learners can relate what is being learnt in the game to the outside world.
Accommodating the learner's styles	To suit and to reach out to different learning styles.

REFLECTION

Reflection is the process by which the learner thinks about the purpose of the learning activities that have been undertaken, and decides the strategy to apply for the next activity. Reflection should take place within the game without letting the learner step out of the game world, and this can be done by offering reflection activities within the game. Garris et al.(2002) stated that the reflection activity can be included within the game by providing a description, an explanation of why this activity is chosen, a discussion of the errors made by the learner, and some corrective suggestions.

GAMES GENRE

Game genre is the type or category of the game played. Genres range from "beat-'em-ups", through open-world sandboxes, to strategy games and simulation. More recently, game designers have developed serious games adopted for learning purposes according to these games genres.

GAME MECHANICS

Game mechanics and game rules define the details of the game (Thompson, Berbank-Green, & Cusworth, 2007). If the game genre is a Real Time Strategy, for example, then it may require game mechanics of resource management and territorial control. The desired learning activities and required instructional content influence the selected game mechanics in order to design a better game that will suit a particular style of learning, a particular target learner, or a particular set of intended outcomes.

GAME ACHIEVEMENT

Game achievement is the level of learner achievement in playing these games. This achievement can be indicated by the game scores, total amount of resources or assets collected within the game, or time taken to achieve game goals. In addition, it gives the pleasure of reward to the learner and also serves a purpose of learner assessment. The learning activities can be modified based on the student's achievements and progress in the game. This paper highlights that the proposed conceptual framework for serious games has the potential to support the design of serious games for effective learning. From the learners' perspective, they too need to acknowledge the educational potential of the serious games so that they will be ready and willing to use the games as part of their learning process. In this regard, the Technology Acceptance Model (Venkatesh & Davis, 2000) can be applied to determine the acceptance of the serious games in learning.

CONCLUSION

The serious games framework presented in this paper identifies the major components that can help create effective learning through the use of serious games. Every component of this framework plays an important role to ensure that learning would take place while playing games. The researchers have identified twelve (12) serious games attributes that can support effective learning with serious games. The attributes are Incremental learning, Linearity, Attention Span, Scaffolding, Transfer of learnt skills, Interaction, Learner Control, Practice and drill, Intermittent feedback, Reward, Situated and authentic learning, and Accommodating the learning styles. Brief descriptions of these attributes are shown in Table 1. The researchers have developed a serious games conceptual framework that can aid game designers or educationists in designing serious games. All the major elements, including the serious games attributes, can be fused synergistically to help realize effective learning with serious games. Overall, this proposed framework provides the guidelines that will be able to help designers and educational practitioners in designing serious games for effective learning.

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