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The Serious Game Constructivist Framework for Children's Learning

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Abstract

Recent studies have shown adoption of basic tenets of constructivism in the design of learning environments. Individual representation of knowledge; active learning through exploration; and learning through social interaction or collaboration make-up the basic tenets of constructivism that is addressed in turns in relation to serious games. In contrast to behaviourism which views learners as active recipients of information, in constructivism, the learner is an active processor of information. The constructivist view of learning has been embraced by the video game world. We are currently witnessing a dwindling interest in drill and practice educational games and an overwhelming acceptance of serious games believed to be consistent with the constructivist view of learning. The broadness of constructivism has made it difficult for serious games to completely adopt this principle. This paper aims at ascertaining the extent to which serious games have adopted this pedagogical principle in its approach to facilitating learning.

Keywords: constructivism; Serious Game; scaffolding; children; framework; learning; cognitive apprenticeship

1. Introduction

The constructivist theory or philosophy is based on "the assumption that knowledge is constructed by learners as they attempt to make sense of their experiences. Learners therefore are not empty vessels waiting to be filled, but rather active organisms seeking meaning" (Driscoll, 1994, p 360) cited in [1]. "Serious games" is a term that has evolved to describe the use of games in education, training, health, and public policy. Serious games do more than add window-dressing or fun to an otherwise serious (and potentially dull) learning task.

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They recast a learning task into one that is game-like and fundamentally alters the experience of the learner [2]. Constructivist is the view that involves the learner building on and modifying their existing mental models. The focus is on knowledge construction rather than knowledge transmission. The ability of serious games to assist in knowledge construction lies in its potential to modify the learner's existing mental model that alter the experience of the learner to incorporate the experience in the game world. The focus is on learner activity rather than teacher instruction [3]. According to [3], the principles of constructivism include individual representation of knowledge in which each person builds on his/her experiences. Also part of the constructivism principle, is active exploration and learning by interaction. A constructivist method for helping novices acquire expertise is cognitive apprenticeship [4]. Cognitive Apprenticeships uses many of the instructional strategies of traditional apprenticeships but emphasizes cognitive skills rather than physical skills [1]. Traditional apprenticeship have three primary components – Modeling, coaching and fading – utilized as the master craftsman models real world activities in sequence geared to fit the apprentice's level of ability. [1]. The master models expert behaviour by demonstrating how to do a task while explaining what is being done and why it is being done that way. The apprentice observes the master, and then copies her actions on a similar task, with the master coaching the apprentice through the task by providing hints and corrective feedback. As the apprentice become more skilled in the task, the master gives more and more authority to the apprentice by "fading" into the background (Johnson, 1992) cited in [1]. In the case of cognitive apprenticeship, cognitive rather than physical skill is emphasized. [5]. Therefore, Modeling, reflection, strategy formation, scaffolded exploration, debriefing and articulation are techniques required to catalyze knowledge construction for children. This paper aims at establishing the extent to which serious games have adopted these techniques. Section 2 briefly discusses the principles of constructivism; In Section 3 a serious game constructivist framework for children's learning is proposed based on the constructivism principle and the cognitive apprenticeship techniques; Section 4 discusses the current limitation of serious games to adopting constructivism while Section 5 is the conclusion.

2. The principles of constructivism

According to [3], the principles of constructivism include

An individualized representation of knowledge: each person builds on his own individual experiences.

Attributed to Piaget: people learn through active exploration, and that learning occurs when the learner's exploration uncovers an inconsistency between their current knowledge representation and their experience

Attributed to Vygotsky: learning occurs within a social context, and the interaction between learners and their peers is a necessary part of the learning process

These principles emphasize the need to enable learners connect an activity into their existing mental models.

3. The Serious Game constructivist framework for children's learning

According to [3] Simulations and microworlds are popular with constructivists for the following reasons

- Simulations [and some microworlds] provide a realistic context in which learners can explore and experiment with these explorations allowing the learner to construct their own mental model of the environment.
- The interactivity inherent in microworlds [and usually in simulations] provide for immediacy of feedback as the learner create models or try out their theories about the concepts modelled.

How these games adopt the following techniques would determine how constructivist they are.

3.1. Modeling

The learning process in the construction of knowledge for children usually begins with Modeling. Modeling is a form of demonstration followed by imitation, frequently used as a way of helping the learner progress through the ZPD. [6] This involves providing the child with background knowledge of the learning objectives of the game. This could be through demonstration, illustrations or videos, as these captivate children. The children are able to observe and build a conceptual model of the process required to attain the learning objectives through game-play.

3.2. Reflection

This involves enabling children to compare their own problem solving processes with those of an expert, another child, and ultimately, an internal cognitive model of expertise [5]. According to Bandura‘s learning theory, observers function as active agents who transform, classify and organize modeling stimuli into easily remembered schemes. During reflection there is a check on the correctness of the learner’s thinking based on these generated schemes. Reflection on the basis of articulation [usually referred to as social verification [7] occurs when people evaluate the soundness of their views by checking them against what others believe. People organize their thoughts so that they make sense, separating the more important thoughts from the less important ones as well as connecting one idea to another. [8]. The outcome of the reflection phase may be personal synthesis of knowledge, validation of hypothesis laid or a new playing strategy to be tested. [9]

3.3. Strategy Formation

When playing the game, the child tries to form appropriate playing strategies in order to solve the problems that the game provides to her [10]. It could be argued that strategy formation encompasses changing in intellectual organization to somewhat adjust to new ideas (accommodation- attributed to Piaget). In accommodation the intellectual organization has to change somewhat to adjust to the new idea (Berger 1978) cited in [8]

3.4. Scaffolded Exploration

Scaffolded Exploration involves guiding students to a mode of problem-solving on their own. Scaffolding is the support a system provides to learners as they carry out different activities (Wood, Bruner, and Ross, 1976). In scaffolding, the ultimate goal is the removal of scaffolds, since we want students to be able to complete the task independently [11]. In serious games, the players are able to perceive the impact and consequences that their actions in the gameworld and thus are informed about how they are performing, check their progress continuously, and eventually adjust their actions [12] – new information is simply added to the cognitive organization already there (assimilation – Piaget).

Note that strategy formation and Scaffolded Exploration is all about the child adapting his thinking to include new ideas. And since adaptation (in Piaget’s view) occurs in two ways: through accommodation and assimilation logically linked to strategy formation and scaffolded exploration respectively, strategy formation and scaffolded exploration is depicted as a two way process.

3.5. Debriefing

Many consider debriefing to be the most critical part of the simulation/ microworld experience [13]. The debrief is critical because it helps learners explore what went on, talk about their experiences, develop insights, reduce negative about aspects of the activity and connect the activities to their real-life situations. [14]. Suffice it to say debriefing may include a description of events that occurred in the game, analysis of why they occurred, and the discussion of mistakes and corrective actions [13]. Debriefing is a fundamental link between game experiences and learning [13]. Without this debriefing time, the effectiveness of the activity may be greatly diminished, as some learners will see the activity as a standalone event and not properly connect it to other aspects of the class. [14] If presented appropriately, debriefing helps the students deconstruct the activity and then connect it into their mental models. [14] Effective debriefing is learning oriented not performance oriented. This is important because research indicates that with performance goals, the entire task choice and pursuit process is built around children's concerns about their ability level. In contrast, with learning goals the choice and pursuit processes involve a focus on progress and mastery through effort. [15] Also revealed is the tendency to withdraw from the challenge if the focus is on ability judgment, whereas a focus on progress through effort creates a tendency to seek and be energized by challenge. [15]

3.6. Articulation

There's need for a forum [preferably online] where children can share their game experiences and acquired knowledge. In this forum, children get the chance to interface with their peers. Piaget argued that peer interaction is both qualitatively different from and superior to adult-child interaction in facilitating cognitive growth. [16] Criticism is born of discussion, and discussion is only possible among equals: co-operation alone will therefore accomplish what intellectual constraint failed to bring about (Piaget, 1932/1965) cited in [16] As children engage in game-play, they share their ideas and findings in the forum. Children should also be able ask questions and peruse each others comments and ideas. Social negotiation of meaning is a primary means of solving problems, building personal knowledge, establishing an identity, and most other functions performed in teams. [17] Articulation emphasizes progress toward collective goals of understanding, rather than individual learning and performance [5].

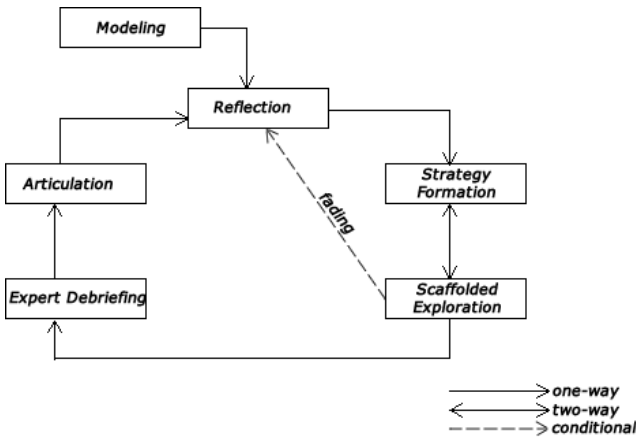

Figure 1. Proposed serious game constructivist framework for children

Figure 1, the serious game constructivist framework for children is based on the constructivist techniques discussed above. The child reflects on the background knowledge of the topic or learning objectives dished out through Modeling – he organises his thoughts so that they make sense, separating the more important thoughts from the less important ones as well as connecting one idea to another. [8] The Modeling and reflection phase help the child form his representation of knowledge. This initiates the strategy formation for the game experience. The child now goes on to explore the scaffolded game world where he is able to perceive the impact and consequences of his actions and in the process he is continuously informed of his performance and progress. In the course of exploration the child is able to uncover inconsistencies between his current knowledge representation and the experience – referred to by Piaget as a state of disequilibrium [3]. In the process the child may change his knowledge representation to incorporate the experience – this is referred to as accommodation which could be linked to strategy formation – making the strategy formation and scaffolded exploration a two-way process. If the child is able to conquer the game hence attain all the learning objectives, the learning support is faded for subsequent game-play (exploration). If the child is unable to conquer the game then he interfaces with experts and peers through debriefing and articulation respectively. He reflects on his finding and re-strategizes for subsequent exploration based on these findings. This is a cyclic process involving the child re-entering the game-world for continued exploration and scaffold fading as the child gains mastery at different scaffolding level.

4. Current Limitation

The fundamental technical restriction identified is the absence of scaffold fading technique in serious games designed for children. This faults the current serious game scaffolding mechanism. It is a crucial limitation to overcome as it will foster the smooth transition from child dependence on the game's learning support to his independence on this support (if implemented) – signifying mastery. Applying the principle of fading in serious games is a workable solution for scaffolding multiple ZPDs found in the classroom.

The fundamental social restriction identified is the lack of structure and enabling environment for peer interaction as it relates to serious game-play. There's need for a known forum for group discussion of game experiences – more like a social network for serious gamers.

There's also the child-persona restriction with emphasis on children's period of cognitive development. This framework could best be ascribed to children at the formal operations stage of development, which is between the ages of seven and eleven. It is only at this stage that the child is capable of systematic thought, organizing and classifying information, and is capable of concrete problem solving. [18] There's need for a realistic child-user abstraction (with proven effectiveness and efficiency) that serious game designers can generally adopt - Children's limited abilities are important because they can be used to constrain and refine designs. [19].

5. Conclusion

This paper is an attempt at summarizing the extent to which games have adopted the constructivist view of learning. The broadness of this approach to learning makes the adoption process challenging especially when it's for children requiring cognitive apprenticeship. By no means do we claim this as a finalized framework. In future work, we aim to test this framework and thereby validate its appropriateness as a serious game constructivist framework for children's learning. Nevertheless this framework is a pointer to the current

areas of deficiency. Researchers should investigate these deficiencies in order to make serious games more "constructivist".

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