Constructivist Principles in Educational Video Games

Amanda Westman

Purdue University

Introduction

Daily life requires critical thinking skills, especially problem solving. From counting out change to solving major global issues, our problem solving skills are constantly put to the test. Despite our glaring need to nurture good thinkers, the public education system in the United States is currently focused on objective multiple choice tests. Because testing drives curriculum decisions, innovative ideas are broadly swept aside for underperforming schools, leaving teachers with little support for teaching ideas that matter.

The theory of constructivism provides the framework needed to guide students from a basic understanding to application of their knowledge. Creating the necessary environments can be accomplished through the use of video games that employ constructivist principles.

Ertmer and Newby (1993) identified five principles of constructivism that are most applicable to the process of instructional design.

Context

According to Driscoll in *Psychology of Learning for Instruction* (2005), students must practice in authentic, complex environments to develop the skills that they will need in real life. These environments can be physical or digital, as long as they allow learners to experiment with ideas.

Learner Control

A single narrative is not sufficient to provide the complex environment. The learner must have the freedom to follow multiple threads from decision to outcome. Driscoll's concept of ownership emphasizes the self-aware student as the one who decides the learning context, and so the instructional designer must build flexible options that the student can navigate (2005).

Presentation Variety

The constructivist memory model can be describe as a large, undulating network of concepts (Driscoll 2005), and information must be presented in multiple ways and from multiple perspectives in order for students to make the necessary connections.

Problem-Solving Skills

The crux of constructivism is building knowledge by solving poorly defined problems. Ertmer and Newby explain that learners should go "beyond the information given." Problem solving is not simply a regurgitation of the facts presented by the teacher, but synthesis of multiple information points to create a new solution. Learners with problem solving skills can recognize patterns and reframe their understanding.

Assessment

Proof of learning comes not with a test, but with the successful application of targeted concepts to new and different situations. Therefore, the context must be rich and varied enough that the learner can explore a number of options. Because constructivism is learner-centered, and the student makes the primary decisions regarding learning context, the instructional designer must help the student understand when the concept has been mastered.

Instructional designers in every possible training arena can employ a constructivist method when the learning goals involve solving ill-defined problems, and K-12 public schools are no exception. The content areas of Science and Social Studies can present subjective problems to students at an early age, and students can begin applying math concepts to ill-defined problems before students have learned advanced concepts. The purpose of this paper is to apply constructivist principles to video games in order to show how they can be used in public school classrooms in the United States.

Review of Literature

Learning by design: Good video games as learning machines

Gee connects video games to what he calls "good principles of learning" (2005). Many of the listed principles include constructivist methods, especially the ideas of problem-solving skills and active learning through learner control.

Problem Solving. Gee's perspective of problem-solving serves as a scaffold, leading learners into the constructivist's ill-defined problems. The scaffolding begins with clearly defined problems presented in a careful order, allowing students to be "pleasantly frustrated." The process increases motivation by letting students set their own pace while encouraging them to progress to higher levels of complexity.

Learner Control. Gee insists on empowering learners by giving them control over the game direction and the ability to manipulate scenarios and avatars. This active learning increases motivation.

A case study of the in-class use of a video game for teaching high school history

A case study by William Watson, Christopher Mong, and Constance Harris examines the effect of a video game in a high school history class (2010). During a unit on the causes of World War II, students played an educational game called *Making History* in teams for three class periods. Many principles of constructivism are successfully applied throughout the case.

Meaningful context. Players enter a virtual world of negotiation and warfare, a nearly impossible feat in real life, and take on the persona of a specific country's representative. The

video game provides a close approximation to this important event in world history, giving students a chance to make risky but realistic decisions.

Learner control and the ability to manipulate information. Although they begin with a historically accurate persona, position, and list of resources, players are not required to follow history's timeline. Instead, they are able to negotiate treaties, manage armies, and go to war independently while meeting teacher-directed goals unique to the country. As a result, the increased engagement is obvious to all participants.

Variety of methods to present information. The three game days occur in between times of traditional classroom instruction. Because of the gaming platform, students learn about the historical period through natural conversations with each other, "teachable moments," and the game itself.

Problem-solving skills. Several students noted the formation of a "little UN" during lunch, when classmates discussed the game and generated strategies. The teacher mentioned that, at times, he would call the class together to highlight a strategy. Student engagement was enhanced by the value of these sessions as students stopped to listen for ideas that could help them solve problems in their own games.

Assessment focused on the transfer of knowledge and skills. While no pre- or post-instruction data is available, the organic conversations and high level of interest show that the overarching goal of this history unit was met: students used strategies they learned through the game to negotiate solutions. It would be interesting to see a follow-up study on a game used during the subsequent unit and determine the extent of skill transfer.

Fostering Motivation, Learning, and Transfer in Multi-User Virtual Environments

The subject of skill transfer was identified by a team from the Harvard Graduate School of Education (Dede et. al. 2005) as an area of weakness in game research. The team studied a multi-user virtual environment (MUVE) called *River City*, which they had designed to help students learn higher-order content in an interesting way.

Complex Learning Environment. The game's narrative depended on hypothesis, experimentation, and action to solve the mystery of an illness affecting the townspeople. The open-world simulation presented the problem differently every time students entered the MUVE, allowing them to interact with a variety of characters. Multiple successful attempts prove the transfer of knowledge and skills.

The Serious Game: What educational benefits?

Social constructivism theory was applied to *Virtual University*, a complex simulation game (Mouaheb 2012). The article focused on the cognitive conflict aspect of problem solving. Players navigate a large world and manipulate many variables as they build their universities, and the cognitive conflict arises when they face a problem that cannot be solved using previously successful methods. When a learned concept no longer applies, the learner must construct knowledge from experience in order to successfully complete the goal.

Learner Control. In addition to problem solving, *Virtual University*'s strengths lie in the players' ability to manipulate minute factors throughout the process and to see the effects of their decisions over time. In multiple repetitions of the simulation, learners can try different combinations of strategies, adding complex ideas to their knowledge base.

Application

An examination of video games in light of the constructivist learning theory solidifies the place of games in the classroom, but several challenges remain. While the nation remains focused on computer-scanned tests and achievement index numbers, teachers are left to independently obtain funding and support for more useful learning methods. While many generous organizations and forward-thinking school managers have been able to provide materials for some classrooms, video games will not gain widespread appreciation without overcoming several specific barriers.

The Games and Learning Publishing Council, established with funding from the Bill and Melinda Gates Foundation, recently released *Games for a digital age: K-12 market map and investment analysis*. The executive summary of this report outlines opportunities and barriers to implementation of games in education, highlighting the learning game landscape and the institutional market.

Landscape

The term "learning games" does not describe a single instructional method, but rather a wide variety of tools with differing functions. Short-form games are intended to help students practice specific concepts, while long-form games, like those described in the literature review, focus on higher order thinking skills and problem solving. The authors of the executive summary note that long-form games align more closely to the common core standards, to which most states are currently transitioning (Stebbins 2013).

Market

The transition to common core standards may open up more of a market for long-form learning games that develop complex thinking skills, but the executive summary highlights

several challenges. Key barriers include current procedures for purchasing materials for school; the decentralized school district structure engenders a fragmented marketplace, which is further complicated by mercurial government policies.

Perhaps our government officials and lobbyists should be more concerned with enabling reform than with assigning numerical values to higher-order thinking skills. A more efficient school governance system could certainly open the door to innovation while still allowing local communities to make decisions about their schools.

Innovative reform that leads to more problem-based learning will allow our students to develop their critical thinking skills. With more good thinkers in the world, we might solve the global problems that haunt our future.

Resources

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