Problem-Solving in History: Strategy Games and Schema

Ben DeVane, Shree Durga, University of Wisconsin-Madison,
Email: devane@wisc.edu

Abstract: This paper connects the conclusions of recent research on video games and learning to prior research on problem schemata and problem-solving. This study examines the problem-solving practices of expert and novice young players of *Civilization III* in a game-based learning program, and concludes that the problem schemata framework has power and utility in analyzing problem-solving in game-based environments.

Introduction

Recent research suggests that the medium of video games are powerful tools for supporting learning and academically-valued cognitive practices. (Squire, 2006; Steinkuehler & Chmiel, 2006; Shaffer, 2007). This research argues that well-designed games for learning can provide players with the skills needed to survive in an information-age economy and a culture of simulation. Because many commercial video games employ well-documented principles of learning (Gee, 2003) – performance before competence, learning through doing, role-related identities and scaffolded cycles of feedback – some educators and researchers have taken to using these "off-the-shelf" games in educational endeavors (Squire et al., 2005). In particular, many successful video games allow players to problem-solve with complex interactive models. While the successful learning outcomes of these programs have been documented, little research has focused on the specifics of how players of games for learning engage with specific problems as they play. This paper examines at the problem-solving strategies of expert and novice participants in a game-based learning program that uses *Civilization III* to teach conceptual history and geography, and argues that players read problems and categorically represent them internally using domain-related schemata (Chi et al., 1981).

Theory

Chi et al. (1981) looks at the way that expert and novice categorize and represent physics knowledge and, drawing on prior research on problem schemata, contends that in the early phase of reading and representing a problem, experts use their declarative knowledge to initially activate and evaluate conceptual knowledge structures that could lead to a solution using conditions of applicability. Experts then further test said schema to determine its appropriateness. Once a correct schema is activated, the expert uses her or his procedural and declarative knowledge to solve the problem. Novices, on the other hand, can be characterized as having enough detailed declarative knowledge to represent the problem, but do not have a sufficient amount of abstract procedural knowledge to solve it.

Method

Six participants, ages ten to thirteen, in an after-school program for low-income youth were presented with a problem in a modified Civilization III scenario, a specific instance of the game. The three expert participants had engaged in more than seventy hours of game play, and the three novices had played the game between six and ten hours prior to the study. The novices were proficient enough with the game that they understood the basic game controls and concepts.

Player were asked to discover how to construct a specific unit in-game. The game scenario had been changed so that the construction of the unit now needed a specific additional natural resource to be connected to a player's city. The problem was constructed to evaluate how well expert and novice players used the in-game visualization tools and historic-information resources to solve problems involving changes in game play mechanics. Prior studies of online communities of expert players had established that seasoned players routinely create scenarios with modified rules and almost universally used said tools to keep track of each scenario's extensive, often user-create, mechanics and rules.

This study utilized a "think aloud" protocol to try to gain direct feedback regarding the participant's thoughts (Ericsson & Simon, 1980). Participants were first told that their goal was to discover how to build a specific game unit, that the normal way to build said unit had been changed and that the in-game tools had been updated to reflect those changes. In default scenarios packaged with the game, construction of the unit (a swordsman) required players to research two specific civilization advances (bronze working and iron working), find a specific natural resource on the game map (iron) and build a road connecting a city to the resource. Participants responses were examined using the framework of Discourse analysis (Gee, 1999).

Results

A schema-based characterization of the differences between the problem solving of experts and

novices was generally consistent with the results of this experiment. All experts had represented the problem, activated accurate schema for the problem and verbally described the solution within five minutes of being given it. In contrast, the novices all struggled with the solution for more than twenty minutes. While the novices had similar difficulties in creating a problem schema, the experts utilized divergent strategies in categorizing the problem, building a solution path and solving the problem.

Two of the three experts actually verbally described the correct procedural solution before they could enact it in game. Expert 1 initially adopted a solution schema connecting new civilization advances with unit construction. Within three minutes he confidently challenged researchers on the construction of the problem scenario, but, while researchers were taking a few seconds formulating a response, he created a more precise schema that connected unit construction to civilization advances and available resources. He took three more minutes to enact in-game the procedural solution that he built based on his new schema. Expert 2 verbally provided an correct categorization of the problem schema – he noted that either the required civilization advance or natural resources had been changed - and a precise description of the steps he would take with each solution. However, he declined to enact these steps in game play, as he said he wanted to challenge himself. He then proceeded to acquire the normally-correct civilization advances needed for the unit and started guessing which natural resources were needed based upon their position. After connecting four resources to his city over the course of ten minutes, he found the two needed resources to solve the problem. Expert 3 initially categorized the problem as one that was primarily about civilization advances and tested in game play two different civilization advances that she thought would solved the problem. After these initial tests weren't successful, she recategorized the problem as one about resources. She then looked up which resources were needed to build the unit, and successfully built the desired unit after eight minutes. While the three expert pursued varying tracks in building a problem schema, testing the schema, outlining a procedural solution and executing the solution, they all successfully represented the problem in terms of conceptual schema and built procedural solutions based on said schema. In contrast, the novices all had trouble representing and solving the problem.

The novices had trouble representing the problem in terms of conceptual schema related to the game, and consequently all failed the problem-solving task. The novices all held conceptualized civilization advances as enabling unit construction, so their schema for the problem was that they need to find the right civilization advance. Given this limitation of their conceptual knowledge, they all failed to formulate correct procedural solutions to the problem. Two of the novices tried researching a civilization advance and then building a unit. When this test of their solution to the problem failed, they were unable to think of any alternative solutions. The third novice thought that he needed a "special technology," or civilization advance, for a solution, but lacked the procedural knowledge to describe how he might go about doing so. Such findings are consistent with the characterization of Chi et al regarding the differences in expert and novice problem solving.

Conclusions

The schema-based framework for describing the relationship between cognition and problem-solving aptly characterizes the practices of the expert and novice Civilization III players. This small, pilot study does not pretend to have provided conclusive evidence that the framework has applicability to the entire range of play practices in which Civilization III players engage, but it does point to the utility of using the framework for the analysis of some practices in context. We plan to use this method as a foundation for further describing the systemic understandings of the game model that players develop. Certainly, much more research is needed to better describe the problem-solving practices of players of video games. Moreover, the question of how to use scheme-based analyses in determining whether game-based models of history connect directly to academic practices and knowledge still looms. While other research has shown that participants in programs that use Civilization III as a curricular resource for history build robust model-based understandings of history, more research needs to relate these longitudinal studies to the specific problem-solving activities of young people in these settings.

References

Chi, M. T. H., Feltovich, P., & Glaser, R. (1981). Categorization and representation of physics problems by experts and novices. *Cognitive Science, 5*, 121-152.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. Palgrave/Macmillan: New York, NY.

Gee, J. P. (1999). An Introduction to Discourse Analysis: Theory and Method. London: Routledge.

Shaffer, D. W. (2007). *How computer games help children learn*. New York: Palgrave Macmillan.

Ericsson, K., & Simon, H. (1980). Verbal reports as data. *Psychological Review 87 (3)*: 215–251.

Squire, K.D. (2006). From content to context: Video games as designed experiences. *Educational Researcher*, 35(8), 19-29.

Squire, K.D., Giovanetto, L., DeVane, B. & Durga, S. (2005). From users to designers: Building a self-organizing game-based learning environment. *Technology Trends 49(5)*, 34-42.

Steinkuehler, C. & Chmiel, M. (2006). Fostering scientific habits of mind in the context of online play. In S.A. Barab, K.E. Hay, N.B. Songer, & D.T. Hickey (Eds.), *Proceedings of the International Conference of the Learning Sciences* (pp 723-729). Mahwah NJ: Erlbaum.