Farmtasia: A Case Study of Knowledge Building Processes in Game-Based Learning

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Abstract

This essay analyzes the effectiveness of three-dimensional digital game-based learning (3D-DGBL) environments in supporting knowledge building processes. Scardamalia and Bereiter (2003) define knowledge building as the "production and continual improvement of ideas of value to a community," resulting in gains in cultural capital. Previous research has linked game-based learning to greater student engagement, multidisciplinary connections, and skill delivery in schools, but less is known about its capacity for innovation (Barab et al., 2005; Gee, 2003). This paper analyzes the first educational game created for knowledge building, known as Farmtasia, a virtual world in which players act as managers to individually run farms (Cheung et al., 2008). This essay argues that Farmtasia does support knowledge building processes using three in-game features: pedagogical scaffolding, situated learning, and communal debriefings. Furthermore, this paper suggests that 3D-DGBL environments are the key to reducing the "educational chasm," the inequalities that occur from barriers to knowledge and skill attainment, such as geography and wealth. By adopting 3D-DGBL environments as educational problem spaces, knowledge building can be made accessible to all communities regardless of physical or economic barriers.

Keywords: game-based learning, knowledge building, educational chasm, situated learning, informational scaffolds

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Three-dimensional digital game-based learning (3D-DGBL) is the use of virtual environments in education, which encompasses literary-historical spaces for interacting with other players, non-player characters (NPCs), and subject content (Neville & Shelton, 2010). Players are represented in the virtual space by avatars, graphical placeholders that symbolize identity and allow interaction using actions that players select (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005; Bolter & Grusin, 1999). Avatars can be customized with abilities and items, allowing users to develop unique appearances and to experiment with identities (Barab et al., 2005). Avatars can interact with one another to create complex social networks in-game, with the purpose of achieving specific goals or sharing common interests.

In 3D-DGBL, these literary-historical spaces provide unique opportunities for experiential learning, as they can "emulate remote or inaccessible real-world sites, recreate vanished environments, and lend substance to literary spaces" (Thomas, 2004). 3D-DGBL is often delivered through role-playing games (RPGs), in which the player adopts a role within the game context and completes meaningful goals within a storyline (Barab et al., 2005). For example, Quest Atlantis is a role-playing game targeted towards children aged 9 to 15 years old (Barab et al., 2005). Players are tasked to rebuild the Arch of Wisdom, a magical structure containing the knowledge of the Atlantian people. The Arch was destroyed by tyrannical rulers, who were obsessed with technological progress and drove Atlantis into environmental, moral, and social ruin. The Atlantian Council assigns quests, which are entertaining and educational tasks containing scaffolds for exploring and experiencing subject content, such as literacy, science, and social studies. As students complete quests, they learn to address similar, real-life issues, such as environmental awareness and personal agency. Therefore, by empowering

students to contribute in virtual environments, game-based learning has been linked to greater student engagement, multidisciplinary connections, and skill delivery in schools (Barab et al., 2005; Gee, 2003).

While game-based learning has been connected to problem solving and inquiry-based learning, less is known about its connection to higher-order processes, such as knowledge building. According to Scardamalia and Bereiter (2003), today's industry is characterized as the "knowledge age," in which the success of societies is dependent on the capacity to innovate. Innovation entails not only the sharing and modification of knowledge, but the ability to create new knowledge to meet changing needs. To create knowledge, people must engage in knowledge building, the "production and continual improvement of ideas of value to a community, through means that increase the likelihood that what the community accomplishes will be greater than the sum of individual contributions and part of broader cultural efforts" (Scardamalia & Bereiter, 2003).

Knowledge building is a social process involving the gathering of information, the designing of experiments, and the evaluation of progress towards the growth of cultural capital. Ideas are treated as objects of inquiry and improvement, which are shared in a public space in order "to be discussed, interconnected, revised, and superseded" (Scardamalia & Bereiter, 2003). To make ideas meaningful, people must work with authentic problems, issues that are experienced and relevant in order to make sense of the world (Scardamalia & Bereiter, 2006). However, since ideas must build upon each other to create new knowledge, ideas must be shared with others so that idea improvement becomes sustainable (Scardamalia & Bereiter, 2006). Therefore, knowledge advancement is distinguished from individual achievement, and the design of the problem space is critical towards achieving innovation (Scardamalia & Bereiter, 2006).

Historically, the sharing of knowledge occurred through threaded discussion, in which authors post messages to a discussion site, which are listed in chronological order (Scardamalia & Bereiter, 2006). This problem space is an impairment to higher-level thinking, as information is displayed in a downward-branching tree structure. As a result, while forums allow ideas to be shared in a public domain, users are unable to make meaningful connections between multiple, simultaneous messages. Therefore, traditional tools such as forums limit the potential for knowledge building discourse.

Recently, the Centre for the Advancement of Information Technology in Education (CAITE) has released Farmtasia, an educational video game targeted towards knowledge building (Cheung et al., 2008). Farmtasia is a massively multiplayer online game (MMOG), set in a 3D-DGBL virtual space in which players act as managers to individually run farms. Students must learn about cultivation, horticulture, and pasturage in order to develop effective investment and operational strategies. Students must also integrate traditional subject areas, such as literacy, science, and social studies, to form multidisciplinary, sustainable solutions to problems. Success is determined by each player's financial gain and public reputation, so investments must be mindful of sustainable development and environmental protection. Along the way, students deal with changing conditions in the virtual world, such as natural disasters and neighbourly competition, to be successful. Therefore, students are immersed in a world embodying realistic scenarios that allow for situated learning.

This essay analyzes the effectiveness of Farmtasia as a knowledge building environment and suggests that Farmtasia deviates from other educational games, such as Quest Atlantis. Furthermore, this paper argues that Farmtasia is an excellent problem space for knowledge building because it contains three features: pedagogical scaffolding, situated learning, and

communal debriefings. In alignment with Scardamalia's (2002) principles of knowledge building, this essay claims that pedagogical scaffolding encompasses authoritative sources and improvable ideas, that situated learning promotes authentic problems and epistemic agency, and that communal debriefings encourage collective responsibility and democratizing knowledge. Additionally, this essay investigates the impact of game-based learning on the Matthew effect, the phenomenon that "the more you know, the more you can learn" (Scardamalia & Bereiter, 2003). Therefore, by fulfilling these knowledge building principles, 3D-DGBL environments like Farmtasia bridge the "educational chasm," the inequalities that occur from barriers to knowledge and skill attainment, such as geography and wealth.

Pedagogical Scaffolding

Pedagogical scaffolding is the use of interactive tools for feedback to support individual and group contributions (Zhang, Hong, Scardamalia, Teo, & Morley, 2011). As previously stated, one of the problems surrounding knowledge building is the educational chasm. For knowledge building to be successful, knowledge must be shared, modified, and created as a community. The process of idea improvement implies that there must be a knowledge base with which to build on (Scardamalia & Bereiter, 2003). However, Scardamalia and Bereiter (2003) note that at all stages of understanding, people are creating knowledge that is useful to themselves. Therefore, knowledge building is not necessarily the creation of radically new ideas, so long as ideas are authentic and novel to their creators.

In Farmtasia, multidisciplinary scaffolds provide cheap, accessible sources to authoritative knowledge, such as teachers. At the beginning of the game, teachers convey preliminary information and provide learning resources needed to move onto the next learning phase (Jong, Shang, Lee, & Lee, 2010). One of the learning resources found in-game is the

Knowledge Manual, a searchable resource bank containing eight knowledge domains: natural environment, biology, government, economics, technology, production systems, natural hazards, and environmental problems. These domains relate to scenarios or problems encountered in the game, and players can access the manual at any time. In dire situations, a game character named Wise Genie appears and gives hints to struggling players (Cheung et al., 2008).

Additionally, Farmtasia has an administrator console for teachers to analyze and prepare data for debriefing lessons. One of the console's features is the record-and-replay function, which allows teachers to replay any gaming action as a video clip (Jong et al., 2010). Scaffolds can be customized to learner needs, since teachers can identify interesting, problematic, or critical situations to present as case studies with the class. These case studies can be shared using the built-in blogging platform, which allows students to reflect and share their gaming experiences with others (Jong et al., 2010).

Based on Scardamalia's (2002) knowledge building principles, Farmtasia's pedagogical scaffolding encompasses constructive uses of authoritative sources and improvable ideas. Constructive uses of authoritative sources is critical to knowledge building because people must know a domain in order to advance the knowledge within it. By having awareness of this knowledge, people can critically analyze ideas and advance them. Additionally, the provision of such knowledge through scaffolds leads to idea diversity, which claims that "to understand an idea is to understand the ideas that surround it, including those that stand in contrast to it" (Zhang et al., 2011). When ideas are plentiful, meaningful connections can be made between ideas, leading to new and more refined forms of knowledge. Therefore, Farmtasia's pedagogical scaffolding provides a large, accessible source of knowledge for users, allowing communities

(regardless of geographical or economic status) to work with and build on ideas in meaningful ways.

Situated Learning

Situated learning is the use of "missions, tasks, and problems that are generative and open-ended, and there is no prescribed solution" (Jong et al., 2010). Social responsibility is embedded in player decisions, since actions can affect the rest of the virtual space (Jong et al., 2010). To make effective decisions, students must piece together subject-specific knowledge learned from virtual spaces and pedagogical scaffolds. Success in these tasks require problem solving skills applied to many contexts, and there are numerous solutions to solving the same problem. Therefore, to be competitive in Farmtasia requires the creation, evaluation, and modification of optimal strategies.

To make the game realistic, Farmtasia has three types of sudden events around contingency and emergency: farm, market, and mass-decision (Cheung et al., 2008). Farm events are contained in farms and will not affect the rest of the virtual world, such as fire accidents and worker strikes. Market events are local or global, such as price fluctuations on products, leading to consequences on all farms. Mass-decision events involve cooperation and collaboration among players to succeed, such as the building of a dam. Furthermore, teachers can use their console to add natural disasters, making the game challenging and unpredictable.

Based on Scardamalia's (2002) knowledge building principles, Farmtasia's situated learning promotes authentic problems and epistemic agency. Real ideas and authentic problems are necessary for knowledge building because ideas are created when learners work with relevant problems that are experienced and understood (Scardamalia, 2002). When problems are authentic, the knowledge created is also authentic and useful to themselves and their community

(Scardamalia & Bereiter, 2003). As a result, the knowledge produced becomes meaningful and part of a greater societal effort to create progress and innovation (Scardamalia & Bereiter, 2006).

Additionally, when students solve authentic problems, they develop epistemic agency, the ability to "set goals, assess their work, engage in long-range planning, monitor idea coherence, use contrasting ideas to spark and sustain knowledge advancement, and engage in high-level knowledge work normally left to the teacher" (Zhang et al., 2011). By allowing students to make decisions and to experience their consequences, teachers demonstrate trust and belief in students' potential for high-level knowledge work (Zhang et al., 2011). Thus, as players experience situated learning, students engage in meaningful decision making in the solving of authentic problems, leading to the empowerment and validation of students through epistemic agency.

Communal Debriefings

Communal debriefings are public reflections of player experience using Farmtasia's blogging platform or in-person discussions. As students complete each stage of gaming, they blog their reflections, acting as a formative assessment used to guide later instruction (Jong et al., 2010). To make the reflections meaningful, students are given journal templates or hard scaffolds, which contain prompts or questions to guide discussion. Questions involve decompressing feelings, describing facts, drawing comparisons, and suggesting improvements (Jong et al., 2010). To tie these reflections together, students complete a summative report at the end of the game, giving advice to Mr. Lam, a fictitious character whose farm is closing down (Jong et al., 2010). These blogs are public, so that all students can view and reply to each other, allowing for more self-reflection and discussion amongst players. These reflections can be used by teachers to identify "debriefable moments," which are memorable actions or scenarios used as

case studies in class (Jong, Lee, & Lee, 2011). As a result, this blogging platform serves as a public space to share, modify, and create new knowledge, allowing for sustainable knowledge building through the collective effort of many players.

Based on Scardamalia's (2002) knowledge building principles, Farmtasia's communal debriefings encourage collective responsibility and democratizing knowledge. When players share their contributions and achievements, they share ideas of value to others, allowing the knowledge to be advanced as a whole by the community (Scardamalia, 2002). Furthermore, through this discussion space, players can work together as a community to achieve broader and more global goals, such as environmental sustainability. This effort allows players to share the responsibility of idea advancement, leading to more valuable and meaningful outcomes. Since players are working in a public space where ideas are made transparent and accessible, democratizing knowledge is also achieved. As a result, players can transcend geographical and economic barriers, gaining and working with the knowledge necessary to make knowledge advances as a community (Scardamalia, 2002). As ideas are treated as communal objects, the diversity of players becomes strengths, offering multidisciplinary sources of information for idea advancement (Scardamalia, 2002). Therefore, Farmtasia's communal debriefings provide universal accessibility to knowledge, allowing students to build on ideas as a community and to take responsibility for those outcomes.

Discussion

This essay has analyzed three of Farmtasia's features with regards to knowledge building processes, which are: pedagogical scaffolding, situated learning, and communal debriefings. As noted earlier, one of the major criticisms of knowledge building has been its perceived exclusivity due to the Matthew effect (Scardamalia & Bereiter, 2003). In a knowledge-based

economy, knowledge is a valuable commodity, and the accessibility of knowledge becomes an influential factor in the ability to compete with other communities.

In alignment with Scardamalia and Bereiter (2003), this paper has offered support for the benefits of 3D-DGBL environments in bridging the educational chasm. Online educational games such as Farmtasia help disseminate both specific and multidisciplinary knowledge in authentic and usable forms, so that it can be applied to real-world problems. Teachers are not only able to provide scaffolds that contain preliminary knowledge of a domain, but students themselves are able to use each other as knowledge resources using blogging. Furthermore, Farmtasia is a role-playing game that allows players to encounter and manage realistic scenarios such as natural disasters, making the gameplay intuitive through its storyline. As a result, there is a low threshold of skill in order to elicit participation, inviting players of all backgrounds to engage in the knowledge building process.

Conclusion

In conclusion, 3D-DGBL environments provide a powerful, dynamic platform with which to initiate and maintain the knowledge building process. This essay has studied the role-playing game called Farmtasia, an educational game created specifically for knowledge building. Embedding principles of agriculture, government, and finance, students draw from subject areas such as literacy, science, and social studies, creating multidisciplinary strategies to realistic problems.

Based on this analysis, Farmtasia supports the knowledge building process using three features: pedagogical scaffolding, situated learning, and communal debriefings. First, pedagogical scaffolding encompasses constructive uses of authoritative sources and improvable ideas, since teachers provide a knowledge base that becomes continually discussed and improved

upon in a public domain. Second, situated learning promotes authentic problems and epistemic agency, since students work in a dynamic environment involving plausible events such as natural disasters. By solving these problems in context, students immerse themselves in the problem solving process, empowering students through the creation of usable knowledge for themselves and their community. Third, communal debriefings encourage collective responsibility and democratizing knowledge, since students are able to access, reflect, and build on the learning experiences of peers and teachers. With the blogging platforms, students are able to work with ideas and to turn diversity into assets, advancing knowledge as a community and sharing responsibility for it. Therefore, through accessible, immersive, and engaging environments like 3D-DGBL games, communities can overcome barriers and develop their cultural capital through the process of knowledge building.

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Conference Themes

This essay was written for the 17th annual Knowledge Building Summer Institute called *Crossing the Educational Chasm: From the Basics to Creative Work with Ideas*. With regards to design-based research, my paper covers the following themes: parallel advances in basic and advanced knowledge work, sustained work with ideas, and knowledge building partnerships. With regards to knowledge building optimization, my essay analyzes assessment tools for knowledge creation, especially the role of teachers in tracking, accommodating, and scaffolding student progress.

References

Barab, S., Thomas, M., Dodge, T., Carteaux, R., & Tuzun, H. (2005). Making learning fun: Quest Atlantis, a game without guns. *Educational Technology Research and Development, 53*(1), 86-107.

Bolter, J., & Grusin, R. (1999). *Remediation: Understanding new media.* Cambridge, MA: The MIT Press.

Cheung, K. K. F., Jong, M. S. Y., Lee, F-L., Lee, J. H. M., Luk, E. T. H., Shang, J., & Wong, M. K. H. (2008). Farmtasia: An online game-based learning environment based on the VISOLE pedagogy. *Virtual Reality, 12*, 17-25.

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

Jong, M. S. Y., Lee, F-L, & Lee, J. H. M. (2011). A case study of an academic achievement-oriented student in game-based learning. *IEEE International Conference on Advanced Learning Technologies, 3*(4), 7-11.

Jong, M. S. Y., Shang, J., Lee, F-L, & Lee, J. H. M. (2010). An evaluative study on VISOLE—Virtual Interactive Student-Oriented Learning Environment. *IEEE Transactions on Learning Technologies, 3*(4), 307-318.

Neville, D. O., & Shelton, B. E. (2010). Literary and historical 3D digital game-based learning: Design guidelines. *Simulation & Gaming, 41*(4), 607-629.

Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Ed.), *Liberal education in a knowledge society* (pp. 67-98). Chicago, IL: Open Court.

Scardamalia, M., & Bereiter, C. (2003). Knowledge building. In J. W. Guthrie (Eds.), *Encyclopedia of Education* (pp. 1370-1373). New York, NY: Macmillan Reference.

Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy, and technology. In K. Sawyer (Ed.), *Cambridge Handbook of the Learning Sciences* (pp. 97-118). New York, NY: Cambridge University Press.

Thomas, W. (2004). Computing and the historical imagination. In S. Schreibman, R. Siemens, & J. Unsworth (Eds.), *A companion to digital humanities* (pp. 56-68). Oxford, UK: Blackwell.

Zhang, J., Hong, H-Y., Scardamalia, M., Teo, C. L., & Morley, E. A. (2011). Sustaining knowledge building as a principle-based innovation at an elementary school. *The Journal of the Learning Sciences, 20*, 262-307.