
Modding the History of Science: Values at Play in Modder Discussions of Sid Meier's CIVILIZATION

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Abstract

Sid Meier's CIVILIZATION has been promoted as an educational tool, used as a platform for building educational simulations, and maligned as promoting Eurocentrism, bioimperialism, and racial superiority. This article explores the complex issues involved in interpreting a game through analysis of the ways modders (gamers who modify the game) have approached the history of science, technology, and knowledge embodied in the game. Through text analysis of modder discussion, this article explores the assumed values and tone of the community's discourse. The study offers initial findings that CIVILIZATION modders value a variety of positive discursive practices for developing historical models. Community members value a form of historical authenticity, they prize subtlety and nuance in models for science in the game, and they communicate through civil consensus building. Game theorists, players, and scholars, as well as those interested in modeling the history, sociology, and philosophy of science, will be interested to see the ways in which CIVILIZATION III cultivates an audience of modders who spend their time reimagining how science and technology could work in the game.

Keywords

civil consensus building, CIVILIZATION, discourse analysis, discursive practices, historical authenticity, historical models, historical thinking, history, history of science, modding, possibility spaces, public understanding of science, simulations, strategy games

A group of citizens convenes to discuss the relationship between technical and scientific knowledge and the role that knowledge plays in discovery and innovation. One citizen proposes that the history of scientific thought suggests that technological and scientific

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development provides the context for individual discoveries. Another posits separate processes for technological development and scientific development. As the group grapples with definitions of science and technology, another citizen suggests that medicine should be understood broadly to include non-Western health practices. This discussion could have occurred in any university classroom. However, it happened in an online forum, among members of a group of modders (video game players who alter game code) discussing a new model for science and technology in the game CIVILIZATION.

CIVILIZATION, Mods, and Historical Counterfactuals

This study examines how communities of game modifiers—commonly called “modders”—reevaluate the models of scientific and technological advance in the game CIVILIZATION III (2003), and explores their possible impact on outreach efforts in public science. Game theorists, players, scholars, and those interested in the history, sociology, and philosophy of science will be interested in how CIVILIZATION has cultivated a community of modders that reimagines how science and technology function within the game. First, it is important to explain the game, modding, and modders and to name key historical issues present in CIVILIZATION.

A Brief History of CIVILIZATION

In CIVILIZATION, Sid Meier has created one of the world’s most successful game franchises. The four major releases of the game, and its many expansions and spinoffs, have been best sellers since the original game was released 18 years ago. Most video game critics will include one version in their top 10. By March of 2008, the most recent version, CIVILIZATION IV, had sold more than three million copies (Green, 2008). It has been hailed as both an educational tool for schools (Squire & Barab, 2004) and a model for building educational historical games, such as Muzzy Lane’s MAKING HISTORY (2007; see McMichael, 2007).

Some analysts do question what exactly players learn from CIVILIZATION. Through extensive analysis of some of CIVILIZATION’s game mechanics, anthropologist Kacper Pobłocki (2002) suggests that the game promotes an imperialistic relationship between players and nature. Christopher Douglas (2002) suggests that the game reinforces ideas of cultural and racial superiority. These critiques generally stem from close readings of the games content and mechanics; by exploring how modders play and understand the game, this study will suggest another perspective on the subject.

Modding CIVILIZATION

Modders play an important role in game communities (Postigo, 2007). All players bring their own experiences into their play; they make their own games within games and set their own goals. Some even reject the fundamental premises behind a game to create fundamentally different experiences (Poremba, 2006). Modders exemplify and extend

this behavior. Squire and Giovanetto's (2008) study of CIVILIZATION's leading fan community, the Apolyton Civilization Site, has demonstrated the important role that modders play in the gaming community at large. As the most dedicated players, modders form the vanguard of the community and act as guides for other players interested in delving deeper into the game.

CIVILIZATION was designed to be modified. Each copy of the game provides the tools to modify the game. The rules and structure of the game were created with the intention that players should change them. To analyze the game without analyzing this component is to ignore a substantial component of the designed experience.

Historical Models and Counterfactual History

Although CIVILIZATION's modders have approached many components of the games model of society, I discuss here three main reasons to explore their approach to science and technology.

1. CIVILIZATION's modeling of the history of science and technology exerts significant influences on the game system and game play.
2. The community exhibits a particular passion for reworking the model.
3. Modeling the relationship between science and technology in society is analogous to the work of historians, philosophers, and sociologists of science.

Modeling relationships between science, technology, and society is a primary strand of scholarship in science and technology studies. Thomas Kuhn's *Structure of Scientific Revolutions* (1962), Karl Popper's *Logic of Scientific Discovery* (2002), and Bruno Latour's *Science in Action* (1988) all focus on critiquing, proposing, and developing models of the reciprocal relationship between science and society. The modders discussed in this article pursue a similar project, constructing and critiquing models of the history, sociology, and philosophy of science inside the sandbox that the game provides.

In contrast, much of the scholarship on historical thinking focuses on how historians engage with source material. Sam Wineburg (2001) has done excellent work in this field. This line of thinking is crucial, but it does not fully represent the work and process of history. Little work on historical thinking has focused on the role historical models play in historical thinking. All historical work involves model construction; critiquing, proposing, and developing models for contextually understanding historical events is a fundamental part of historical work (White, 1975).

Some historians and teachers are troubled by the idea of replaying history. The most common criticism is that replaying history requires counterfactual thinking, exploring how history might have played out differently. For these critics, this kind of speculation deviates from understanding what actually happened. However, Niall Ferguson (1997) suggests that counterfactual thinking offers valuable historical insight for historians, and Martin Bunzl (2004) suggests that core parts of counterfactual thinking are deeply

connected to historical thinking in general. For historians to piece together their narratives, they must weigh the importance of pieces of evidence, and this requires imagining how events could have turned out differently. The value of counterfactual thinking is evident in model building. Interpreting new historical evidence, revising existing historical models, and testing existing models all rely on the creative thought required by counterfactual thinking.

Analytical Approach and Methodology

Although many studies of gamer thinking use surveys and interviews, analysis of game discussion “in the wild” has become an established approach for understanding how players explore, understand, and interpret games (Gee, 2003). Public discussions on message boards and forums offer material for researchers to explore a wide range of topics (DeVane, 2009). Analysis of discussions in game forums provides an entry into the argumentation and habits of mind of game communities (Duncan, 2008; Steinkuehler & Chmiel, 2006) and a portrait of player agency in interpreting games (Schott, 2006). These studies illustrate how player discussions express the cognitive models of players outside of formal learning environments or experimental settings (Hutchins, 1995).

My research began with a broad exploration of discussions of science and technology in the CIVILIZATION games in two fan communities: the CivFanatics and Apolyton Civilization Web sites. These two communities provide a medium to discuss game play and work collaboratively on mod projects. Firaxis Games, the developer of CIVILIZATION, makes extensive use of these communities to test ideas, disseminate game news, and even recruit staff (Johnson, 2006). Apolyton is an example of how game communities help players become good players and, ultimately, competent designers (Squire & Giovanetto, 2008).

After surveying discussions of science and technology in both sites, I focused on how modders are working with the system of “civilization advancements,” commonly known among players and modders as the “tech tree.” To characterize how these discussions work, this article provides a detailed analysis of a single discussion between CIVILIZATION modders working on a model for science and technology for two large mod projects, the *Clash of the Civilizations* mod and *The Guns, Germs and Steel* mod.

Although my study is informed by broad engagement with discussions across these communities, my analysis explores a single threaded discussion in greater depth. Following a single discussion (or thread) allows me to document the objectives and considerations that CIVILIZATION modders pursue and discuss. The approach allows the development of “thick description” to go “beyond the mere or bare reporting of an act” in order to describe and probe the “intentions, motives, meanings, contexts, situations and circumstances of action” (Geertz, 1973) **[AQ: 1]**. To develop this “thick description,” I have employed a method of text analysis (Fairclough, 2003) informed by James Gee’s (2005) approach to discourse analysis. This approach allows me to identify a set of values found throughout discussions in the modder community



Figure 1. **[AQ: 2]**

as exemplified by one discussion within that community. My aim is not to quantify the statements of values but to lead readers through a single discussion as a means to understand their values in context. My analysis is informed by 13 years of experience playing CIVILIZATION. However, I am not a member of either site, nor am I a modder. My discussion of models for the history and sociology of science is part of my work in the history of science (see Owens, 2009).

How CIVILIZATION III Models Science and Technology

CIVILIZATION provides players with a “science advisor,” who displays possible technologies and cultural advancements. Players choose a research agenda, generate research points, and eventually “acquire” technologies, which yield certain game play advantages, conceptualized in Figure 1.

Players generate research points by allocating a percentage of their civilizations taxes to research. To acquire additional points, they can turn citizens into scientists and construct buildings, such as laboratories, which generate additional research points. An increase in research points accelerates their rate of discovery. Each new technology comes with game advantages, new units, new buildings, new forms of government, and world wonders, as illustrated in Figure 2.

Figure 2 illustrates a section of CIVILIZATION’s “tech tree.” Tech trees provide a common mechanic for managing advancement in strategy games (Bates, 2004). The figure illustrates the kinds of choices players face. In this example, the science advisor offers two options: Nationalism or Steam Power. Choosing Nationalism will allow for training Riflemen, make it possible to draft military units, and initiate Trade Embargos. Ultimately, the discovery of Industrialization will require both Steam Power and Nationalism. This process facilitates much of a player’s available action in the game.

Modders Discuss Science and Technology in CIVILIZATION

This analysis of a 2001 discussion between modders on the Apolyton Civilization Site highlights four components in these modders’ thinking and values. These modders explicitly establish their desire to increase the historical authenticity of the game. They offer critiques of how game mechanics model sociohistorical behavior. Over the course

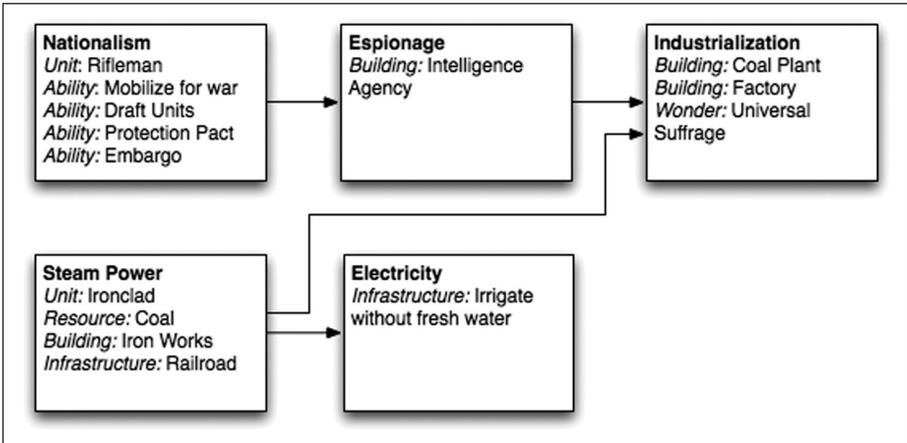


Figure 2. [AQ: 3]

of the conversation, these modders introduce nuance and complexity to make the game more authentic. They conduct their discussion by building consensus. Through these values, the modders demonstrate sophisticated and thoughtful thinking usually identified with scholarly discourse.

Historical Authenticity

The discussion starts with a post from Ryan. All names in the discussion are pseudonyms, and for clarity of analysis, I have organized their comments into stanzas. To begin the discussion, Ryan explains his reasons for wanting to modify the game. He begins his post with the following affirmation:

Stanza 1 (Ryan)

- (1) The gradual and complicated process of human learning and advancement
- (2) cannot be summarized into a 100 unrelated milestones,
- (3) as has been done in the Civ series.
- (4) The player is unrealistically limited to doing one thing at a time.

Ryan starts the thread by presenting a problem with how CIVILIZATION models the history of knowledge. He appeals to other players' historical knowledge to argue against the "unrealistic" system where players research a single technology at a time. Ryan's appeal illustrates one of the concepts valued by these modders. Ryan values historical and social authenticity and wants to modify the game to better reflect his understanding of the past.

Ryan continues his post with a plan for an improved system. In the version of the game, he proposes the following:

Stanza 2 (Ryan)

- (1) there'll be three sets of quantities to keep track of:
- (2) Science (theoretical knowledge), Technology (practical knowledge) and one-time-only innovations, or Milestones.
- (3) Examples of Sciences would be Mathematics, Physics, and Astronomy.
- (4) Technology would include fields such as Construction, Shipbuilding, and Metallurgy.
- (5) Milestones are inventions such as the Wheel, Shortbow, Rope, etc.
- (6) Milestones would be one-time packages, but scientific and
- (7) technological fields would have many levels of knowledge or skill.
- (8) The higher the level, the better the people excel at that field.
- (9) This is to prevent the ridiculous idea of researching a complete package like Mathematics in one blow . . .
- (10) The research points will be influenced by social conditions, technology, infrastructure, etc.
- (11) It is also possible that some milestones would become randomly available
- (12) or seen in a different civilization and adopted.

After detailing his critique of the game's rules, Ryan presents his own model. He proposes to distinguish one-time discoveries, to be called "milestones," from the gradual progression of knowledge in the games model (Line 2). He wishes to "prevent the ridiculous idea of researching a complete package like Mathematics in one blow" (Line 9). He expects his readers to agree with him that the discovery of mathematics, which includes addition, algebra, and spherical geometry, requires a more historically accurate model. This example again focuses his readers on the historical authenticity of the model, asking them to use their own historical knowledge to evaluate his proposal. In the second post of the thread, another modder mentions that he is also working on the problem Ryan has identified.

Game Mechanics Model Social Behavior

The third poster, Frantic, explains that he is "uncomfortable" with Ryan's model. Frantic demonstrates a clear understanding of interaction between the player's role and the game's social and political worldview.

Stanza 3 (Frantic)

- (1) I hope that the player won't be some totalitarian communist leader who can completely determine what his minions discover.
- (2) Most discoveries should be done by the private sector.
- (3) You should only have the ability to influence the flow of scientific progress.
- (4) Unlike all civ games, where, as said above,

- (5) you always had complete control over people's production capacities and their creative juices,
- (6) even if you were a democratic free market.

Frantic's critique of Ryan's proposal stems from the same preoccupation with historical authenticity. Frantic argues total control of the society's knowledge choices makes the player a totalitarian leader. "Most discoveries should be done by the private sector" (Line 2) suggests that Ryan's model does not resolve the problems with the technology tree. Frantic is mapping the mechanics of the game onto his own ideas about how science and politics work. Ryan responds thus to Frantic's critique:

Stanza 4 (Ryan)

- (1) That's partly what the randomness is for.
- (2) It reduces the impact of what the user chooses.

Ryan argues that randomness represents the influence of forces, such as the private sector, outside the control of the leadership of the player. Ryan uses a specific mechanic to represent a complex set of social behaviors. He argues that his model already addresses Frantic's doubts about a single leader making decisions for everyone in a society. Ryan deploys the randomness of specific milestones to represent the role of individuals.

Nuance and Complexity in Models

As the thread continues, additional posters propose increasingly subtle ways in which CIVILIZATION could be modified to model their understanding of how science, technology, and knowledge work in society. The community responds positively to suggestions that make the proposed model more complex and subtle. Moreland, for example, suggests the following:

Stanza 5 (Moreland)

- (1) . . . technology should be affected by what the player does in the sense that
- (2) if he builds a lot of ships, his shipbuilding technology should go up,
- (3) and if he stops making ships, the technology deteriorates.
- (4) Maybe technology level could be a property of a population
- (5) (meaning, those sailors on the coast have better shipbuilding tech and the inland farmers excel at . . . uhm . . . plowing),
- (6) whereas scientific knowledge is the property of the whole civilization?

Moreland's "shipbuilding" illustrates his argument that using a specific technology should develop additional expertise with that technology. This suggestion resolves a problem he perceives in Ryan's model—that basic scientific and applied technical knowledge are modeled the same way. Ryan agrees to incorporate the suggestion into

his model. The manner in which participants collaborate to produce progressive improvements to the game's model provides insight into the structures underlying the exchange. Throughout this thread, community members demonstrate the high value they place on nuance and detail in their game mods. While other media, like television, are frequently derided for failing to encourage the subtlety and nuance required for scientific literacy (Collins, 1987; Dingwall & Aldridge, 2006; Leon, 2008; Toumey, 1996), these modders are using a game as an effective platform for encouraging nuanced and complex discussions of the role of science in society.

Later in the discussion, Symtryx raises another issue:

Stanza 6 (Symtryx)

- (1) I'm not sure how we'd introduce new sciences though,
- (2) guess we need to look into real examples throughout history for each one—
- (3) medicine, for example,
- (4) that seems to have been around forever,
- (5) just in different forms from the one that actually works today
- (6) (witch doctors etc) . . .

Symtryx proposes another problem: When should the game introduce specific sciences into game play? He suggests that players “look into real examples throughout history,” explicitly restating the importance of historical authenticity (Line 2). His medical example provides an historical thought experiment to illustrate his concept. In suggesting that “Witch doctors etc” he proposes that non-Western practices might help widen understanding of the history of medicine (Line 6). While CIVILIZATION has been criticized for presenting a Eurocentric approach to history (Douglas, 2002), this player's suggestion offers insight into how the players' ideas about the game are not bound by limitations in its existing design. Instead of absorbing the Eurocentric model the game presents, these players indirectly address the problem through their suggestions for redesign.

Cautious and Courteous Exchanges

Much public discourse on the web is aggressive and antagonistic, but the modders' discussion is not. Many posts begin or end with statements such as the following:

Symtryx: Here's how it looks to me, have I got it right?

Moreland: I just hopped on to this thread and I'm not quite sure if I understand the model . . .

Moreland: Okay, so let me get this straight once more . . .

The modders avoid an aggressive formulation of their critiques and suggestions. Symtryx's phrase “how it looks to me” presents his suggestions as personal reactions. Asking a rhetorical question “have I got it right” avoids provocation. Moreland's

statements, having “just hopped onto this thread,” being “not quite sure if I understand the model,” and asking to “get this straight once more,” indicate a willingness to listen. As the modders proceed with their discussion of science and technology in the game, they use qualification techniques to develop a civil atmosphere in the community. Their courtesy affirms the importance that they place on the community as a whole and on individual members’ contributions (Brown & Levinson, 1987; Goffman, 1967). This is the same courtesy frequently found in scholarly discourse among historians, sociologists, and philosophers of science.

Discussion

Instead of uncritically absorbing the problematic model of science and technology presented in the game, these discussants question it and engage in collaborative and creative critique of the model. One could write these players off as a small minority of the games player community, but Squire and Giovanetto’s (2008) research on how the Apolyton community helps players become game designers suggests that the way modders understand the game is a significant component in the larger communities understanding of the game. The problems that these modders saw stimulated their curiosity. They collectively, seriously, and freely discuss the same issues as professional historians, philosophers, and sociologists.

Implications for Public Understanding of History and Science

Historians have been interested in creating and working with simulations and models in history for quite some time, as illustrated by chapters in *The Virtual Representation of the Past* (Greengrass & Hughes, 2008) or by David Staley (2003), who suggests that historians take an active role in developing these virtual historical environments. Historians interested in such work can learn from the communities of players and modders of CIVILIZATION who engage in a collaborative modeling of historical events and phenomena.

Historians can take a cue from recent “citizen science” projects, which form partnerships between amateur and enthusiast communities, much like these modders, to further scientific research, while helping enthusiasts and amateurs understand the nature and process of science better. Citizen science projects such as GalaxyZoo, which allows enthusiasts to help classify galaxies from the Sloan Digital Sky Survey, and FoldIt, the University of Washington’s protein folding game, turn generating data for the scientific community into a game play (see also Cai, Lu, Zheng, & Li, 2006). GalaxyZoo has 250,000 citizen scientists whose primary motivation for participating is to contribute to science (Raddick et al., 2009). The participants in these citizen science projects have much in common with the CIVILIZATION modder community.

If historians want to push the public to develop more sophisticated understandings of history, it might be in their best interest to leverage the participant structures present in these informal communities and reach out to gamers whose interest in historical

modeling has already been piqued. Several grant-funded projects have developed mods for CIVILIZATION, using CIVILIZATION as a platform for building educational historical games. Future projects that develop mods of CIVILIZATION might actively invite participants to critique and imagine better models for representing history in the game series. Historians should consider reaching out to modders and working with them on their projects, rather than developing historical mods outside the existing modder community.

The success of citizen science projects such as GalaxyZoo and FoldIt demonstrate the potential for incorporating the public into cutting edge research, and the vibrancy and engagement of the modder community surrounding CIVILIZATION demonstrates that similar, existing communities of enthusiasts may well be excited about the prospect of collaborating in citizen science-style historical projects. The most direct implication is that historians interested in developing simulations must be thinking about how they can invite communities of enthusiasts like these modders to take ownership and participate in these kinds of projects. This could provide the dual benefit of enhancing digital projects through the time and energy amateurs contribute while simultaneously helping those amateurs and enthusiasts become more sophisticated consumers and producers of history.

Implications for Education

Historian and Professor Rob MacDougall (2009) provides a working example of this line of research for teaching. MacDougall begins a college level history course by discussing the underlying assumptions about determinism, contingency, and technological change in CIVILIZATION and then uses the game as a prompt for students to imagine new approaches for modeling science and technology in the game. His students develop diverse approaches, working in much the same manner as the CIVILIZATION modders briefly described above. MacDougall's approach demonstrates that imagining new systems for technology and science in CIVILIZATION is not an oddity of the modder community but that the game experience prompts its players to do some serious historical thinking.

Implications for Studying Games

Recent studies of open-ended games such as CIVILIZATION describe them as “possibility spaces” (DeVane & Squire, 2008). The structure of these games gives players flexibility in making sense of the game environments; the games' players are directly involved in cocreation of the games (Jenkins, 2002; Morris, 2003) **[AQ: 4]**. In this theory of games and learning, it is crucial to focus on the personal sense each player makes out of the games. Every player develops an understanding of the game and its implications by exploring the possibilities afforded by the game. This disposition toward games in which players redesign and cocreate their own games is visible in many aspects of game play, but it is completely realized when game modders modify the actual game code.

Conclusion

CIVILIZATION has been approached from many perspectives. This approach underscores some of the problems that arise when examining games outside the context of its community of players. I could have provided a detailed analysis of flaws and problems in CIVILIZATION's model of the history of science, but when we look to the game community, we find that the flaws and problems in the model actually invited players to think more deeply about their own understanding of science and technology. Critics can point to flaws in how a game presents issues, but without analysis of how players actually make sense of those issues, there is no reason to believe that problems in a games model are transmitted uninterpreted into the minds of game players. Far from poisoning young minds, this game is intellectually engaging on multiple levels, as a game mechanic and as a kind of laboratory for collective experiments.

Popular media are routinely given a failing grade for communicating scientific knowledge. The mechanics and content of CIVILIZATION provide an opportunity for gamers to discuss models for understanding the different variables in history, in particular the role of science in society in the thread we examined. These players have developed the methods and courtesies of scholarly discourse, such as historical authenticity, attention to arguments and questions, and respect for the interlocutor. It is curious that so much of the public discourse about science in society, online or on television, as illustrated by the cases of stem cell research or the theory of evolution, is shrill and aggressive, while these gamers show courtesy and attention in their discussion of how the game models science and technology as a variable of civilization. Perhaps we can suggest that some games, such as CIVILIZATION, unlike the negative stereotype, might provide a useful approach to engage members of the public and students in a productive process of developing and refining their understanding of science, and of its role in society.

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References

- Bates, B. (2004). *Game design*. Boston, MA: Premier Press.
- Brown, P., & Levinson, S. C. (1987). *Politeness: Some universals in language usage*. Cambridge, England: Cambridge University Press.
- Bunzl, M. (2004). Counterfactual history: A user's guide. *American Historical Review*, 109, 845-858.
- Cai, Y., Lu, B., Zheng, J., & Li, L. (2006). Immersive protein gaming for bio edutainment. *Simulation & Gaming: An Interdisciplinary Journal*, 37, 466-475.

- CIVILIZATION III: GOLD EDITION. (2003). [Developed by Sid Meier]. Hunt Valley, MD: Firaxis.
- Collins, H. M. (1987). Certainty and the public understanding of science: Science on television. *Social Studies of Science*, 17, 689-713.
- DeVane, B. (2009). "Get some secured credit cards homey": Hip hop discourse, financial literacy and the design of digital media learning environments. *E-Learning*, 6, 4-22.
- DeVane, B., & Squire, K. (2008). The meaning of race and violence in Grand Theft Auto: San Andreas. *Games and Culture*, 3, 264-285. doi: 10.1177/1555412008317308
- Dingwall, R., & Aldridge, M. (2006). Television wildlife programming as a source of popular scientific information: A case study of evolution. *Public Understanding of Science*, 15, 131-152.
- Douglas, C. (2002, September). You have unleashed a horde of barbarians! Fighting Indians, playing games, forming disciplines. *Postmodern Culture*, 13(1). doi: 10.1353/pmc.2002.0029
- Duncan, S. (2008, March). *Literacy implications of online fan debates*. Paper presented at the Annual Meeting of the American Educational Research Association, New York, NY.
- Fairclough, N. (2003). *Analysing discourse: Textual analysis for social research*. London, England: Routledge.
- Ferguson, N. (1997). *Virtual history: Alternatives and counterfactuals*. New York, NY: Basic Books.
- Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York, NY: Palgrave Macmillan.
- Gee, J. P. (2005). *An introduction to discourse analysis: Theory and method* (2nd ed.). London, England: Routledge.
- Geertz, C. (1973). *The interpretation of cultures*. New York, NY: Basic Books.
- Goffman, E. (1967). *Interaction ritual: Essays on face-to-face behavior*. Garden City: NY: Anchor Books.
- Green, J. (2008, June 27). *Interview: Spore's Soren Johnson: Leaving Civilization IV and settling into Spore's universe*. Retrieved from <http://www.1up.com/do/feature?pager.offset=1&cId=3168266>
- Greengrass, M., & Hughes, L. (Eds.). (2008). *The virtual representation of the past*. Farnham, England: Ashgate.
- Hutchins, E. (1995). *Cognition in the wild*. Cambridge: MIT Press.
- Jenkins, H. (2002). Interactive audiences? The "collective intelligence" of media fans. In D. Harries (Ed.), *The new media book* (pp. 157-170). London, England: BFI.
- Johnson, S. (2006). One civ, many worlds. In Sid Meier's *Civilization chronicles* [CD-ROM]. Novato, CA: 2K Games.
- Kuhn, T. S. (1962). *The structure of scientific revolutions*. Chicago, IL: University of Chicago Press.
- Latour, B. (1988). *Science in action: How to follow scientists and engineers through society*. Cambridge, MA: Harvard University Press.
- Leon, B. (2008). Science related information in European television: A study of prime-time news. *Public Understanding of Science*, 17, 443-460.
- MacDougall, R. (2009, March 18). *Technology grows on trees. Old is the new new*. Retrieved from <http://www.robmacdougall.org/index.php/2009/03/technology-grows-on-trees/>
- MAKING HISTORY: THE CALM & THE STORM. (2007). [Developed by Muzzy Lane]. St. Newburyport, MA.

- McMichael, A. (2007). PC games and the teaching of history. *The History Teacher*, 40, 202-218.
- Owens, T. (2009). Going to school with Madame Curie and Mr. Einstein: Gender roles in children's science biographies. *Cultural Studies of Science Education*, 4, 929-943. doi: 10.1007/s11422-009-9177-6
- Poblocki, K. (2002). Becoming-state: The bio-cultural imperialism of Sid Meir's CIVILIZATION. *European Journal of Anthropology*, 39, 163-177.
- Popper, K. (2002). *The logic of scientific discovery*. New York, NY: Routledge.
- Poremba, C. (2006). Patches of peace: Tiny signs of agency in digital games. In *Level Up conference proceedings* (CD-ROM, Vol. 20). Utrecht, Netherlands: Digital Games Research Association.
- Postigo, H. (2007). Of mods and modders: Chasing down the value of fan-based digital game modifications. *Games and Culture*, 2, 300-313.
- Raddick, M. J., Bracey, G., Gay, P. L., Lintott, C. J., Murray, P., Schawinski, K., . . . Vandenberg, J. (2009). *Galaxy zoo: Exploring the motivations of citizen science volunteers*. Retrieved from <http://arxiv.org/abs/0909.2925>
- Schott, G. (2006). Agency in and around play. In D. Carr & D. Buckingham (Eds.), *Computer games: Text, narrative and play* (pp. 133-148). Cambridge, England: Polity.
- Squire, K., & Barab, S. (2004). Replaying history: Engaging urban underserved students in learning world history through computer simulation games. In *Proceedings of the 6th international conference on Learning Sciences* (pp. 505-512). Santa Monica, CA: International Society of the Learning Sciences.
- Squire, K., & Giovanetto, L. (2008). The higher education of gaming. *E-Learning*, 5(1), 2-28.
- Staley, D. J. (2003). *Computers, visualization, and history: How new technology will transform our understanding of the past*. Armonk, NY: M. E. Sharpe.
- Steinkuehler, C., & Chmiel, M. (2006). Fostering scientific habits of mind in the context of online play. In *Proceedings of the 7th international conference on Learning Sciences* (pp. 723-729). Santa Monica, CA: International Society of the Learning Sciences.
- Toumey, C. P. (1996). *Conjuring science: Scientific symbols and cultural meanings in American life*. New Brunswick, NJ: Rutgers University Press.
- White, H. (1975). *Metahistory: The historical imagination in nineteenth-century Europe*. Baltimore, MD: Johns Hopkins University Press.
- Wineburg, S. (2001). *Historical thinking and other unnatural acts: Charting the future of teaching the past*. Philadelphia, PA: Temple University Press.

Bio

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