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Marc I. Cicchino
Rutgers Graduate School of Education, marc.cicchino@gse.rutgers.edu

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ARTICLE

Using Game-Based Learning to Foster Critical Thinking in Student Discourse

Marc I. Cicchino (Rutgers Graduate School of Education)

Previous research indicates the importance of student discourse in the construction of knowledge and the fostering of critical thinking skills, especially in the field of problem-based learning (PBL). Further, a growing body of research on game-based learning (GBL) draws parallels between playing certain types of games and the solving of ill-structured problems, citing similar conditions for learning (student centered, small student groups, teachers as facilitators, problems as vehicles for development), and similar learning outcomes (communication, problem-solving, critical thinking, collaboration) as PBL. However, there is a gap in understanding how GBL affects critical thinking as embodied by student discourse when implemented in traditional classroom environments. In this study, I examined student discourse throughout a GBL intervention designed to promote content knowledge and critical thinking in an 8th grade social studies classroom. A total of three 8th grade social studies classes engaged in the intervention. Post-tests and delayed post-tests were conducted for the entire 8th grade (ten social studies classes across two instructors). Five groups of students that engaged in the GBL intervention were videotaped and analyzed. Data analysis showed that features of the GBL intervention and particular cycles of gameplay were effective in promoting higher levels of critical thinking, including the development of independent beliefs prior to engaging in collaborative discourse and providing opportunities for guided reflection. This study has implications for the developers of GBL frameworks, researchers interested in exploring GBL, and teachers seeking to integrate GBL into their classrooms.

Keywords: game-based learning, GBL, critical thinking, games, educational games, problem-based learning

Game-based learning (GBL) is inherently driven by a sociocultural view of learning (Young et al., 2012). Generally speaking, game-based learning environments enable learners to make meaningful choices within problem spaces that may span the visual, spatial, and aural, and that provide learners with challenges that must be overcome (McCall, 2012). Much like problem-based learning (PBL), these GBL environments often present learners with ill-structured problems or, similarly, well-structured rules with ill-structured paths to resolution; in either environment, students typically work in small groups and construct knowledge through the activation of prior understandings, as well as by engaging in collaborative discourse (Gresalfi et al., 2009; Hmelo-Silver, 2004).

While the implications of PBL on critical thinking and collaborative discourse are well documented (Hmelo-Silver & Barrows, 2006), research on GBL in this context is still limited. Most of the work on GBL has been theoretical in nature (Malone, 1980, 1981; Prensky, 2001; Schaffer, 2005), and while a growing body of research exists regarding the educational power of games—that is, video games (Gee, 2007; Squire, 2006), experiential educational games (Nicholson, 2012), and so on—limited work has been done regarding of GBL interventions, problem-solving, and critical thinking in traditional classroom contexts. Eseryel et al. (2014) explore the relationships between complex problem-solving, student motivation, and engagement in the context of GBL, helping to bridge the gaps between GBL, problem-solving theory, and practice. In their study, the problem inherent to the game being played is ill structured in that its state (that is, the relationship between the *present condition* and the *desired goal state*) is constantly in flux and thus never clearly defined. The problem exists due to the disconnect between both states and the lack of a routine method by which the issue may be solved (Mayer, 2003), and the process for seeking resolution—that is, the process of problem-solving (Lovett, 2002)—doubles as *gameplay*. This provides a compelling springboard for the consideration of how a problem-solving lens can bring depth to our understanding of GBL (and games in general).

Another large obstacle in gaining a more complete understanding of GBL is the lack of common language across re-

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Table 1. Six principles of game-based learning

GBL Principles	Purpose / Outcomes
The intervention must inspire critical thinking.	• All aspects of learning environment set up to encourage active and critical, learning. • Encourage students to utilize and practice skills we are seeking to develop.
The intervention provides "just enough" challenge for players.	• Ample opportunity for learner to operate at the outer edge of his/her resources • Create a surmountable challenge. • Environment provides necessary scaffolds for overcoming challenge and/or learning task.
The intervention provides opportunities for players to discover/ construct their own knowledge/ understandings.	• Learners have opportunities to engage in guided discovery. • Congruent with constructivist learning theories.
The intervention provides a fictional-world.	• Metaphor or fantasy-driven context for gameplay. • Learner has choices in developing a virtual identity in this fictional world. • Learners can take risks where real-world consequences are lowered.
The intervention is "social."	• Players must interact with one another to make progress in the game. • Learners constitute a group that is bonded through shared endeavors, goals, and practices. • Community of practice.
The intervention must be winnable—and by various avenues.	• Win-states provide challenge and competition via multiple routers. • Intervention maintains its allure as a game. • Learners may make choices, rely on their strengths and learning preferences, and engage in problem solving.

search. The term GBL is itself quite vague; does it refer to the nascent power of hyper-immersive online video games, or the timeworn brawn of backgammon? Should we concern ourselves with the platform (Is it digital? Are there varying degrees of digital? If so, how digital is it?), the genre (Is it a *game* or is it a *simulation*?), the context (Is it played in school? At home? In a museum? In an underwater dungeon?), or simply the mechanics (which, as it turns out, are not quite so simple)? Myriad efforts have been made to make the terms associated with games and learning concrete, the most recent and most sensible of which offer suggestions for propelling the field forward in a cohesive fashion. The National Research Council (2011) details the differences of scope and purpose between simulations and games, as well as between formal and informal learning contexts. In short, while a simulation permits the exploration of a concept, it does not necessarily hold to the principles of gameplay, hence the focus of this study on *games* and *not* on simulations. Young et al. (2012) offer suggestions for furthering the collective understanding and evaluation of games. Suggestions include constructing working definitions, creating an educational video game repository with metatagged curricular objectives, researching educational video games that are already in use, and conducting longitudinal studies in order to examine the impact of educational games.

For the purposes of this study, I sought to investigate the effects of a game-based learning environment designed for implementation in a traditional/formal (nondigital) school context with hopes of enhancing our understanding of how GBL might inform traditional K–12 education. A nondigital platform was utilized for gameplay so as to explore the viability of game-based learning in instructional spaces that may be otherwise lacking in technology. A number of game-based learning frameworks and principles were taken into consideration, including those detailed by the National Research Council (2011) and those put forth by Gee (2007), Squire (2008b), Prensky (2001), and Malone (1981). A working definition of GBL was derived from the research in the form of six principles, indicated in Table 1. These principles were selected because of the effects they should have on learning, such as fostering student engagement and providing opportunities for knowledge-making.

The six principles selected for this study require that the GBL intervention: (1) be provocative of critical thinking via one or more problem states; (2) be appropriately challenging (similar to Vygotsky's zone of proximal development); (3) provide opportunities for players to discover and/or create their own knowledge; (4) provide a fictional world or fantasy-driven metaphor; (5) be "social" (i.e., encouraging collabora-

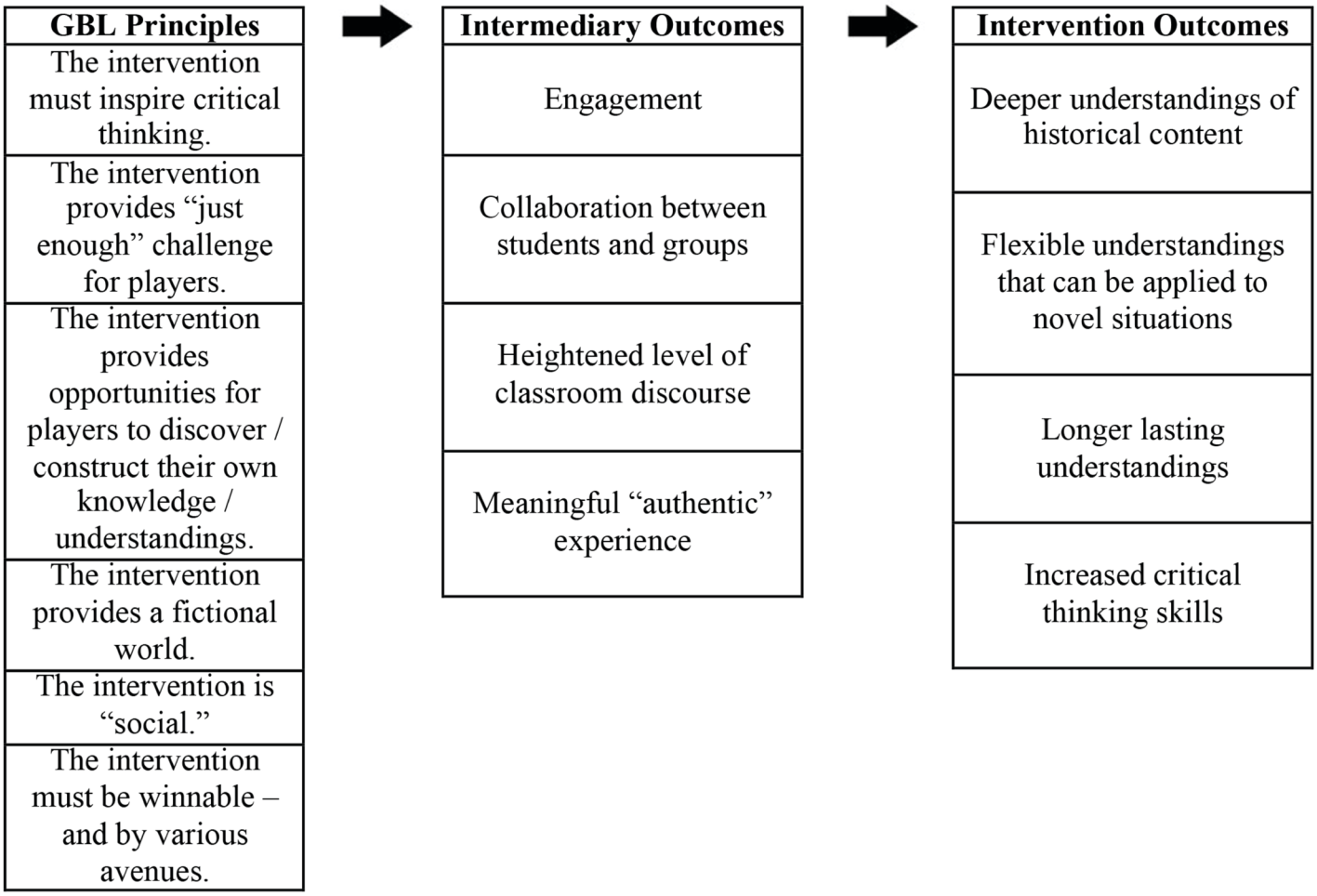

Figure 1. Logic model linking six principles of game-based learning to intermediary outcomes and intervention outcomes.

tive interactions between players); and (6) be winnable (so as to provide goals, as well as some sense of competition). It is also important to consider that effective GBL environments are designed with learning outcomes in mind (Squire, 2006), but given its ubiquity, this point was not included among the principles of GBL.

In designing a classroom experience that embodied each of these principles, I expected that students would utilize higher order thinking skills in a manner that was frequent and compelling. Beyond promoting higher levels of engagement, I also anticipated that students would gain a deeper and longer-lasting understanding of the content that was covered (see logic model, Figure 1).

The logic model in Figure 1 demonstrates how the six selected principles of GBL should produce four intermediary outcomes: (1) engagement, (2) collaboration among students and groups of students, (3) heightened levels of classroom discourse, and (4) meaningful and/or authentic experiences. These intermediary outcomes will ultimately guide participants to the following intervention outcomes: (1) deeper understandings of content knowledge (in the case of this intervention, *historical* content knowledge), (2) flexible understandings that can be applied to novel situations, (3) longer-lasting understandings, and (4) increased critical thinking skills.

The similarities shared between GBL and problem solving in the way of honing individuals' capacity "to use cognitive processes to resolve real, cross-disciplinary situations where the solution path is not immediately obvious" (OECD, 2003, p. 156) suggest that well-designed games may provide comparable learning benefits in the way of engagement and critical thinking skills. Given the structure of the GBL environment, one might even expect to see the development of flexible knowledge, effective problem solving skills, and intrinsic motivation (Hmelo-Silver, 2004). Consequently, a deeper understanding of GBL—how it affects student learning, engagement, and critical thinking in discourse—holds significant implications for educators.

Much of the work done on GBL (even in a constructivist light) focuses on the integration of commercial video

games into educational contexts. For instance, Squire has done research on students' learning experiences while playing *Civilization III* (Squire, DeVane, & Durga, 2008; Squire, 2008a; Durga & Squire, 2011; Squire, Giovanetto, DeVane, & Durga, 2005). Squire argues that by playing *Civilization*, students are given the opportunity to play through weeks of ancient history curriculum, while simultaneously developing communities—whether online via message forum, or in real-life via middle-school sleepovers—and engaging in sophisticated mentoring models, where both adults and experienced players mentor novices. Squire, DeVane, and Durga's (2008) study sought to create a community of expert players of *Civilization III*. Twelve participants, largely low SES African American 5th and 6th graders, were immersed in gameplay with the intentions of investigating how players might gain access to more sophisticated academic practices. These included historical content, vocabulary, "deeper" conceptual understandings, and problem solving skills. Participants demonstrated a strong grasp of historical content knowledge associated with the gameplay through researcher-administered pop quizzes. Moreover, the actions that players took during gameplay indicated growth in systemic expertise with regard to the workings of the game itself.

Similarly, Shaffer (2005) argues that games offer players the opportunity to develop epistemic frames, which he defines as a way of seeing, valuing, and being in the world—for instance, learning to think like a lawyer, or a soldier, or any other identity and world into which a player is immersed. Shaffer suggests that this allows players to bring more expansive and profound insights into other areas of their lives. He explains that epistemic games provide opportunities for educators to evolve beyond the increasingly obsolete forces that shaped the inauthentic structures associated with traditional schooling. Instead, games provide opportunities for authentic, reflective, and critical thinking practices that are not only pertinent, but *essential* for success in the 21st century. Shaffer investigated these theories by implementing a game that asked 11 high school seniors to take on the roles of urban planners over the course of a two-day weekend workshop. Students were asked to develop plans, make important decisions, and ultimately present their finished products to a representative from the city planning office. Through qualitative analysis of observations and interviews, Shaffer found that students not only enjoyed the gameplay, but developed ways of thinking and doing congruent with the characteristics of urban planners.

DeVane and Squire's (2008) study of how kids play the video game *Grand Theft Auto: San Andreas* suggested that rather than passively absorbing game content, players situated content in the context of their own experiences. Interviews with participants indicated that different players interpret the same content and gameplay experiences in different ways, essentially allowing each individual to construct his/her own localized understandings in a fashion that requires higher order thinking skills.

The effects of such game-environments on engagement during history instruction is documented in several studies (Devlin-Scherer & Sardone, 2010; Watson, Mong, & Harris, 2011). One of the few empirical studies of history learning and video games was conducted by Moshirnia and Israel (2010), examining 74 undergraduate students' learning across three conditions—a pretest-posttest control group that received PowerPoint instruction, a pretest-posttest group that played *Civilization IV*, and a posttest-only group that also played the game. The study found no significant difference in knowledge gained between the PowerPoint and the game group, although they did note two interesting observations. The first was a retention effect evidenced in the gameplay group (i.e., players were able to recall facts learned for one week longer than their PowerPoint counterparts), and the second was with regard to the trajectory of game players' attention—*toward* gameplay, *away* from historical facts in game text and cut scenes.

A recent meta-analysis (Young et al., 2012) of 300+ articles on video games and academic achievement across content areas "found some evidence for the effects of video games on language learning, history, and physical education (specifically exergames), but little support for the academic value of video games in science and math" (p. 61). Further, Young et al. (2012) call for more contributions in the way of empirical research to deepen our understanding of games' impact on learning. The present study seeks to contribute to the research and to our understandings in this fashion, particularly in the way of GBL's potential for impacting learning and critical thinking through discourse.

Games and Classroom Discourse

A considerable amount of research has been done on the role of classroom discourse in fostering comprehension and learning using sociocognitive and sociocultural frameworks. Steinkuehler (2006) applies Gee's (1999) discourse theory (with particular attention to massively multiplayer online games) and argues that, given the richness of discourse, learning, and social interaction taking place in these virtual worlds, these games must be taken seriously. When these interactions are harnessed in a classroom, and students interact with group-members in deep and meaningful ways, the group's learning is essentially "greater than the sum of its parts" (Wertsch, Del Rio, & Alvarez, 1995). This is generally attributed to the social perspectives and cultural values that each group member brings to the discussion, as well as

the inherent nature of these interactions for fostering critical thinking skills. Because talk is central to social constructivist pedagogy, verbal interactions are strong indicators of student learning; in turn, the quality of student talk is immediately linked to the quality of student problem solving, understanding, and learning (Nystrand, Gamoran, Kachur, & Prendergast, 1997; Dunlap, 1999). Additionally, Murphy et al. (2009) argue that spoken discourse is a substantive indicator of thinking and learning; they claim that "sufficient reliability in language use to enable us to make valid inferences about the productiveness of talk for student learning" (p. 741) in the meta-analysis in which they examine the effects of utilizing group discussions as a means for promoting high-level comprehension of text (i.e., "critical, reflective thinking about text"). By the same token, this study utilizes student discourse as a means for measuring critical thinking as participants experience the GBL intervention.

Although the term *critical thinking* has often been used loosely with regard to a smorgasbord of complex thinking skills, the present study has adopted Moon's (2008) definition of critical thinking as a "capacity to work with complex ideas whereby a person can make effective provision of evidence to justify a reasonable judgment. The evidence, and therefore the judgment, will pay appropriate attention to context" (p. 7). Additionally, this study considers (1) the importance of developing these skills so that individuals might ultimately deal with complex problems in authentic/real-life contexts (Bransford, Brown, & Cocking, 2000; National Research Council, 1996), and (2) the necessity of students to engage in active critical thinking processes. These include purposeful and reasoned thinking, analysis of appropriate data, construction of evidence-based arguments, inference-making, and evaluation of relevant information (Halpern, 1999; Paul, 1995; Perkins, 1998). Moon's (2008) definition of critical thinking, as well as the oft-emphasized cognitive skills such as analysis, interpretation, evaluation, explanation, and synthesis (Abrami et al., 2008; Ennis, 1987; Fischer, 2001), are embodied by Xin's (2002) framework of intellectual acts of progressive stages of engaged collaborative discourse. Xin originally utilized this scheme in order to explore individuals' levels of understanding during online seminars. This framework was adapted for the purposes of coding and analyzing discourse in the context of a GBL intervention (Table 4).

This study ultimately grounded in the problem of maintaining student engagement while seeking to foster higher order thinking skills. Given the pertinence of problem-solving and game-based learning literature, this research seeks to contribute to the growing field of game-based learning by embodying the principal features of GBL frameworks in an intervention, and by examining the effects of this intervention as implemented in a traditional school setting. The primary research question posed by this study is: *How does game-based learning affect student learning in terms of content acquisition, retention, and critical thinking?* The context for this study is a role-play game in 8th grade social studies classes. The answer to this question will better inform our understanding of how GBL can be utilized in traditional schools. This study also examined gender as a factor impacting the effects of GBL in order to investigate how the features of game-based learning might affect males or females differently. Much work has been done in the way of exploring the popularity of playing video games (and effects thereof) among males and females (Wright et al., 2001). Results of a large-scale survey (n = 534) indicated that female respondents play less frequently, feel less motivated to play in social situations, and feel less attracted to competitive game genres as male counterparts (Lucas & Sherry, 2004). Because of concerns that effects of GBL might be mediated by gender, I explored this variable as well.

The effectiveness of the GBL intervention was explored using a quasi-experimental, mixed methods design. The qualitative portion of this study examined students' utterances and interactions as captured on video during gameplay. Additionally, post-tests were used to compare student learning across treatment, and delayed post-tests were used to measure retention.

Methods

Participants

The GBL intervention was implemented in a middle school located in suburban New Jersey that served approximately 600 students in grades 6 through 8. The township served had an approximate median household income of $130,000, and a median family income of $150,000. Approximately .8% of families and 1.4% of the population were below the poverty line at the time of the study. In 2010, the racial makeup of the township was as follows: 85.64% White, 1.49% African American, 10.43% Asian, and 5.12% Hispanic (*2010 Census*).

This particular middle school was selected as the research site for several reasons:

- The 8th grade social studies classes in this school were not tracked. That is, social studies classes were not randomly assigned but academic ability was not used as criteria for grouping students.
- The teacher who volunteered to facilitate the GBL intervention in his 8th grade Social Studies classroom had previously implemented game-based activities. He had also taught the French and Indian War in a "traditional" fashion (i.e., via lecture, textbook, worksheets, and small-group work), and was willing to implement

Table 2. French and Indian War game objectives

Territory	Objective	Dice
British	Finish the game with 16 spaces under your control, including at least six of your original British spaces, at least one original Ottawa space, at least one original Miami space, and at least one original Huron space.	6
French	Finish the game with 16 spaces under your control, including at least six of your original French spaces, at least one original Ottawa space, at least one original Miami space, and at least one original Shawnee space.	6
Huron	Finish the game with at least two of your original spaces, plus two additional spaces. You are not allowed to form an alliance with the Erie people.	3
Erie	Finish the game with at least three of your original spaces, OR two of your original spaces *plus* two additional spaces. You are not allowed to form an alliance with the Miami people.	2
Shawnee	Finish the game with at least three of your original spaces, *plus* two additional spaces. You are not allowed to form an alliance with the Ottawa people.	3
Miami	Finish the game with all three of your original spaces.	2
Ottawa	Finish the game with at least two of your original spaces, plus at least one additional space.	2

both the "traditional" and the "GBL" across multiple sections of 8th grade Social Studies. The participating teacher was in his fourth year of teaching 8th grade Social Studies at the time of the investigation.

The GBL intervention was be implemented in a total of three 8th grade Social Studies classes. These classes were selected at random from the five sections that the participating teacher was responsible for teaching. The seven remaining 8th grade Social Studies classes (two of which were taught by the participating teacher, five of which were taught by another instructor) received traditional business-as-usual instruction. Lesson plans indicated that business-as-usual instruction entailed mini-lectures, guided note taking, and screening educational film clips. A total of 62 students were in the intervention condition and 115 were in the comparison condition.

GBL Intervention

In the two years preceding this study, the participating teacher enacted similar iterations of this game during the French and Indian War unit of his 8th grade Social Studies course. In order to ensure that the six principles of GBL (see Table 1) were embodied in the iteration of the game being studied, the participating teacher and I worked together to identify necessary rules and mechanisms of play (i.e., grouping, turn-taking, etc.), and to make necessary revisions to the intervention.

At the onset of the game, students who were permitted to participate in the study were randomly assigned to small groups (two to five students per group), and each group was randomly assigned to a particular territory (i.e., British, French, Huron, etc.). Each territory was visually represented on a map in the front of the classroom, and different territories were allotted varying numbers of land-spaces (i.e., the French began the game with six land-spaces, whereas the Miami began with three). Further, each territory received a predetermined number of dice (i.e., the French received six dice, the Miami received two dice, etc.). Every territory was also assigned an overarching game objective—most of which required "waging war" against other territories (i.e., competitively rolling dice) in an effort to win their land-spaces. For example, the French objective was: "Finish the game with 16 spaces under your control, including at least six of your original British spaces, at least one original Ottawa space, at least one original Miami space, and at least one original Huron space."

Here, the uneven distribution of land-spaces and dice was intended to mirror the historical advantages and disadvantages of specific forces (i.e., the British and French began with more "firepower"/mathematical advantage of victory by sheer number of dice to roll than any single Native American tribe). Objectives were designed to reflect the historical motives of the territories to which students were assigned (i.e., the French would have to take control of a great deal of North American land in order to win, whereas the Miami people would simply have to hold on to their own land), and constituted potential "win states" for players. The territories, their respective objectives, and the number of dice distributed at setup are detailed in Table 2; the rules of gameplay, including an explanation of how dice are used to "wage war," are indicated in Table 3.

It is important to note that while rolling of dice is a central facet of play, this mechanism does not work to constrain student thinking. Rather, it purposes to contribute to

Table 3. French and Indian War game rules

Rule #1	When attacking and/or being attacked, both territories must roll all of their dice. The territory with the highest single roll is the winner. (For example, if France rolls six dice: *1, 1, 1, 2, 2, 5* – their highest roll is a *5*. If the Huron then roll a *1* and a *6*, the Huron's *6* trumps the French *5*, and the Huron win the battle.)
Rule #2	Territories can only attack other territories that are connected to their own spaces, or their ally's spaces.
Rule #3	Alliances can be broken by either ally.
Rule #4	If the aggressor wins a battle, he/she gains the space that was attacked.
Rule #5	If a battle is lost, the territory loses a die. (No territory can have less than one die.)
Rule #6	If a territory is attacked, it may forfeit its space to the attacker. (This allows for the conservation of dice.)
Rule #7	Allies may choose to combine their dice when attacking an enemy. If they lose the battle, every member of the alliance loses one die.

the ill-defined nature of students' trajectories toward "winning." While students' objectives are clear, their constraints and paths to victory are ill defined. The bulk of student participation and discourse revolves around strategizing within groups (i.e., arguing for or against plans of action, forming external alliances with other groups, referencing history as a model for decision-making). In considering dice a limited resource, students' thought processes parallel those whose histories they are "replaying." In essence, dice become a metaphor for war supplies and an engine for gameplay.

Once students were assigned territories, the teacher provided an introductory mini-lecture on the French and Indian War (historical context, between five and ten minutes). This was framed for students as an opportunity to learn from the past, and to actively engage in the process of "replaying history." Given that students had already been assigned specific territories, it was expected that they would find the historical content to be more meaningful. This content was also intended to provide opportunities for students to consider how their territories historically participated in the French and Indian War, how they fared, and whether or not these techniques merited replication in the GBL intervention.

As the gameplay began, students were given time (approximately one minute) to discuss strategy with their own groups, followed by an opportunity (approximately one more minute) to form alliances with their fellow players in *other* groups. Then, in a rotating fashion, each territory was given an opportunity to make a move (i.e., to declare war). After each territory had the chance to attack, the process was repeated, beginning with another opportunity to discuss strategy within their groups. As the game was played, students were permitted to make and break alliances at any time.

Students were continually provided with opportunities to engage in active discussion regarding the strategies that they sought to employ (i.e., the turn cycle: one minute to discuss strategy with their own groups, followed by one minute to negotiate alliances with other groups). While the rules and objectives provided the necessary structure for play and embodied the six core principles of GBL, the game itself was open-ended in that there was uncertainty regarding the time it would take to complete, the avenues that students would take in an effort to achieve their objectives, the strategies students would employ, and the kinds of discussions students would be having throughout.

Data Sources

Video data collection began on the first day that the French and Indian War GBL intervention was introduced to the class, and continued for the entire course of the game. The gameplay was videotaped using six recording devices set up at various points in the classroom, as well as four external microphones in an effort to ensure satisfactory audio recording. A total of eight GBL groups (across three classes participating in the GBL intervention) were filmed across four days, playing approximately 35 minutes per day, resulting in about 19 hours of video data.

Within one month of the GBL intervention, students were given a five-question content test in order to assess their knowledge regarding the French and Indian War. This test was valid in that it was designed collaboratively by both 8th grade teachers to assess students' content knowledge regarding the French and Indian war, and in that the test items were open-ended. Questions included: "What was the Treaty of Paris?"/"What is guerilla warfare?"/"What are two reasons why the French and Indian War happened?"/"What was Pontiac's rebellion?"/"How did the British react to Pontiac's rebellion?" These items were used in previous years, and have been part of both teachers' implemented Social Studies curriculum. These assessments were issued to *all* 8th grade classes. Although students belonging to the control and treatment groups may have discussed their divergent learning experiences, this was presumed to have not affected students' responses given that time between the intervention and the post-test was limited. Six months after the initial post-test,

Table 4. Adaptation of intellectual acts of progressive stages of engaged collaborative discourse (Xin, 2002)

Code (Critical Thinking)	Intellectual Acts	Description of the Intellectual Act	Example
0. Off-Task	Off-task	Student is evidently disengaged, engaging in an inappropriate act, and/or visibly off-task.	*"Where did you buy those shoes?"*
1. Initiation Zone (Lower Order)	Posing	Introducing new concepts, ideas, or topics of discussion often describing their origin, background, or context, or definition of problem boundaries, ends and means.	*"We should declare war with the English."*
	Clarifying	Making clear by removing misunderstanding or ambiguity of a specific point, a problem situation, or related context, often associated with restating an issue or concept, or asking and answering a specific question.	*"If we declare war on the English, we'll be able to take our sixth territory and get closer to winning."*
2. Negotiation Zone (Middle Order)	Confirming	Expressing agreement or providing supporting arguments by giving examples, relating to personal or other people's experiences, and/or providing evidence from various sources.	*"She's right. The English attacked Miami last turn and now they're in the lead. We should go ahead with her plan."*
	Disagreeing	Expressing disagreement or providing counter argument(s) by giving counter examples or counter evidence, and/or presenting alternative approaches or perspectives.	*"No. The English lost that battle and now they're behind. If we fight against them, we'll lose allies. We should form a truce."*
3. Co-Construction Zone (High Order)	Elaborating	Articulating at greater length or in detail based on previous contributions, often associated with hypothesizing, reasoning, and or analyzing.	*"By forming an alliance with three different tribes, we can probably fight more wars and have a big advantage."*
	Evaluating	Testing ideas or hypotheses, comparing and analyzing different perspectives, proposals, or solutions, and/or making substantiated judgments.	*"Joe thinks we should battle. Jane thinks we should form a truce. The battle is riskier but we can win sooner if it works. The truce might work, but the Miami people already betrayed the French twice. We can't trust them."*
4. Integration Zone (Higher Order)	Extending	Branching into new ideas or concepts, generalizing to other contexts, drawing out implications and predictions, or indicating new applications.	*"This reminds me of Jamestown. We're outnumbered. If we don't make peace, we're goners."*
	Synthesizing	Identifying emerging themes and unifying concept(s), agreements, and disagreements, organizing and integrating multiple perspectives, and/or drawing conclusions or making resolutions based on synthesis.	*"Everyone is driven by their own motives. Jane has a good point, but John's idea is a risk we have to take. We can't trust anyone."*

Table 5. The frequencies and percentages of intellectual acts coded in five GBL groups

Act	Group 1		Group 2		Group 3		Group 4		Group 5	
	N	%	N	%	N	%	N	%	N	%
Off Task	0	0.0	0	0.0	0	0.0	4	13.8	0	0.0
Initiation	22	75.9	10	37.0	12	42.9	17	58.6	11	37.9
Negotiation	4	13.8	7	25.9	10	35.7	4	13.8	7	24.1
Coconstruction	2	6.9	8	29.6	6	21.4	2	6.9	10	34.5
Integration	1	3.4	2	7.4	0	0.0	2	6.9	1	3.4

the same assessment was given again; students were not made aware of this assessment prior to its being given.

Data Analysis

Approximately 12 hours of video data was uploaded into *Dedoose*—a web-based qualitative data analysis package. The uploaded data were pertinent to five of the eight GBL groups filmed, purposefully selected because they were verbal, and because technical quality of audio and video was adequate for analysis.

Video footage was divided into five-minute segments, and each segment was coded as the highest level of critical thinking expressed. An adaptation of Xin's (2002) Intellectual Acts of Progressive Stages of Engaged Collaborative Discourse was used to code segments, shown in Table 4. Xin's coding scheme lends itself to an examination of students' critical thinking in that it provides a categorical structure for identifying various levels of depth in thinking as demonstrated through discourse. These codes were treated as ordered variables. In order to ensure the reliability of this study's findings, a second scorer coded 20% of the video data and attained 86.2% agreement.

An analysis of variance (ANOVA) was used to look for effects of treatment condition on post-tests and to see whether this interacted with gender. This allowed for testing of the hypothesis regarding the effects of the intervention on improving learning, and for the identification of unintended consequences, that is, differences between male and female students. This process was repeated for the delayed post-test (given approximately six months later) to examine long-term retention.

Results

All five intellectual acts were identified across the five GBL groups. As indicated in Table 5 and by Figure 2, "initiation" was the most prevalent intellectual act, followed by negotiation, coconstruction, integration, and off-task behavior.

Additionally, not every group expressed every intellectual act. For instance, "off task behavior" was only coded for group 4, while group 3 was never coded with "integration." Table 5 shows the frequency (in terms of the number of times coded) and the percentage of units spent engaged with each intellectual act per individual group. Figure 2 shows the average percentage of units coded across all five groups. The presence of lower acts (such as "initiation" acts) were often embedded in the units coded as higher acts given that units of analysis consisted of five-minute "chunks," and that units were coded for the highest intellectual act expressed.

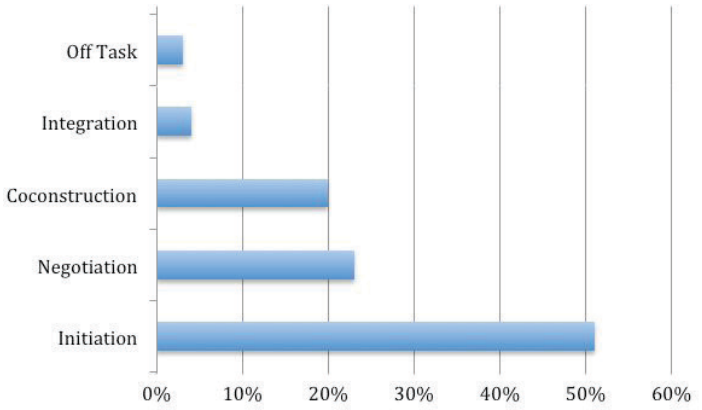

Figure 2. Average percentage of intellectual acts in five GBL groups

Figure 3 shows the trajectory of each group's intellectual acts as coded across four days of GBL activity. Video data consisted of approximately 35 minutes of footage per class day, providing an average of 29 units per group.

As shown in Figure 3, each group's dialogue indicated a different trajectory of critical thinking expressed through discourse. "Peaks" (groups achieving 4:Integration) and "valleys" (the group coded as "off-task") are immediately identifiable here. This figure also makes visible some semblance of oscillation between intellectual acts (i.e., between 3:Coconstruction and 1:Initiation). Higher-level acts are generally not maintained across consecutive units of analysis. This is significant, given that the GBL intervention purposed to foster higher levels of critical thinking. In turn, these moments were examined with particular deliberation so as to better understand their contexts and causes.

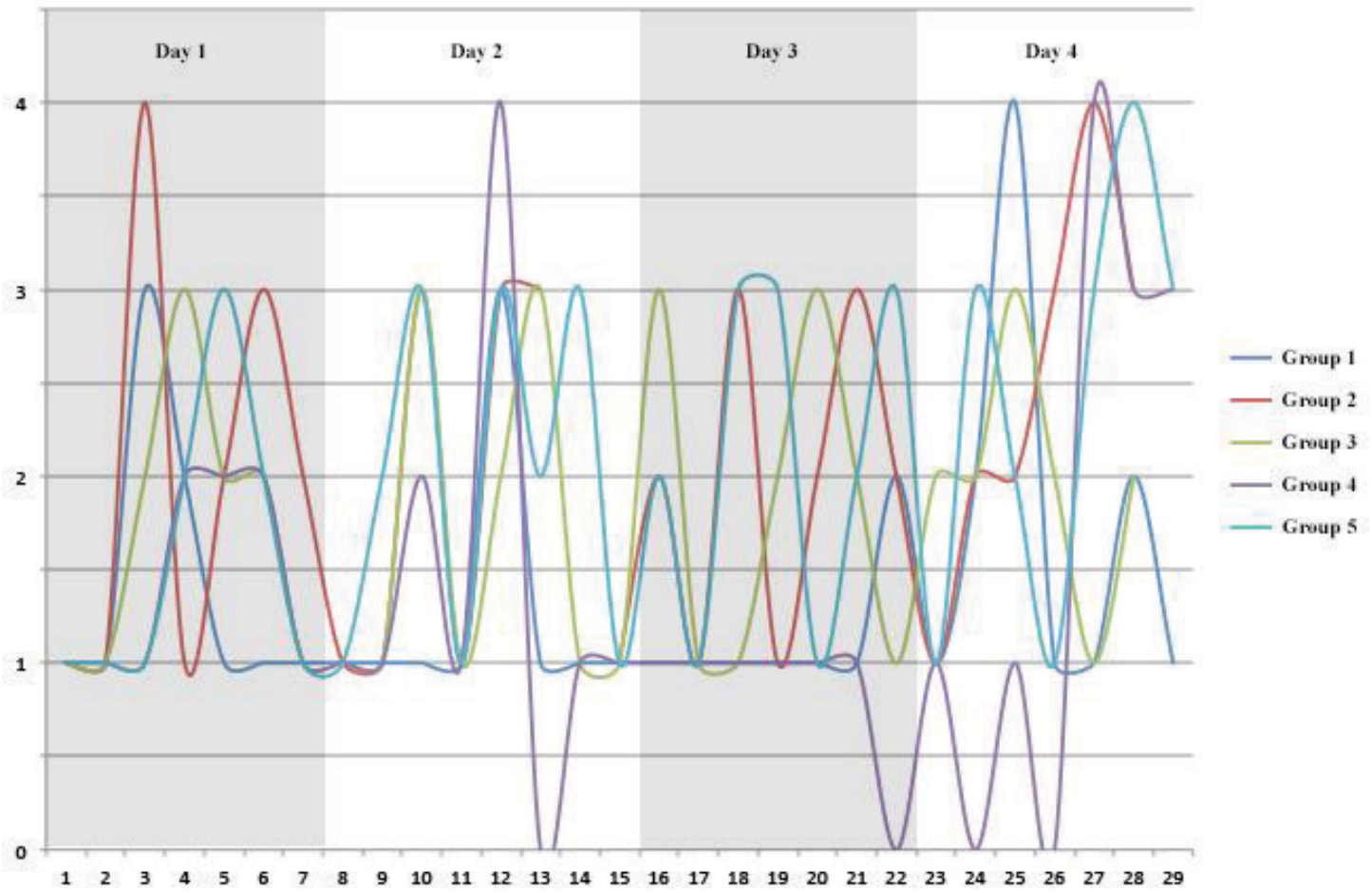

Figure 3. Intellectual acts as coded for individual groups across four days

In the sections that follow, the most common patterns and trajectories of groups' intellectual acts will be explained in the context of the video data, and representative excerpts will be provided. Pseudonyms are used for all participants.

Oscillation

A frequently exhibited pattern in groups' discourse was an oscillatory trajectory, most often wavering to and from Initiation and Co-construction. The high rate of occurrence of Initiation units was anticipated, and can be attributed to the necessity of posing/clarifying points prior to moving toward higher levels of critical thinking and discourse (Bransford, Brown, & Cocking, 2000). In this fashion, segments coded as Initiation can be considered springboards for critical thinking as they were often identified during the instructor's explanations of gameplay/content, and consistently preceded by Negotiation and Co-construction.

The following excerpt is taken from group 1's discourse in their first unit of play:

Teacher: So throughout the game, you are going to take turns deciding if you want to attack other spaces because everybody has the objective of controlling more territory. The amount of territory you have to control by the end of the game though is different from group to group.
Erin: (Looking to group member and pointing to map) These are the spaces?
Jason: (Nods in the affirmative.)
Erin: There's thirty-nine.
Jason: (Nods in the affirmative.)
Teacher: There are, I think, thirty spaces.
Erin: Thirty? I thought it was . . .
Jason: Thirty-nine.
Erin: But I counted the big ones too.
Teacher: Thirty-one spaces.

Discourse of this nature (i.e., teacher explanations followed by students' clarifying questions) continued for the first two units of group 1's play, until the teacher asked all students to discuss strategy with the members of their own groups. The following excerpt is taken from group 1's third unit of play, and is significant in that it exemplifies how both tactics and understandings can be coconstructed once an appropriate knowledge base has been established.

Erin: So let's make an alliance with the Shawnee. That way it blocks—(pointing to map)—then they can't get through here, they can't get through here, or down here.
Ashley: We're British. Almost every person here (pointing to map), they can attack us.
Erin: It doesn't matter though, cause we get six die and everyone else only gets three. Except for the French. The French can't attack us though.
Ashley: Why?
Erin: Read the map. So, Louisiana territory. What is the Louisiana territory?
Ashley: (Indicates the Louisiana Territory on the map)
Erin: This. So we can't—we have to block them getting anywhere down here.
Jason: We'll make an alliance here to here (pointing at map).

This discourse is compelling for several reasons. First, the group is clearly immersed in the gameplay. This is evidenced in the fluency of their discussion regarding alliances and game tactics. Second, students are contending for the best tactic using evidence that is grounded in knowledge learned during Initiation segments. This is indicative of the critical thinking "springboard" effect. Further, once immersed in the game-space and engaged in small-group discussion, students seem to organically negotiate and co-construct knowledge. For instance, Erin's proposal to form a strategic alliance with the Shawnee so as to blockade the other tribes was made possible by the knowledge that she attained during the preceding Initiation segments (historical content, game mechanics). Ashley, who was also present for the preceding Initiation segments, internalized potential avenues for winning in a different way. Ashley's intuitional demand for Erin to substantiate her proposal before moving forward inherently prompted the group to think more critically about their circumstances.

Shortly thereafter, Initiation was revisited in the context of the group clarifying their strategic plans and imminent decisions. While these moments have proven fertile ground for generating higher-level discourse, that is, opportunities for making an evidence-based argument for or against a clarified point and therefore for thinking critically (Postman, 1997), group discourse occasionally remained static. In the excerpt that follows, Ashley and Erin wait their turn to roll the dice. Their exchange simply clarifies the tactics they resolved to pursue in the previous Co-constructional segment.

Ashley: (During attack phase, to her group) Guys. Were we going to go up and attack them too?
Erin: (Nods in the affirmative.)
Ashley: Can I go up?
Erin: Yeah. Go. (Hands her dice.)
Ashley: (Regarding dice) Wait, all of them?
Erin: Yeah!

As such, Initiation units may often represent unrealized opportunities for critical thinking (i.e., passive agreement, disagreement without support). While Initiation discourse does not qualify as higher-level thinking, the presence of this kind of talk is significant in the context of facilitating learning with understanding. If this type of GBL intervention is to be used as a means of facilitating learning with understanding so that students may develop a deep body of factual knowledge, understand facts and ideas in the appropriate context and on a theoretical level, and organize knowledge in flexible ways that can be applied to novel contexts (Bransford, Brown, & Cocking, 2000), the process of posing and clarifying ideas is paramount.

Peaks and Valleys

On occasion, the seemingly predictable oscillations discussed in the preceding section were disrupted by "peaks" (leaps to the highest level of critical thinking) and "valleys" (plunges into off-task behavior). Understanding the causes and contexts of these moments is significant in considering how this particular GBL intervention (and learning environments at large) might be refined to create conditions that better foster critical thinking and that shirk off-task behavior. Group 4 best lends itself to the discussion of peaks and valleys in that it was the only group to exhibit both the highest levels of critical thinking and off-task segments.

In the case of group 4, units coded as "off-task" consisted largely of passive watching, stretches of silence, irrelevant behaviors (i.e., drawing pictures), and irrelevant discourse.

Joseph: (Makes hand gesture toward camera.)
Cassandra: Seriously?
Joseph: What do you have against the Vulcan hand signal?
Cassandra: You just do it a lot.
Steven: (Drawing a picture on a piece of paper, looking frustrated.) I suck!
Joseph: Okay. Spock didn't do it for nothing.
Cassandra: I'm not sure. Where is he now?
Joseph: Well I actually saw the person who played Spock at my cousin's graduation.

However, the above example of off-task discourse is far less remarkable than its context. Group 4 was not coded as "off-task" until their 14th five-minute unit of analysis. In their 13th unit, two significant events took place: (1) group 4 lost all of their territory, ultimately "losing" the game (at which point they were assigned the task of writing to track other groups' progress), and (2) group 4 was coded at their highest intellectual act.

The imminent loss seemed to inspire a final effort to "survive," characterized by reflective analysis and a plea to the teacher to alter the game rules to better reflect "real wars."

Steven: The funny thing is the French, after they get from everyone else and beat everybody else, then the French is going to attack their friends.
Cassandra: Yeah, what everyone doesn't realize is that once we're gone, the common hatred—
Steven: Yeah. The French is going to attack them.
Cassandra: Everyone is going to go running.
Steven: (To neighboring group) You groups that are helping them, they are going to attack you after they are done with us.
Joseph: (To teacher) I say we should have a raffle to win back die right now. Come on, that would add more suspense.
Cassandra: Yeah! I agree with Joseph on that one.
Teacher: Yeah but then it will all be chance.
Steven: This game is about chance.
Cassandra: Yeah.
Teacher: Part of it is about chance.
Joseph: Well yeah but in a real war, it depends on how hard and determined someone is. Now it's just, if I roll my lucky numbers, I win the war. If that's how regular war was fought, then there would be a lot less war in the world.

In sum, group 4 was not coded as "off-task" prior to losing all of their territory (thus being ejected from the GBL intervention) and "peaking" (i.e., extending their gameplay experience to their understanding of "real wars") in the preceding unit of analysis. While off-task segments appear to be the byproduct of experiencing a "game over" condition, the watersheds that occurred in the dire moments preceding loss are of tremendous importance. These peaks may be interpreted as indicators of forced synthesis and reflection, prompted by the imminence of a condition that ultimately detaches players from the game-environment. Through this lens, it is not surprising to see that the highest moments of critical thinking were often followed by steep drop-offs, and that the majority of these moments occurred during the final stages of gameplay.

Critical Thinking: Aha!

As per the coding scheme used in this study, "Integration" is intended to indicate the highest levels of critical thinking, demonstrative of extension and synthesis. The qualities of Integration discourse include branching into new ideas, making implications and predictions, indicating new applications, and identifying overarching themes/concepts. Unlike other intellectual acts discussed, Integration does not seem to emerge as fluidly and in association with "precursor" acts. Rather, Integration was only coded six times across all video data, and only in four of the five GBL groups. In the first two instances, Integration happened earlier in the game, somewhat unexpectedly (i.e., just prior to Group 4 losing the game, discussed in the "*Peaks and Valleys*" section above). In the remaining four instances, these "peaks" came on the last day of the intervention as teams began to seek closure and make overarching, reflective statements about the gameplay.

Shawnee Student 1: Okay. We'll go for the—blue
French Student 1: What are you talking about? No!
Shawnee Student 2: No! Go with the Erie.
Shawnee Student 1: Listen to them (referring to her group members), not me.
French Student 1: Go with the British!
Shawnee Student 3: What?!
French Student 2: What?! The British just supported us!
Shawnee Student 1: Decide. Decide.
Shawnee Student 3: Erie.
French Student 2: (Sigh of relief.) Oh my god. That was like a nuclear war.

These instances of Integration (synthesis and/or extension) are critical in that they represent the kind of thinking and discourse that this intervention seeks to foster, and ultimately, to maximize. The features of play that promote Integration appear to happen organically as a part of gameplay—often in dire circumstances and/or as late/postgame reflections. The question of how these kinds of reflective processes might be prompted is significant in considering how future iterations of this intervention (and of GBL environments in general) might be refined to better promote critical thinking. These findings are echoed by much of the current of literature that examines strategies for promoting critical thinking; recent research frequently cites (1) asking high quality questions, and (2) providing time for reflection, as two of the most effective avenues for promoting critical thinking (Arend, 2009). However, rather than honing in on "the best kind of *question*," the present study's findings suggest that a *learning environment* in which students are prompted to (1) reflect on their progress, and (2) generate such questions as they grapple with an ill-structured problem, may be equally as effective in promoting critical thinking.

Intergroup Dialogue

While the majority of discourse took place between group members (within single groups), instances of *inter*group dialogue are particularly interesting in that they seem to prompt a different and deeper kind of thinking. For instance, Negotiation was prevalent in moments that promoted *intra*group dialogue (often prompted by the teacher) as students brought

Table 6. Descriptive Statistics for Post-Tests and Delayed Post-Tests

		Game-Based Learning			Traditional		
	Total *N*	*N*	*M*	*sd*	*N*	*M*	*sd*
Post-Tests	177	62	3.66	1.07	115	3.88	.98
Males	91	28	3.39	1.20	63	3.75	.98
Females	86	34	3.88	.92	52	4.04	.96
Delayed Post-Tests	167	60	2.11	.75	107	2.28	1.02
Males	84	27	2.20	.89	57	2.28	1.01
Females	83	33	2.03	.62	50	2.27	1.04

their ideas to the table for the first time, questioned the strategies put forth by their peers, and supported their own with evidence. These findings are consistent with critical thinking literature that has examined the effectiveness of various discussion and facilitation strategies, indicating that questioning, expressing agreements and disagreements, and providing opinions were among the most effective techniques (Lim, Cheung, & Hew, 2011). The following excerpt from group 2 exemplifies typical intragroup Negotiation:

David: No, no, no. Screw the French. The French are going to hell.
Matthew: They're going to think that they're our allies.
David: I already told them.
Matthew: You already told them that? What is your problem?
David: No, no. They're going down. We're taking all the Indian tribes and we're going against them. Because then, once we—Ottawa said they would stay with us so once we get rid of the French, we take Ottawa, and we try to take Erie.

However, groups were also allotted time to form alliances, to which intergroup dialogue is essential. In these instances, students engaged in higher order processes, evidenced by their elaborately detailed and often evaluative discourse. The following excerpt exhibits a typical intergroup exchange between Matthew and David of group 2, and Lori of group 3:

Matthew: Erie, do you want to be in our alliance?
David: Come over here!
(Lori walks over.)
Matthew: You backstabbed us! You backstabbed us in the middle of the game!
Lori: You did that to us too!
Matthew: Attack the British and we're gonna support you.
Peter: They have one die. You have one die. I have one die. And he has one die. That's three on two, which means they can't beat us.
Matthew: They call it the French and Indian war for a reason.
Lori: (Silent and pensive for a moment.) Okay. Fine. But we're going to make it look like we don't have an alliance. I'm going to take this space (pointing to map), and you take this space.

This kind of evaluative discourse may be attributed to the circumstances of gameplay; as one group approaches another with the intention of forming an alliance, players inherently evaluate the perspectives of their peers and of their prospective alliances. Further, the discussions and in-game actions that have already taken place (i.e., betrayals) often fueled a more meticulous consideration and elaboration of surmised intentions.

Posttests and Delayed Posttests

A five-question content-based post-test was given to 177 participants, 62 of whom received the GBL treatment condition, 115 of whom received traditional "business as usual" instruction (see Table 6 for descriptive statistics). An analysis of variance (see Table 7) did not show any reliable effect of condition ($F(1, 173) = 2.66$, $p > .05$), and there was no condition by gender interaction ($F(1, 173) = .42$, $p > .05$). There was a significant main effect for gender ($F(1, 173) = 5.96$, $p = .02$), whereby females ($M = 3.88$) outperformed males ($M = 3.39$) on the GBL group post-test.

Six months later, the same post-test was taken by 167 of the same participants, 60 of whom belonged to the GBL condition, 107 of whom received traditional instruction. An analysis of variance did not show any reliable effect of condition ($F(1, 163) = 1.09$, $p > .05$), of gender ($F(1, 163) = .37$, $p > .05$), and there was no condition by gender interaction ($F(1, 163) = .29$, $p > .05$).

Table 7. Tests of Between-Subjects Effects

	Post-Test		Delayed Post-Test	
	F	*p*	*F*	*p*
Condition	2.66	.11	1.09	.30
Gender	5.96	.02	.37	.55
Condition by Gender	.42	.52	.29	.59

In order to increase reliability, an analysis of variance was also conducted without the second teacher's "traditional" students. These results indicated that the mean score for the GBL students' post-tests (M = 3.66) was slightly higher than those of the traditional students (M = 3.60), and the mean score for GBL students' delayed post-tests (M = 2.11) was also slightly higher than those of traditional students (M = 2.00). These results did not show any reliable effect of condition on either the post-test ($F(1, 96) = .07$, $p > .05$) or on the delayed post-test ($F(1, 91) = .45$, $p > .05$).

Discussion

In this study, GBL seems to have proven itself a viable means for promoting critical thinking and learning. Given the lack of significant difference across test and control groups as indicated by post-tests and delayed post-tests, and the quality of student discourse, the results suggest that GBL has the potential to flourish in otherwise traditional school settings.

The Absence of Difference

The lack of significant difference in effect across the condition and control group is a compelling finding in that it speaks to the viability of GBL in traditional classrooms. That being said, it is important to consider the costs and challenges associated with the development and implementation of any new practice, particularly GBL and PBL, before proposing their widespread practice in schools (Ertmer & Simons, 2006). Implementation challenges pertinent to classroom or school culture, the adaptability of curriculum, time constraints, and the cost of resources, materials, and training must all be accounted for. Given that the implementation of GBL will typically necessitate that at least some of these obstacles be surmounted, a lack of difference with regard to learning and retaining content knowledge when compared to traditional instructional strategies does not present a strong enough case for widespread use. This echoes the bulk of research findings that suggest that more traditional environments may be favorable in terms of content knowledge when compared to PBL, whereas the allure of inquiry-based learning environments continues to live in student outcomes pertinent to motivation, problem-solving, and self-directed learning (Ertmer & Simons, 2006). In the context of this study, it is also important to consider the sensitivity, or lack thereof, associated with a five-item test when seeking to gauge content knowledge and retention.

The statistically significant finding indicating greater achievement for females than males on the content post-test in the GBL condition is also fascinating, but raises more questions than it answers: Are female students more apt to learn in GBL environments than males? In light of the fact that the highest scoring group was the female population in the control condition (M = 4.04), is it that 8th grade female students are simply more adept at mastering content? What kept the male GBL students' post-test scores from achieving the same heights as their female peers? Did these male students, who scored significantly lower than their female counterparts on the post-test but equivalently on the same test given six months later, learn any less? And again, is a five-item measure sensitive enough to capture the notable differences at stake? While the answers to these questions are beyond the scope of this study, they are important pieces in the GBL puzzle, and should be examined in future research.

Quality of Student Discourse

The implemented GBL intervention essentially asked students to play a game in which they took on the collective identities of various tribes and nations during the French and Indian war, and to compete (using the game's system of rules) against other small groups in order to complete predetermined objectives. In doing so, students engaged in varied levels of discourse, ranging from posing ideas and clarifying questions to making substantiated judgments based on the synthesis of evidence. Interestingly, lower-level discourse occurred most frequently during teacher-driven explanations and dice-rolling "war" phases, whereas higher-level discourse was most often grounded in intra- and inter-group discussion. The juxtaposition of these findings with those of studies examining the effects of PBL (Hmelo-Silver, 2004; Hmelo-Silver & Barrows, 2006) yield similar results regarding the pertinence of student-centeredness, of small-group discourse, of teacher-as-facilitator, and of authentically-driven (i.e., problem-based) learning scenarios when seeking to foster critical thinking.

These findings have implications for traditional schools in that the tenets of GBL mentioned above are congruent with the highest levels of teaching as described by the most widely-adopted teacher-evaluation models. For instance, Danielson's (2007) Framework for Teaching heralds student engagement, student choice, and student-driven learning as critical to the high-quality teaching. These findings corroborate the salient features of such evaluation models, and suggest that constructivist-style learning environments (such as the GBL intervention examined in this study) are harmonious with great teaching.

The results of this study are important for the sake of better understanding and refining the implemented GBL intervention, as well as for the design of future GBL environments. The first of these results, clearly evidenced in Figure 3, is the oscillation rather than sustainment of intellectual acts across units of time. After careful analysis of the video data, the wavering of student discourse between the first, second,

and third codes appears attributable to the logistical structure of the game—that is, the system of turn-taking, of teacher-interjections, and of 40-minute class periods. It might also be argued that the codes associated with lower levels of critical thinking ("posing" and "clarifying") were essential for building a deep knowledge base, therefore empowering students to achieve deeper understandings and higher levels of critical thinking ("elaborating" and "evaluating") (Bransford, Brown, & Cocking, 2000). The questions that arise: Is student discourse inherently oscillatory in constructivist/game-based learning environments? Is higher level critical thinking sustainable across extended periods of time in such environments? If so, how might sustained levels of thinking and discourse be cultivated?

Moreover, the highest level for critical thinking (Integration) was only coded in 4.2% of all measurable units. Integration was most prevalent for group 2 (coded in 7.4% of their units), and was wholly absent for group 3 (coded in 0% of their units). The pressing questions here are fairly obvious: What is it about these groups that supports higher levels of critical thinking, and how might that support be utilized to the advantage of all groups? As mentioned in the results, the majority of Integration codes are embedded in reflective contexts; that is, as students were faced with dire circumstances (i.e., imminent loss, major strategic shifts, etc.), they often responded by sharing sweeping insights into the game, by making connections to major pieces of the Social Studies curriculum (often using them as evidence to substantiate their claims), and/or by extending their in-game experiences to their own lives. Here, it seems that a critical seventh principle should be appended to the six principles of game-based learning detailed in Figure 1: *The intervention must create deliberate spaces for reflection and synthesis*. The importance of reflection has been documented with regard to experiential learning (Kolb, 1984), problem-based learning (Hmelo-Silver, 2004), and even game-based learning (Nicholson, 2012) (although often referred to as "debriefing" in the context of GBL). These reflective spaces might be embedded into GBL environments as explicit opportunities to express feelings, to explore the learning that has recently occurred, and to relate prior knowledge and/or experiences. With regard to the GBL intervention considered in this study, a relatively straightforward revision may have achieved these ends (i.e., following each "intergroup discussion" or "battle" phase with a "reflective talk" phase; embedding a reflective/dialectical journal exercise; holding a full-class "debriefing" at the game's end), and will be pursued in iterative implementations.

The limitations of this study are primarily drawn from the real-world constraints. The students who received the GBL intervention were not randomly selected, although the fact that the participating middle school did not track students in terms of ability helped to promote variation across participants. Similarly, the content-based post-test was authentic in that it was designed by the teachers and used in previous years; however, its sensitivity may be inadequate given its brevity. A subsequent study would certainly benefit from a more thorough measure of content acquisition and retention.

Further, the three sections receiving the GBL intervention were compared with seven sections receiving "traditional" business-as-usual instruction. The same teacher who implemented the GBL intervention also taught two of the seven business-as-usual classes, and as a result, his potential bias for game-based learning should be taken into consideration. Five additional sections of 8th grade Social Studies were taught by a different instructor altogether. In order to determine that the methods being utilized in these classes were not consistent with those of the GBL intervention, teachers were asked to share their lesson plans for this particular unit.

Future research should explore the possibility of heightened and/or sustained levels of critical thinking in innovative problem-solving contexts. This can be done by implementing multiple iterations of a GBL intervention using this study's findings as a springboard for design, and/or by implementing reiterations of the intervention discussed in this article. The logic model (Figure 1) that was used to demonstrate the outcomes associated with principles of GBL continues to offer significant areas of investigation for researchers, including the refinement of essential GBL and problem-solving principles, the explication of each principle's function, and the varying degrees to which intermediary and intervention outcomes are attained. While many of these outcomes are well documented in the present body of research, more sophisticated measures and creative research designs promise to deepen our understanding of how critical thinking skills, knowledge acquisition, and content retention are affected by GBL and, more broadly, the use of problem-solving-based pedagogy. Researchers and educators alike are encouraged to continue exploring game-based learning for purposes of engaging students, fostering critical thinking skills, and teaching content in a manner that is student-centered, congruent with the grammar of traditional schooling, and at least equally as effective as conventional teaching practices.

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Marc I. Cicchino is a graduate of Rutgers' Graduate School of Education. His research has focused largely on game-based and problem-based learning in authentic school environments. Correspondence concerning this article should be addressed to Marc I. Cicchino, 1 Bryant Drive, Succasunna, NJ 07876. Email: marc.cicchino@gse.rutgers.edu.