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“Games are made for fun”: Lessons on the effects of concept maps in the classroom use of computer games

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ABSTRACT

Does using a computer game improve students’ motivation to learn classroom material? The current study examined students’ motivation to learn history concepts while playing a commercial, off-the-shelf computer game, Civilization III. The study examined the effect of using conceptual scaffolds to accompany game play. Students from three ninth-grade classrooms were assigned to one of three groups: one group used an expert generated concept map, one group constructed their own concept maps, and a control group used no map. It was predicted that the use of concept maps would enhance the educational value of the game playing activity, in particular students’ motivational levels; however, the opposite happened. Students who used a concept map showed lower motivation on the task relative to their baseline motivation for regular classroom instruction. In contrast, the levels of motivation in playing the game, for students in the control group, met or exceeded their levels of motivation during regular classroom instruction. These results suggest that using a conceptual scaffold can decrease students’ motivation to learn classroom material through game play, perhaps because conceptual maps can (a) focus students’ attention on the difficulty of learning the concepts and on the extrinsic rewards for playing the game and (b) make game play less autonomous, less creative, and less active. All of these can negate the primary property that provides playing its principal potential pedagogical power: fun.

1. Introduction

Games are potentially powerful learning tools because they can motivate, engage, stimulate higher order thinking, replicate phenomena accurately, and speed up or slow time in order to provide relevant instructional experiences (Alessi & Trollip, 2001; Gee, 2003; Rieber, Smith, & Noah, 1998; Van Eck, 2006). Commercial games, such as SimCity, Railroad Tycoon, and Civilization, have been integrated into instructional situations in order to take advantage of the great game play, graphics, and audio of commercial games and because they are associated with specific content area (Charsky & Mims, 2008; Kirriemuir, 2005a, 2005b; Squire, 2002). The use of games to improve student motivation and learning is not new (Abt, 1970), yet recently there has been a renewed interest in games and learning.

Randel, Morris, Wetzel, and Whitehill (1992) conducted a meta-analysis of educational simulation game studies from the years 1963–1991. The analysis included 68 studies that compared the effects of simulation games and conventional instruction on student performance. Summarizing their findings, 38 (56%) of the studies found no difference, 27 (40%) found differences favoring simulations or simulation games over conventional instruction, and 3 (4%) found differences favoring conventional instruction. Further, out of the 14 studies that measured the motivational effects of simulation games, 12 reported that students preferred simulation games to conventional instruction. Klein and Freitag (1991) showed that playing an educational game significantly increased students’ motivation, as measured by attention gained, perceived relevance, confidence instilled, and satisfaction.

Research has identified two factors that appear to be associated with improved learning and enhanced motivation to learn when using these games: congruence and appeal. When the game activity and the learning activity are congruent and mutually supportive, learning improves; conversely, when the game activity and the learning activity are mutually exclusive, learning tends not to improve, even though the learner tends to perform well in the game (Lepper & Malone, 1987). The more closely the game is tied to the educational content, the

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more motivated students will be to learn from the game Malone and Lepper (1987). Although fantasy external from the learning (exogenous fantasy) will be more motivating than conventional instruction, fantasy closely tied to the content (endogenous fantasy) tends to improve interest in the educational content of the game even more (Rieber, 1996)—if the fantasy appeals to the learner. Research has shown that when games appeal to students, playing them will enhance their intrinsic motivation to learn and will improve learning (Lepper & Cordova, 1992; Lepper & Hodell, 1989; Parker & Lepper, 1992). Further, Lepper and Cordova (1992) found that boys and girls who learned from an embellished fantasy program showed greater learning regardless of whether they were able to choose the game or were assigned the game by the instructor.

Miller, Lehman, and Koedinger (1999) demonstrated that undergraduates who either were told to first explore the microworld of an educational game or were shown the correct strategy in the game performed better than students who began playing the game without prior preparation. The authors recommended that the entertaining game aspects are motivating, but they must be supported with carefully selected tasks, teacher guidance and monitoring, and assessment of the learning outcomes. Charsky and Mims (2008) also suggested that the integration of commercial computer games needs to be accompanied by instructional activities or scaffolds that help students learn the game, relate the game to the content area, and analyze the game as a theoretical model of the content area. One type of scaffold that might help integrate the commercial game as well as facilitate student learning from the commercial computer game is concept mapping.

A concept map is a diagram representing the conceptual structure of a topic or content area. Concept maps are graphical diagrams in which nodes represent concepts and connections between nodes represent cognitive links or relationships. Concept maps thus identify concepts and their relationships to one another. A concept map represents the creator's conceptual organization and interpretation of the topic or content area. Concept maps are derived from Ausbel's Assimilation Theory (Novak & Gowin, 1984). Assimilation Theory advocates the development of meaningful learning because it is more flexible, generalizable, and longer lasting compared to rote learning. Concept mapping is a process that can be used to help an individual describe his or her ideas, verbally or in writing, on any topic or content area (Mccagg & Dansereau, 1991; Novak & Gowin, 1984).

Concept mapping can be useful in helping students identify the important concepts, topics, and ideas, and to understand the interrelationships among them (Crandell, Kleid, & Soderston, 1996). Concept mapping encourages students to reflect on their knowledge in order to re-evaluate their learning. Concept maps can be used as instructional content or as scaffolds. When used as instructional content, concept maps are typically created by an expert or instructor and given to student for analysis. When used as instructional scaffolds, concept maps are typically constructed by students after the students have begun learning about the topic or content area (Schmid & Telaro, 1990).

Numerous researchers continue to examine the role of concept maps. Maps can be used to evaluate cognition (e.g. Gill & Persson, 2008). Maps can also be used to stimulate cognition, by enhancing satisfaction and feelings of self-efficacy (Shaw, 2010) or by stimulating metacognition and creativity (Kao, Lin, & Sun, 2008), all of which can affect motivation to learn (Burleson, 2005). Motivation—or more accurately, frustration—has been studied using concept maps within a problem based learning inquiry (Laxman, 2010). Concept maps have been studied within game based learning experiences. Coller and Scott (2009), for example, used concept maps as an evaluation instrument for a game based course; their use was associated with students' deeper understanding relative to a typical lecture-and-text based course. Kwon and Cifuentes (2009) used collectively constructed and individually constructed concept maps to explore their differing effects on learning through game play. Concept maps can be used as an instructional tool to support learning because they have been shown to help learners understand the complex relationships among various ideas. Greenfield (2010) postulated that requiring gamers and learners to understand and manipulate a variety of variables is what makes games useful for learning. Pilner-Blair (2005) created a game that required students, playing in-game avatars, to teach a computer-controlled avatar; learners tracked their instruction through a concept map that demonstrated the students' facilitation of the computer-controlled avatar's "thinking process." Charsky (2010) has also advocated for the use of concept maps in the design of serious games as a replacement of the typical inventory collected by players in role-playing games; instead of players merely collecting the items, the inventory of items could be set up as a concept map, in which students can strategically place items that are most useful for their learning and game play.

Integrating commercial, serious, or digital games into learning environments is an area lacking data on the effectiveness of their integration (Becker, 2010). She has pointed out, as have Low, Jin, and Sweller (2010), that the still nascent understanding about the relationship between learning and games compels researchers to study varying means of enhancing learning through game play—including the use of concept maps.

The current study addresses two research questions. First, does the use of commercial computer games improve student motivation as compared with more conventional classroom instructional techniques? It is hypothesized that students' motivation to learn historical concepts will be greater among students who play a computer game. Second, do different instructional activities, specifically concept mapping activities, affect student motivation when they play a commercial computer game as part of their classroom instruction? If so, how are concept maps and commercial computer games most effectively employed to elicit greater student motivation? It is hypothesized that this instructional experience will help students to attend to, see the relevance of, and feel confident and satisfied in their ability to master the material presented in the commercial computer game. Concept maps are thus used as one of many possible tools for exploring the more general concepts of (a) motivation and learning, (b) congruence and appeal of the gaming and learning experiences, and (c) students' autonomy, active learning, and creativity in using the game to learn through play. Conclusions, therefore, have implications beyond this specific type of scaffold.

2. Material and methods

2.1. Material

2.1.1. Game

The computer game used in this study was Civilization III (Civ III) (Firaxis Games, 2001). Civ III is a strategy game that enables players to create their own civilization that advances through time. There are no specific learning goals or objectives associated with Civ III. Nevertheless, the game has the potential for teaching about history through its use of accurate historical locations, figures, and events and through its in-game lexicon of historical terms and concepts, the "Civlopedia," which provides definitions and explanations typical of a history text.

Civ III begins in 4000 BC with the player operating a “worker” and a “settler”, a game unit that can build a city. Once players build a city, they can build other units, such as a warrior, or improvements, such as a granary, or wonders, such as Pyramids. As the game progresses, players make more cities, units, improvements, and wonders that improve and advance their civilization through time, making choices as the civilization grows. Once a player’s civilization meets other civilizations, relational decisions must be made regarding war, diplomacy, and trade. As the Civ III gaming experience evolves, the constant need to make new decisions keeps the game entertaining and engaging, as all the while the game’s underlying simulation engine puts forth a theory of civilization development, using five forces that impact civilization development: exploration, economics, knowledge, conquest, and culture.

2.1.2. Measures

The motivational measure used in this study was adapted from John Keller’s Instructional Materials Motivation Scale (IMMS) (Keller, 1987, was the source of items for this study; for a recent description of the IMMS, see Keller, 2010). The scale was developed by Keller using the ARCS model of motivation: Attention, Relevance, Confidence, and Satisfaction. The IMMS thus has four subscales that correspond to each of the ARCS model’s components.

For the study, the original IMMS items were reworded using Keller’s instructions for customizing the survey without changing the basis of the original. For the pre-study, items were reworded to measure student motivation for the overall content and activities of the Global Studies course. For the post-study, items were reworded to measure student motivation for the content and activities of the game playing unit of the course. Table 1 presents examples of the original items from the IMMS alongside the corresponding reworded items used in the pre-study.

Cronbach alpha reliability coefficients for the reworded pre-study scale and subscales were as follows, with the reliability coefficients for Keller’s original scale and subscales in parentheses: Attention .83 (.89), Confidence .85 (.90), Relevance .68 (.81), Satisfaction .77 (.92), and the entire IMMS .92 (.96). Cronbach alpha reliability coefficients for the reworded post-study scale and subscales were as follows, with the reliability coefficients for Keller’s original scale and subscales again in parentheses: Attention .85 (.89), Confidence .78 (.90), Relevance .74 (.81), Satisfaction .77 (.92), and the entire IMMS .92 (.96). Students’ journals included their reflections on the game. These were collected at the conclusion of the study and read by the first author.

2.2. Participants

Participants attended a public high school in a small city in northern Colorado. The school had 1475 students, of whom 553 were in ninth grade. The student population included 65% white students, 33% Hispanic students; 23% of students received free lunch (Colorado Department of Education, 2002, 2002–2003). According to Colorado Student Assessment Program examination scores from 8th grade, 47% of students scored at or above proficiency in reading, 32% scored at or above proficiency in writing, and 20% scored at or above proficiency in mathematics (Weld County School District 6, 2002–2003). These scores are below 8th grade proficiency levels for the state of Colorado in 2005, in reading (86%) and mathematics (74%) and below the proportion of 8th grade students at proficiency for 28 of the 34 states (reading) and 35 of the 36 states (mathematics) reported on by the National Center for Education Statistics (2007).

Three classrooms, containing 82 ninth grade students, 42 male and 40 female, aged 14–15 years, studying Advanced Global History, participated in the study. Two additional students elected not to participate. Due to lack of computers, eight additional students were eliminated from the data analysis because they were not able to play the game individually. The selection of participants was determined by the school district’s policy for allowing outside researchers into schools. The study received district approval and was assigned to a high school. The principal presented the study to the Social Studies department faculty, and one faculty member volunteered her three honors level Advanced Global Studies classes. Although participants were not randomly selected, the procedure described was typical of research conducted in similar school settings.

2.2.1. Treatment groups

The study contained three groups: a pre-generated concept map group, a student-constructed concept map group, and a no-map control group. One of the authors randomly assigned one treatment to all of the students in each of the three classes. For the sample, the mid-term grade point average, on a scale of 4, was 3.1. The mean mid-term grade for students in the student-constructed concept map group was 3.0, in the pre-generated concept map treatment 3.0, and in the no concept map group, 3.3. These differences were not statistically significant [$F(2, 79) = .90$, *n.s.*]. Moreover, the variance in mid-term grades within the three groups – a reflection of the range of academic ability within

Table 1
Reworded IMMS items.

Subscale	IMMS Original	Reworded Items: Pre-study	Reworded Items: Post-study
Attention	2. There was something interesting at the beginning of this lesson that got my attention.	2.There was something interesting at the beginning of this Global Studies course that got my attention.	2.There was something interesting at the beginning of this unit (game, journaling exercise, and concept mapping activity) that got my attention.
Relevance	6. It is clear to me how the content of this material is related to things I already know.	6. It is clear to me how the content of this Global Studies course is related to things I already know.	6. It is clear to me how the unit (game, journaling exercise, and concept mapping activity) is related to things I already know.
Confidence	13. As I worked on this lesson, I was confident that I could learn the content.	13. As I worked on this Global Studies course, I was confident that I could learn the content.	13. As I worked on this unit (game, journaling exercise, and concept mapping activity), I was confident that I could learn the content.
Satisfaction	5. Completing the exercises in this lesson gave me a satisfying feeling of accomplishment.	5. Completing the exercises in this Global Studies course gave me a satisfying feeling of accomplishment.	5. Completing the unit (game, journaling exercise, and concept mapping) gave me a satisfying feeling of accomplishment.

the groups - did not differ significantly [Levene Statistic (2, 79) = 1.25, *n.s.*]. The same teacher taught all three sections of the course, using the same curriculum.

2.2.1.1. Treatment group one: pre-generated concept map. In one section, all students played the game, Civ III, accompanied by a concept map prepared by one of the authors. The students had four, 80-min class sessions to play the game. At the beginning of each session, each student was given a list of concepts contained in the researcher-generated concept map, such as “masonry”, “population growth” or “culture”. The researcher directed the students to locate the items on the concept map. Students who did not know a concept were encouraged to look it up in the Civlopedia, the game’s built-in lexicon. This section had 28 students. Fig. 1 provides an example of a pre-generated concept map used in this treatment group.

2.2.1.2. Treatment group two: student-constructed concept map. In the second section, each student played the game, Civ III, and was instructed to create a concept map while playing. The students had five, 80-min class sessions to play the game. At the beginning of each session, each student was given a list of the same concepts given to the first treatment group, along with a list of connector terms that could

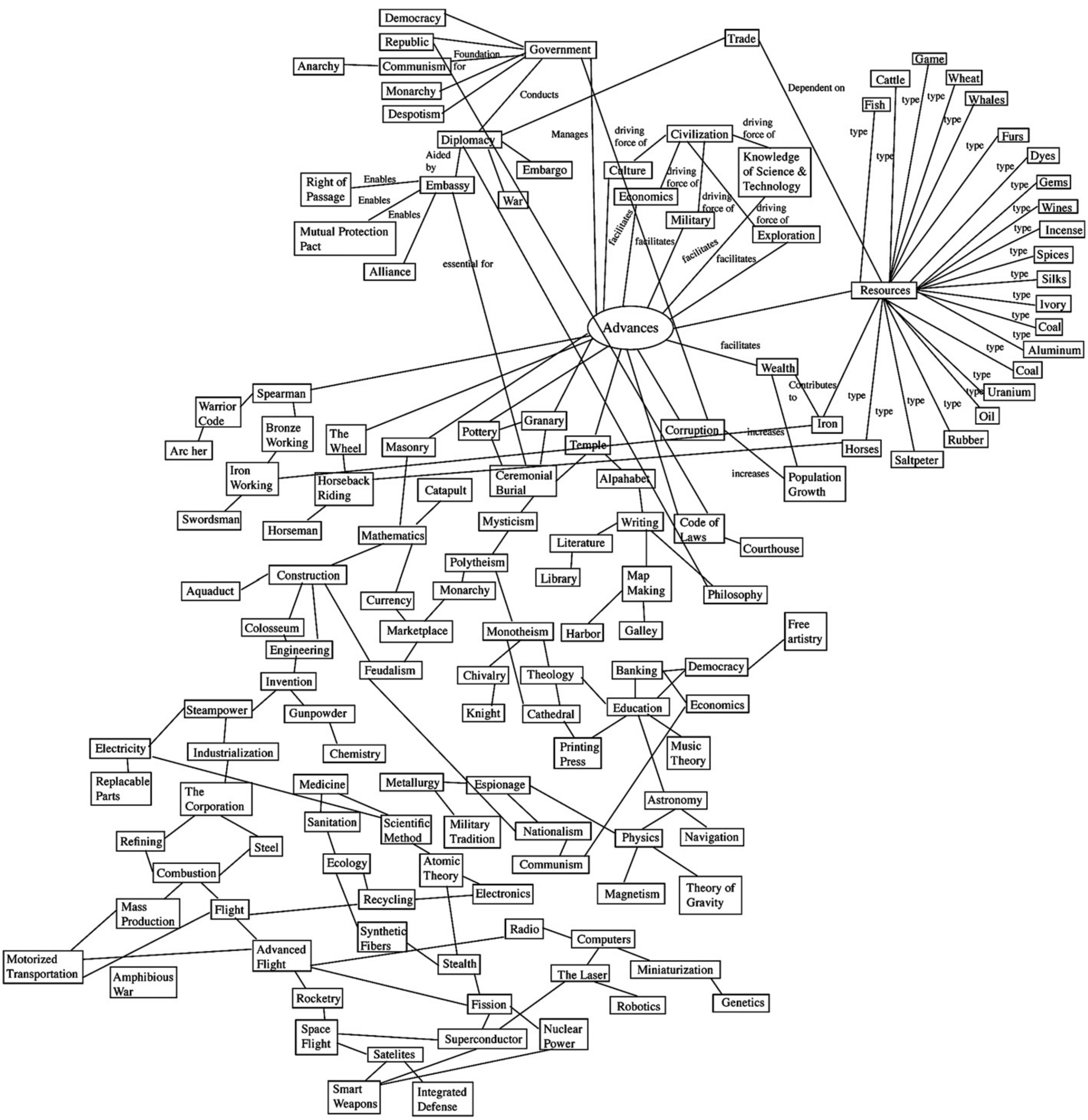

Fig. 1. Pre-generated concept map.

be used to show relationships between the nodes, such as “develops”, “determines”, or “uses”. Students were instructed to construct their own, individual concept maps. Students who did not know a history concept were encouraged to look it up in the Civlopedia. This section had 25 students. Figs. 2 and 3 provide examples of concept maps created by students in this treatment group.

2.2.1.3. Control group: no concept map. In the third section, all students played Civ III without a concept map. The participants in this treatment group had five, 80-min class sessions to play the game. At the beginning of each session, each student was given a list of the same concepts given to the other two groups; however, the students were not required to do anything with the terms. Students who did not know a concept were encouraged to look it up in the Civlopedia. This section had 29 students.

2.2.2. Participation

Students in the pre-generated concept map treatment group had one fewer opportunity than the other two groups to play Civ III, because college entrance exams interfered with one of their game sessions. Students who missed more than half of the study’s sessions were eliminated from the data analysis. Tables 2 and 3 show the attendance distribution.

Two trends emerged. First, students in the no-map group were most likely to have missed a game playing session (12/29 = 41%). Thus it might be expected that this group was the least motivated to play and learn from the game. Second, because a class session was cancelled for the college entrance exam, the pre-generated map group played the game fewer times, on average, than the other two groups. Thus it is possible that this group had a lower likelihood of becoming engaged by the game than members of the other two groups. It is worth noting that these two trends make predictions in opposite directions regarding their respective motivations to play the game; if anything, they suggest that the student-constructed map group ought to have had the highest relative motivation to play and learn from the game, relative to their baseline motivation to learn the concepts and perform the activities of their regular classroom learning.

2.3. Procedures

Prior to beginning the study, all three sections of the course were in the final quarter of a year-long study of world history. All three sections were taught by the same teacher, using the same teaching methods in each section, including lectures, cooperative learning, individual projects, printed texts, electronic and multimedia resources, but not including computer games or simulations.

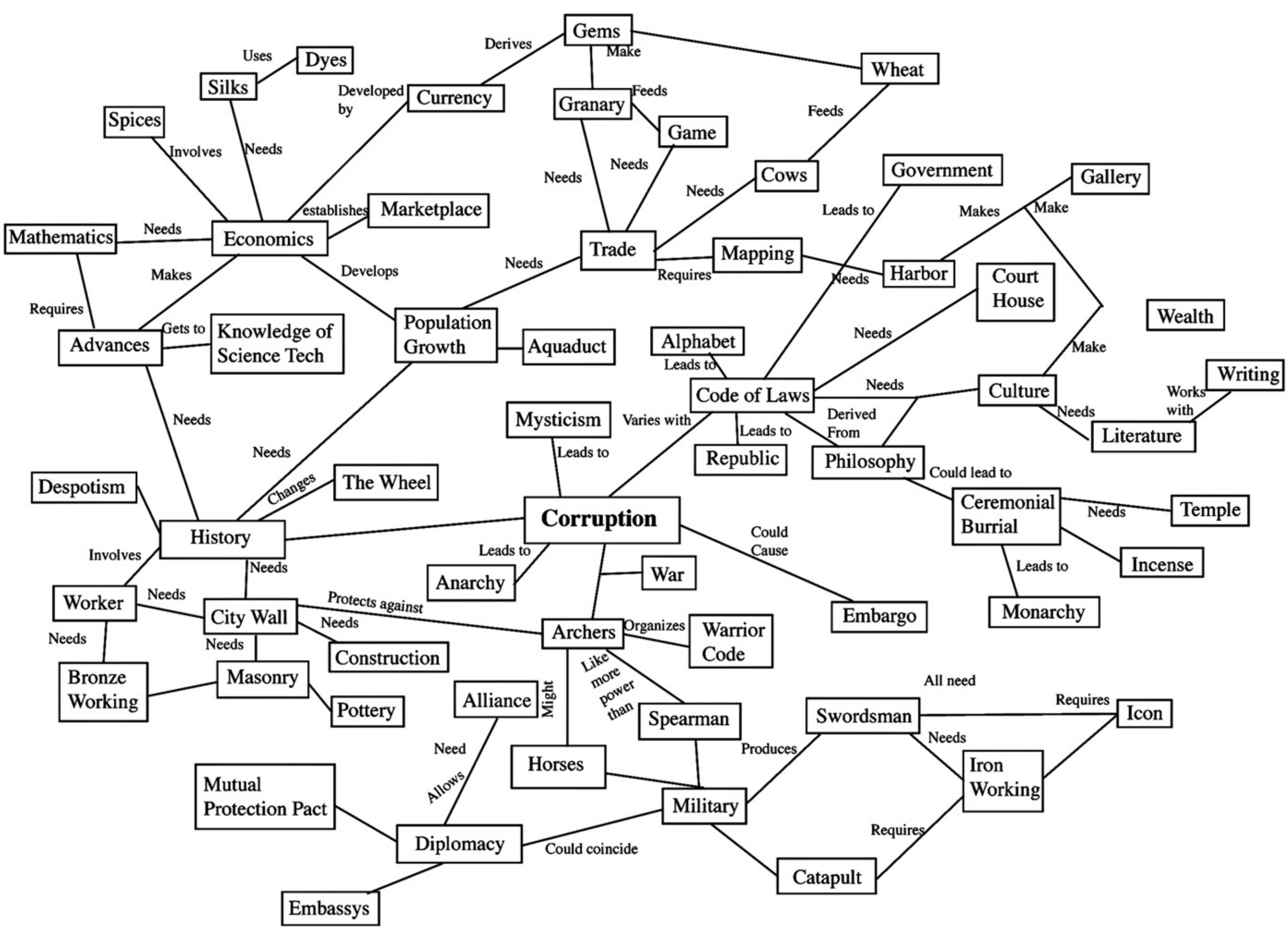

Fig. 2. Student-constructed concept map 1.

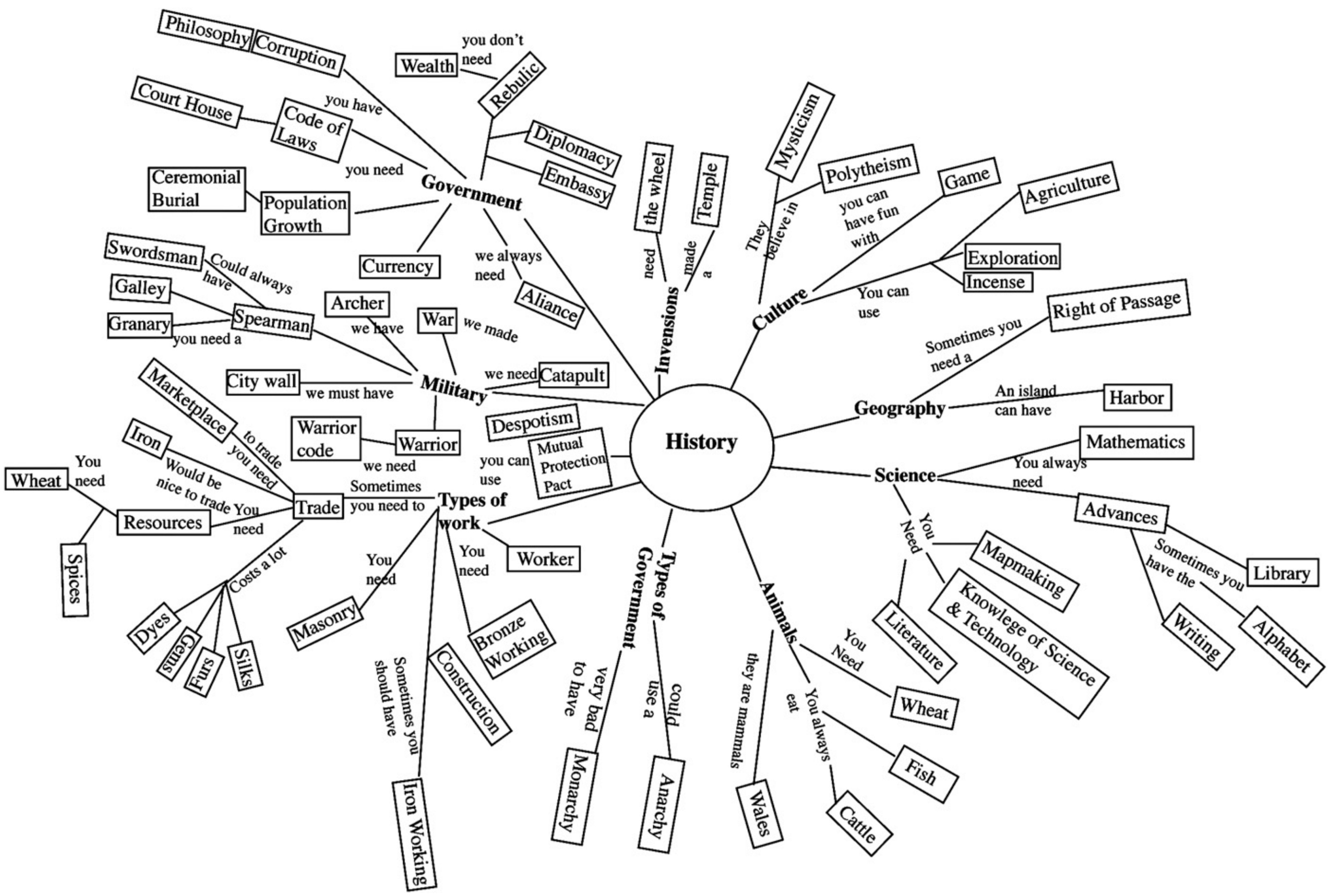

Fig. 3. Student-constructed concept map 2.

The instructions on concept maps were pilot tested among undergraduate students at the University of Northern Colorado who were taking the course, Technology in Education for Pre-Service Teachers. The usual course instruction on developing a concept map was replaced with the study's instructions and materials. The concept maps created were evaluated using the course's rubric for grading concept maps. Although these college students were more advanced than the high school students in the study, the goal of the pilot study was simply to evaluate the clarity of the instructions and materials. Based on results of the pilot test, adjustments to the concept map instructions and materials were deemed to be unnecessary.

2.3.1. Initial preparation

On the first day, students completed the pre-study motivational survey, after which the researcher delivered instructions on concept maps, their use and construction, in the two sections in which students would be instructed to use a concept map. These students then practiced constructing a concept map on the topic of animals. The no-map group did not discuss concept maps, but instead watched a history video unrelated to the study.

On the second day, the researcher taught all three sections how to play Civ III and how to use the Civlopedia. Each student was also given a guide that they could use throughout the study.

2.3.2. Introducing the concept maps

The study treatments began on the third day. Each student in the pre-generated map group was given the pre-generated concept map with an initial list of concepts and was told to play the game and locate the relevant concepts on the pre-generated map. Each student in the student-constructed map group was given the same list of concepts, a list of connector terms, and a piece of 11 × 14 inch paper, and were

Table 2
Game play sessions missed by treatment group.

Treatment Group	Missed 0 Sessions	Missed 1	Missed 2	Mean
Student-Constructed Concept Map	20	5	0	.2
Pre-Generated Concept Map	20	7	1	.3
No Concept Map	17	10	2	.4
Total	57	22	3	.3

Table 3
Game play sessions attended by treatment group.

Treatment Group	Played 5 Sessions	Played 4	Played 3	Played 2	Mean
Student-Constructed Concept Map	20	5	0	–	4.8
Pre-Generated Concept Map	–	20	7	1	3.7
No Concept Map	17	10	2	–	4.5
Total	37	35	9	1	

instructed to begin playing the game and constructing a concept map using the concepts and connector terms. Each student in the no-map group was given the same list of concepts, but was not instructed to do anything specific with the concepts. All students were given a journal for recording their scores, observations, and reflections on the game.

2.3.3. Game play

The students were told that for the next two weeks they would be playing Civ III, and that at the end they would be tested on their knowledge of the game and understanding of history, which would be included in their course grade. They were also told how they would be graded for their journal entries and—in the relevant groups—concept maps. All students were asked not to play the game outside of class, not to seek game hints or strategies, and not to discuss the class activities with others.

On the fourth, fifth, and sixth days, students continued playing Civ III, recorded their game scores, wrote in their journals, and—in the relevant groups—used or constructed their concept maps.

3. Results

In order to investigate the effect on student motivation of the scaffolds, two-factor repeated measures ANOVAs were performed on the overall IMMS scores as well as the individual subscale scores. The statistical comparison of the pre-test and post test motivational levels of students, is important for addressing the question whether students are indeed motivated more through playing the game. Additionally, although the differences among the three sections on important criteria of potential relevance to the study's results were not significant, the fact that participants were not assigned randomly, as individuals, to treatment groups makes it important to look at any pre-existing differences among the three treatment groups as well as the two-way interactions between treatment group and pre- versus post test levels of motivation, allowing the results of the post test to be framed relative to any differences—significant or otherwise—among the students from the three separate classrooms. If conceptual scaffolds confer a motivational advantage, then it should show up in a two-way interaction that reflects an incrementally higher motivational gain in the two concept map groups, relative to the no-map group.

A series of one-way ANOVAs indicated no significant pre-existing differences among treatment groups with respect to their motivation to learn the advanced Global History material and to perform regular classroom activities, either on their overall IMMS score or on any of the four subscales.

3.1. Overall IMMS scores

The results of the two factor repeated ANOVA included a significant main effect on the repeated measure and a significant interaction; the main effect for treatment group was not significant (see Table 4). Overall—and for both of the concept map groups—students' IMMS scores declined over the course of the unit. The decline in both concept map groups' scores was particularly evident relative to the no concept map group (see Fig. 4).

3.2. Individual subscales

The main effect for treatment group was not significant on any of the four individual subscales. On three of the subscales, the interaction between time and treatment group tended toward significance, such that the scores declined over time in the two concept map groups relative to the no concept map group; this effect was particularly striking on the attention subscale (see Fig. 5 through 8 and Table 4). In addition, on the relevance and satisfaction subscales, the three groups' average scores over time significantly declined from pre- to post test.

4. Discussion

One of the goals in supplementing regular classroom pedagogy, whether through educational field trips, educational television programs, or educational video games, is to raise students' motivation—their interest in, perceived relevance of, confidence in their ability to master, and satisfaction from learning that material. In this sense, then, the use of a commercial video game to increase students' motivation to learn history appears at first glance to have been an abject failure. On further inspection, however, results of this study offer important lessons for using commercial video games and other supplements effectively in order to increase students' motivation to learn the content.

Table 4
Results of statistical significance testing for IMMS scale and subscales.

	Overall IMMS	Attention Subscale	Confidence Subscale	Relevance Subscale	Satisfaction Subscale
Treatment	$F(2, 79) = .59$, *n.s.*	$F(2, 79) = .32$, *n.s.*	$F(2, 79) = 1.97$, *n.s.*	$F(2, 79) = 1.06$, *n.s.*	$F(2, 79) = .07$, *n.s.*
Pre-Post	$F(1, 79) = 6.04$, $p = .01$	$F(1, 79) = .16$, *n.s.*	$F(1, 79) = .20$, *n.s.*	$F(1, 79) = 22.7$, $p < .001$	$F(1, 79) = 14.6$, $p < .001$
Interaction	$F(2, 79) = 3.13$, $p = .04$	$F(2, 79) = 4.03$, $p = .02$	$F(2, 79) = 2.79$, $p = .06$	$F(2, 79) = 1.34$, *n.s.*	$F(2, 79) = 2.32$, $p = .10$

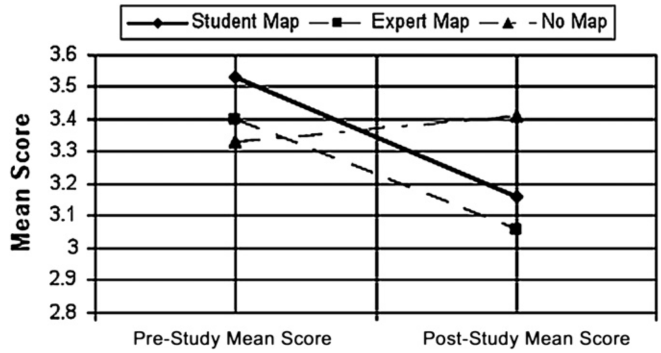

Fig. 4. Overall IMMS pre- and posttest scores.

4.1. Main effects

Overall, the students' motivational level for playing the game and learning from it were significantly lower than their initial motivational levels for the conventional classroom learning. While their attention to the material and confidence in their abilities to master it did not change when the game was introduced, their satisfaction did. More tellingly, so did the perceived relevance of learning through playing the game. In other words, the game itself did not seem to have been a distraction, but to the students it did not seem to fit the content of the lessons as much as they may have wanted.

This could be a function of the students' not having had enough time to play the game and thus not enough time to be able to move to higher levels of integrating the game and the educational content. Most commercial off-the-shelf (COTS) games take at least 40–60 h to complete (Charsky & Mims, 2008; Squire, 2004), far more than the students in the current study were given. Unable to complete the game, the students may have been unable to understand the game as an abstract conceptualization of the content area. Research has shown that sufficient time is necessary for students to progress from lower, concrete levels to higher, abstract levels; from learning the rules to interpreting the game as a theoretical conceptualization of the content area (Kolb, 1984; Laveault & Corbeil, 1990).

Alternatively, something in the way the concept maps were used could have affected students' motivation adversely. The patterns of interactions suggest that this may have happened.

4.2. Interactions

While the game itself may not have distracted students from learning the material or reduced their confidence in their ability to master it, the scaffolds seem to have done both. The study was predicated on testing the theoretically derived hypothesis that the use of scaffolds—in this case, concept maps—would enhance the educational value of playing the game, in part by increasing students' motivation to learn. In the event, the opposite result obtained, as seen in the study's consistent pattern of interactions. The students in the scaffold conditions, who were taught how to use a concept map and were either given a pre-generated concept map or given the concepts and connector terms necessary to construct their own concept map, were those whose motivation was lower than their baseline motivation for conventional classroom instruction. Conversely, the students who were allowed to play the game without scaffolds were those whose motivation met or exceeded their baseline motivation for conventional classroom instruction. These interactions were observed, too, on individual subscales that correspond to the underlying components of motivation. These individual interactions may simply be a more detailed manifestation of the failure of the scaffolds. Alternatively, this pattern may suggest reasons for their failure and thus offer insights into the mechanisms of and best practices for their effective use.

4.2.1. Confidence

The interaction between treatment group and confidence in being able to master the material suggests the influence of students' expectations. The conceptual scaffolds may have primed students to expect that the activity ahead would be difficult to master—why else would one need such a complicated and convoluted map to guide play? As one student from the pre-generated map group noted in her journal, "There is so much stuff to think about." This comment could also reflect the cognitive burden felt by students while managing the

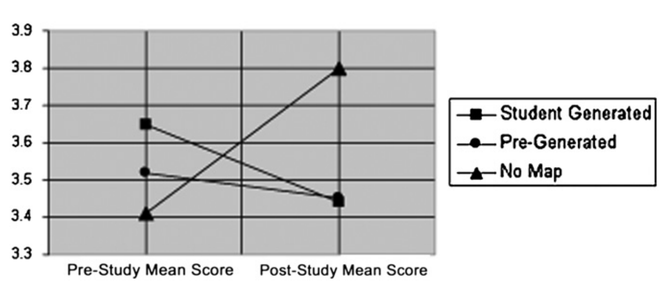

Fig. 5. Attention subscale pre- and posttest scores.

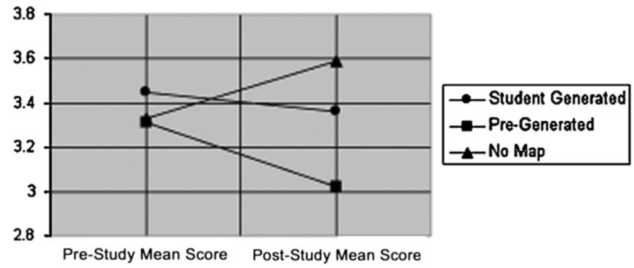

Fig. 6. Confidence subscale pre- and posttest scores.

concept map at the same time that they were trying to master the game. One member of the student-constructed map group wrote, "I didn't have the playing time needed because of the concept maps." Another wrote, "There's so much you need to be making sure of," while a third wrote, "I wasted a lot of time trying to figure out the significance of key things." Instilling confidence in their ability to master the material is essential to motivating students to learn (Burleson, 2005; Kao et al., 2008; Shaw, 2010), and studies have suggested that insufficient time spent learning how to construct and use concept maps can lead to exactly the type of frustration expressed in the students' journals (Mccagg & Dansereau, 1991; Shaw, 2010). This frustration typically results in diminished motivation to learn (Schmid & Telaro, 1990; Shaw, 2010; see Burleson, 2005, for theoretical foundations). Even using pre-generated maps can overtax students (Faure et al., 1972). As noted above, insufficient time may have been allotted for playing the game and allowing students to learn it well enough to integrate it into higher levels of understanding the course material. For the two concept map groups, then, using the concept map increased rather than relieved the cognitive burden of playing the game. For concept map use to instill confidence, the map should be integrated better into the playing of the game, with greater emphasis on the game itself and an overt demonstration of how the map fits with game play. Future game design and modification of off-the-shelf games should bear in mind that the game needs to fully integrate the map into game play. Moreover, sufficient instructional time should be dedicated to demonstrating the ways in which the concept map connects the game content to the course content.

4.2.2. Satisfaction

The interaction between treatment group and satisfaction suggests a role for students' need for autonomy. Games are most engaging when they give players choices, including the choice of accessing help (Charsky, 2010). By focusing students' attention on the concept map and away from the game, the researcher may have taken away two interrelated and highly motivating aspects of playing the game: the challenge of mastering it on one's own (Low et al., 2010) and choosing how to play the game. In other words, focusing on the concept maps from the outset may have spoiled the game for students, removing the potential advantages of endogenous value and fantasy. Sixty-one journal entries addressed the anticipated level of challenge of the game. In only five did students state that they expected the game to be an enjoyable and satisfying test of their abilities, what Swan (2010) referred to as "meaningful challenge." The majority—53 of the 61—anticipated that playing the game would be a frustratingly difficult and trying endeavor. Future game development and modification of existing games will need to find the balance between the fun aspects of the game and the instructional elements, working the latter into the game in a gradual, seamless, and restrained manner. Students need to be satisfied by the game experience first and foremost, and the map or any other instructional scaffold needs to relate clearly back to the game play. One solution might be to frame concept maps as cheats. Children are familiar with computer game cheats and cheat codes; they use them regularly and share them openly. Concept maps could be framed in this way and either provided to players as they go along or developed by the players as they make decisions during game play; it could even be a shared endeavor among different players.

4.2.3. Attention

The interaction between treatment group and attention to the material suggests a role for students' need to be active learners. As noted above, both concept map groups may simply have had too much given to them from the outset, including the students who ostensibly constructed their own maps but in reality were supplied with both concepts and connector terms. This process may have limited their ability to interact with the game on their own terms. This may have had any combination of the following three consequences. First, this may have changed the meaning of the unit, drawing attention away from the hypothesized motivating act of playing a game and focusing attention

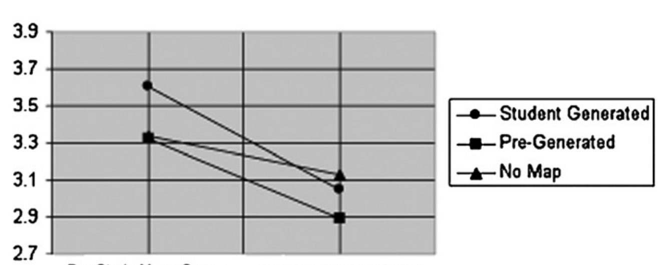

Fig. 7. Relevance subscale pre- and posttest scores.

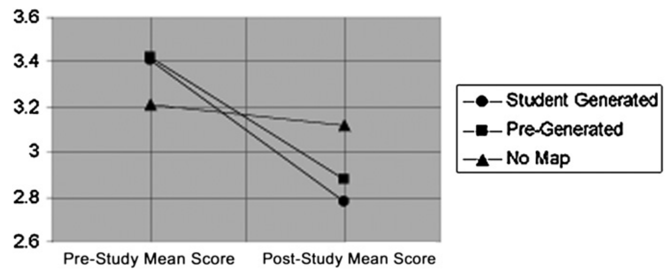

Fig. 8. Satisfaction subscale pre- and posttest scores.

instead on the tedious task of completing yet another assignment; indeed, a possible advantage of being in the no-map group may have been that students were forced to attend more to the game in order to extract information. Second, providing too much information at the beginning may have taken away an element of challenge and discovery in playing the game and rendered the students passive learners. Indeed, this can be expected to influence not only the attention paid to playing the game, but also the level of students' satisfaction (Burleson, 2005; Swan, 2010). Third, the emphasis on performing the concept mapping task may have elicited an overjustification effect (Bem, 1972), such that focusing attention on rewarding or punishing performance on an activity external to the game made playing the game intrinsically less rewarding.

The students' journal entries may contain a possible interpretation—and solution. A number of students from all three groups made comments in their journals similar to the following student, who wrote, "it would work better if we would have played the game first then learned." The juxtaposition of the concepts—playing and learning—is significant. As one student wrote, "[The game] is meant for fun not learning." In other words, by providing conceptual scaffolds up front, the game became a daunting, workaday chore—read learning—to be completed, rather than enjoyed. It made the game taxing rather than challenging. It made the activity and the reward extrinsic to playing the game (see Burleson, 2005). It reduced the degree of cognitive curiosity (Malone, 1981) by making the students' knowledge structures appear to them to be too complete, too parsimonious. By providing the educational content through concept mapping *after* the game has been played, however, students apparently believed they would have been more willing—i.e., more motivated—to learn from the game. It would have allowed them to attend to the playing of the game, to enjoy the self-paced inference of concepts, to maintain a level of uncertainty and challenge, and to remove the expectation of extrinsic reward or punishment that may have undermined intrinsic motivation to play the game.

Perhaps, too, using only one instructional strategy, concept mapping, is insufficient. Creating game based learning environments is akin to creating other learning environments, such as open-ended learning environments (Hannafin, Land, & Oliver, 1999), problem based learning environments (Savery & Duffy, 1995), goal based scenarios (Schank, Berman, & Macpherson, 1999), and anchored instruction (CTGV, 1992). All of these call for utilizing a variety of strategies to facilitate learning by providing access to (a) additional information, (b) contrasting problems (Burleson, 2005), (c) cognitive tools for increased self-awareness (Kao et al., 2008), (d) discussions and collaboration among students (Burleson, 2005; Schmid & Telaro, 1990), (e) expert advice (Schank & Neaman, 2001), and (f) other types and methods of scaffolding—such as replacing pencil-and-paper mapping with computer generated mapping (Kwon & Cifuentes, 2009). The game based learning environment created in this study lacked these additional elements of learning environments. Using only concept maps may have provided insufficient instructional support, leaving learners overwhelmed and thus less motivated. Whether and how a full repertoire of instructional activities would affect student motivation is a question that needs to be addressed, including the role of concept maps within a problem based learning environment and the interaction of concept maps with other elements of the learning environment. Within this broader environment, the question of having sufficient time for playing the game and using the concept map could also be explored.

5. Conclusions

In asking the question, does the use of a computer game help students to be more willing and able to learn classroom material, the current analysis has looked at the former: students' motivation to learn classroom concepts when they are presented in the context of playing a computer game. Is playing a game more motivating than conventional classroom instruction? The answer appears to be: It depends. Including a conceptual scaffold, hypothesized to enhance motivation for the material and activities of playing the game, seems to have had the opposite effect, perhaps because students lacked sufficient time or sufficient support to complete the game, but perhaps because the scaffold undermined the potential pedagogical power of playing the game. Therein lies a lesson from the current study: an activity meant to complement the limitations of conventional classroom instruction cannot succeed if the activity, itself, perpetuates those same limitations.

This could be teased out in the future by using separate scales. One set of IMMS items could be worded to measure students' motivation specific to playing the game. A second set of IMMS items could be worded to focus on students' motivation for learning the material. Using separate tools could thus help differentiate between the cognitive burden of playing the game and the cognitive burden of learning the material. It could thus be concluded with more confidence whether using the concept maps made learning more difficult or made the game more of a chore.

Nevertheless, the IMMS tool used in this study helped discriminate between the two concept map groups on one hand and the no concept map control group on the other, enabling the identification of a number of problems with the ways concept maps were used. Trying to incorporate the concept map into playing the game without proper practice in either may have distracted students, created a burden, and thus taken away from the time available for learning. Isolating concept map use without integrating it better into game play may have put too much emphasis on the scaffolding at the expense of focusing on playing the game. Using the scaffold too early may have put too much attention on learning, making game playing a chore. The scaffold may have been so detailed that it took away the curiosity and discovery inherent in play. Taken together, the results show how using any conceptual scaffold, such as a concept map, can reduce rather than enhance motivation to learn—and even motivation to play. In other words, if learning through games is meant to replicate children's more natural style of learning (Rieber et al., 1998), then making them less like play and more like schoolwork will render them ineffective as educational tools.

The pattern of results in this study suggests that scaffolds can enhance the effectiveness of educational games, but only under the right conditions. Using a scaffold is not a substitute for generating expectations of enjoyment. A scaffold, properly used, should allow students more rather than fewer choices and reduce rather than add to task and informational overload. It should focus attention on the internal rewards of playing the game and allow students to be curious, active, and even social learners. In other words, using the scaffold should be an ongoing part of playing the game. It should emerge from game play as a consequence of game play rather than an antecedent.

This study carries with it a warning for educators who adopt game based learning approaches: Do not dilute the potential effectiveness of games by taking away the one distinct attribute that gives them their advantage—play. Like the games they complement, scaffolds must first engage students in order to enhance learning and motivation by seamlessly integrating learning with play. A number of frustrated students from the pre-generated map group wrote this in their journals. Their sentiments were captured succinctly in the words of one student—"Games are made for one purpose: fun."

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