7-2011

Beyond Jeopardy and Lectures: Using Microsoft PowerPoint as a Game Tool to Teach Science

Jason Paul Siko
Wayne State University

Michael K. Barbour
Sacred Heart University

Sacip Toker
Wayne State University

Recommended Citation

Siko, J., Barbour, M. K., & Toker, S. (2011). Beyond Jeopardy and lectures: using Microsoft PowerPoint as a game tool to teach science. *Journal of Computers in Mathematics and Science Teaching, 30*(3), 303-320.

Jl. of Computers in Mathematics and Science Teaching (2011) **30**(3), 303-320

Beyond Jeopardy and Lectures: Using *Microsoft PowerPoint* as a Game Design Tool to Teach Science

JASON SIKO, MICHAEL BARBOUR, AND SACIP TOKER
Wayne State University, USA
sikojp@gmail.com
mkbarbour@gmail.com
saciptoker@gmail.com

To date, research involving homemade PowerPoint games as an instructional tool has not shown statistically significant gains in student performance. This paper examines the results of a study comparing the performance of students in a high school chemistry course who created homemade PowerPoint games as a test review with the students who used a traditional study guide on two separate unit tests. There was no statistically significant difference in performance on either test. Furthermore, there was no difference in performance between students who created games multiple times. More work is needed to strengthen the relationships between the protocol and the philosophical justifications, as previous studies found at least one of these justifications to be lacking in the student.

Constructivists believe that students learn by creating their own knowledge, and in an active fashion through meaningful interactions rather than having the information provided through direct instruction (Duffy & Cunningham, 1996). One view of this philosophy is constructionism, which believes that students create meaning through the act of building something (Papert, 1991). Examples can range from building and controlling a robot in a computer science class to creating models of decentralized systems, such as an ant colony, using *StarLogo* (Resnick, Bruckman & Martin, 1996).

While *Microsoft PowerPoint* was not originally designed for the K-12 classroom, over the years it has become a staple in classrooms and lecture halls as an instructional tool, allowing teachers and professors to present information in a more visually appealing manner than chalkboards and overheads. It is primarily used to deliver direct instruction, and studies investigating the effects of *MS PowerPoint* as a tool for direct instruction have not shown statistically significant improvement in student performance (Bartsch & Cobern, 2003). Recently, researchers have begun to look at *MS PowerPoint* as a possible constructionist teaching tool (Rieber, Barbour, Thomas & Rauscher, 2008), where students construct games using the application. Based on a constructionist viewpoint, learning from these games does not necessarily take place by playing the games; rather it is through the constructing of the game that learning is facilitated (Barbour, Thomas, Rauscher & Rieber, 2008).

This article describes a study examining the performance of students that used *MS PowerPoint* to create review games in a secondary science classroom. We begin by discussing the theoretical underpinnings of homemade PowerPoint games and existing studies on the games effect on student performance. Next, we evaluate the student performance of those who used *MS PowerPoint* to create games and students who reviewed the content using traditional methods. Finally, we identify future research that is needed into the use of game design in the K-12 classroom, including an examination of the questions students write for homemade PowerPoint games and the classroom protocols for the project itself.

LITERATURE REVIEW

In general, attitudes toward gaming and education are usually negative, with games being viewed entirely as a leisure activity or viewed as a medium rife with violence (Squire, 2006). The mindset of the general population is based on the marketing of games to the public, where the hype surrounding the release of a new game rivals (and sometimes even exceeds) that of a blockbuster movie. Video games are also seen as a distraction to homework, and thus gaming in education seems counterintuitive. Another problem with games in education is that teachers have not been trained to use games as an effective classroom learning tool, and since any advanced game design project would require large amounts of assistance and infrastructure, it is often ignored (Rice, 2006). Squire (2006) argued that there needs to be a paradigm shift toward games being considered "designed experiences" for learning.

One way to accomplish this shift is to have students create the games themselves. Creating quality games is not an easy task. Rieber et al. (2008) argued that good games draw on the competitive nature of players, and draw them in with a good storyline. In addition to maintaining the player's interest, designers of educational games must include learning outcomes as well (Hirumi, Appelman, Rieber, & Van Eck, 2010). Other problems have been noted in the literature concerning students' use of technology to design games. Students can get caught up in the bells and whistles that often accompany applications, such as *MS PowerPoint,* rather than the actual content (Parker, 2004). Unequal access to technology among students can also factor into the completion of the assignment. Kafai & Ching (2001) noted declines in time on-task while working on a computer-based project, with students often discussing topics not related to the task at hand. Teacher comfort level may also play a role in the success of a game design project. In a comparative case study involving two fourth grade classes, Lotherington & Ronda (2010) found that the teacher's comfort level with technology, along with constructionist pedagogy influenced the student experience. The authors also found the less comfortable teacher resorted to rewarding students for writing questions only rather than designing games, essentially removing the motivation for constructing the artifact.

MS PowerPoint is obviously not game design software. However, it is ubiquitous in schools and has the advantage of being accepted by school-based personnel (Barbour, Kinsella, & Rieber, 2007). As a tool for instruction, *MS PowerPoint* has produced mixed results. While students have a higher perception of *MS PowerPoint* presentations than other formats, there were generally no significant difference in student performance compared to traditional formats (Frey & Birnbaum, 2002; Perry & Perry, 1998), and even negative effects if the presentation is graphics-intensive (Bartsch & Cobern, 2003). However, these studies have focused on using the software in an instructivist manner. The proponents of homemade PowerPoint games offer it as a constructivist alternative to these traditional uses.

A homemade PowerPoint game begins with a narrative that provides details on the context and the objectives for winning the game (Parker, 2004). The game can be completely contained within an *MS PowerPoint* file or it can have a game board and pieces that are printed out from slides within the file. Multiple choice questions are presented to the players, utilizing the action button feature in *MS PowerPoint*, to allow students to click on correct and incorrect choices. As with any good game, the level of difficulty should increase as the player advances, so the questions should become more difficult.

The philosophical justification for using homemade PowerPoint games as a learning tool is three-fold (Barbour et al., 2008). First, the idea of learning by doing is consistent with constructionist philosophy. Constructivism and constructionism share the common thread of building knowledge structures (Papert, 1991). Constructionism takes this idea one step further and applies the creation of a meaningful artifact as the context for these structures (Kafai & Resnick, 1996). Moreover, it is through the design and creation of the artifact, rather than the artifact itself, where the learning takes place. Kafai, Ching, & Marshall (1997) also discussed the importance of representing new knowledge in a new medium, one constructed by the learners themselves. In this instance, the medium the students utilize to construct that knowledge is a game designed using *MS PowerPoint*.

Second, the actual construction of a game requires creating a theme, writing a game narrative, and providing objectives for the game. In the case of a homemade PowerPoint game, all of these elements must be written in a very concise format to allow each item to fit on a single *MS PowerPoint* slide. This forces students to synthesize the material to only the essential details. This kind of writing is similar to a style of writing known as a microtheme, where statements and ideas are consistently revised and shortened in order to fit within a defined word limit (Stewart, Myers, & Culley, 2010). The ability to write well in this format has been shown to lead to better student performance on assessments (Ambron, 1987; Collins, 2000).

Third, students must synthesize the content in order to write good questions. The process of writing the question, determining the correct answer, and then coming up with viable alternatives (i.e., incorrect answers that are plausible responses) forces the students to work with the content in a way that makes sense to themselves and others. In a review of 26 studies where question generation was used as a reading comprehension strategy, Rosenshine, Meister, and Chapman (1996) found these strategies increased student comprehension. To make the game challenging, but not impossible, students must vary the level of difficulty of the questions (usually in a progression from easier to more difficult), which may require students to rewrite simple, declarative questions into questions that involve comprehension or application. Lotherington and Ronda (2010) found that students were writing better questions over time when given the opportunity to revise them or edit the questions of others. Research has also shown that students who were able to write higher-order questions on a specific topic develop a deeper understanding of the material (Wong, 1985). As students practice constructing questions they should be able to write more higher-order questions over time, which also leads to better understanding of the material (Rickards & DiVesta, 1974).

In the first reported study using homemade PowerPoint games, Parker (2004) examined the games use to teach the parts of speech to middle school students. He found that students in the treatment group showed gains from their pre-test to their post-test, students in the control group scored higher than the treatment group and the control group showed greater gains between the pre-test and post-test. Parker did note several methodological issues with these findings. First, the students in the control group had a much higher class average than the treatment group prior to the project, but the students in the control group scored much lower on the pre-test. The combination of a lower pre-test score and a higher post-test score attributed to the result of a greater gain with traditional instruction. Parker argued that the treatment could be considered more effective because the treatment group scored higher on the test than their class average would have predicted. In addition, Parker stated that since the treatment class as a whole was near failing yet achieved a passing average grade on the project, the games acted as a motivator for those struggling students.

Research on homemade PowerPoint games at the secondary level has focused on the social studies and language arts. In a study using homemade PowerPoint games in two Midwestern British Literature classes, Clesson, Adams and Barbour (2007) found no statistically significant difference in student performance. The authors noted the small class size for both groups as a possible reason for their findings (i.e., the control group had only 15 students, while the treatment group had 20 students). In another study, students created homemade PowerPoint games in a blended Midwestern U.S. History classroom (i.e., students were in a face-to-face environment, but instruction was primarily delivered through a course management system). Barbour et al. (2007) found a slight increase in the scores of those who created homemade PowerPoint games, but the increase not statistically significant.

In a follow-up to the Barbour et al. (2007) study, the student-generated questions from those Midwestern U.S. History student games were analyzed to see where they aligned on Bloom's taxonomy. Barbour et al. (2009) were concerned that students were not writing higher-order questions for their games, and that this was one of the reasons for the no significant difference finding. In their analysis of almost 1900 student-generated questions, the vast majority of the questions (i.e., 93.7%) were categorized as "Knowledge" level – the lowest level on the taxonomy. In addition, none of the questions were higher than the "Application" level, which is only the third level on the hierarchy. This indicated that the students did not construct a single higher-order question (e.g., analysis, synthesis, or evaluation). As one of the philosophical justifications for utilizing homemade PowerPoint games included a better understanding through constructing higher-order questions, it was not surprising that previous research had resulted in no statistically significant differences in student performance based on this analysis.

In summary, proponents of constructionism believe that students learn by building artifacts, giving personal meaning to the knowledge they are acquiring. Since students have a high interest in games, it is possible that students would benefit from designing their own games as a learning tool. As *MS PowerPoint* is a staple in most computer labs, students can create homemade PowerPoint games without having to learn advanced technology skills. Recent studies involving homemade PowerPoint games have shown no differences in student performance; however, these studies have occurred in only a few select subject areas and have often suffered from small sample sizes.

METHODOLOGY

The purpose of this study was to compare the performance of students who constructed homemade PowerPoint games to students who did a more traditional review (i.e., a study guide). In this study we set out to answer the following research questions:

1. Do students reviewing for a chemistry test by generating homemade PowerPoint games perform better on multiple-choice tests than students who use a traditional worksheet review guide?
2. Do students who have used this technique more than once perform better than those who have never constructed homemade PowerPoint games or have only constructed games once?

For these two research questions, we developed the following hypotheses:

H_o: No difference in student performance

H_1: A positive difference in student performance

To test this hypothesis, students from certain sections of a high school chemistry class were placed into groups of two or three and tasked with creating a homemade PowerPoint game to review for their unit test, while students from other sections were assigned a more traditional study guide.

A four-day protocol, revised from a five-day protocol used in several of the previous studies using homemade PowerPoint games (Rieber et al, 2008), was used to construct the games. On the first day, students were introduced to the homemade PowerPoint games, played several example games (which were downloaded from the homemade PowerPoint game website - http://it.coe.uga.edu/wwild/pptgames/), and discussed qualities possessed by good games. Students also began to come up with themes and questions for the games. During the second and third classes, students used the template to construct their games, writing additional questions if necessary. During the fourth class, students checked their games for errors and played games created by others.

Instruments and Analysis

The instruments used in the study consisted of two exams containing 40 multiple-choice questions. In the first trimester, 60 questions were used in the test for the first unit, and the results were analyzed to select 40 questions for the study instrument. We used two indices in the item analysis to reduce the number of questions in the instrument. The first was difficulty index, which was the percentage of students who answered a question correctly (Linn & Gronlund, 2000). The criteria for interpreting and using the difficulty index are dependent on the purpose of an achievement test (Thorndike & Hagen, 1977). In the present study, the teachers, who indentified the purpose of the test, considered the questions with scores over .90 too easy and questions with scores under .70 too difficult in accordance with the purpose, and these questions were eliminated from the instrument.

Additionally, a discrimination index was calculated for each question. This index demonstrated to what extent questions differentiate the highest and lowest achievers on a test. A good test question should be answered correctly by the all members of high-achiever groups, while at the same time be answered incorrectly by members of the low-achiever group (Nitko, 2004). In the current study, the questions that had negative discrimination index were eliminated since these questions worked reversely as anticipated. The final test used in the study consisted of 50 questions, 40 questions being used for the study plus 10 additional questions the teachers felt were necessary for assessing student progress. This process was repeated for the instrument used for the second unit.

Participants

The research setting was a large, suburban Midwestern high school. The school district included a village and the majority of two surrounding townships, covering approximately 54 square miles. The school, which was 11 years old, housed grades 10-12 and was the only high school in the district. The student population was approximately 2,100 students, approximately 90% of whom were Caucasian and the remainder consisting primarily of Hispanic and African-American students. The district was also experiencing an influx of English language learners at the time of the study. The socio-economic makeup of the district was primarily professional, middle class households, although representation from the entire economic spectrum was quite visible in the school. There were 110 teachers on staff, and the median teacher had approximately 10 years experience at the school.

The course used in the study was entitled Environmental Chemistry, and was designed around the American Chemical Society's "Chemistry in the Community" curriculum (often called ChemCom). Most research involving this curriculum has focused on the benefits of a science-technology-society curriculum and the college readiness of students who take ChemCom over chemistry (Brent, 1998; Sanger & Greenbowe, 1996). The ChemCom curriculum, however, has less emphasis on both memorization and the math required by a traditional chemistry course, replacing it with environmental, political, and social questioning.

The ChemCom curriculum strives to instill the importance of chemistry in everyday life. As their frequently asked questions section of their website stated:

> The primary difference is that ChemCom is structured around societal issues related to chemistry rather than around specific chemical concepts. ChemCom features decision-making investigations and activities that give students practice applying their chemical knowledge in various problem-solving situations. (American Chemical Society, 2009)

The purpose of this course in our research setting was to provide an elective to college-bound students who were interested in science but were not considering a career in the sciences.

The school utilized a trimester system, with traditional year-long courses being covered in two of the three trimesters. The course did not need to be taken in consecutive trimesters (i.e., students could have the course during the first and second, first and third, or second and third trimesters).

Three teachers taught at least one trimester of the course, with only one teacher utilizing the intervention. There were eight different sections of the course taught over all three trimesters by three different teachers (i.e., Teachers A-C). The distribution of sections, control groups, and treatment groups are summarized in Table 1.

Table 1
Distribution of Control and Treatment Groups Among Teachers A-C

	Unit 1		Unit 2	
Trimester	Control	Treatment	Control	Treatment
1st	A – 2 sections (n = 37) B – 2 sections (n = 44) C – 1 section (n = 20)			
2nd		A – 3 sections (n = 62)	B – 2 sections (n = 37)	
3rd			B – 2 sections (n = 32)	A – 4 sections (n = 69)

The normal complexities of student scheduling meant that depending on what courses each student desired to take affected which teacher they received for Environmental Chemistry, offering as much as possible a random assignment of students to the treatment teacher's sections. Yet, one limitation of the study was that we could not test for the effect each teacher had on the results.

RESULTS

In order to answer the first research question, scores from the control and treatment groups were compared using an independent *t*-test to determine if students who created the homemade PowerPoint games scored better than students who completed a more traditional review. Table 2 provides descriptive results for both groups on the first unit test.

Table 2
Comparison of Test Scores Between Control and Treatment Groups for the First Unit

Group	*N*	*M*	*SD*
Control	101	29.53	5.36
Treatment	62	28.52	5.86

The t-test indicated that while students who used a traditional review technique (M = 29.53, SD = 5.36) performed better than those who used homemade PowerPoint games (M = 28.52, SD = 5.86), the difference was not statistically different, t (161) = 1.14, p = .26. This result did not support our hypothesis for the first research question.

Table 3 provides descriptive results for both groups on the second unit test.

Table 3
Comparison of Test Scores Between Control and Treatment Groups for the Second Unit

Group	*N*	*M*	*SD*
Control	69	26.00	5.49
Treatment	69	25.99	5.12

The t-test for the second unit test also did not indicate a significant difference between the groups in favor of the treatment group, t (136) = .016, p = .99, supporting the hypothesis for the first research question. Students who created homemade PowerPoint games (M = 25.99, SD = 5.12) did not perform as well as students who did a traditional review (M = 26.00, SD = 5.49), although given the small difference one would consider their performances to be approximately equal.

To answer the second research question, a univariate ANOVA was conducted to examine differences among the groups who made homemade PowerPoint games twice, those who only made the games once, and those who never created a homemade PowerPoint game (see Table 4).

Table 4
Comparison of Air Unit Test Scores Between Students who Made Games Twice, Once, or Never

Group	*N*	*M*	*SD*
2nd time with games	35	26.29	5.35
1st time with games	34	25.68	4.94
Never	69	26.00	5.49

The students who were exposed to homemade PowerPoint games the second time (M = 26.29, SD = 5.35) performed better than both students who used homemade PowerPoint games the first time (M = 25.68, SD = 4.94), and those who had never used homemade PowerPoint games in their classes (M = 26.00, SD = 5.49). In addition, the first time group did not perform as well as the group who never used the games in class. The result of univariate ANOVA did not indicate any significant difference between groups, F (2, 135) = 0.113, p = .89, which did not support the hypothesis for the second research question.

DISCUSSION

With respect to student performance, students showed no statistical difference in performance on both unit tests. Prior studies examining the performance of high schools students also found no significant difference between groups reviewing in a traditional manner and those who created homemade PowerPoint games (Barbour et al., 2007; Clesson et al., 2007; Parker, 2004). It should be noted that previous studies mentioned that the performance was usually higher with the groups who constructed the games, and attributed the lack of statistical significance to small sample sizes. Our study used multiple sections and two testing periods, which served to increase the sample size to a total of 300 students. This was a larger sample than the less than 100 students included in the Barbour et al. study, and a much larger sample than the 35 students included in the Clesson et al. study. Both Barbour et al. and Clesson et al. speculated that had their sample sizes been larger that the differences in student performance they experienced may have been statistically significant. We did not find that an increased sample size led to statistical significance. In fact, unlike the Barbour et al. and Clesson et al. studies, the control group had a higher score (albeit not statistically significant, and for all practical purposes equal on the second unit test) in spite of the larger sample size.

In the study conducted by Barbour et al. (2007), the research examined performance of the same group of students on different portions of the same test – based on whether they had created a homemade PowerPoint game to review that portion of the exam. We compared the performance of two different groups of students, who as a whole may have performed quite differently on tests regardless of the review technique. Similar to Parker's (2004) study, comparing student performance without controlling for the natural differences that may exist between the control and treatment groups was a limitation. However, as all of the students in this study had an equal chance – depending on their own selection of courses – of being placed into any of the sections of the ChemCom course in any of the three trimesters, there was a natural element of random selection involved in the control and treatment groups. In addition, the difference in trimester averages for the control and treatment groups was less than four percent.

A possible reason for the lack of significant improvement in the first unit was the idea that practicing question writing will lead to more higher-order thinking questions, which leads to a deeper understanding of the material (Rickards & DiVesta, 1974; Wong, 1985; Lotherington & Ronda, 2010). Since the other studies using homemade PowerPoint games were contained within a single semester (Barbour et al., 2007; Clesson et al., 2007; Parker, 2004), this result was the first opportunity to compare performance with various levels of students' experiences designing the games. On the second unit test, the control group and treatment group scores were practically equal. However, when the scores of the treatment group were separated by the number of times they created games, the group that created games twice scored higher than the control group, who scored higher than the group that only created games once. When this result was combined with the result of the first unit, where the control group's scores were higher, we could speculate that students experience some initial discomfort with the new style of instruction. But after having experience with the game project one time, the students were more comfortable with the technique and it became a more useful tool for them. Again, this idea of comfort and acclimation to the process is only speculation, since we did not collect any qualitative data to explore these aspects and none of the results were statistically significant.

Furthermore, students were not given ample time to revise their questions, nor did they obtain feedback from other students while creating their games, as noted by Lotherington and Ronda (2010). However, we did not analyze the questions to see if students did indeed write higher-order questions or whether they wrote more higher-order questions if they created games for both units. Based on the Barbour et al. (2009) study, students primarily wrote "Knowledge" level questions. Without a systematic analysis of the questions, we did notice similar results with the students in this study. Any differences in the number of higher-order questions written by students may be explained by this anecdotal observation. The content in the first unit contained few objectives that required mathematical computation, while the second unit contained a higher amount of objectives that required mathematical computation. Questions involving mathematical computation inherently go beyond the simply "Knowledge" level questions, usually being classified as "Comprehension" or "Analysis" questions. Students could have created more higher-order questions simply based on the differences in content between the two units. This is an area that should be explored in greater detail through a comparative analysis of the student-created questions for both units.

We also noticed anecdotally that some of the game narratives were related to the topics being covered in the units, but many were not. Some students engaged in making the topic as bizarre as possible, which often led to several problems as they progressed in creating their game. First, the focus changed from writing a clear, concise, microtheme-style narrative to simply making the narrative outlandish. In light of the research on microthemes (Ambron, 1987; Collins, 2000), the students' actions did little to improve the aspects of the game. Additionally, the teacher did little to encourage the students to revise the narrative to make it more in keeping with the principles of homemade PowerPoint games, other than to tell them it needed to fit on one *MS PowerPoint* slide. There was no minimum or maximum word count for the theme, and font sizes are automatically adjusted by the software in *MS PowerPoint* to fit the content into the text box. Based on these realities of the implementation of this project, we need to question whether students were actually writing their narratives in a way where they would gain the benefits associated with microtheme-style writing.

The potential limitations caused by the students' narrative were further compounded by the students' use of graphics. The process of writing questions became deemphasized when students became more interested in style over substance. We noticed that students, after developing an outlandish theme, searched for graphics that were representative of that theme. A common approach was to find a bizarre picture and insert it into the background of a slide that appeared when a question was answered incorrectly. This also transferred the focus from constructing a game based upon certain foundations related to the student written narrative and questions to significant amounts of time being spent on essentially off-task activities. This was consistent with Kafai and Ching (2001), who found an increase in off-task time during their students' use of computer lab time. Due to the outlandish theme and bizarre graphics, the teacher also expressed some reservation in sharing the games on his school website for others to download because the games could be considered offensive to some. This supported the observations of Squire (2006), that the popular opinion of games is that they should be used for leisure purposes only.

The disconnect between the narrative and the content seemed to hamper some of the students' abilities to create good games. The teacher provided some anecdotal evidence that the students who used the most graphics often had games with the highest number of technical problems (e.g., inoperable game buttons, missing slides, etc.) and did not create games that had an increasing level of difficulty (i.e., games with 20 questions in no coherent order), in addition to the narrative having little or no relation to the actions of the player once they began the game. These aspects (i.e., properly operating game, increasing level of difficulty, and consistent and compelling narrative) are all traits that Rieber et al. (2008) underscored as important in attracting and maintaining the interest of players in a particular game. However, as Hirumi et al. (2010) noted, it is a difficult task to accomplish all of these aspects in addition to having learning outcomes as well.

In summary, there were no statistically significant differences in performance on either of the two unit tests. There were several possible explanations to account for these findings; including differences in the content between the two units, and students letting other aspects of the game (i.e., the graphics) interfere with the pedagogically important components of the game. Finally, there were no differences in student performance based on creating homemade PowerPoint games on more than one occasion.

CONCLUSION AND IMPLICATIONS

In this study we examined student performance that compared students who reviewed for the test by creating homemade PowerPoint games and students who used a traditional review worksheet. On both of the unit tests there was no statistical difference in student performance. Also, students performed better if they had created the games more than once, although this finding was not statistically significant.

Previous researchers have made the argument that the technique of using *MS PowerPoint* as a game design tool was pedagogically "as good as" traditional review techniques. That is, the lack of statistical significance in the differences in scores indicated that creating the games was neither a benefit nor a detriment to student learning. Considering the process required to create a homemade PowerPoint game consisted of four or five days, this pedagogical strategy is probably more time consuming than traditional review techniques. Practitioners may not find homemade PowerPoint games to be the most efficient method of reviewing for a test. However, we do have several recommendations if educators did wish to use homemade PowerPoint games in their classroom. First, teachers should place a limit on the file size of the game in order to limit the distraction of searching for images. Second, teachers should spend as much time as possible on reviewing and suggesting revisions to the narratives of the students' games, as well as placing some guidelines on the narrative itself (e.g., requiring that the game narrative is related directly to the content). Third, the protocol could be altered so that more time is spent on writing questions, which could be done outside of the computer lab. Again, the focus is to emphasize the content over some of the distractions that technology creates.

Also, one could actually question whether using the games to review the content is truly a form of constructionism (as you could argue that the students have already learned the content and the review activity is simply to refresh the students' existing schema). Future research should examine the creation of homemade PowerPoint games as a method for students to learn original content. The process of writing the game narrative (i.e., practicing the process of writing in a microtheme format) could also be examined, as this principle underlying the theoretical premise of homemade PowerPoint games has not been explored. Additionally, there has been no research to date that compares the grades assigned to students' on their homemade PowerPoint games and performance on the test. The proponents of homemade PowerPoint games include a scoring rubric on the project website, yet the scores students receive on their games has never been compared to scores students receive on the testing instrument in any of the previous studies. Finally, future research needs to continue to consider the process of question creation to ensure that students are truly writing higher-order thinking questions. The work conducted by Barbour et al. (2009) was an interesting starting point, as it indicated that the students in Barbour et al. (2007) had not written higher-order questions. What impact this had on the no statistically significant findings of that study, as well as what obstacles prevent students from writing higher-order questions needs to be examined.

References

Ambron, J. (1987) Writing to improve learning in biology. *Journal of College Science Teaching, 16*(4), 263-266.

American Chemical Society (2008). *Chemistry in the Community (ChemCom): Frequently Asked Questions*. Retrieved from http://portal.acs.org/portal/acs/corg/content?_nfpb=true&_pageLabel=PP_ARTICLEMAIN&node_id=557&content_id=CTP_005518&use_sec=true&sec_url_var=region1&__uuid

Barbour, M. K., Kromei, H., McLaren, A., Toker, S., Mani, N., & Wilson, V. (2009). *Testing an assumption of the potential of homemade PowerPoint games*. Proceedings of the Annual Conference of the Society for Information Technology and Teacher Education (1381-1387). Norfolk, VA: AACE.

Barbour, M. K., Thomas, G. B., Rauscher, D. & Rieber, L. P. (in press). Homemade PowerPoint games: Preparing the next generation of teachers to use creative design activities in the classroom. In A. Hirumi (Ed.), *Digital video games for PreK-12 education: Engaging learners through interactive entertainment.* Washington, DC: International Society for Technology in Education.

Barbour, M. K., Kinsella, J., & Rieber, L. P. (2007). *PowerPoint games in a secondary laptop environment.* Proceedings of the World Conference on E-Learning in Corporate, Government, Healthcare and Higher Education (2328-2332). Norfolk, VA: AACE.

Bartsch, R. A., & Cobern, K. M. (2003). Effectiveness of PowerPoint presentations in lectures. *Computers & Education, 41*(1), 77-86.

Brent, B. M. (1998). *The achievements of "Chemistry in the Community" students compared to traditional chemistry students in an introductory university chemistry course*. Ph.D. dissertation, University of Missouri - Columbia, United States -- Missouri. Retrieved from Dissertations & Theses: Full Text. (Publication No. AAT 9901220).

Clesson, K., Adams, M., & Barbour, M. K. (2007, October). *Game design as an educational pedagogy.* Paper presented at the annual National Association of Laboratory Schools Symposium, Johnson City, TN.

Collins, M.A.J. (2000). *Do microthemes improve student learning of biology*. Paper presented at the annual National Science Teachers Association National Convention, Orlando, FL.

Duffy, T., & Cunningham D. (1996). Constructivism: Implications for the design and delivery of instruction. In Jonassen, D. H. (Ed.), *Handbook of Research for Educational Communications and Technology.* New York: Simon and Schuster, 170-198.

Frey, B., & Birnbaum, D. J. (2002). *Learners' Perceptions of the Value of PowerPoint in Lectures*. ERIC Document Reproduction Service: ED467192

Hirumi, A. Appelman, B., Rieber, L., & Van Eck, R. (2010). Preparing instructional designers for game-based learning: Part 2. *TechTrends, 54*(4), 19-27.

Kafai, Y.B., & Ching, C. (2001). Affordances of collaborative software design planning for elementary student's science talk. *The Journal of the Learning Sciences, 10*(3), 323-363.

Kafai, Y. B., Ching, C. C., & Marshall, S. (1997). Children as designers of educational multimedia software. *Computers & Education*. *29*(2), 117-126.

Kafai, Y.B., & Resnick, M. (Eds.). (1996). *Constructionism in practice : designing, thinking, and learning in a digital world*. Mahwah, NJ: Lawrence Erlbaum Associates.

Linn, R. L. & Gronlund, N. E. (2000). *Measurement and Assessment in Teaching* (8th ed.) Upper Saddle River, NJ: Prentice-Hall, Inc.

Lotherington, H., & Ronda, N.S. (2010). Gaming geography: Educational games and literacy development in the Grade 4 classroom. *Canadian Journal of Learning and Technology, 35*(3). Retrieved from http://www.cjlt.ca/index.php/cjlt/article/view/542/265

Nitko, A. J. (2004). *Educational Assessment of Students* (4th ed.). Upper Saddle River, NY: Pearson Merrill Prentice Hall

Papert, S. (1991). Situating constructionism. In I. Harel & S. Papert (Eds.), *Constructionism* (pp. 1-11). Norwood, NJ: Ablex.

Parker, J. S. (2004). Evaluating the impact of project based learning by using student created PowerPoint games in the seventh grade language arts classroom. *Instructional Technology Monographs 1* (1). Retrieved from http://projects.coe.uga.edu/itm/archives/fall2004/JPARKER.HTM

Perry, T., & Perry, L. A. (1998). University students' attitudes towards multimedia presentations. *British Journal of Educational Technology, 29*(4), 375–377.

Resnick, M., Bruckman, A, & Martin, F. (1996). Pianos not stereos: Creating computational construction kits. *Interactions, 3*(6). Retrieved from http://web.media.mit.edu/~mres/papers/pianos/pianos.html

Rice, J.W. (2006, April). *New media resistance: Barriers to implementation of computer video games in the classroom*. Paper presented at the American Educational Research Association Annual Meeting 2006, San Francisco, CA.

Rieber, L. P., Barbour, M. K., Thomas, G. B. & Rauscher, D. (2008). Learning by designing games: Homemade PowerPoint games. In C. T. Miller (Ed.), *Games: Their purpose and potential in education* (pp. 23-42). New York: Springer Publishing.

Rickards, J. P. & DiVesta, F. J. (1974). Type and frequency of questions in processing textual material. *Journal of Educational Psychology, 66*(3), 354-362.

Rosenshine, B., Meister, C., & Chapman, S. (1996). Teaching Students to Generate Questions: A Review of the Intervention Studies. *Review of Educational Research. 66*(2), 181-221.

Sanger, M. J., & Greenbowe, T.J. (1996). Science-Technology-Society (STS) and ChemCom courses versus college chemistry courses: is there a mismatch? *Journal of Chemical Education, 73*(6), 532-535.

Squire, K. (2006, November). From content to context: Videogames as designed experience. *Educational Researcher, 35*(8), 19-29.

Stewart, T., Myers, A., & Culley, M.. (2010). Enhanced learning and retention through "Writing to Learn" in the psychology classroom. *Teaching of Psychology, 37*(1), 46.

Thorndike, R. L. & Hagen, E. P. (1977) *Measurement and Evaluation in Psychology and Education* (4th ed.) New York: John Wiley & Sons, Inc.

Wong, B. Y. (1985). Self-questioning instructional research: A review. *Review of Educational Research, 55*(2), 227–268.