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Computer animation for learning building construction management: A comparative study of first-person versus third-person view

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Computer Animation For Learning Building Construction Management: A Comparative Study Of
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For the degree of Master of Science

Is approved by the final examining committee:

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Raymond P. Hassan

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Hazar Dib

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05/19/2014

Head of the Department Graduate Program

Date

COMPUTER ANIMATION FOR LEARNING
BUILDING CONSTRUCTION MANAGEMENT:
A COMPARATIVE STUDY OF FIRST-PERSON VERSUS THIRD-PERSON VIEW

A Thesis
Submitted to the Faculty
of
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by
Jun Yu

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ABSTRACT

Yu, Jun M.S., Purdue University, August 2014. Computer Animation for Learning Building Construction Management: A Comparative Study of First-Person versus Third-Person View. Major Professor: Hazar Dib.

In this paper, we have explored the effect of perspective view in educational animations on students' learning of building construction management tasks and on students' preference of perspective views. We conducted a pre-test and post-test and found no significant advantages of computer animation presented in different perspective views across three different groups. Results showed that although students have preference on perspective views, perspective views did not influence learning outcome. The study also investigated the efficacy of animation as a teaching/learning tool in comparison to the traditional textbook. Findings showed that animation enhanced student learning, although the difference was not statistically significant. This finding adds to the body of research that suggests that animation can be an effective educational approach.

CHAPTER 1. INTRODUCTION

This chapter provides an introduction to the concept of the effect of different perspective views (first-person view and third-person view) in educational 3D computer animations and gives an overview of this research study. This chapter also includes the description of background and significance, the problem statement and related research questions. The assumptions, limitations and delimitations of the study are also included in this chapter. Finally, the chapter concludes with a summary of its coverage.

1.1 Background

3D computer animation has been widely applied in educational settings. In most 3D animations where a character performs a sequence of tasks, scenarios are presented in either first- or third-person views, which offer differential perspectives for viewers.

In animations where a character performs a sequence of tasks, two types of perspective views can be used for rendering the animation: first person and third person. In the first-person view, the camera is placed in front of the character's eyes and the animation is rendered as seen by the character. In this type of view, the user experiences the scenario and observes the character's operation as if the user is performing the task by himself. In contrast, the third-person view places the camera beside the character and renders the animation as if a third person is standing next to the main character and observing what the character is doing. In this type of view, the user experiences the

scenario and observes the character's operation as a bystander. Different perspectives offer the viewer a different viewing experience. A body of research (Anquetil & Jeannerod, 2007; Bateman et al., 2011; Pazuchanics, 2006; Rouse III, 1999; Salamin, Tadi, Blanke, Vexo, & Thalmann, 2010; Salamin, Thalmann, & Vexo, 2006) has shown the effects of perspective view on user performance in interactive games, virtual reality and simulations. However, we haven't found an existing study that focuses on the effect of perspective view in watching education 3D computer animation. Thus, this research work aims to fill the gap that exists in this specific domain.

In this study, we intend to investigate the benefits of egocentric versus exocentric view in an educational 3D computer animation. The goal of this study is to find a better way to teach undergraduate students the various tasks that a construction manager needs to perform in the field. In order to present learning materials in building construction management, we designed a 3D computer animation that covers several chapters' main content of the course book.

1.2 Significance

This study uses two training animations for building construction managers to examine how student learning is affected by perspective views in the 3D computer animation (first person versus third person). The 3D computer animations simulate several tasks that a building construction manager needs to perform on a construction site. With the appropriate rendering view, the computer animation should increase students' learning outcome, and the building construction management students should have better training before they go to work in the construction field.

1.3 Statement of Purpose

Since universities have begun using educational animation to enhance student learning, improving the learning effects of educational computer animation is very important. There are many factors that will affect the learning outcome of computer animation. Computer animation presented in different perspective views (egocentric and exocentric) might have a differential effect on learning. Therefore, it is necessary to examine the impact of perspective views in computer animation on student learning.

1.4 Research Questions

The questions central to this study were:

1. In educational animations for learning Building Construction Management, does the perspective view (egocentric versus exocentric) have an effect on student learning of the concepts being presented?
2. Does the perspective view have an effect on student preference?
3. Does the student preference of perspective view change based on the concepts/tasks being presented?

1.5 Assumptions

The following assumptions were innate in the pursuit of this research:

1. The participants selected from the Building Construction Management course in the College of Technology were a representative sample of students pursuing a degree in BCM.
2. The number of participants in this study was sufficient to produce test results among variables that were significantly different from the mean.

3. The participants in this test watched the computer animation, learned from it and tried their best on all experiments.
4. Participants were honest and did not cheat during the experiment tests.
5. The instruments in this study were a paper test, online animation video and online survey. The instructions were understandable to the subjects so that they knew exactly what they would receive.

1.6 Limitations

The following limitations were innate in the pursuit of the project:

1. The results of this experiment can only be generalized to the limited population: students studying building construction management.
2. This study was limited by the participant's preference or habit about 3D computer animation technology.
3. Data was collected from a limited number of participants available from the building construction management course, even with the incentive of extra credit for that course.
4. The integrity and accuracy of data collection was limited to the participants' consistency of participation
5. This study was limited by the quality of the 3D computer animation we designed.
6. The study was limited to the accuracy of the One-Way ANOVA Test in measuring the learning outcome of different perspective views.

7. The researcher could not provide the perfect experimental environment (without any interference, perfectly designed experimental materials) for the participants in this study.
8. The background, knowledge and experience of the participants about building construction might affect the test results in this study.

1.7 Delimitations

The following delimitations were innate in the pursuit of the project:

1. This study was defined as testing only for effect of different perspective views in educational 3D computer animation of students whose major is building construction management.
2. The study focused on the learning effect and preference of 3D computer animations that are rendered in first-person view and third-person view.
3. The study utilized the intervention competency testing and online survey to measure the learning efficiency and preference of different perspective views.

1.8 Definitions of Key Terms

The following terms were defined to assist the reader:

Computer animation: sequence of generating animated images by using computer-simulated graphics

3D – Three Dimension or Three Dimensional

Virtual reality: computer simulates physical presence in places in the real world or imagines computer-designed worlds.

Augmented reality: is a live view of an actual environment where elements are augmented (or supplemented) by computer-generated sensory input.

Perspective view: *“A view of a 3D world is the 2D projection of the world presented to the user. It is entirely defined by the camera’s location, angle, and field of view (FoV). A first-person view places the camera where the user’s eyes would be in the virtual environment. A third-person view moves the camera away from the object of control (e.g., the avatar or car), and often increases the angle of the camera to reduce occlusion”* (Bateman et al., 2011).

1.9 Summary

This chapter provided an overview of the current research study. It discussed the description of background, significance and the statement of purpose. Furthermore, research questions, assumptions, limitations and delimitations of the study were included in this chapter.

CHAPTER 2. LITERATURE REVIEW

As this thesis focuses on the effect of computer animations designed in different perspective views on student learning, this chapter proposes a literature review on computer animation in education (Section 2.1), computer animation in simulating construction process (Section 2.2) and the effect of different perspective views (Section 2.3). The review discusses the various types of developmental research, consensus and disagreement related to the topic, different development methods and methods for improvement.

2.1 Computer Animation for Education

It has been observed that computer animation provides certain benefits for learning (Mayer & Moreno, 2002). Computer animation has been used in many educational areas, such as biology, chemistry and construction. Many of those studies showed that computer animation technology yields certain improvement on learning outcome (Burke, Greenbowe, & Windschitl, 1998; Habbal & Harris, 1995; Sanger, Brecheisen, & Hynek, 2001).

In contrast, there has been evidence that animation provides little advantage for learning. For instance, although some researchers argued that animation could provide dynamic information, in reality, the quick graphical changes in visual display places greater demand on information processing (Lowe, 2003). In another study, Lih-Juan

(2000) showed that educational animations did not offer benefits for viewers because viewers may process the graphics information incorrectly. Similarly, Tversky, Morrison, and Betrancourt (2002) pointed out that, compared with static graphics, animation is so complex and fast that it is hard for users to conceive the meaning of the story.

To address the potential disadvantages of animation, researchers have proposed principles to guide the animation design process. For example, designers need to apply congruence principle and apprehension principle in designing animation. The congruence principle suggests that it is important to keep the content and format of the graphics corresponding to the content and format of the concepts to be conveyed. The apprehension principle suggests that it's important for graphics to be accurately perceived and appropriately conceived. So the animation should be slow, easy and clear for users to perceive and comprehend. In addition, the apprehension principle suggests that in order to let users apprehend animation easily and accurately, the designer should carefully craft animations with suitable speed and appropriate view and allow the user to change orientation, zoom in and out, stop and start (Tversky et al., 2002).

In conclusion, most of those researchers focus on designing interactivity for computer animation; some researchers proposed that the appropriate view will influence the effect of the animation, but none of them deeply focus on the perspective views (first-person and third-person) that computer animation is rendered from.

2.2 Simulating the Construction Process in Computer Animation

Kamat and Martinez (2000) is one of the earliest studies that used 3D animation technology to simulate the construction process. The researchers used a 3D text

file-driven visualization system to enable visualization of both the construction processes and the evolving products in 3D. It was shown that 3D animation technology has an advantage in visualization, such as increasing users' realism and concluding detailed statistical or charts information. In addition, the system helps the planner to make better decisions for construction.

Another test run by the author is Kamat and Martinez (2001). Researchers have indicated that, despite its great potential, 3D simulation tools developed for construction processes have been very limited. In Kamat and Martinez's study, they developed a simulation modeling system, called a Dynamic Construction Visualizer, to help in designing complex construction operations and decision making. They pointed out that 3D visualization can help construction operators to visualize and consider the subtleties in construction operation planning that are unlikely to be quantified in non-3D conditions. This Dynamic Construction Visualizer system enables construction operators to spatially and chronologically visualize construction operations and resulting products in 3D. Such realistic feedback allows operators to modify or redesign operation planning based on the visualization outcomes. Therefore, 3D visualization tools have the potential to facilitate the planning and analysis process in construction operation and management.

2.3 Effect of Different Perspective Views

“A view of a 3D world is the 2D projection of the world presented to the user. It is entirely defined by the camera's location, angle, and field of view (FoV). A first-person view places the camera where the user's eyes would be in the virtual environment. A

third-person view moves the camera away from the object of control, and often increases the angle of the camera to reduce occlusion” (Bateman et al., 2011).

The switch between first-person and third-person view usually involves the camera’s position and rotation of the center change. As a result, two different visibilities provide the viewer with two different types of experiences. (Rouse III, 1999).

Pazuchanics (2006) investigated two methods to increase operators’ performance of UGV(uninhabited ground vehicles). Typically, the camera on UGV only provides their operators with a very narrow field of view (FOV) and a first-person camera perspective. Research proposes that the narrow FOV and first-person view would make teleoperated navigation difficult. His study investigated two methods for providing an operator with additional contextual information: widening the FOV and capturing a third-person perspective of the vehicle in its environment. Findings showed that the additional information provided by either method can increase navigation performance. Of the two methods, widening the FOV produced the greatest performance benefit, however capturing a third-person perspective also facilitated certain aspects of navigation. The benefits associated with each method were found to be cumulative, and therefore ideal video displays may incorporate both methods.

According to Bateman et al. (2011), there was no significant effect of view perspectives on driving performance in a car racing game. This result contradicts the researchers’ expectation that the third-person views should be better in certain aspects (Pazuchanics, 2006). However Bateman’s discovery showed there was an effect on player’s preference. The participants preferred the first-person view and predicted that they could perform better with such view. This may be because first-person view

provides a better sense of player immersion (Rouse III, 1999). But in reality, the size of the image of the road is the main difference between the two views. The first-person view shows more road, while the third-person view shows more of the cars and surroundings. The rest is the same, which may be the reason that the performance in the two views is very close. In conclusion, third-person view is not always as good as people thought. Most of the time, it doesn't make a significant difference in performance compared with first-person view.

Salamin et al. (2006) examined whether it is beneficial for users to have the choice to switch from the first-person perspective to the third-person perspective in virtual and augmented reality. They asked participants to perform experiments in both views including: walking through a gallery with obstacles, putting a ball into a cup of coffee, receiving and sending a rolling ball with the feet and with the hands. Results showed that while some actions, such as looking down or hand manipulations (catching a close object) are performed better in first-person perspective, others, such as interaction with moving objects, require the third-person perspective. This is due to the fact that the third-person view offers a larger field of view, and therefore provides the user with more cues to evaluate the distances and anticipate or extrapolate the trajectory of mobile objects. As a conclusion, switching between different perspective views based on tasks would best increase participant's performance.

Salamin et al. (2010) also investigated the effects of training participants in the third-person and first-person perspectives in a ball-catching task in virtual reality. Participants performed five tasks: walking in a corridor, a slalom between pillars, evaluating distance of a wall in front of them, and playing football and basketball with

the first-person perspective and third-person perspective. Results showed that for a certain trajectory of the ball, participants who received the third-person perspective training performed similarly to their performance after baseline perspective training. However, participants who received first-person training performed significantly differently from both third-person and baseline perspectives. The researchers suggested that using third-person perspective in training and learning methods might be more effective as it facilitates performances and leads to quicker adaptation of distance evaluation in extra personal space.

Anquetil and Jeannerod (2007) examined subjects simulating a grasping action with either first- or third-person views. In one condition, participants simulated movement from the first-person perspective, while in the other condition they simulated the same movement from a third-person perspective. The time used to complete the movement was almost the same between the two conditions, and there was a similar difference in time between easy and difficult grasps between the two conditions. These results showed that first- and third-person views share the same representation, which can be used from different perspectives.

In general, researchers proposed that both first- and third-person perspective views are necessary under the majority of these scenarios and that it's very helpful for users to switch between two views. Different perspective views have certain effects, and the magnitude of this effect usually depends on the type of task. But most of the previous studies are focused on games, virtual reality or remote control where users actively interact with the simulation; little emphasis has been given to the effects of different perspective views in simulations where users are simply observers.

2.4 Summary

This section provided an overview of the literature in computer animation, simulated construction processes in 3D technology and the effect of different perspective views.

The majority of existing studies focused on the effects of perspective views in interactive gaming or virtual reality simulations. There has been a dearth of research on the efficacy of different perspective views in computer animation designed for educational settings.

This study intends to fill in this gap by developing a relevant test and design in a building construction management course to investigate this issue.

CHAPTER 3. FRAMEWORK AND METHODOLOGY

This chapter outlines the framework and methodology used in this study. The purpose of this chapter is to give a detailed description of the experiment procedures, data collection methods and analysis of quantitative methods applied to this research. It also includes the design of the experiment instrumentation.

3.1 Framework

The objective of this study was to investigate the effect of different perspective views in educational animations on students' learning of building construction management tasks and students' preference of perspective views. The study compared two types of computer animations: one was rendered using an egocentric perspective view (first-person view), and one rendered using an exocentric perspective view (third-person view). The animations presented to the participants were designed for an undergraduate course in building construction management (BCM175) -- Construction Materials and Methods. The content was identical to three chapters in course textbook and focused on tasks that a building construction manager needs to perform on a construction site.

Figure 1 Example screen shots of first-person view and third-person view.

Figure 1 shows frames extracted from both types of 3D computer animations.

The study used a quantitative approach and tested the hypotheses listed below. In instructional 3D computer animations for building construction management education:

H01: There is no difference in the learning effectiveness between first-person perspective view and third-person perspective view.

Ha1: There is a difference in the learning effectiveness between first-person and third-person perspective view.

H02: Users do not have preference on perspective view

Ha2: Users have preference on perspective view.

H03: The student preference of perspective view does not change based on the concepts/tasks being presented.

Ha3: The student preference of perspective view changes based on the concepts/tasks being presented.

In addition, the study also tested the following hypotheses to determine whether watching the animation, either first- or third-person view, had an effect on students learning:

Ha4: There is a difference in subject learning between students who watched the educational animation (first- or third-person view) and used the textbook and those who did not watch the animation and used the textbook.

H04: There is no difference in subject learning between students who watched the educational animation (first- or third-person view) and used the textbook and those who did not watch the animation and used the textbook.

For hypotheses 1 and 4, the learning objective considered by the study was the student's ability to demonstrate knowledge and understanding of the tasks that a building construction manager performs on a construction site (these tasks are listed in Appendix A). We measured this learning objective using pre- and post-educational intervention competency testing. The study included three independent variables: the first-person view 3D computer animation, the third-person view 3D computer animation, and the traditional textbook. The subjects were divided in three groups:

- Control group (1) -- exposed to textbook
- Experimental group (2) -- exposed to first-person view animation and textbook

- Experimental group (3) -- exposed to third-person view animation and textbook.

The dependent variables were the mean scores of the test in the three groups after the experiment. To test hypotheses 2 and 3, a survey including questions about the subjects' experience was administered to the students.

The experiment included two phases. In phase 1 the study collected data on students' preference and formative feedback on the animation. In phase 2 the study collected summative data on students' learning outcomes and also collected the preference and formative feedback.

3.2 Data Collection Procedure

Quantitative data is measured and expressed as numbers. The study used intervention competency testing to measure the effect and preference of different perspective views in educational 3D computer animation aspect. It was important to choose an appropriate sampling approach, sufficient sample size, and accurate data analysis. The data collections were performed once for each experiment phases.

3.2.1 Participants

Participants were selected from two building construction management courses (74 from BCM175 and 34 from BCM250) and age range around nineteen in the College of Technology, Purdue University. Most students from those courses participated in the experiment. Hypothesis 2 and 3 were tested on students from BCM250. All of the hypotheses were tested on student from BCM175.

3.2.2 Instrumentation

We used two 3D computer animations, an intervention competency testing and an online survey to measure the learning effect of different perspective views and preference.

3.2.2.1 3D Computer Animation

By referencing the course textbook, we used computer software, Autodesk Maya, to design the 3D computer animation. The animation basically demonstrated what the building construction manager needs to perform on the actual construction site during each level of the building construction. The processes in the animation were split up in to several parts, from starting of the foundation to the completion of the whole building construction. Three example images of the construction site are shown in Figure 2.

In order for users to view the richness of the animation, we rendered the 3D computer animation in full 1080P resolution (1920*1080). It keeps the animation in very good quality and offers a lot of details. Most of the character animations in the video are more slowly animated than the actual speed that building construction managers perform in the field. The reason for this is to allow users more time to view the movement and content in the animation so that users can memorize content better. (Tversky et al., 2002)

Sometimes, first-person views are too narrow. So we widened the field of view (FOV) a little bit for the first-person view. As Pazuchanics (2006) proposed, narrow field of view (FOV) would decrease the performance.

Figure 2 Example screen shots of several construction process scenes

The first-person view 3D computer animation can be accessed at:

<http://www.youtube.com/watch?v=g4gAlqJv9F4&feature=youtu.be>

The third-person view 3D computer animation can be accessed at:

<http://www.youtube.com/watch?v=kW7SAZllumo&feature=youtu.be>

The main task's frames extracted from the computer animation (both first-person view and third-person view) also could be accessed at: Appendix A.

3.2.2.2 Paper Test

The intervention competency testing was a seven-question quiz, which included six short essay/fill-in-the-blanks questions and one true or false question. This quiz focused on the “STEEL” part of the animation. It mainly asked about wide flange steel, a tension control bolt steel column that the character demonstrated in the computer animation. The full quiz can be accessed at: Appendix B.

When we designed the quiz, we did not choose questions that were exactly modeled and subtitled in the 3D computer animation. To avoid providing answers to students in experiment groups 2 and 3, all questions are related to both the animation and the course textbook.

Intervention competency testing also can be accessed at:

https://purdue.qualtrics.com/SE/?SID=SV_6rPM70AsLNp7fFj

3.2.2.3 Online Survey

Two online surveys (one for BCM175 and the other one for BCM250) were comprised of 19 multiple-choice questions and one open-ended question. The first question asked students whether the animation could have helped them learn the content more efficiently. The second question asked about their overall perspective view preference. The following 16 questions asked about perspective view preference (and prediction of learning more efficiently from this view) for each individual task simulated in the animation. The open-ended question prompted students for comments and suggestions for improvements.

Surveys for BCM250 and BCM175 are almost the same except for the introduction and the first question, which is also a very general question about the learning outcome of the 3D animation. Surveys for BCM250 and BCM175 can be accessed at: Appendix A.

3.2.3 Procedures

This experiment process included two phases. Phase 1 was to test hypotheses 2 and 3 on the students from BCM250. Phase 2 was to test all the hypotheses on the students from BCM175.

3.2.3.1 Phase 1

The objective of this phase was to test hypotheses 2 and 3 and collect formative feedback from 34 undergraduate students enrolled in a Building Construction Management program from course BCM250. All subjects had prior knowledge of the educational content (BCM 175) presented in the animation. Each subject was sent both 3D computer animation and survey links through email. Subjects had the option to play the animations as many times as they wanted. After watching the animations, the subjects completed the online survey and submitted their answers.

3.2.3.2 Phase 2

The objective of phase 2 was to test all of the hypotheses, but concentrating on hypotheses 1 and 4, using 66 students enrolled in a Building Construction Management undergraduate course, BCM175. All subjects were given a pre-test to assess their basic knowledge of the educational content. After the pre-test, a randomized complete block design was used to divide the subjects into three groups with similar pre-knowledge: (1) control group – traditional textbook; (2) experimental group – first-person view animation; and (3) experimental group –third person view animation. At the same time, 3D computer animations were sent to the experiment group through email. Group 2 interacted with the first-person view animation; Group 3 interacted with the third-person view animation; and group 1 can only reviewed the content using the textbook. The following two weeks, the class was given normal lectures and labs on the chapter. Students did the homework as usual. Two weeks later, all participants were administered a post-test that was identical to the pre-test in the lecture.

After the post-test, both first-person view and third-person view animations and the survey were sent to all three groups. Two experimental groups watched two different perspective views and switched between them on the same task to see if they had a different experience. Finally, all three groups completed the survey (same as the Phase 1 survey) to get their preference and experience of animations on both perspective views. The purpose of this part of experiment was to get more data to evaluate the hypotheses 2 and 3.

3.2.4 Statistical Data Analysis

In order to analyze the effect of different perspective views on students' learning, Two One-Way ANOVA tests were conducted to evaluate the effect of different perspective views. The main effects of three levels (first-person view, third-person view and textbook) and questionnaire results were analyzed to reveal significance.

3.3 Summary

This chapter provided an overview to the framework and methodology used in this study. It discussed the sampling approach, sample size, measurement, experiment procedure and instrumentation. The next chapter will focus on data collection and data analysis. In this chapter, researchers will test hypotheses and reveal the nature of the effect between first-person view and third-person view.

CHAPTER 4. FINDINGS AND DISCUSSION

4.1 Findings Phase 1

After watching the two types of 3D computer animations, 34 survey reports were collected from students in course BCM 250. Four survey reports were removed from the statistical analysis due to system error, duplicated submission or extreme random answers.

Findings (as shown in Figure 3) show that 67% of the subjects thought the animations were effective tools for learning the content. Results also show that participants have a preference on perspective view in computer animation. The distribution of the response for general preference shows that 20% of the participants prefer the first-person view, 73% of the participants prefer the third-person view, and 7% do not have a preference. In general, more than 90% of the participants have preferences in watching computer animation. Appendix C shows the distribution of all survey questions' responses.

Figure 3 First two question of the phase 1 survey's results.

Findings demonstrated that subjects' general preference on perspective view changes based on the type of task being simulated. For example, participants strongly preferred the first-person view when the task depicted in the animation is about checking the footing size and the location of anchor bolts (Question 2 and 3 in Appendix C, Bottom picture of Figure 1). Whereas users indicated stronger preference for the third-person view when the task focuses on verifying the top of beam elevations, checking the elevation at both ends of sloped beams, checking the vertical alignment of the wall after building CMU blocks and coordinating the anchor bolt layout with concrete pour schedule (Question 6 and 16 in Appendix C).

Figure 4 shows the distribution of students' choices of perspective views. Depending on test subjects' general preferences of perspective views, the data has been separated into three parts for each report. The blue section is number choosing first-person view. The orange section is the number choosing third-person view. The gray section is the number choosing no preference.

In the first- and third-view section, all the subjects indicated that they have preferences in general (Full results in Appendix D). However, we noticed that all of the subjects changed the preferences on perspective views for at least one of the following 16 independent tasks. The majority of them changed preferences in more than 30% of the tasks. Therefore, we can infer that all of the subjects' preferences of perspective views shift in response to different tasks presented in computer animation.

Figure 4 Example of several reports of survey's results distribution.

4.2 Discussion Phase 1

We observed that several participants indicated higher frequencies of preferred views that contradicted their preference (No.4, No.7, No.9, No.20, and No.28 in Appendix D).

A potential explanation is that some tasks in the video are similar. If these similar tasks happen to trigger the change of the preference, then we are likely to observe a higher number of preferred views that contradict subjects' general preferences, as in Question 13 and 14 as shown in Figure 6.

Figure 5 Checking the vertical alignment of the wall after building CMU blocks

The second question (Appendix C) shows that the third-person view is more popular among subjects. In the open-ended questions, the test subjects said that the third-person view gives a full view of the environment; they can see everything the person is doing in the video, as in Figure 5. The third-person view is really good for tasks that need larger pictures where the detail is less important than understanding the space and the configuration of the system.

Some participants commented that the first-person view is too magnified. A few got confused when they watched the first-person view, but there are still about 20% of the test subjects who prefer the first-person view in general.

Figure 6 Question 13 & 14

There are several similar situations where subjects preferred first-person view. Tasks such as Question 2, 3 and 10 that show the use of drawings and zooms of details are reserved for the first-person view. This is likely due to the advantage of the magnified first view that will make user more focused on the core content of the animation. In other words, users will prefer first view when the environment is not relevant and users have to look at a more focused target in the animation.

Questions 13 and 14 as shown in Figure 6 show the less irrelevant influence of the environment; the task being presented does not have to focus on the small object or details. In this situation, the number of users who prefer the first view is very close to the third view.

One participant commented that the third-person view is very helpful to students who are inexperienced as it provides an “effective overview of the construction site and puts the various activities into context.”

In general, users preferred the first-person view when the environment is not relevant and the simulated task requires focusing on a small object/detail. In contrast, the third-person view is preferred for tasks that require understanding of the environment or of a larger system/area.

4.3 Findings Phase 2

The pre-test was given to 66 participants before the chapter was taught. As the students had not learned the chapter, the average score of the test was only about 16.7%.

After the pre-test, a randomized complete block design was used to divide the students into three groups with similar pre-test average scores: (1) control group, average score 16.82% — only review traditional textbook during the next week lecture; (2) experimental group, average score 16.59% — was sent the first-person view animation; and (3) experimental group, average score 16.82% — was sent the third-person view animation.

During the next few lectures and labs, professors gave normal lectures. The students read books and finished assignments as usual. Additionally, the students in Group 2 and Group 3 could watch animations.

During a span of two weeks, participants attended four lectures and two lab sessions that covered materials presented in the chapter. Afterwards, all participants were given a post-test that was identical to the pre-test.

Two One-way ANOVA tests were performed to compare the differences in pre-test and post-test scores for each group. Ten students missed the post-test (eight from Group 1, one from Group 2 and one from Group 3), so their post-test data was discarded.

Table 1 Descriptive statistics for pre- and post-test

Descriptives									
		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimu m	Maximu m
						Lower Bound	Upper Bound		
PreTest	1	22	.1682	.07487	.01596	.1350	.2014	.05	.30
	2	22	.1659	.09308	.01984	.1246	.2072	.00	.40
	3	22	.1682	.07799	.01663	.1336	.2028	.00	.30
	Total	66	.1674	.08109	.00998	.1475	.1874	.00	.40
PostTest	1	14	.3429	.10535	.02816	.2820	.4037	.15	.50
	2	21	.3833	.08266	.01804	.3457	.4210	.20	.55
	3	21	.3857	.10385	.02266	.3384	.4330	.20	.60
	Total	56	.3741	.09676	.01293	.3482	.4000	.15	.60

Table 2 Results of ANOVA analysis for pre- and post-test among three groups

ANOVA						
		Sum of	df	Mean Square	F	Sig.
		Squares				
PreTest	Between Groups	.000	2	.000	.006	.994
	Within Groups	.427	63	.007		
	Total	.427	65			
PostTest	Between Groups	.018	2	.009	.976	.384
	Within Groups	.497	53	.009		
	Total	.515	55			

Results showed that that difference between the control and the experimental group in the pre-test is not statistically significant ($F_{(2, 63)} = 0.006$, $p > .05$, M (Group 1) =0.1682 SD (Group 1) =0.07487; M (Group 2) =0.1659; SD (Group 2) =0.09308; M (Group 3) =0.1682; SD (Group 3) =0.7799 ;). See table 1 for descriptive statistics and Table 2 for results of ANOVA analysis.

Figure 7 Pre-test and Post-test average percentage score

Results (as shown in Figure 7) show that attending the lecture and watching the animation (first or third person) led to an increase in subject content learning by 4.28 % and 4.27% respectively, compared to the control group. Group 1 (control) post-test scores increased by 17.47% from pre-test. Experimental group 2 (first person) post-test scores increased by 21.74%, while for Experimental group 3 (third person), the increase was 21.75%.

Results show that the difference in learning gains between the two experimental groups is not statistically significant. They also show that the difference in total learning gains between the control and the experimental groups is not statistically significant ($F(2, 53) = 0.976, p > .05$; $M(\text{Group 1}) = 0.3429$ $SD(\text{Group 1}) = 0.10535$; $M(\text{Group 2}) = 0.3833$; $SD(\text{Group 2}) = 0.08266$; $M(\text{Group 3}) = 0.3857$; $SD(\text{Group 3}) = 0.10385$;). Table 1 shows a summary of results.

In summary, perspective view did not have an effect on students' learning outcomes, although students had expressed a preference for third-person view and had predicted to learn more from this view.

After the post-test, two types of computer animations and a survey were sent to three groups. There were 66 survey reports were collected. Seven reports were removed from the statistical analysis due to system error, extreme random answers and duplicate submissions. There were only 59 survey reports include in data analysis.

Findings (as shown in Figure 8) show that 40% of the subjects thought the animations are effective tools for learning the content. Results also show that participants have a preference on perspective view in computer animation. The distribution of the response for general preference shows that 19% of the participants prefer the first-person view, 68% of the participants prefer the third-person view, and 14% do not have a preference. In general, 87% of the participants have preferences in watching computer animation. The results are very close to the Phase 1 study. Appendix E is the distribution of all responses for Phase 2 study.

Figure 8 First two question of the phase 2 survey's results.

Findings also demonstrated that subjects' general preference on perspective view changed based on the type of task being simulated. During this phase, two experiment

groups have watched their type of animation during the experiment respectively, which we initially worried may influence their preference for different perspective views. In the findings, we did not find a huge view preference difference compare to the phase 1 experiment. Similar to findings from Phase 1, participants strongly preferred first-person view when the task depicted in the animation is about checking footing size and location of anchor bolts. Similarly, users showed stronger preference for the third-person view when the task focuses on verifying the top of beam elevations, checking the elevation at both ends of sloped beams, checking the vertical alignment of the wall after building CMU blocks and coordinating the anchor bolt layout with concrete pour schedule (Appendix E). The 16 questions' preference distribution was very similar to that of phase 1.

Figure 9 shows the comparison of number of choices among first, third and none for all of 16 independent tasks in the survey for parts of the reports (Full reports see Appendix F). However, we noticed that there are only four reports that showed the subject did not change the preference of perspective views for all of the 16 independent tasks. All the other 51 subjects changed preferences on perspective views at least once. Therefore, we can still infer that all of the subjects' preferences of perspective views shifted in response to different tasks presented in computer animation.

Figure 9 Example of several reports of results distribution.

4.4 Discussion Phase 2

The analysis showed that in the post-test, there was no significant difference among participants assigned to the three conditions, $p > 0.05$.

Having access to the 3D computer animation (either first or third views) did not result in a significant difference between the control group and experiment groups. As shown in phase 1 of the study, students wished to watch animations for class, and they thought they were helpful study tools (Figure 3), but the results from phase 2 (Figure 8) showed that computer animation doesn't seem to make an obvious improvement in students' grades.

We can make several assumptions based on these test results.

1. The computer animation was designed to correlate with several chapters in the textbook. The test covered only one chapter. There were not enough questions on the test to generate a significant result.
2. The way the course is constructed is highly dependent on the instructor. Most post-test scores were not high. So the instructor may not have placed emphasis on content covered by the computer animation we designed. As a result, the students in experiment groups did not make a strong connection between the animation and lecture.
4. There were eight students who missed the post-test, and the number of subjects decreased from 22 to 14, which may cause issues for the One-Way ANOVA statistical analysis.
5. As the goal of the study was to test the learning effect of different perspective views, we purposely categorized the design of 3D computer animation into first-person

view and third-person views. The single view animation may not maximize learning benefits for students.

6. As computer animation is about graphical images, it may help students with real-life experience and practical skills rather than paper exams.

7. There are nuances in presenting knowledge in static versus 3D imagery formats. Some students may not be able to establish the connection between book content and computer animation. So we may have to design a better animation following the Congruence Principle (Tversky, 2002).

Most students preferred the third view. Our expectations were that the third-person views would generate a better learning outcome. But we did not find a significant outcome difference as a result of watching animations of the two different perspective views.

This part of the experiment mainly tests the H01/Ha1. There is no significant difference in the learning effectiveness between first-person view and third-person view. Though most students preferred third-person view, their learning outcome did not show greater improvement than first-person view. So there is no obvious correlation between the learning effectiveness of a specific perspective and concept/task being presented in computer animation.

We propose several test methods for future studies on different perspective views:

1. Let the researchers enroll in the course used in the study so the researcher would have better understanding of course content and design better computer animation associated with course content.

2. More computer animations are needed for the course content. If possible, use all the content included in the course book chapter to design computer animation. Also, more questions for the paper test and test subjects are needed for this study in order to generate results with significant difference.
3. One more experiment group is needed. This group will be exposed to both first-person and third-person view animation and evaluate the learning effect compared to the other experiment and control groups.
4. Instead of a paper test, let test subjects go to a construction site and perform actual tasks, then evaluate their performance. Perspective views may show more obvious effects on interactive tests.

We also propose ways to improve 3D animation design from the perspective of first- or third-person views:

1. Regardless of the environment, start the computer animation from the third-person view for all tasks; the wide third-person view will give users a general idea about the environment and task.
2. After showing the third-person view, show the same task in first-person view again if the task requires focus on detail or small objects.
3. Increasing the field of view will decrease the narrow feeling of the first-person view.

4.5 Summary

This chapter provided an overview of the findings and discussion in this study. It included the data findings for the test and discussion of the data analysis.

CHAPTER 5. CONCLUSION

This chapter mainly discusses the conclusion and proposes future work. Section 5.1 briefly provides a summary of the study methods, procedure and discussion of the findings of the research. The future work of this study is discussed in Section 5.2.

5.1 Conclusion

In this paper, we have explored the effect of perspective view in educational animations on students' learning of building construction management tasks and on students' preference. We conducted the pre-test and post-test and found no significant advantages for computer animation of different perspective views across three different groups. Results show that students have a preference on perspective view, however perspective view does not influence learning outcomes. The study also investigated the efficacy of animation as a teaching/learning tool. Findings show that animation led to higher learning gains than traditional teaching/learning methods, although the difference in learning was not statistically significant in this study. This finding adds to the body of research that suggests that animation can be an effective educational approach.

5.2 Future Work

Our study had several main limitations: a relatively small sample size, short 3D computer animation and few test questions. Because of the limited number of participants

and test materials, we cannot generalize the results and we can only suggest that perspective view does not have an influence on students' learning in educational animations. In order to build stronger evidence, additional studies with larger pools of participants, longer computer animation and more test questions in different subject domains and in different settings will need to be conducted.

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LIST OF REFERENCES

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APPENDICES

Appendix A Survey

After watching the animation about building construction management, which is related to the course content covered in BCM 175, please provide your response for the following questions.

If you had watched this computer animation last semester, would your learning have been improved?

- ☐ Yes
- ☐ No
- ☐ Not sure

After watching the animation about building construction management, which is related to the course content covered in BCM 175, please provide your response for the following questions.

Do you feel you have improved your grade by watching this computer animation this semester?

- ☐ Yes
- ☐ No
- ☐ Not sure

In general, which perspective view do you prefer to watch in this computer animation?

- ☐ First Person View
- ☐ Third Person view

- ☐ No preference

First person view

Third person view

The two pictures above are the two perspective views of the same task---Coordinate the anchor bolt layout with concrete pour schedule. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---Check footing size and location of anchor bolts. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---Check footing size. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---Establish anchor bolt survey requirements and verify elevation of anchor bolt. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

The two pictures above are the two perspective views of the same task---Check the typical details (in the floor slab or steel supports beneath the opening) for additional reinforcing for openings. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

The two pictures above are the two perspective views of the same task---Verify top of beam elevations and check elevation at both ends of sloped beams. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---Materials must be properly handled stored and prepared. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---Units must be laid with full head and bed joints, joints must be tooled properly. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---CMU alignment, CMU color inspect units and the mortar, texture of the units, check pattern by the type of bond and the unit. . Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---Materials must be properly handled stored and prepared, check walls' layout and openings location. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---If steel is to be fireproofed, inspect thickness of fireproofing material. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---Check location of expansion joints and make sure they are properly caulked. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

The two pictures above are the two perspective views of the same task---Check joints are tooled and finished properly. Example showing Concave joints. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

The two pictures above are the two perspective views of the same task---Check joints are tooled and finished properly. Example showing Vee joints. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---Checking joints are tooled and finished properly. Example showing Weathered joints. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person View
- ☐ The same

First person view

Third person view

The two pictures above are the two perspective views of the same task---checking the vertical alignment of the wall after building CMU blocks. Which of these two perspective views help you understand the task better?

- ☐ First person view
- ☐ Third person view
- ☐ The same

Regardless of your preference that you indicated in the last question, how would combining two different views (first person view and third person view) benefit your learning?

- ☐ Every task uses both person views
- ☐ Some task use both views, some use first person view, the others use third person view.
- ☐ Some task use first person view, others use third person view.
- ☐ No need to use both views, just use the one you prefer.

Beside the question above, do you have any other thoughts about your learning experience on first and third person views?

Appendix B Quiz

BCM 175

Quiz: STEEL

Q-1 A W21x83 wide flange steel, what does the 21 stand for and what does the 83 stand for?

Q-2 What is a tension control bolt, and what is the main advantage of using such a system?

Q-3 What is the difference between a bolted connection and a welded connection?

Q-4 Why grout is used at the base of a steel column?

Q-5 Identify the various components of the steel column connection, use the pointers to identify the various connection components. (Four in total)

Q-6 List three methods to fire proof a steel column.

Q-7 The steel compressive strength is equal to the steel tensile strength.

(Circle the correct answer) True False

Appendix C Distribution of phase 1 survey responses

Question	Yes	No	Not Sure
estimated learning effects on performance	67%	10%	23%
	1.	2.	3.
	First-Person View	Third-Person View	No View Preference
General preference	20%	73%	7%
1. Coordinate the anchor bolt layout with concrete pour schedule.	30%	67%	3%
2. Check footing size and location of anchor bolts.	73%	24%	3%
3. Check footing size.	70%	20%	10%
4. Establish anchor bolt survey requirements and verify elevation of anchor bolt.	33%	60%	7%
5. Check the typical details (in the floor slab or steel supports beneath the opening) for additional reinforcing for opening.	30%	60%	10%
6. Verify top of beam elevations	13%	74%	13%

and check elevation at both ends of sloped beams.			
7. Materials must be properly handled, stored and prepared.	30%	53%	17%
8. Units must be laid with full head and bed joints; joints must be tooled properly.	27%	56%	17%
9. CMU alignment, CMU color inspect units and the mortar, texture of the units, check pattern by the type of bond and the unit.	40%	50%	10%
10. Materials must be properly handled, stored and prepared, check walls' layout and openings location.	50%	37%	13%
11. If steel is to be fireproofed, inspect thickness of fireproofing material.	43%	43%	14%
12. Check location of expansion joints and make sure they are properly caulked.	23%	60%	17%
13. Check joints are tooled and finished properly. Example showing	37%	33%	30%

Concave joints.

14. Check joints are tooled and finished properly.	47%	33%	20%
15. Checking joints are tooled and finished properly.	37%	53%	10%
16. Checking the vertical alignment of the wall after building CMU blocks.	23%	77%	0%

Appendix D Distribution of phase 1 survey views preference comparison

Heading level	Test	The comparison
	Subject Number	of choice:
		First versus Third
		versus No Preference
First view section:	No. 1	12:4:0
Subjects who prefer	No. 2	12:4:0
first-person view in general	No. 3	9:1:6
	No. 4	6:8:2
	No. 5	8:8:0
	No. 6	10:3:3
Third View	No. 7	11:5:0
Section:	No. 8	4:8:4
Subjects who	No. 9	7:3:6
prefer third-person view	No. 10	3:13:0
in general	No. 11	8:8:0
	No. 12	1:15:0
	No. 13	4:12:0
	No. 14	6:10:0
	No. 15	1:13:2
	No. 16	6:10:0

	No. 17	2:12:2
	No. 18	2:5:9
	No. 19	7:9:0
	No. 20	8:7:1
	No. 21	3:8:5
	No. 22	5:11:0
	No. 23	5:11:0
	No. 24	6:10:0
	No. 25	6:10:0
	No. 26	3:7:6
	No. 27	9:7:0
	No. 28	8:8:0
No preference	No. 29	3:8:5
section:	No. 30	7:9:0
Subjects who		
don't have view		
preference in computer		
animation.		

Appendix E Distribution of phase 2 survey responses

Question	Yes	No	Not Sure
estimated learning effects on 3D	40%	30%	40%

computer animation

	1.First Person View	2.Third Person View	3.No Preference
General preference	19%	68%	14%
1. Coordinate the anchor bolt layout with concrete pour schedule.	28%	60%	12%
2. Check footing size and location of anchor bolts.	66%	24%	10%
3. Check footing size.	60%	26%	14%
4. Establish anchor bolt survey requirements and verify elevation of anchor bolt.	15%	69%	15%
5. Check the typical details (in the floor slab or steel supports beneath the opening) for additional reinforcing for opening.	32%	53%	15%
6. Verify top of beam elevations and check elevation at both ends of sloped beams.	15%	73%	12%
7. Materials must be properly handled, stored and prepared.	36%	44%	20%
8. Units must be laid with full head	39%	47%	14%

and bed joints; joints must be tooled properly.

9. CMU alignment, CMU color	32%	54%	14%
inspect units and the mortar, texture of the units, check pattern by the type of bond and the unit.			
10. Materials must be properly handled, stored and prepared, check walls' layout and openings location.	51%	27%	22%
11. If steel is to be fireproofed, inspect thickness of fireproofing material.	51%	44%	05%
12. Check location of expansion joints and make sure they are properly caulked.	16%	69%	12%
13. Check joints are tooled and finished properly. Example showing Concave joints.	34%	49%	17%
14. Check joints are tooled and finished properly.	36%	46%	19%
15. Checking joints are tooled and finished properly.	36%	42%	22%

16. Checking the vertical alignment of the wall after building CMU blocks.	22%	64%	14%
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Appendix F Distribution of phase 2 survey views preference comparison

Heading level	Test	The comparison of		
	Subject	choice:		
	Number	First	Third	No
				Prefer ence
First view section:	No. 1	11	0	5
Subjects who prefer first-person view in general	No. 2	7	8	1
	No. 3	8	6	2
	No. 4	9	7	0
	No. 5	7	1	8
	No. 6	11	5	0
	No. 7	16	0	0
	No. 8	6	2	8
	No. 9	10	5	1
	No. 10	7	8	1
	No. 11	5	3	8
Third View	No. 12	7	9	0
Section:	No. 13	9	7	0
Subjects who	No. 14	4	8	4
prefer third-person view	No. 15	2	7	6

in general	No. 16	2	11	3
	No. 17	5	11	0
	No. 18	9	7	0
	No. 19	0	7	9
	No. 20	6	10	0
	No. 21	6	10	0
	No. 22	12	4	0
	No. 23	7	8	0
	No. 24	4	12	0
	No. 25	9	7	0
	No. 26	6	10	0
	No. 27	4	12	0
	No. 28	7	7	2
	No. 29	8	8	0
	No. 30	13	3	0
	No. 31	0	16	0
	No. 32	3	13	0
	No. 33	0	16	0
	No. 34	8	2	6
	No. 35	6	10	0
	No. 36	6	9	1
	No. 37	1	15	0

	No. 38	5	7	4
	No. 39	5	7	4
	No. 40	5	11	0
	No. 41	6	8	2
	No. 42	4	12	0
	No. 43	0	16	0
	No. 44	1	15	0
	No. 45	8	3	5
	No. 46	5	11	0
	No. 47	10	6	0
	No. 48	4	12	0
	No. 49	8	7	1
	No. 50	4	12	0
	No. 51	8	8	0
<hr/>				
No preference	No. 52	4	10	2
section:	No. 53	4	12	0
Subjects who	No. 54	0	0	16
don't have view	No. 55	0	0	16
preference in 3D	No. 56	7	1	8
computer animation.	No. 57	2	6	8
	No. 58	3	8	5
	No. 59	2	11	3