Computer Animation for Learning Building Construction Management: A Comparative Study of First Person Versus Third Person View

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Abstract. The paper reports a study that investigated the effect of egocentric versus exocentric view in an educational animation whose goal was to teach undergraduate students the various tasks that a construction manager performs in the field. Specifically, the study aimed to determine the effect of perspective view on students' subject learning and preference. Findings show that while students have a preference on perspective view, the perspective view does not have a significant effect on students' learning outcomes.

Keywords: Educational animation · Egocentric view · Exocentric view

1 Introduction

Several studies found in the literature suggest that 3D computer animation can be an effective educational approach [1–4]. In most 3D animations, scenarios are presented in either first- or third-person 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, and often increases the angle of the camera to reduce occlusion*" [5]. In animations where a character performs a sequence of tasks, either view can be used. 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 the third-person view the camera is placed beside the character and the animation is rendered as if a third person is observing what the character is doing.

While several studies can be found in the literature on the effect of perspective view on user performance/preference in interactive games and simulations, to our knowledge, no study exists on the effect of perspective view in educational animations. The work reported in the paper aims to fill this gap; it investigated the effect of egocentric versus exocentric view in an educational animation whose goal was to teach undergraduate

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students the various tasks that a construction manager performs in the field. Specifically, the study aimed to determine the effect of perspective view on students' subject learning and students' preference.

2 Existing Studies on the Effects of Different Perspective Views

Researchers have studied the effect of different perspective views in games and interactive simulations. A change in perspective view in a game/interactive simulation usually involves a change in the position and rotation of the center of the camera. In addition to visibility changes, a different perspective view provides the viewer with a different type of experience (e.g. more or less immersive) [6].

A study by Bateman et al. [5], shows that while there was no significant effect of perspective view on player's driving performance in a car racing game, there was an effect on player's preference. In Bateman's test, participants preferred the first-person view and predicted that they could perform better with such view. This may be because first a-person view provides a better sense of player immersion [6].

Salamin et al. [7] examined whether it is beneficial for users to have the choice to switch from first-person to third-person perspective in virtual and augmented reality environments. They asked participants to perform various tasks 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 a third-person perspective. This is due to the fact that a 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.

Salamin et al. [8] also conducted a study whose goal was to quantify the differences between the effects induced by training participants to the third-person and first-person perspectives in a ball catching task in virtual reality. Results of the experiment showed that for a certain trajectory of the ball, the performance of the participants after training to the third person perspective was similar to their performance after baseline perspective training. Performance after first person training varied significantly from both third person and baseline perspectives. The researchers concluded that usage of the third person perspective in training and learning methods might prove to be more effective as it facilitates performances and leads to quicker adaptation of distance evaluation in the extra personal space.

Anquetil and Jeannerod [9] conducted a study in which subjects simulated a grasping action with two levels of difficulty. In one condition, they simulated the movement from their own, first person perspective, while in the other condition they simulated the same movement made by a person facing them (third person perspective). The time to complete the movement was found to be almost the same in the two conditions and a similar difference in time between easy and difficult grasps was retained in the two conditions. These results show that a self-generated and an observed action share the same representation and this representation can be used from different perspectives.

Pazuchanics [10] investigated two methods to increase UGV (uninhabited ground vehicles) operators' performance. Typically, UGV cameras provide their operators with a very narrow, field of view (FOV) and a first-person camera perspective. 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 show 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 may also facilitate certain aspects of navigation. The benefits associated with each method were found to be cumulative and therefore ideal video displays may incorporate both methods.

3 Description of Study

The objective of this study was to investigate the effect of different perspective views, in educational 3D animations, on students' learning of building construction management tasks, and students' preference. The study compared two types of computer animations: one rendered using an egocentric perspective view, and one rendered using an exocentric perspective view. The animations presented to the participants were designed for an undergraduate course in building construction management. The content was identical and focused on the tasks that a building construction manager needs to perform on a construction site. The first person view animation can be accessed at:

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

The third person view animation can be accessed at:

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

Figure 1 shows frames extracted from both animations.

The study used a quantitative approach and tested the hypotheses listed below.

In instructional 3D animations for building construction management education:

H01: There is no difference in the learning effect 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: There is no correlation between the learning effectiveness of a specific perspective view and concept/task being presented
Ha2: There is a correlation between the learning effectiveness of a specific perspective view and concept/task being presented
H03: Users do not have preference on perspective view
Ha3: Users have preference on perspective view
H04: The student preference of perspective view does not change based on the concepts/tasks being presented
Ha4: 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:

Ha5: There is a difference in subject learning between students who watched the educational animation (first or third person view) and those who did not watch the animation and used the textbook

H05: There is no difference in subject learning between students who watched the educational animation (first or third person view) and those who did not watch the animation and used the textbook

For hypotheses 1, 2 and 5, 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 the left column of Table 1). We measured this learning objective using pre and post educational intervention competency testing. The study included three independent variables: the first-person view animation, the third-person view animation, and the traditional textbook. The subjects were divided in three groups: control group (1)–exposed to text book, experimental group (2)–exposed to first-person view animation, and experimental group (3)–exposed to third-person view animation. The dependent variables were the mean scores of the test in the three groups after the experiment.

To test hypotheses 4 and 5, 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.

3.1 Phase 1

The objective of phase 1 was to test hypotheses 3 and 4 and collect formative feedback.

Subjects: 34 undergraduate students enrolled in a Building Construction Management program. All subjects had prior knowledge of the educational content presented in the animation.

Testing instrument: An online survey comprised of 19 multiple-choice questions and 1 open-ended question. The first question asked the 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.

Procedure: Each subject sat in front of a monitor displaying the two animations side by side (as shown is Fig. 1). 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.

Findings and discussion: Findings show that 67 % 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 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. Findings demonstrate that subjects' 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. 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.

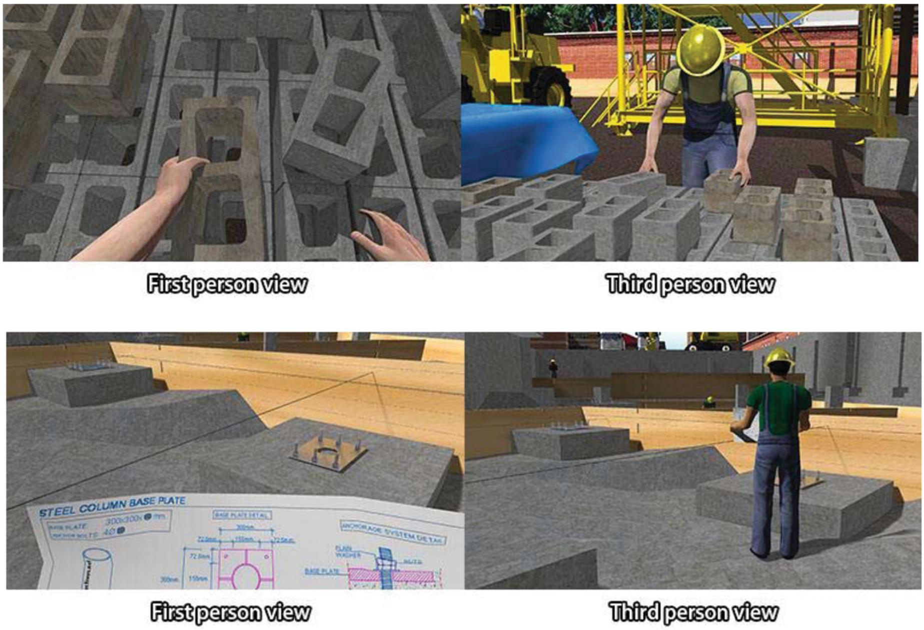

Fig. 1. Example screen shot of first person view and third view.

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. 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.*" A summary of results is included in Table 1.

Table 1. Findings from the survey on perspective view preference

Question	Yes	No	Not Sure
Watching the animations would have helped me learn the content	67 %	10 %	23 %
	1.First person view %	2.Third person view %	3.No preference %
Overall preference of perspective view	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 and check elevation at both ends of sloped beams	13	74	13
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	23	63	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 Concave joints	37	33	30
14. Check joints are tooled and finished properly. Example showing weathered joints	47	33	20
15. Checking joints are tooled and finished properly. Example showing V shape joints	37	53	10
16. Checking the vertical alignment of the wall after building CMU blocks	23	77	0

3.2 Phase 2

The objective of phase 2 was to test hypotheses 1, 2 and 5.

Subjects: 66 students enrolled in a Building Construction Management undergraduate course.

Testing instruments: a 7-question test including 6 short essay questions and 1 true/false question. The test focused on the "STEEL" part of the animation, e.g. tasks 1- 6 and 11 listed in the left column of Table 1.

Procedure: 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: control group (1) – traditional textbook; experimental group (2) – first person view animation, and experimental group (3) – third person view animation. One week after the pre-test all students were given a 45-min lecture on the content. One week after the lecture, group 2 interacted with the first person view animation for 30 min in the lab; group 3 interacted with the third person view animation for 30 min in the lab; and group 1 reviewed the content using the textbook for 30 min. Two weeks later, all participants were administered a post-test which was identical to the pre-test.

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

Results show that attending the lecture and watching the animation (1st or 3rd person) led to an increase in subject content learning by 4.28 % and 4.27 % respectively, compared to the control group. Group 1 (control)'s post-test score increased by

Table 2. Summary of findings

		N	Mean	Std. deviation	Std. error	95 % Confidence Interval for mean		Minimum	Maximum
						Lower Bound	Upper Bound		
PreTest	1	22	0.1682	0.07487	0.01596	0.1350	0.2014	0.05	0.30
	2	22	0.1659	0.09308	0.01984	0.1246	0.2072	0.00	0.40
	3	22	0.1682	0.07799	0.01663	0.1336	0.2028	0.00	0.30
	Total	66	0.1674	0.08109	0.00998	0.1475	0.1874	0.00	0.40
PostTest	1	14	0.3429	0.10535	0.02816	0.2820	0.4037	0.15	0.50
	2	21	0.3833	0.08266	0.01804	0.3457	0.4210	0.20	0.55
	3	21	0.3857	0.10385	0.02266	0.3384	0.4330	0.20	0.60
	Total	56	0.3741	0.09676	0.01293	0.3482	0.4000	0.15	0.60

ANOVA

		Sum of Squares	Df	Mean Square	F	Sig
PreTest	Between groups	0.000	2	0.000	0.006	0.994
	Within groups	0.427	63	0.007		
	Total	0.427	65			
PostTest	Between groups	0.018	2	0.009	0.976	0.384
	Within groups	0.497	53	0.009		
	Total	0.515	55			

17.47 % from pre-test. Experimental group 2 (1st person) post-test score increased by 21.74 %, while for group 3 (third person), the increase was of 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 ($F(2, 53) = 0.976$, $p > 0.05$; M (Group 1) = 0.3429 SD (Group 1) = 0.10535; M (Group 2) = 0.3833; SD (Group 2) = 0.08266; M (Group 3) = 0.3857; SD (Group 3) = 0.10385;). Table 2 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 for 5 out of the 7 tasks relevant to the test.

4 Discussion and 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. 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.

Our study had one main limitation: a relatively small sample size. Because of the limited number of participants, 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, in different subject domains and in different settings will need to be conducted.

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