Integration of Blender 3D in Basic Computer Graphics Course
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Abstract: Students find Computer Graphics concepts of transformations difficult to visualize. Using Blender 3D, we developed a three-hour training module on solving transformations problems. Students found this training module beneficial to visualize and solve these problems.

Keywords: Blender 3D, computer graphics, think aloud, transformations

1. Introduction and related work

Computer graphics (CG) is an important component of computer science curriculum. Many students who study this subject face the difficulty in understanding the basic CG concepts (He & Zhao, 2010). Major difficulty is in visualizing the concepts, such as three dimensional transformations. Methodology for teaching these concepts varies from teacher to teacher. Traditional strategies like drawings, verbal explanations and supportive hand gestures are commonly used for teaching these CG concepts. Apart from these, computer based training (CBT) is also found to be useful (Yuan, 2010; Divjak, 2004, Luiz, 2002). Since, in most cases, the software used for CBT is proprietary, the implementation is resource intensive and has limited reach. The methodology which integrates open source software is desirable.

In this paper we present one such methodology for teaching transformations in CG using open source tool Blender. Blender is a free open source 3D content creation suite, available for all major operating systems under the GNU General Public License (Blender website, 2013). Blender has been used for the educational purposes, primarily because it is open source and offers high quality 3D visuals (Gumster, 2003), in domains like biology (Andrei 2012, Callieri, Marco, et al. 2010), computer science (Mustaro, 2011), chemical and physics lab experiments (Sahasrabudhe, 2009, Dere, 2010). We used Blender to study the improvement of mental rotation ability of engineering students (Kadam, et al. 2012).

The objective of this study is to evaluate the effect of Blender training module in learning and solving transformation problems in CG. This is operationalized into following research questions:

1. How do students use Blender to visualize transformation concept in CG?
2. Does Blender training module motivate students to learn CG concepts?

In order to address our objectives we have developed a three-hour training module for teaching CG concept using Blender. We use think-aloud method to capture students’ behaviour across time spent to solve CG problems. We also conduct interviews to capture their motivation of using Blender and learning CG. Analysis of these qualitative results suggests that, students benefit from training module procedure to visualize and understand transformations. During the interviews, students mention about getting motivated towards learning CG.

2. Treatment details

The treatment comprised of a four hour Blender workshop, and a problem solving test. The focus was to teach transformations topic from basic CG course. We trained 22 first year masters students to perform 2D as well as 3D transformations in Blender such as, translation, scaling and rotation along different axis and from different views. Blender features used to perform these transformations were 3D viewport, keyboard shortcuts, multiple views and transform properties. After training we administered a post-test, based on composition of 3D transformations problem, that student had to solve using Blender.
The aim was to investigate the problem solving trends of students, rather than the correct/incorrect answer to the problem. Think aloud protocol was used during the post-test. After the post-test + think aloud, an interview was also administered.

3. Research Methodology

Sample consisted of 22 undergraduate students from second year masters course from a college in Goa University in India. We randomly selected 6 students for the think-aloud method, followed by an interview. Think-aloud was the main data collection method, and was supported by a screen capture (of the students solving the problems and participating in the think-aloud). Qualitative method of think aloud protocol was chosen to bring out the details of the trends and the patterns of students’ behavior (Ericsson & Simon, 1993). The students were asked to constantly narrate their thoughts, while the events were being performed. Two observers studied the events of the actions performed by the students. The entire proceedings were audio-video taped and, the computer screens of the students were captured to support the student narratives. Interview was administered to augment the data of think-aloud and screen capture.

3.1 Data analysis procedure

Qualitative data of the think aloud method is analyzed by categorizing it in terms of time, occurrences, and individual performance of the students. Coding scheme is created to identify behaviours from the overall events of occurrence. Patterns are created and represented in graphs. Behavioral variables are the actions performed to solve the transformations problems. These are: 1. Read / understand. 2. Perform sequence of transformations: the sequence is important, since a wrong sequence leads to incorrect answer in the end. 3. Observe final state: helps in finalizing the answer. 4. Compare two compositions: understanding the student’s behaviour of checking in between the process. It can avoid time wastage on wrong steps. 5. Perform recheck: could help the users to avoid wrong answer being submitted as right answer, and save time.

4. Results and analysis

The primary source of data is transcripts of think-aloud method across time, and the screen capture during the post test. Figure 1 shows the sequence of occurrences of actions/behaviours across time for individual student. In this representation, the students’ behaviour is compared with instructor’s solution approach (shown in the last row).

![Figure 1. Sequence of occurrences of behaviours and actions performed by students, across time.](image-url)
X axis represents the timeline, while the students are placed on the Y axis. It shows the solution approach, time taken to solve the problem, time spent on each behavior and the differences in pattern of successful and unsuccessful students.

5. Discussion

The students with correct solution have behaviour identical to the instructor’s approach. The behaviour of students with incorrect solution is not identical with the instructor’s approach. It can be seen that, time spent by the students on each of the behaviour varies as compared to instructor.

Interview results also endorse the benefits of the methodology to use Blender training module for transformations concepts in computer graphics. Students mentioned that they found Blender features like multiple views and transform properties useful to visualize and solve transformations problems.

The study provides insights on how students use Blender features to solve transformations problems. It also shows that Blender training module has increased their interest in learning and solving CG problems like transformations. In future, more such modules can be designed for other CG concepts which require visualization.

References

URL: Blender website: http://www.blender.org/