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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. We used think-aloud method and conducted interviews for data collection. Analysis of results suggests that, students found training module beneficial to visualize and solve transformations.

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. A 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 CG concepts and solving transformation problems. This is operationalized into following research questions (RQ):

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 data suggests that, students benefit from training module procedure to visualize and understand transformations. During the interviews, students mentioned about getting motivated towards learning CG.

2. Treatment Details

The treatment comprised of a three-hour Blender training, 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.

Our aim was to investigate the problem solving approaches taken by students (RQ1) and whether our Blender training has any effect on their motivation to learn CG (RQ2). We used think aloud protocol during the post-test to answer RQ1 and interviews after the post-test to answer RQ2.

3. Research Methodology

Sample consisted of 22 undergraduate students from second year masters course in computer application from a college in Goa University (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). Rationale for choosing think-aloud protocol was 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. After post-test, an interview for the same 6 students was administered to augment the data of think-aloud and screen capture, to answer RQ2.

3.1 Data analysis procedure

Qualitative data of the think aloud method was analyzed by categorizing it in terms of time, occurrences, and individual performance of the students. Coding scheme was created to identify behaviours from the overall events of occurrence. Patterns were created and represented in graphs. Behavioral variables were the actions performed to solve the transformations problems. These are: 1. Read / understand. 2. Perform sequence of transformations: the sequence important, since a wrong sequence leads to incorrect solution 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

4.1 Think-aloud

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). It can also be seen that, students have successfully used training process in solving transformation problem (irrespective of getting correct/incorrect solution). Transcripts and screen capture data shows that, Blender features such as transform properties were more useful in verifying actions at each stage of problem solving.

4.2 Interviews

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.

5. Discussion

As mentioned earlier, the aim was not to evaluate the correct/incorrect solutions, but to observe the problem solving trends. This was clearly visible in the sequence of occurrences (figure 1). The students with correct solution had behaviour identical to the instructor's approach. Analysis of the

think aloud data of the students who got incorrect solutions reveals that, they either followed the instructors' steps partially or repeated same steps couple of times. This created confusion for them while reaching the correct answer. For example, one of the students (S1: blue label in the first column) realized that the answer is incorrect, after 'performing recheck'. Repeating the process with correct steps got him/her the correct answer in the end.

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.

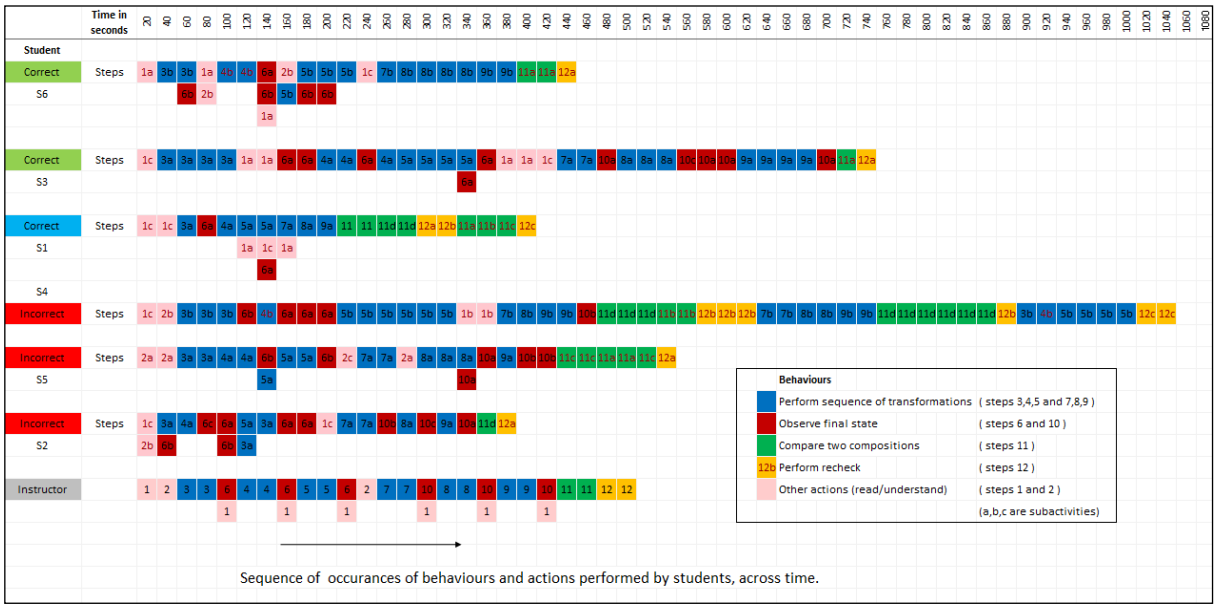

Figure 1. Sequence of occurrences of behaviours and actions performed by students, across time.

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