EG-Easy: Design and Testing of Blender-based tool to teach projections in engineering drawing

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***Abstract*—Engineering Graphics (EG) is an important course for engineering students at first year level and fundamental course for mechanical, civil or other similar branches. Engineering Graphics problems demand application of spatial ability by students. Computer aided visualizations support spatial ability [3]. Blender based visualizations are designed and tested to develop mental rotation ability which help to improve spatial ability [2]. In our study we have designed blender based tool to develop conceptual understanding for topic of point and line projections. We found that students were able to understand and solve graphic problems faster and with more precision.**

Keywords—Engineering Graphics;Spatial ability;blender.

I. INTRODUCTION

EG is mostly taught by the conventional board and marker approach. In this method students need to take efforts to visualize the object in 3D by themselves. One of the preliminary concepts where visualization is applied in Engineering Graphics (EG) is the concept of projections (Orthographic Projections). This concept requires spatial ability. "Spatial ability is the ability to perform mental rotation of objects, visualize how objects appear at different angles, and conceptualize how objects relate to each other in 3D space"[2]. We have used blender to develop our tool which is a 3D open-source software commonly used for modeling and animations [1]. EG-Easy (Engineering Graphics Easy) has been developed using blender to depict various cases of basic engineering projections, and animated to show how these projections are represented in 2D. The purpose of EG-Easy is to help the student create an image of the problem in his mind and solve the problem more efficiently. We did a pilot study in which the students reported that they were able to visualize the situation more clearly with the help of the tool.

II. RELATED WORK

Spatial visualization is an important element of Engineering Graphics and particularly in case of projections [4]. Spatial visualization is necessary for success in graphics and engineering as a whole [5].It has been proven that blender[2] can be used to improve the Mental Rotation (MR) ability of the users, particularly engineering students. This paper indicated improved MR ability [2] but focuses on random objects and its rotations. It is difficult to apply this method for specific topic such as projection in EG particularly where students have to imagine process of conversion of projections from 3D to 2D.

III. DESIGN OF EG-EASY

Basic modeling and animation techniques were used in the making of EG-Easy. Shapes such as spheres, circles and cylinders are available by default in the software.

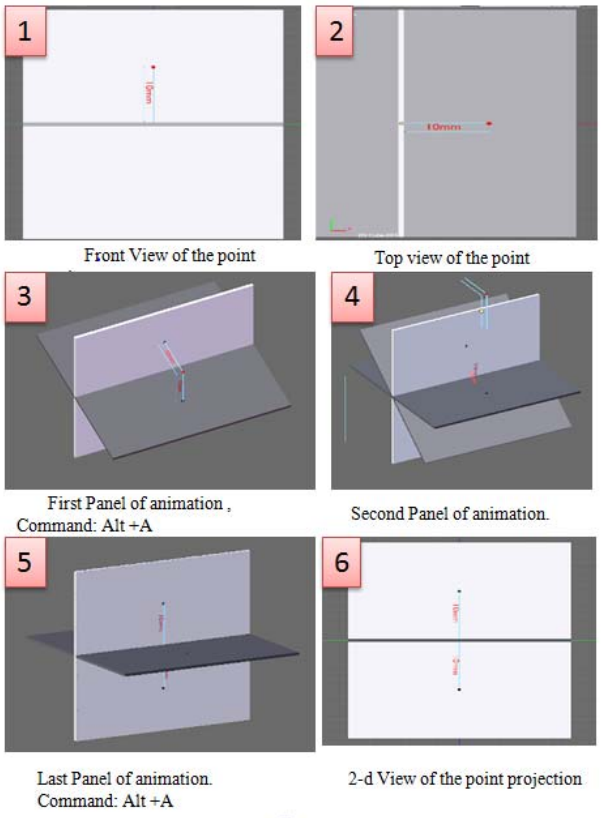

Fig.1: Animation of Projections of a point

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These shapes were then manipulated to represent points, lines and projections respectively using "Scale" and "Grab" functions. Components of design were the planes, lines, points and projections. Each module had 3 key-frames of animation. Frames are still pictures which when played together at a high speed (~24 frames per second) depict the animation. Key-frames are the frames which define the key transition points of an animation.

While animating the procedure of visualizing a projection as taught in class was taken into consideration and the following method was used:

The 2D representation of point projection is as shown in figure 1. Planes of projection rotate, the line moves out and dimensions of projections move into the planes of projection. This is depicted in images 4, 5 and 6 of figure 1.

The user can interact with all of the modules using certain commands on the keyboard and the mouse. The user can change their 3D view angle by pressing the middle mouse button and then moving the mouse. He / She can switch from 3D view to the Front view or Top view of the object by pressing Numpad 3 or Numpad 7. An animation has been created showing the method of 2D representation of projections. The user can start/stop these animations by pressing Alt+A on the keyboard. The student can view the 2D representation of the views by pressing Numpad 3, once the animation stops.

IV. EVALUATION REPORT

We evaluated EG-Easy by conducting focus group study. In this paper we report pilot study for effective testing of our EG-Easy tool. The research question we addressed is: What is the difference in student's conceptual understanding after learning with EG-Easy? The sample consisted of 12th standard students (N=05,3 male and 2 female) who wish to take up engineering in future. The main criteria in our minds while deciding our sample was that the sample must not have any past experience of learning engineering graphics. We evaluated conceptual understanding through a test which was validated by two EG teachers.

A. Procedure of Study

STEP 1: Taking one student at a time, at first we introduced them to the basic concepts of projection (lines and planes) on a white board. The student was asked to clear his doubts. Time for step completion: 30-45 minutes (varying from student to student).

STEP 2: We took a small test based on the topics that were taught. The time taken to complete the test and the marks scored by the student was noted.

STEP 3: The same concepts that were taught in the STEP 1 were taught again, but this time using our tool. Time for step completion: 15-20 minutes (varying from student to student).

STEP 4: A test based on the same concepts but of higher difficulty was taken. The time taken to complete the test and the marks scored by the student was noted.

B. What are our measurements?

The time taken and the marks scored by each student in both the tests were noted and their difference was studied.

TABLE I. COMPARISON OF SCORES AND TIME

Sr. No	***Student***	***Test1 (Before) (Number of Questions solved/Total No. Of Questions solved)***	***Time (In minutes) (T1)***	***Test2 (After) (Number of Questions solved/Total No. Of Questions solved)***	***Time (In minutes) (T2)***	***% efficiency*** $\frac{(T2-T1)}{T1}$
1	S1	1/6	40	5/6	30	25
2	S2	5/6	25	5/6	15	40
3	S3	5/6	40	6/6	20	50
4	S4	6/6	35	6/6	18	48.57
5	S5	6/6	15	6/6	10	33.33

There was an increase in their efficiency of solving but no significant improvement in their test scores was noted.

V. CONCLUSION AND DISCUSSION

All students were able to complete the test-2(after) in much lesser time as compared to the test-1. When asked whether the tool was helpful one of the students said, "When the projections were actually shown in 3-D it helped in the better visualization", another student said that " The tool will help in projection of complex shapes" , indicating that EG-Easy helps in improvement of spatial ability. Other than the basic topics of projection of point and line, modules can be developed for topics such as projection of solids, section of solids, development of surfaces etc.

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