Visualization Skills Among Universiti Teknologi Malaysia Student

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Abstract—Visualization skills are very important in engineering field and it is positively correlated with achievement in engineering disciplines. Therefore, this preliminary study was carried out to study the levels of visualization skills among engineering students in Universiti Teknologi Malaysia (UTM) Skudai. 730 respondents were involved in this study. They were students from thirteen faculties in this campus. The respondents of this study were first year until fourth year students. This quantitative study was analyzed using descriptive method. The instruments in this study were biographical data sheet and short version of visualization standard tests. The finding of this preliminary study reveals that UTM students possess moderately high skill in visualization. Thus, suitable teaching approach should be taken into consideration in order to provide the right technique to enhance students’ visualization skills.

Keywords—visualization skills; engineering;

I. INTRODUCTION

Visualization is a way of thinking where the image is produced or memorized. It is an essential factor in learning engineering drawing subjects such as drawing graphics [12]. Most students have problems when studying the topics in engineering drawing, which require high visualization skills [18]. Engineering drawing is a way to communicate graphically. It covers technical regulations or requirements of drawing and visual skills [20]. Visualization is an innate skill or ability. Sorby and Baartmans [26] observe that visualization skills can be enhanced by providing explanation to students with lower visualization ability and using specific training modules to enhance their visualization capabilities in engineering drawing. According to Sorby [25], the use of multimedia with workbooks has shown positive impact in developing and enhancing three-dimensional spatial skills of students.

Students must understand the basic concepts of engineering drawing in order to assist them in understanding the complexity of learning in other engineering subjects. However, to master engineering drawing basic concepts, students must first master visualization skills. Some studies show that students usually face difficulty in solving problems in engineering drawing because of poor visualization skills. Contero et al. [8] suggested that engineering students need to improve their visualization skills because it is necessary in explaining concepts, ideas and processes as well as to attract attention and information delivery.

II. BACKGROUND OF STUDY

According to Bertoline and Wiebe [6], engineering drawing subject consists of the skills in fundamental visualization ability where this subject deals with the construction of 2D and 3D geometry and creating multi view and pictorial representations. In Malaysia, engineering drawing was taught at all technical and vocational schools. Only a few selected daily secondary schools provide engineering drawing subject to students. According to Widad and Lee [28], students always face problems in engineering drawing because they have difficulty in visualizing the given images. In developing understanding, students use their mental scheme to visualize and develop the view or certain images. Other previous studies (Adanez and Velasco [1], Alias et al.,[3 Basham [5], Contero et al. [8], Sorby et al. [27], Sorby [24]) also show that visualization is important in engineering drawing because, in technical work communication through graphic is compulsory and engineering drawing is the basic capability of communication technique in graphic method.

Traditional teaching methods such as using sketches, printed module, lecture method and hand drawing resulting in students having trouble to understand the subject matter. When the students do self-study, their cognitive levels increase. Thus, heavy load of information in working memory will cause the failure of information to be registered in long-term memory [10]. Even though, there are practical sessions for several subjects, but not all of the content of the syllabus can afford to have practical sessions especially when involving huge, dangerous and costly equipment [7]. Therefore, it is important to have a dynamic cognitive device to overcome the problem. Suitable and practical multimedia animation appearance, courseware and teaching aids can be of assistance.

Numerous researches have been done in areas of science and technology especially in engineering (Basham [5], Contero et al. [8], Sorby et al. [27], Sorby [24]). As an example, understanding the concept in chemical engineering
may be developed when students do observations of visual interactions among atoms and also in atoms simulation in gravitational and conservation of energy. Besides that, in learning construction technology, students need to use their visualization skills to visualize construction process and component of the assembled facilities. In short, many disciplines in engineering and computer-related fields involve the simulation approach in teaching and learning. Thus, to investigate the effective ways to teach engineering course such as engineering drawing, the best practice should offer ways to maximize their use through co-constructed meaning and application [19]. There are many other visual functions such as improving the performance of memory, causing emotional response and enriching the reading as well as the demonstration. This statement is supported by a study conducted by Ramanujan Dimension Group [22], which states that the use of visuals could be applied to convey different information in education.

III. RESEARCH OBJECTIVES

Previous studies have shown that learning by using animation exhibits better performance than conventional learning [2],[9],[30]. By using multimedia as a teaching tool, it could have effect on student visualization skills and achievement in learning [14],[29],[13],[15],[11]. Thus, the purpose of this research was to determine the level of mental cutting skills, spatial visualization ability and visualize a 3D object from 2D object skills among students who are pursuing their studies in engineering programs at UTM Skudai.

IV. RESEARCH METHODOLOGY

This study was conducted in Universiti Teknologi Malaysia, Skudai Campus. The students from Bachelor of Engineering programs were the respondents of this study. In order to identify the students’ level of visualization skills, this study applied three standard visualization tests on the visualization skills and their components. This study was carried out quantitatively using descriptive and inferential statistics. The data were analyzed using Statistical Packages for Social Science (SPSS) version 13.0. The descriptive statistics provides mean value, frequency and percentages. According to Yahya et al. [4], the use of descriptive analysis is to explain or provide an overview of the information or data obtained from the population or sample. Meanwhile, inference analysis is used to describe the relationship between achievement tests and gender differences of engineering students. The inference statistics used in this study is to test correlation at 0.05 alpha level and one way ANOVA analysis.

The instrument used for this study was adopted from the Spatial Visualization Ability Test (SVAT), Mental Cutting Test (MCT), and Differential Aptitude Test: Space Relations (DAT: SR). The tests used are standard achievement tests. Thus, the reliability and validity of the test have been determined in order to ensure that the instrument is consistent and credible. Meanwhile, the content validity of instruments is determined through a verification process carried out by the expertise in this discipline of study. Items are reviewed in terms of content, namely the relationship between the research questions and the scope of the study.

<table>
<thead>
<tr>
<th>Research Instrument</th>
<th>Alpha value</th>
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<tbody>
<tr>
<td>SVAT</td>
<td>0.804</td>
</tr>
<tr>
<td>MCT</td>
<td>0.803</td>
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<tr>
<td>DAT: SR</td>
<td>0.805</td>
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V. DISCUSSION

Table 2 shows the scores on visualization test based on year of study. The findings showed visualization skills of engineering students in UTM are at moderately high level. This is based on the achievement of the proficiency tests of each aspect of visualization test involved in this study. Meanwhile, based on the students’ academic year, the analysis found that fourth year students’ have high level of visualization skills. On the other hand, visualization skills of the third year, second year and first year students are at moderately high.

<table>
<thead>
<tr>
<th>Year of Study</th>
<th>Average Score of Visualization Skills Test (%)</th>
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<tbody>
<tr>
<td></td>
<td>DATSR</td>
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<tr>
<td>1</td>
<td>72.2</td>
</tr>
<tr>
<td>2</td>
<td>74.3</td>
</tr>
<tr>
<td>3</td>
<td>82.2</td>
</tr>
<tr>
<td>4</td>
<td>85.4</td>
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<tr>
<td>Average Score (%)</td>
<td>78.2</td>
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</table>

These results are paralleled with a study that was conducted by Mohd Safarin and Muhammad Sukri [16], which related to the visualization ability of engineering high school students. The results showed that on the average, students studying engineering in this study only had a satisfactory level of mastery in one of the six visualization tests. The analysis of this study has proven that more than half of the students are at the moderate level and are lacking in the aspect of mentally transforming, developing, folding and rotating object mentally using visualization skills. Besides that, studies conducted by Rebecca [23] showed that students with higher levels of visualization skills might be influenced by students' previous experience especially during their earlier exposure in subjects such as geometry or engineering drawings. In addition, according to a study done by Oyanka and Kinsey [21], various engineering disciplines apply visualization skills in teaching and learning, such as CAD software in order to enhance the visualization skills of the students.

Visualization skills are one of the aspects of intelligence found in all humans. The difference is the level of visualization capabilities; they have either be high or low. According to Maizam [14] and Mohd Safarin [17], visualization ability is important for learning and solving engineering problems. With high visualization ability, students
in engineering are able to solve and understand an abstract concept that is difficult to be understood by other students [24]. For example, in engineering drawing subject, engineering students should have a high level of visualization to solve problems in geometric, abstract objects and describing the image of the object in 2D or 3D. Thus, to master a topic in the engineering drawing, students must first master the knowledge and understanding of the previous study, have good visualization skills, understand the concept clearly and then be able to succeed in achieving a balanced scheme between existing knowledge with new learning process.

In preparing for future engineers with a high level of visualization skills, they should be equipped with certain knowledge and skills with visual approaches. This study has clearly found that visualization skills is an important skill not only in the working field, but it is necessary at all levels of study in schools, universities and colleges that offer engineering programs. With this, the design of instructional strategies should be effective and efficient toward the development of visualization skill through engineering drawing. Strong visualization skills, particularly the ability to visualize in three dimensions, are cognitive skills that are linked to success in science, technology, engineering, and mathematics fields. Therefore, Malaysia's educational goals to produce technical human resource with good knowledge in problem solving and effective in technical fields will not be achieved if the level of visualization skills is at moderately high level. Poor visualization skills will lead the students to have difficulty in problem solving activities such as in doing product design, in understanding drawings or thinking for other engineering solutions.

VI. CONCLUSION

Improving the students’ visualization skills is now becoming the main topic of interest to educators and researchers in the disciplines of engineering and related industries. For the industry to remain competitive in the global market, students graduating from the engineering program should have strong visualization skills to communicate effectively and grow professionally in the engineering field. Therefore, engineering students should be provided with the knowledge and basic skills of drawings in various disciplines or fields of engineering. Most studies in visualization skills investigate and test new methods of improving the skills such as conventional, computer-based and the integration methods. Some of the alternatives to traditional methods have been successfully adopted, while others are still being tested for their effectiveness on students, especially in engineering. Thus, there is a need for comprehensive research on improving learning and teaching of visualization skills to students in engineering programs or courses.

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REFERENCES


