Chapter 11

Visualization Skills in Engineering Education:
Issues, Developments, and Enhancement

Dayana Farzeeha Ali
Universiti Teknologi Malaysia, Malaysia

Arun Patil
CQuniversity, Australia

Mohd Safarin Nordin
Universiti Teknologi Malaysia, Malaysia

ABSTRACT

This chapter provides a comprehensive literature overview related to visualization skills development methods, theories related to cognitive development, and use of graphics in learning and teaching engineering drawing subject. In addition, the skills of visualization components and test instruments for testing these skills are also discussed. The description in this chapter begins with an overview of the curriculum in the context of engineering drawings for Higher Education Institutions. Further understanding of visualization skills in engineering, especially elaborated earlier by some scholars and researchers in the science of visual, spatial, and cognitive psychology, are also discussed in this chapter.

INTRODUCTION

Graphic language is a way of communicating to present or deliver a design idea. Traditionally, engineering professionals use graphic language of geometric drawings or commercial applications of computer aided design (CAD) with the 2-dimensional standards in solving a design problem (Contero et. al. 2005). Generally, the engineering drawing subject or course is introduced at the earlier stage or levels in most engineering education programs to provide engineering students with basic knowledge about graphs and visualisation. In particular, the teaching of engineering drawings is intended for students to understand and adept using the standard descriptive geometry and the tool capable of building a mental image. However, rapid developments in technologies and computer

DOI: 10.4018/978-1-4666-0243-4.ch011

aided design (CAD) software have resulted in lack of attention to develop these skills (Petrina, 2003; Safarin and Muhammad Sukri, 2007).

Visualization is one element of a difficult skill to learn in the engineering curricula, especially for courses related to engineering drawing or graphics (Kopp, 1999). Most students have a problem when studying engineering drawings that require high visualization skills (National Science Foundation, 2006). When students fail to master these abilities, they also indirectly struggle to master the concepts based on the visualization ability. However, Contero et. al. (2005) suggested that engineering students always try to improve their visualization skills. This chapter presents a study conducted to examine the integration and effectiveness of learning and teaching facilities of engineering drawing that impact on visualization skills of students enrolled in engineering education programs.

VISUALIZATION IN ENGINEERING DRAWING

Engineering drawing is a way to communicate graphically. It covers technical regulations or requirements of drawing and visual skills (Olkun, 2003). Visualization is a skills or capabilities naturally born, however Wiley (1989) and Sorby and Baartmans (2003) observe that the visualization skills can be enhanced by explaining students with lower visualization ability and then trained using specific training modules to enhance their visualization capabilities in engineering drawing. According to Sorby (2007), the uses of multimedia with workbooks have shown positive impact in developing and enhancing three-dimensional spatial skills of the student.

There is clear evidence that visualizing three-dimensional objects and manipulating them in mind is important to engineers and helps many graphics engineering professionals solve engineering drawing problems (Deno, 1995; Miller & Bertoline, 1991a, 1991b; Parolini, 1994). In engineering, Miller (1990) and Sorby and Gorska (1998) specialize in the field of visualization research also appears as a subfield of research exploring spatial ability and spatial rotation as a process of mental imagery manipulation. For example, Pellegrino, Alderton and Shute (1984) subdivide spatial ability into two components as spatial relations and spatial visualization with a psychometric measurement of speed, power and complexity of an individual's spatial manipulations.

Pellegrino et al. (1984) specifically examine the ability to think quickly and the ability to manipulate mentally complex mental models, by maintaining that this was a sign of spatial intelligence. Witkin, Moore, Goodenough and Cox (1977) also cite similar results in their famous 'field dependent–field independent studies'. Gaylean (1983) performed research that combined visualization and cognition and presents visualization exercises as a learning aid to help students to more effectively learn these skills. Furthermore, Gaylean (1983) finds that visualization increases cognitive accomplishment, provides more social interaction between student–student and teacher–student, and enhances creativity.

The visualization studies of Kosslyn and Thompson (2000) indicate that visual imagery is produced in the area of the brain called 'the visual cortex'. Through the use of the visual perception to work through visual problems, the rear area of the brain helps handle visual processes in problem solving and allow the formation of mental imagery. An engineer needs to visualize spatially in two and three dimensions with the skills in engineering projection theory and engineering graphics that involve the use of 2-D and 3-D image and cognitive process (Bertoline & Wiebe, 2002). Visual images can be present in the forms of a tool, a mental model, a mind tool or basic communication tool which are used to convey messages and ideas.

Related Content