

# Chapter 17

## Assessing Mechanical Engineering Undergraduates' Conceptual Knowledge in Three Dimensional Computer Aided Design (3D CAD)

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### **ABSTRACT**

*Research on the relation between conceptual and procedural knowledge has shown that fusing them enhances understanding of domain knowledge. Various methods have been developed to assess undergraduates' conceptual understanding of a particular domain. Nevertheless, in the teaching and learning of Computer Aided Design (CAD) in higher education, students were not assessed on their conceptual understanding on the utilization of the software. The assessments of outcome were based on procedural or command knowledge rather than the conceptual understanding, which is usually associated with a particular subject matter. In addition, both types of knowledge are emphasized within the context of achieving outcomes of domain related subject matter such as Machine Design or Technical Drawing. Some students might not be aware that there are concepts underlying the procedure they are using. As such, students' conceptual knowledge in Three Dimensional Computer Aided Design (3D CAD) is as important as their procedural knowledge. The question now arises as to whether the students acquire adequate conceptual knowledge through a formal or informal learning process in higher institution before they are employed by manufacturing industries. This chapter briefly discusses the concept of developing 3D CAD model. Then, categories of the essential concepts in the development of the model are presented. Implementation of Concept Map to assess students' conceptual understanding on 3D modeling technique will be addressed.*

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## **INTRODUCTION**

A group of final year Mechanical Engineering undergraduates was assessed on their understanding of conceptual knowledge in 3D CAD modeling. Results from the assessment provided empirical evidence of students' lack of conceptual understanding of modeling techniques in the context of their discipline. The proposed assessment method could be used by instructors in higher education to examine students' conceptual understanding of 3D CAD modeling in the context of any specific courses or course content.

Computer Aided Design (CAD) software has been the prime tool to support Mechanical Engineering courses in higher institutions throughout the world. It was initially used only as a tool to replace hand drawn engineering drawings. Then, as the software and hardware were developed further, these have caused the systems to be more affordable resulting in higher institutions incorporating the system into their curriculum. Extensive use of the system to support teaching and learning in Mechanical Engineering programmes materialized because the systems are capable of producing three dimensional (3D) virtual objects. 3D models developed by the system are used in teaching engineering design subjects whereby graduates can visualize and present their design ideas. For instance, Mechanical Engineering undergraduates at Universiti Teknologi Malaysia (UTM) use the software throughout their study at the faculty. The software is utilized in producing engineering drawing during their freshmen year, presenting design ideas during second year of study (introduction to design), presenting and representing design project in engineering design subject in their third year and using the software for capstones design project. Learning of these domain subjects generally utilizes this software as a supporting tool.

Similarly, other higher institutions also integrate the software in their Mechanical Engineering curriculum. For instance, Hamade and Artail

(2008) and Garcia et al. (2005) reported that CAD subject is included in their mechanical engineering curriculum, whereas some other faculties are incorporating the teaching of the software in Engineering Design Graphics or Computer Graphics subjects (Sung and Ou, 2002, Devon, 2007, Sorka-Bizon, 2007). However, this is not the case in UTM. Knowledge in the use of CAD software is taught as part of the Engineering drawing subject without any dedicated time for teaching and learning of the software. This is due to the fact that curriculum is packed with engineering sciences and other related domain subjects. 2D CAD software was initially employed for teaching engineering drawing at the faculty. The system was later upgraded to 3D CAD system as the software and hardware became affordable. CAD software is taught in parallel with the engineering drawing subject. The undergraduates are taught the principles of engineering drawing and consequently produce the relevant output in the form of CAD generated drawings. Procedures and methods in developing 3D CAD models are explained in dedicated CAD computer laboratory. Engineering drawings are generated from the models and presented to instructors for assessment. This assessment is only based on students' understanding of the domain subject matter.

The teaching and learning process in developing the models is primarily focused on procedural knowledge where uses of related commands are emphasized. This is due to the fact that the emphasis of the instructors is assessing students' outcomes in the engineering drawing subject. These students are not assessed on their knowledge or skills in developing 3D CAD models. However, this is the only experience that the students are formally trained to use the software, where they are required to use the software to solve problems in other domain subjects. To what extent students acquire conceptual understanding in 3D CAD modeling remains unknown. Therefore, strategies of measuring learning outcome of complex computer software, such as CAD will be addressed.

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