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A design software to facilitate learning via repeated practice by Chemical Engineering students

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ABSTRACT

A design software was developed within the paradigm of Technology Enhanced Learning (TEL) to facilitate learning via a repeated practice approach by Chemical Engineering students reading a core module called Fluid–Solid Systems. The software was developed to be able to generate detailed solution steps to typical engineering design problems encountered within this core module. Students were able to utilize the software to generate complete solutions to such problems for comparisons with their own hand calculations and thereby apply a repeated practice approach towards their learning of engineering design calculations. Highly favorable responses were received from students with regards to the utility of the software towards enhancing their abilities to apply the knowledge they had acquired in the module, engage in independent learning of the subject outside of formal classroom hours and understand concepts that were discussed during lectures and tutorials. Students who utilized the software more frequently throughout the semester performed better in the final examination. Interestingly, a minimum threshold in usage frequency of the software seemed to be necessary for the positive effect on performance in the final examination to be significant. As a TEL intervention to enhance students' learning via a repeated practice approach, this pedagogical intervention was deemed highly scalable to large class sizes and effective in overcoming constraints relating to limited classroom hours.

1. Introduction

Undergraduate students pursuing Chemical Engineering at a University are likely to be interested and proficient in Mathematics, Physics and Chemistry at the high school level. In Singapore, most students who decide to major in Chemical Engineering would have acquired good knowledge of these subjects and strong problem-solving skills through a rigorous high school education which emphasized mastery learning by a repeated practice approach. However, mastery learning by repeated practice is usually not applied at the University level due to various logistical constraints, educators' beliefs and other factors. It is thus common to hear Chemical Engineering students commenting that more example problems should be discussed in what are already very lengthy lectures or more tutorial problems should be provided for practice. Many Chemical Engineering students learn well by having a teacher discuss many example problems during lectures, solving many problems within each topic by themselves and then having a tutor discuss the solutions to these problems in details. Such an approach for teaching and learning may be feasible at the high school level where each subject, such as Physics or Chemistry, is taught over a span of two to three years but is unlikely to be possible at the University level where every module is taught over three to four months. Consequently, some of the best and brightest students who had excellent mastery of Mathematics, Physics and Chemistry at the high school level and who major in Chemical Engineering at the University for their undergraduate education may not be able to achieve their fullest potential in mastering the various subjects in a typical Chemical Engineering curriculum.

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In a recent review on the application of technology in engineering education, Deshpande and Huang (2011) concluded that simulation games have the potential to enhance transferability of academic knowledge and uplift engineering education. Philpot et al. (2005) developed two computer-based games to facilitate engineering students to learn the subject of Statics. Students rated the games as more effective than the textbook for learning the subject and the authors concluded that games are an effective teaching tool for fundamental engineering topics that require repetition or practice to master. Deliktas (2011) applied computer technology such as models, graphics, animations and interactive problems to enhance teaching and learning of an Engineering Mechanics course. The approach was found to be effective in enhancing higher order thinking, analytical thinking and reducing learning by rote. Llado and Sanchez (2011) developed an education software to assist their teaching of Dynamics to first-year engineering undergraduates. The software simulated the 3D movements of various components of a washing machine and students were able to explore the effects of different

Fig. 1 – Graphical User Interface of the design software developed to facilitate repeated practice by Chemical Engineering students.

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