Teaching and assessment of mechanics courses in engineering, which encourage and motivate students to learn threshold concepts effectively

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Mechanics fundamentals make the solid foundation for most engineering disciplines. Conventionally, at most engineering schools, the study of mechanics comprises up to 25% and 40% of 1st and 2nd Year levels respectively. Failure rates of up to 20% to 50% are common in introductory mechanics courses in engineering, which has been an issue of continuing concern.

The implementation of innovative teaching strategies into the UG courses such as 1st year Engineering Mechanics 1 (>275 students) and 2nd year Solid Mechanics 1 (>300 students) using blended online and face-to-face teaching has been carried out at UNSW. The development, use and evaluation ways of using an online intelligent tutoring system, i.e. Adaptive Tutorials (ATs), is targeted to help students develop their conceptual understanding of mechanics. In large and diverse groups of students, it is often difficult to identify and help the students who are struggling. The ATs provide a way of dealing with common sticking points, or threshold concepts[1] that prevent students progressing in their study of mechanics. These can sometimes be addressed by skilled one-to-one coaching but are usually missed by traditional 'book and board' teaching in large classes. The ATs use artificial intelligence principles along with online interactive virtual laboratory activities (simulations), to: (a) track each student's interaction with the simulation, and provide tailored feedback; (b) generate data that teachers can use to identify common conceptual sticking points in large classes; and (c) provide information for adjusting the simulation, feedback and other learning activities in a course to help students through threshold concepts.

The author's work shows how ATs can help students to learn threshold concepts efficiently[2]. The tutorials not only improve students' performance in assessments, but also improve students' satisfaction with the course. The student response has been very positive, and the technical and pedagogical approach adopted in developing the ATs has helped not only our learning and teaching activities in mechanics at UNSW but also provides the opportunity for further development and dissemination into cross-institutional, cross disciplinary, collaboration.

Student feedbacks such as "*Fantastic program I was really struggling with the force analysis, however this program has instilled confidence for understanding real-life application of engineering and mechanics*" and "*I highly recommend this tutorial. It has a very appealing practical approach yet at the same time helps me in improving my conceptual understanding of the topic at hand especially regarding the shear force and bending moment. The free body diagram on the side is also very helpful. Two thumbs up!*" bears testimony to the success of this approach.

Furthermore, few strategies have been implemented to examine the usefulness of this tool in improving learning in the Mechanics course. Evaluation strategies have included a comparison of guided vs. discovery-based learning tasks, comparing performance across different cohorts of students with and without access to ATs and looking at overall student satisfaction and performance after using ATs. Results are promising and

support the benefits of ATs for learning as well as for giving the teachers to take control of the learning process.

References:

1. Meyer, J. H. F., & Land, R. (2005). Threshold Concepts and Troublesome Knowledge (2): Epistemological Considerations and a Conceptual Framework for Teaching and Learning. Higher Education: *The International Journal of Higher Education and Educational Planning*, 49(3), 373-388.
2. Prusty, B. G., Ho, O. and Ho, S. (2009). Adaptive Tutorials using eLearning Platform for Solid Mechanics Course in Engineering, *Proceedings of the 2009 AaeE Conference*, Adelaide.