Virtual learning: how online tutorials shape learning of threshold concepts

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Our earlier work of student learning in introductory electronics revealed areas (i.e., threshold concepts, see Meyer, & Land, 2003) where students get stuck in analogue electronics (Harlow, Scott, Peter & Cowie, 2011). In our previous research, through surveys, interviews, and focus groups, we collected data on how changes in a lecturer's pedagogy impacted students' perceptions and understanding of threshold concepts (TCs). One of the recurrent themes in students' reports was that in the face-to-face tutorials there were not enough examples to practice on—particularly examples containing TCs. To remedy this problem e-tutorials were designed to allow learning that best suits students' learning style and previous knowledge. The e-tutorial system differed from similar systems, such as that of Smaill (2013), in its low-pressure approach, having no penalty for wrong answers other than a lack of progression. For the present study we investigated the impact of these multimodal, online tutorials on learning TCs in first year electronics engineering.

A set of online tutorials, relating to specific concepts in the course, assessed students' previous and new knowledge (e.g., TCs). Multiple-choice questions had additional space provided for students to explain why they chose a particular answer. Links to related online resources were provided for each question and immediate feedback to answers was given. Data on 53 students' trajectories through e-tutorials, grades on a mid-term test after the TC had been taught, their final exam grades, and their survey responses about their preferred ways of learning and doing e-tutorials were used to assess the impact of e-tutorials on learning a particular identified TC (Thevenin's equivalent circuit). The data were analysed for evidence of learning and mastering the TC in the online environment and provided insights into shifts, or lack thereof, in students' understanding of the TC. Individual students' paths through e-tutorials (number of attempts and accuracy) were examined and compared across three groups of students: low/medium/high achievement in the final examination. Students' revisions of e-tutorial questions were explored. Regression analysis and analysis of variance were conducted to reveal whether and which tutorials had an impact on students' learning in general and mastering of the TC in particular.

In general, there were considerable differences in the impact of the e-tutorials on the three groups of students. The least impact was observed for low achievers who tended to spend less time on the e-tutorials, were frustrated with lack of help with problems, and end up guessing or working alongside someone else rather than researching the questions before answering. The e-tutorial grades were more predictive of final grades for the medium and high achievers who worked in a more confident and independent way, researching the questions before selecting an answer.

The objective of online tutorials was to motivate students to think and act as electronics' engineers, not just learn about electronics. The results are discussed in regard to their implications for learning of TCs in online environments and course design in higher education. The discussion will explore ways in which lecturers may use e-tutorials to detect and support students with difficulties solving TC problems.

Acknowledgement
This research was supported by a grant from the Teaching, Learning and Research Initiative (TLRI), NZ.

References

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