If We Build It, Will They Come? A Maths Adaptive Tutorial Experience

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ABSTRACT:
A constant growth in class size and a topic student's find difficult to grasp, led to the integration of technology into a numeric methods maths course. An interactive adaptive tutorial was created and incorporated to support student's learning. The study compared examination results from 2014 where no tutorial was used with 2016 where tutorial was used. Analytics data provided insight into student participation rate and to understand what type of students voluntarily made use of the tutorial in a real world situation. Findings indicated that students across the academic spectrum used the tutorial, resulting in improved learning outcomes with the 2016 median score being significantly higher than in 2014. Moreover, student feedback was extremely positive, with particular appreciation of the instant, adaptive feedback generated and the opportunity to revise in this blended learning environment.

What is presented

This presentation describes a study in which an adaptive tutorial was integrated into a traditional face-to-face numeric methods course. In so doing, a blended learning environment was created in which students were able to rehearse, reinforce, recall and revise what they had learned in their face-to-face sessions. By being able to integrate technology into the course, students were able to take control of their learning in a time, place and pace that suited them.

Context

Numeric Methods is a mandatory course in the third year engineering degree at a higher education institution in Australia. It is an important subject that introduces students to mathematical concepts that support complex engineering theories used in iterative problem solving procedures. The topic boundary value problems, forms part of the numeric methods course and was identified as a topic in which student's traditionally experience problems. Being a mandatory course, students tend to have varying mathematical skill levels and prior knowledge. In addition, student enrolment numbers over the past few years have grown exponentially, making it more and more difficult for lecturers and tutors to interact with students, particularly if they are experiencing difficulties or developing misconceptions.

What is lacking from traditional worksheets and/or watching a video explanation online is the support and guidance one can gain from instant feedback. Although many educators make themselves available via chat forums or emails, it is the instant feedback one can gain in a face-to-face situation that is often missing from learning online. With a course of over 400 students, being able to provide that type of support and guidance is problematic for a number of reasons. By incorporating an adaptive tutorial into the teaching and learning of this topic, educators were empowered

to tackle the problem, enabling students to gain instant, adaptive, formative feedback as they worked through the tutorial. The Smart Sparrow™ platform was utilised as it provides educators with pedagogical ownership (Ben-Naim, Velan, Marcus, & Bain, 2010) to create tutorials to suit their students and specific requirements. It also allows for the creation of customised feedback that is generated based on student input to questions and misconceptions they may experience.

Aim of the study was to better understand

1. Whether there were measureable benefits of incorporating an adaptive tutorial into a traditional face-to-face course?
2. Whether students would voluntarily make use of the tutorial despite marks not be allocated to their use?
3. Whether there was a particular academic type of students who would make use of this resource?

Method

The topic was identified with educators then turning their attention to the design and creation of the adaptive tutorial. The adaptive tutorial was built utilising the Smart Sparrow™ Adaptive eLearning Platform, which is an instructional content and design platform and authoring tool. Content and concepts were chunked up so that they could be presented in a step-by-step guided process, with calculations following a worked example format (Ayres, 2006; Sweller, 1988). Decisions were made as to what activities students would be required to carry out in order to ensure that students were actively involved in the learning process, and not passively reading through screens of notes. For each activity students were presented, relevant feedback was created. Feedback was generated for both the situation where student inputted a correct answer as well as for when they provided an incorrect answer (Halabi, 2004).

As feedback was utilised as part of the learning process and not simply as a summative aspect of the students' learning, students were given more than one opportunity in which to achieve a correct response. If an incorrect answer was given the first time, students were provided with a hint or a tip as to what they may have done incorrectly, or what they may need to consider and given a second chance to answer the question. If on the second attempt they still presented an incorrect response, they were provided with the correct response and allowed to move on. Depending on the situation, they may also have received further explanation to the response. This format was used so as to encourage students to keep working through the tutorial and not find themselves caught in a loop, which could become frustrating if prevented from being able to progress. It also ensured that students were not clicking a variety of options in order to force the system to allow them to move on without knowing why a particular response was the correct one.

The adaptive tutorial was created and launched in the second week of the topic being taught. It was left open for the duration of teaching, up to and including the day of the semester examination. Students were notified in class of the tutorial and a link was added to the Course Moodle site, with the standard notification being sent out to all students when the tutorial was made available for use.

In addition to examination scores being compared in the study, analytics from the platform were utilised in order to gain insight into details of student use of the tutorials. Open ended questions were also asked of students in regards to their likes and dislikes of utilising the tutorial.

Results

Student examination scores were compared from the boundary value problem (BVP) question in 2014, where no adaptive tutorial existed with the same question in 2016, where an adaptive tutorial was incorporated into the teaching and learning process. A Mann-Whitney U test was carried out, indicating that the median scores for 2016 was significantly higher than the median score for 2014 ($U=52770$, $p<.001$). Furthermore, when analysing frequency of marks across the course, 26.8% of students achieved full marks for the BVP question in 2016, compared to 2014 where only 9.5% did.

Table 1: Comparison of BVP Question scores from 2014 and 2016 examination

Question	Median	Inter Quartile

		Range
BVP Question 2014	8.0	16.0
BVP Question 2016	14.0	12.0

From the analytics engine, it was observed that 242 students (58%) voluntarily accessed the adaptive tutorial. Of these students, 179 (74%) went on to complete the tutorial, with only 63 students (26%) not completing the tutorial.

In order to reveal whether there was a particular academic type of student who would voluntarily make use of an adaptive tutorial in their learning process, students were grouped according to their WAM scores, see Table 2 (Weighted Average Mark is a score internally calculated by the University, comprising of an average of marks across all courses a student has completed) in order to make the comparison.

Table 2: WAM Groups

WAM Group	
Description	Score
High Distinction (HD)	85 – 100
Distinction (D)	75 – 84
Credit (C)	65 – 74
Pass (P)	50 – 64
Fail (F)	<50

Data was analysed in order to gain insight into the percentage of students that fell into each WAM group within the course. Furthermore, data comprising of students who had logged into the tutorial and those who did not attempt (DNA) to access the tutorial was investigated. Figure 2 reveals the percentage of students within their WAM groups who accessed the tutorial compared to those who did not attempt to use the tutorial.

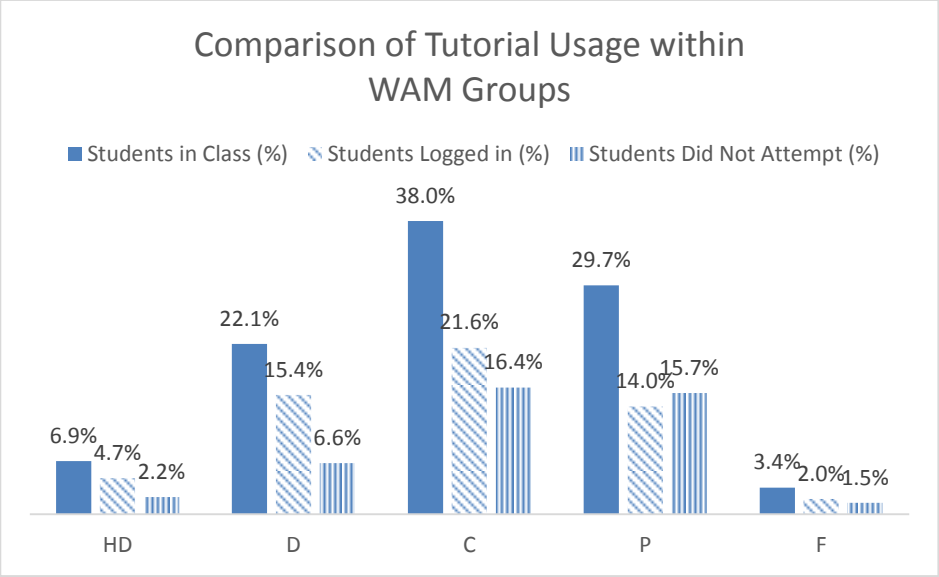

Figure 1: Shows the percentage of students who logged into the tutorial compared to the percentage of students who did not (DNA).

In regards to student feedback, students overwhelmingly indicated their appreciation of this form of study, with many students requestion more tutorials for other topics. Furthermore, students commented on the step-by-step nature of the tutorial with special mention of the instant feedback they received.

Discussion

Having built and incorporated an adaptive tutorial into a traditional face-to-face course, results showed that students did indeed use the tutorial. More than half the class voluntarily accessed the tutorial without external incentives such as marks. Teaching and learning is complex with a variety of factors influencing it (Killen, 2016). There isn't a one size fits all methodology in face-to-face lessons, nor does this change when teaching online. The more opportunities one can provide for students to rehearse, reinforce, recall and revise what they are learning, the better chance they have at retaining and transferring their knowledge. It would seem, that by utilising the adaptive tutorial in this course, students were given this opportunity, resulting in a significant difference in their learning outcomes in the form of examination scores in 2016 compared to that of 2014. Furthermore, on investigating whether there was a particular academic type of student who made use of the tutorial, it was evident, that students across the learning spectrum, voluntarily and independently took control of their learning, utilising the tutorial to support their learning process. In addition, on inspection of the frequency of marks, nearly three times more students gained full marks in 2016, compared to that of 2014 where no tutorial was available.

In regards to students who did not complete the tutorial, it would be interesting in future studies to better understand why this occurred. Due to ethical restraints, it was not possible in this study to investigate whether the dropout rate was due to student motivation, the structure of the tutorial or whether students simply ran out of time prior to their examination. Furthermore, it would be interesting to understand the students who did not attempt to use the tutorial.

By embracing and utilising an online adaptive tutorial and incorporating it into their teaching and learning process, students were able to actively take part in their learning. The instant adaptive feedback and the guided practice they received provided them with the opportunity to work at their own time, place and pace, resulting in improved learning outcomes.

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