We Built It and They Came: An Adaptive eLearning Experience

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SESSION Integration of teaching and research in the engineering training process

CONTEXT Large classes, students with diverse educational and cultural backgrounds and a time poor society are just some of the pressures educators are faced with today. Added to this is a need to provide students with different opportunities in which to learn. Furthermore, in this 24/7 switched-on world, students expect to be able to learn at a time and place other than in a classroom. It was with this in mind that the concept of a weekly Smart Quiz was integrated into a Petroleum Engineering face-to-face course, providing students with an opportunity to test their knowledge in a low risk, stress free environment. Additionally, it provided students and educators with an opportunity to identify and tackle misconceptions sooner, rather than later.

PURPOSE Research was carried out in order to assess whether given a choice, students would engage with and make use of the Smart Quiz. In addition, evaluating students' perception of learning online, and their attitude towards instant, adaptive feedback took place.

APPROACH In order to carry out this research Smart Sparrow's Adaptive eLearning Platform was utilised. The platform is an instructional content and design tool usually used to create adaptive tutorials. However, in this study it was used to create Smart Quizzes. The major difference between these Smart Quizzes and traditional ones is the instant, adaptive feedback generated as students interact with the activities and questions provided. The Smart Quiz was launched after students had attended face-to-face lectures and tutorials where the various topics were taught and discussed.

Data was collected via a participant's online questionnaire in order to gain insight into students' attitudes and perceptions. The questionnaire consisted of questions in the form of a five point Likert scale, as well as open ended questions. Furthermore, data from the analytics engine in the platform was used to gather information relating to student usage of the Smart Quizzes.

RESULTS Students were overwhelmingly accepting of the Smart Quiz concept, with the vast majority of the class accessing them. This included students across the academic spectrum. In addition, 89.3% of students agreed or strongly agreed that the feedback generated was helpful. In regards to identifying their preferred feedback style, they reported the 'try again' feedback that included a hint, extremely helpful.

CONCLUSIONS In conclusion, students were extremely accepting of the Smart Quiz concept. Without external incentives, students eagerly took control of their learning, making use of the Quizzes in order to support their learning. The ability to access the Smart Quizzes when they wanted, where they wanted and being able to work through them at a pace that suited them was not only evident by the responses provided in the questionnaire, but in the data captured from the analytics engine.

KEYWORDS feedback, adaptive learning, blended learning.

Introduction

Students and educators are constantly faced with time pressures. In addition, they are faced with the complexities which large and diverse classes pose (Baik, Naylor, & Arkoudis, 2015; Tisdell, 2017). Added to this, is the pressure educators are under to provide students with engaging, personalised learning opportunities. From a student's perspective, the need to juggle studies with work commitments has led to an expectation of more flexible learning environments (French & Kennedy, 2017). The advancement of technology has provided educators with a means to adapt the way they teach and the opportunities they provide for their students.

Learning takes time and effort and requires a variety of learning opportunities. There is no one-size-fits-all solution, particularly as students' needs and abilities differ. Papert (1993) proposes that for learning to take place, students need to be actively engaged in the process. In addition, they need to be able to take charge of their learning. Furthermore, Kirschner, Sweller, and Clark (2006), have shown that novice learners benefit from explicitly guided tasks and activities. Added to this knowledge, is the importance feedback plays in learning (Hattie, 2015; Narciss, 2013; Shute, 2008). When classes are large and diverse, however, this is not always easily accomplished.

Online resources involve major in-depth planning. They take time and effort to create. It is therefore beneficial to gain insight into students' attitudes towards such resources. Additionally, it is useful to understand whether there is a particular type of student who would voluntarily make use of them. If online resources are to be embraced by students, evidence is needed regarding potential benefits they may offer; with a specific focus on the role feedback may play.

We describe a real-world study carried out in a 3rd year petroleum engineering course that integrated online adaptive quizzes into a regular face-to-face course. The specific questions considered were:

1. Given a choice, would students voluntarily engage with Smart Quizzes as a way of supporting their learning that could lead to improved subject confidence and understanding?
2. Would students' perceive the inclusion of instant, adaptive feedback to be beneficial and would they have a preference to the type and structure of the feedback?
3. Would educators be able to effectively guide and support students' understanding of complex content from afar?

Background

Students enrolled in a Petroleum Engineering course attended a two hour face-to-face lecture once a week as well as a one hour smaller face-to-face tutorial group. The tutorial occurred prior to the lecture, where students were provided with a question they were required to solve in groups facilitated by tutors. The lecture that followed the tutorial concentrated on advanced and complex areas of the topic. At set times in the course, students completed assessments and/or examinations where they received summative feedback on their progress. One of the aims of the course was to introduce students to background knowledge in numerical reservoir simulations whilst guiding them in how to solve engineering problems. The lecturer involved in the course recognized a need to provide students with learning opportunities that would enable students to rehearse, recall, reinforce and review their knowledge, despite the large and diverse class. He also wanted to provide his students with a safe environment where they could learn without fear of failure (Hattie & Yates, 2013). Thus, in order to provide students with an additional learning opportunity, it was decided to create a weekly online quiz with the aim of supporting and guiding students

from afar. We were also interested in whether the quizzes would be used by students, if they didn't count towards their course grades.

The proposed quiz was to take the form of an adaptive quiz that included instant feedback, and was referred to as a Smart Quiz (SQ). The aim of the quiz was to provide students with a flexible opportunity to practice and test their understanding in a low-risk, stress-free environment, that also allowed them to learn from their errors (Hattie & Yates, 2013). It was decided that the resources would not simply digitize lecture notes, but rather aim to provide students with a more personalised interactive and engaging learning opportunity. Moreover, students could learn at a time, place and pace that suited them.

The SQs created, were based on the structure of adaptive tutorials created on Smart Sparrow's™ Adaptive eLearning Platform (AeLP). The AeLP is a web-based, instructional design and content authoring tool enabling educators to create interactive, and adaptive online resources that included the ability to generate instant, adaptive feedback. This platform was selected as it enables educators to maintain their pedagogical ownership of the resources created. It also does not require any specific programming skills. Furthermore, it enables educators to gain 'inside information' on their students use of the resource via the analytics engine (Ben-Naim, Velan, Marcus, & Bain, 2010; Marcus, Ben-Naim, & Bain, 2011).

Quizzes traditionally provide students with summative feedback. However, as this resource was specifically aimed at guiding and supporting learning and not being used purely as a testing resource, it was decided to use formative feedback, allowing the feedback to become part of the learning process. Different feedback types were used, depending on the level and complexity of the question. At the very least, feedback messages included verification such as 'knowledge of response', which identified an answer as being correct or incorrect. Elaborated feedback was used where questions were deemed to be more complex. Feedback included 'knowledge of response' with an explanation (Kulhavy & Stock, 1989; Mason & Bruning, 2001; Narciss, 2013).

Method

Material

The SQs were created using Smart Sparrow's™ Adaptive eLearning Platform (AeLP). The inclusion of instant, adaptive feedback which adapts to students' interactions is a major difference between the Smart Quizzes in this study compared with traditional style quizzes. The first quiz was implemented in week 7 of Semester 2, 2016 followed by a second quiz a week later. The quizzes were uploaded to the course LMS, launching in the relevant weeks and remaining open a further three weeks leading up to the examination period.

Structure of SQs

The SQs consisted of between six and eight questions, with each question or activity linked to relevant adaptive feedback. All questions and feedback were developed by the course lecturer.

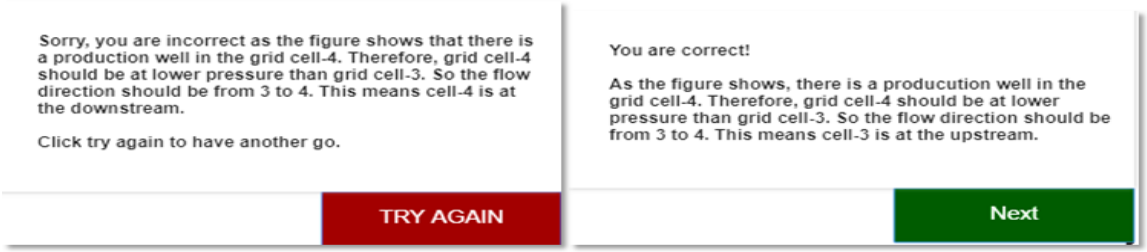

Figure 1: Examples of incorrect and correct feedback messages

A variety of feedback styles were utilised, depending on the type and complexity of the question. Most of the feedback messages included verification as well as elaborate feedback that consisted of a hint or further information (Kulhavy & Stock, 1989). At the most basic level, the feedback reflected 'knowledge of response', indicating to the student that their answer was correct, or incorrect. If an answer was incorrect, students were provided with 'multiple try' feedback. This was 'knowledge of response' with a hint or guidance as to what they may have missed, or what they needed to consider in order to be given another opportunity to answer the question. If they were still unable to answer the question, they were either directed to their notes, or other resources, or they were provided with an explanation that took the form of a worked example and were able to continue with the SQ and their learning process. Where students answered a question correctly, they received 'knowledge of correct response' feedback. This included verification that the answer was correct, as well as an explanation of the correct answer. This explanation was provided so that students who may have guessed the answer, or who may not have been completely sure of their answer, could benefit.

The three attempts 'multiple try' feedback method was specifically selected for use, rather than 'answer-until-correct' feedback style in order to prevent students from becoming frustrated or finding themselves caught in a loop if unable to answer a question. This in itself could possibly add to a students' unnecessary cognitive overload.

There were no time restrictions and students where not restricted by the number of times they utilised the quiz. This enabled student to take control of their learning, allowing them to identify when, where and how they chose to best make use of the resource. Although there were no assessment marks associated with the quizzes, game points were embedded into the various questions and activities, allowing students to see how they fared. These points were included as a motivational factor and were summative in nature.

Data

To gain insight into the students' learning experience, attitudes and perceptions, data was collected via a participant's online questionnaire. The questionnaire consisted of five point Likert scale type questions, as well as open ended questions regarding students' likes and dislikes. Furthermore, data from the analytics engine was extracted, relating to the students' use and interaction with the Smart Quizzes.

Data gained from the analytics engine could highlight particular areas where students may have experienced misconceptions, allowing educators to adapt their teaching accordingly.

Results

This study consisted of both Australian and international students in a first year petroleum engineering course. Student's responses indicated that 43% (n=48) came from English speaking backgrounds, with 57% (n=64) of students coming from a variety of non-English speaking backgrounds. Of the 113 students enrolled in the course, 107 students responded to the question relating to gender, with 62% (n=66) of students identifying as male and 38% (n=41) of students identifying as female.

Given a choice, would students voluntarily engage with Smart Quizzes as a way of supporting their learning, that could lead to improved subject confidence and understanding?

In order to assess whether there was a particular academic type of student who elected to access the SQs, the university weighted average mean (WAM) score of participants were analysed. WAMs are generated by the university based on all the courses a student has completed. Results from the analysis of the 74 participants involved, indicated that students across the academic range elected to make use of the SQs, with the largest group 38%

(n=28) made up of ‘Credit’ students, followed by 31% (n=23) ‘Distinction’ and 22% (n=16) ‘Pass’ students.

Students overwhelmingly embraced the Smart Quizzes. Of the 113 students enrolled in the course, 96.9% (n=107) of students elected to use the week 7 SQ and 92.9% (n=105) of students, used the week 8 SQ, with a 100% completion rate of the quizzes in both weeks. The SQs remained open until the examination period, with students continuing to make use of them leading up to the morning of the examination. In addition, from student logs, it was seen that students made us of the quizzes at all times of the day and night, including the very early hours of the morning.

Of the 62 students who elected to take part in the participant questionnaire, 84% (n=47) of students, agreed or strongly agreed that the quiz had enhanced their knowledge and understanding of the subject matter. This included 78.5% (n=44) of students who agreed or strongly agreed that the quiz had enhanced their understanding of complex formulas required in the subject.

Would students’ perceive the inclusion of instant, adaptive feedback to be beneficial and would they have a preference to the type and structure of the feedback?

In order to assess students’ attitudes to the instant, adaptive feedback they had received in the SQs, students were asked to identify their preferred feedback type. They reported that when an answer was correct, they preferred receiving feedback that included the correct answer as part of the feedback message, with 100% of students finding that extremely helpful or helpful. The try again feedback, without any sort of hint, or guidance was identified by 65% of students as being the least helpful.

Table 1: Students' response to different feedback types

	Extremely Helpful	Helpful	Neither helpful, nor unhelpful	Unhelpful	Very Unhelpful
CORRECT + NO answer	16%	14.5%	17%	37%	16%
CORRECT + answer	56%	44%	0%	0%	0%
Try again + NO hint/guidance	12%	12%	11%	38%	27%
Try again + hint/guidance	61%	37%	0%	0%	2%
Feedback - link to notes	42%	47%	9%	0%	2%

Out of the 62 students who completed the participant questionnaire, 98.4% (n=61) of students reporting having found the feedback clear and easy to follow, with only 1.6% (n=1) unsure. Furthermore, 89.3% (n=50) of students agreed or strongly agreed that the feedback they received had been effective and helpful to their learning. In addition, in the open ended question regarding what students liked most about the SQs, the theme of feedback came up. Below are some of the comments they made:

“I felt encouraged on my way to the right answer instead of stressing over it. That it was clear and simple with answers and hints.”

“Instant Feedback, Multiple attempts and Reasons why an answer is correct or incorrect”

“The instant feedback is actually very handy to have since it can alert you to small details that you might have missed.”

Would educators be able to effectively guide and support students' understanding of complex content from afar?

Data captured in the analytics engine provides educators with insight into students' interaction with the platform. Educators are able to drill down to see how many students are answering a question correctly and whether the feedback being generated is leading to a positive outcome or not. Furthermore, this information provides educators with insight into whether students are possibly experiencing misconceptions, allowing them to adjust their teaching or if necessary the question being asked.

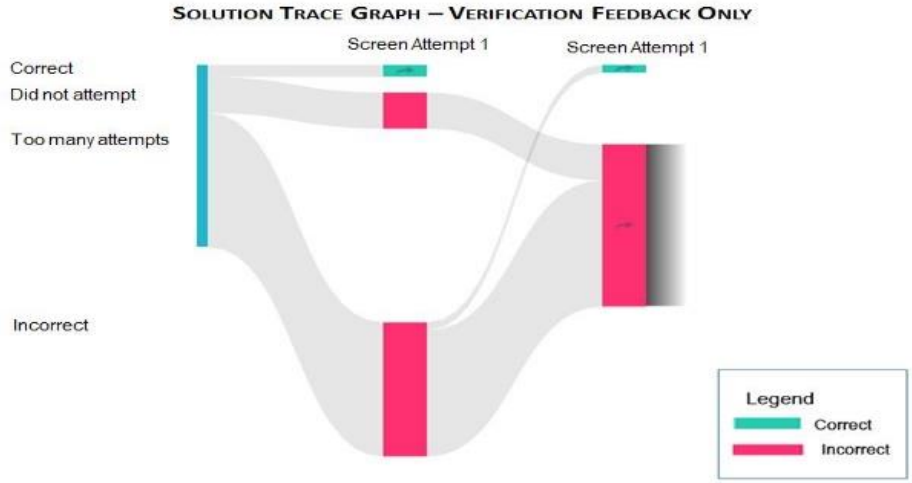

Figure 2: Figure 2: A solution trace graph indicating students' attempts on Question 6

Figure 2, shows a solution trace graph where only verification feedback was generated in a calculation type question that did not include elaborate feedback. The correct verses incorrect response rate on students' second attempt was very low.

In comparison, as seen in Figure 3, in a question that included both verification and elaborate feedback, the feedback provided on the second and third attempts produced 59 correct responses, with only 3 students having to be given the correct answer and explanation before moving on.

Figure 3: Solution trace graph of students attempts when verification feedback used

In addition, the lecturer noted that the insight students were able to gain from having made use of the SQs, allowed him to set a far more conceptual type of examination question than

in previous years where this resource did not exist. Instead of students being asked to simply derive a generic equation, he was able to give them an equation and ask them in-depth questions on their observations and understanding of the situation.

Discussion & Conclusions

Students are unique, with different prior knowledge and individual needs. This diversity is difficult to address in large classes. By integrating technology into face-to-face classes, educators can attempt to tackle some of the issues they face in teaching and learning today.

Our study found that an average of 94.9% of students accessed the Smart Quizzes (SQs). It was evident, that despite the lack of external incentives, students across the academic spectrum elected to utilise the quizzes at all hours of the day and night. It also showed that 98% of students preferred the use of 'knowledge of response' with elaborated feedback when they got a question wrong. Furthermore, evidenced by the 100% completion rate each week, and the overwhelmingly positive comments related to formative feedback, students found the SQs valuable to their learning. As novice learners, learning a complex topic, this resource provided students with support and guidance that enabled them to effectively engage in their learning at a time, place and pace that suited them. In essence, the SQs provided a guided learning context which has been shown by many to support and improve learning outcomes (Kirschner et al., 2006). The SQs did not only provide students with evidence of their knowledge level, but also provided lecturers with insight into the students learning. Input from the lecturer revealed that students appeared to have gained a greater depth in their knowledge compared to students in previous years.

It is noted that future studies could include a comparison of learning outcomes in the form of marks in order to measure learning outcomes.

The Smart Quizzes did not duplicate what was done in class, nor did they attempt to replace the educators, but instead provided students and educators with an effective, complementary learning and teaching opportunity, enabling students to be supported from afar.

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