The MeLTS Audience Response System: Student Reception, Benefits and Usage

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BACKGROUND

This study presents the investigation of a web-based audience response system, Monash eLearning Tools System (MeLTS), in a first year engineering unit. The system was designed and built by two engineering students and trailed by approximately 230 students over the course of a semester. Given the increasing size of higher education classes, non-traditional methods are needed in order to engage students and provide an active learning environment. Current research has shown that, while there are some minor challenges to employing audience response systems, when used correctly, they have been effective at improving students' learning and their instructors' assessments in addition to the learning environment itself.

PURPOSE

The purpose of this research was to monitor how first year engineering students respond to, use and benefit from the MeLTS web-based audience response system and compare these findings to other methods of engagement.

DESIGN/METHOD

In order to explore these questions, an online audience response system was developed as a web-app by two fourth year engineering students. This system was used over the course of a first year engineering unit to test students' understanding of lecture content with student answers being recorded over the duration of the semester. This data was analysed in conjunction with tutorial attendance, final unit scores and a student survey amongst other data.

RESULTS

There was a positive correlation between the MeLTS audience response system questions attempted and students' final scores for the unit. Survey responses suggested that the audience response system was well received by the students. It was found that smartphones were by far the most popular device students used to access the system, followed by tablets and then laptops.

CONCLUSION

Students tended to use smartphones to access the web-app, they predominantly enjoy using audience response technology such as MeLTS and, given the correlation between audience response system question attempts and final unit scores, it appears that using audience response systems has a positive effect on student learning and increased student engagement. This agrees with current literature on the subject which states that, when used correctly, audience response systems are effective at increasing learning performance and are largely well received by students.

KEYWORDS

Audience Response System; Student Engagement; Peer instruction

Introduction

As class sizes in higher education continue to grow, the importance of scalable methods for student-lecturer interaction and student engagement has increased. Currently, institutions such as Monash University utilize a range of established methods to engage students in course content including practical labs and tutorials in which students are able to apply the course's theory. One less common method of engagement, which is increasingly being explored since 2003, is the use of audience response systems (Kay & LeSage, 2009). These systems allow lecturers to gain real time feedback on students' current understandings of concepts in lectures at any given time. They also provide a way for large scale 'peer instruction' (Crouch & Mazur, 2001) whereby the class is able to discuss an idea and arrive at a consensus before the lecturer moves on.

Literature on audience response systems points to many advantages in using this technology (Kay & LeSage, 2009). Benefits include increasing students' attention during lectures, fostering students' peace of mind through anonymity, increased student participation and engagement, increased intellectual discussion and feedback for both the instructor and students on the class's current levels of understanding. A number of studies also provide evidence to show that using an audience response system can increase student exam performance (El-Rady, 2006; Kennedy & Cutts, 2005). This is likely a result of the aforementioned benefits.

One literature review of audience response systems (Kay & LeSage, 2009) states that there are three main categories of challenges faced when using audience response systems. These categories are technology-based challenges, teacher-based challenges and student-based challenges. Of particular interest to this study was the technology based challenges which include students not bringing their audience response remotes to class and technical malfunctions whereby the audience response systems did not work.

While audience response technology has been used and researched broadly in recent years, there is limited literature on the way in which engineering students react to, use and benefit from web-based audience response systems. In addition to this, most audience response systems only feature the ability to answer questions and do not to provide a 'panic button' if the content is not clear or a leaderboard which adds an optional, competitive element to the platform ("Student response systems - Available systems | eLearning @ UQ," n.d.).

This paper provides an insight into the use of the MeLTS system - a web-based audience response system which can be accessed on smartphones, tablets and PCs. The paper also details a number of new and innovative design considerations for audience response systems, explains and justifies the design process of the MeLTS system and details the outcomes of its real world testing.

In undertaking this experimental research, the primary conclusions were that the MeLTS audience response system was well received by students, that using MeLTS appeared to have a positive effect on student performance and that engineering students, at this point in time, predominantly use smartphones as their chosen internet device for web-based audience response systems. The implication of these findings for audience response system designers states that web-based audience responses systems should be designed for mobile first. In addition to this, this study supports the majority of literature which suggests that there are many benefits to using these systems when used correctly and in line with constructivist principles (Andrews, Leonard, Colgrove, & Kalinowski, 2011; Freeman et al., 2014).

Method

The design of the MeLTS application was a collaborative effort between two final year engineering students at Monash University and their academic supervisor. This allowed the students to provide their own student perspectives in the design process.

The primary design features of the MeLTS system were the web-platform deployment, the ability for students to signal to lecturers that they are struggling with the current content, real time communication between lecturers' and students' devices and, finally, an aspect of gamification through a student leaderboard.

The web browser was chosen to be the most suitable platform for deployment. Development time and monetary costs for native Android and iOS applications would have been significantly higher while also preventing anyone not using Android or iOS devices (such as Windows PCs and non-iOS Apple products) from being able to use the software. Additionally, previous research has identified a number of problems with hardware clickers such as flat batteries, broken clickers or students forgetting them (Caldwell, 2007). Deploying MeLTS to the web provided an opportunity to circumvent this problem while also gauging the penetration levels of smartphones capable of running modern web apps amongst engineering students. Furthermore, it facilitated a way to gauge engineering students' receptivity to web-based applications of this nature.

The ability for students to provide live feedback and inform lecturers to indicate that they are or are not understanding the content is a less common feature in audience response systems. It was hypothesized that this feature would enable lecturers to teach contingently based on how students reacted to their delivery and content.

Real time communication was deemed necessary for student answers to be displayed in a histogram which would dynamically update as students answer a question. It was postulated that this feature would encourage students to challenge each other's ideas and discuss their answers before committing to a final answer.

The leaderboard provided an aspect of gamification (the application of gaming elements to non-game environments). It was theorized that this may add to student motivation and increase engagement.

Screenshots of an example question used in MeLTS and the leaderboard can be found in the Appendix.

Given the scope and nature of this project, it was deemed appropriate to make the development of the application an iterative process. This meant that while the core design considerations were fixed, the implementation of these features was open to changes as was the addition of other features based on what appeared to work or not work. For example, it was found that students were changing their answers to quizzes after the quiz had finished and so a 'lock question' feature was added. Another example was the addition of a messaging feature which was seldom used and thus will probably not stay part of the MeLTS system in its current form.

A number of design considerations were brought to focus in deciding what software was to be utilized in creating the application. Audience response systems are, to a great extent, real time systems. Input from students must be relayed to the lecturer near instantly. It was also deemed beneficial to have the lecturer able to instantly broadcast questions to students' devices. Given this instantaneous and bidirectional nature of information exchange, 'WebSocket' – a web technology which provides a persistent bidirectional data connection between the server and client – was deemed to be a necessary component of the design. In particular the package 'Socket.IO' (a JavaScript library which implements WebSocket) was used in conjunction with 'Node.js' (a server-side runtime environment for JavaScript applications).

At the time of MeLTS's construction, Node.js was under development. Due to this, the platform was open to sudden changes and possibly bugs. Furthermore, the learning curve for creating applications purely in Node.js was quite steep as a result of the small size of the Node.js community at the time. As such, a more traditional 'Apache2' server was also deployed alongside the Node.js/Socket.IO server. This enabled more rapid development of the application. The Apache2 server performs interactions with a MySQL database and serves the static content such as HTML pages, images and CSS stylesheets which determine the site's layout and design.

In order to create, read, update and delete items in the database, the 'PHP' scripting language was deployed. This choice was again made for the purpose of rapid development. PHP is a relatively easy language to learn and utilize for simple tasks. Similarly, 'JQuery' – a JavaScript library – was deployed on the client side for these same reasons.

The database used in MeLTS is a standard 'MySQL' database. MySQL was chosen as it is an industry standard, well tested and well documented database implementation. The application data for MeLTS (student names, quiz questions, unit names etc.) also suited a relational database model (a model where data is stored in tables which relate to one another).

Once a basic prototype had been built, it was introduced into to a first year engineering unit. This provided a way to gauge student reactions and find issues both software and practical in nature. The initial prototype featured a multi-choice question 'clicker' and a student 'panic meter' which allowed students to provide feedback to lecturers when they were struggling with the current topic. No data was collected at this stage as it was simply an initial proof of concept. Throughout the semester, a number of other features were added to the audience response system including a leaderboard, a discussion board and the ability to export data on students' responses to questions.

In the following semester, a 2.5% participation mark was awarded based on the number of MeLTS questions attempted in order to promote use of the system amongst students. This 2.5% participation mark could also be earned by tutorial attendance in case students did not have access to an internet enabled device. Students who attempted more than 80% of MeLTS questions throughout the semester received the full 2.5%.

Once a more full-featured prototype had been constructed both qualitative and quantitative data was obtained over the course of another semester. This data was used to measure how effective the software was with respect to increasing student performance and engagement. The data was attained through tutorial attendance spreadsheets, final unit scores spreadsheets, online lecture video usage logs and an online student survey which received a 43% response rate.

The survey was posted to the Learning Management System, 'Moodle', at the end of the semester and required students to enter their university usernames so that the survey data could be later correlated with the other datasets. The survey asked combination of nine multichoice and short answer questions and provided a method for qualitative analysis of MeLTS usage.

All students who received 0 marks for the final exam were removed from the datasets under the assumption that these students had deferred.

Results

The collected data was analyzed in order to find correlations between different methods of engagement and student performance. The correlation between final scores and MeLTS usage was of particular interest.

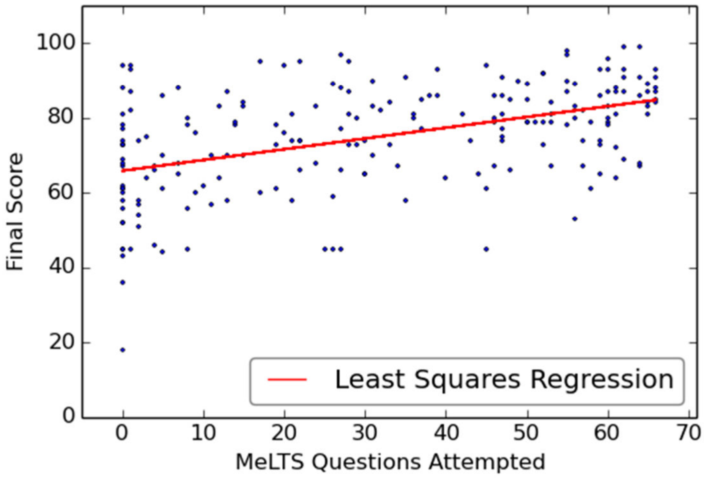

Figure 1: MeLTS Usage vs. Final Score

As can be seen in Figure 1, there is a correlation between the number of questions attempted by students and the final scores received by students. A similar correlation was also observed for tutorial attendance.

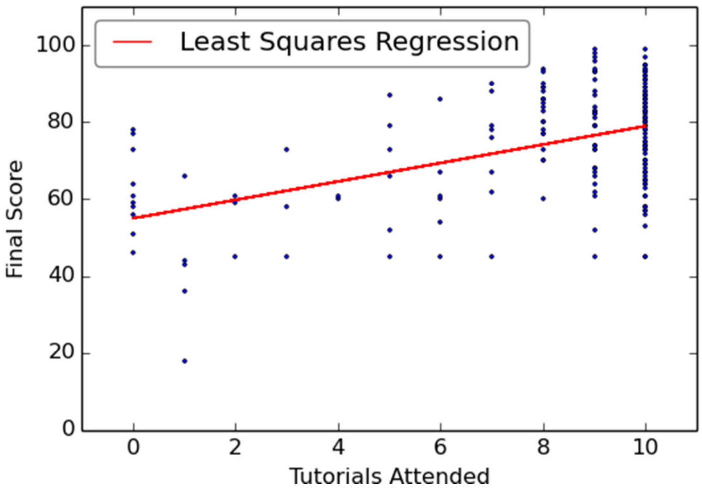

Figure 2: Tutorial Attendance vs. Final Score

It was noted from the data that many of the students who used MeLTS frequently also went to tutorials frequently. There were two students who did not attend any tutorials but did attempt at least 80% of the MeLTS questions. One of these students received a final score of 64 while the other received a score of 78.

The data was also analyzed in order to find a recommended number of MeLTS questions which should be attempted by students. The results were split into averages greater than and less than a particular value of MeLTS question attempts.

Table 1: Splitting Averages Based on MeLTS Questions Attempted

	Average Final Scores		Percentage HD		Percentage Fail		Number of Students	
Questions Attempted (X)	**More than X**	**X or less**	**More than X**	**X or less**	**More than X**	**X or less**	**More than X**	**X or less**
10	78.6	65.2	53	18	3	16	147	56
20	79.2	67.6	56	21	3	12	128	75
30	80.8	69.1	61	25	1	12	101	102
40	81.1	70.6	61	31	1	10	84	119
50	82.4	71.7	66	34	0	9	61	142
60	84.4	73.5	81	38	0	7	26	177

As Table 1 illustrates, students on the ‘More than X’ questions side tended to be 10 marks higher on average than those on the ‘X or less’ side.

A student survey was posted to the Learning Management System and received a 43% response rate (106 students). In response to the question: “How helpful did you find the MeLTS system for learning during lectures?”, the vast majority of students gave MeLTS a score of 4 or 5 out of 5. A similar response was received for the question “How helpful was the MeLTS system for keeping you engaged with the subject during lectures?” where 39 students gave a score of 5 out of 5.

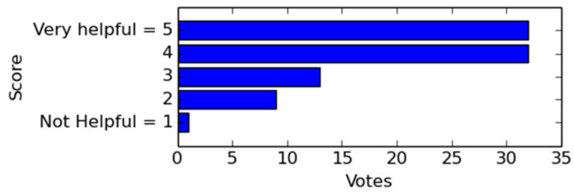

Figure 3: Student Responses to the Question “How helpful did you find the MeLTS system for *learning* during lectures?”

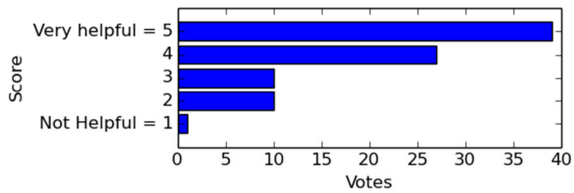

Figure 4: Student Responses to the Question “How helpful was the MeLTS system for keeping you *engaged* with the subject during lectures?”

The survey included a question “If you have any thoughts, comments or suggestions regarding MeLTS, please feel free to put them here.” This section received many positive comments such as:

> *“I would recommend that you put melts on offer for every unit in [t]he university to use. It keeps everyone really engaged and is simple to use. In other units they have used [another audience response system] which requires registration, but melts is just done for us. I've shown people in other courses and they believe it would stop them from just having information going through one ear and out the other!”*

Negative comments in this section focused predominantly on internet speed and lack of stable Wi-Fi access in the lecture theatre. For example, one student responded:

> *“really enjoyed using melts. the only problem is Monash’s wifi”*

It was found through informal feedback from a lecturer that the 'panic button', in its current implementation, was not helpful in providing a way to dynamically adjust the lecture. It appeared to be a distraction to the lecturer.

The student survey also provided data on which devices students used to access MeLTS. It was found that mobile phones were by far the most popular device with 84.3% of students opting to use their smartphones to answer MeLTS questions.

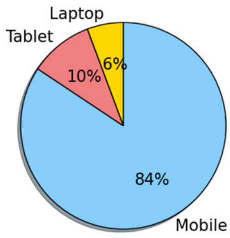

Figure 5: Mobile Device Preferences

Discussion

The correlation between final grades and MeLTS question attempts in conjunction with the positive feedback from the online questionnaire provides a case for the effectiveness of MeLTS in achieving student engagement and improving student performance. It was hypothesized that there would be a correlation between MeLTS attempts and final scores given the wealth of current literature in support of the benefits of audience response systems (Freeman et al., 2014). The poor quality of internet connection was not anticipated, however. This is an issue which needs to be considered in the use of the system in lecture theaters. In conclusion, these findings suggest that, when used correctly, a web-based audience response system such as MeLTS is a highly useful tool for lecturers provided adequate internet connectivity is available, in addition to some understanding of active learning principles.

The survey data on devices used to access MeLTS showed a strong preference for mobile phones over tablets, and PCs. This was hypothesized to be the case as smartphone penetration amongst the Australian population within the average age of university students is very high ("Our Mobile Planet," n.d.). In addition to this, using a smartphone is often quicker and easier than starting up a laptop. This illustrates the importance of designing audience response system software for the smartphone and suggests it should be the platform of focus when it comes to targeting a device for audience response systems.

Conclusion

This research was focused on determining how engineering students responded to, used and benefited from the MeLTS web-based audience response system. In addition to this, comparisons between the MeLTS system and other methods of engagement such as tutorials were explored. In undertaking this research it has been found that MeLTS, in line with the majority of literature on audience response systems (Freeman et al., 2014), was well received by the students with the majority of students claiming that the MeLTS system benefited their learning and increases their engagement in lectures. This was supported by the MeLTS usage data which showed a correlation between MeLTS questions attempted and final score. A similar correlation was noted for tutorial attendance and final score. Additionally, every ten MeLTS questions attempted rose the average score of the group who had done that number or more by 10 marks. It is worth noting that while these statistics look promising, a causal relationship cannot be inferred. Smartphones were by far the most popular device used to access the MeLTS system with 84.3% of students opting for their mobile phones.

Future work which would extend this study may include the use of on-going data from the MeLTS system augmented with other on-going data from a unit in order to produce a predicted final score for each student. This would allow lecturers to find students who are at risk of failing the unit, any time after the initial weeks of the course, and potentially intervene. Additionally, the data obtained from MeLTS could be made open for student viewing and analysis. This would allow students to make their own models and predictions and, in turn, change their study behaviour based on their own theories.

MeLTS appears to be a useful tool to help lecturers engage students in course content and ultimately improve student performance. This study outlines some challenges in implementing a web-based audience response system such as MeLTS and provides both quantitative and qualitative data to support the effectiveness of these systems.

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Appendix

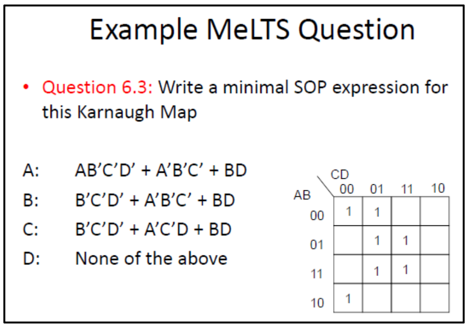

Figure A1: Example PowerPoint slide asking a question to be answered using MeLTS

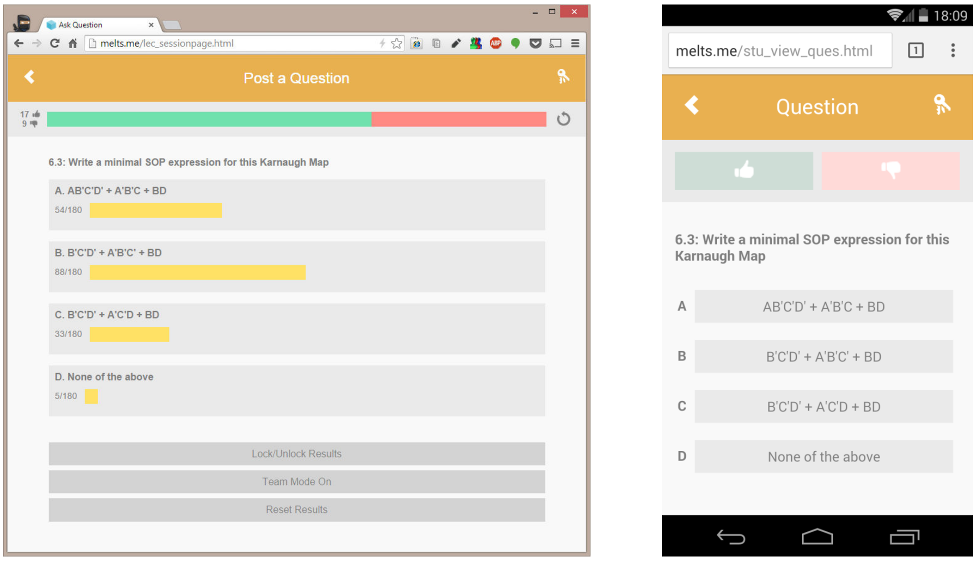

Figure A2: Lecturer and student interfaces to MeLTS asking and answering a question

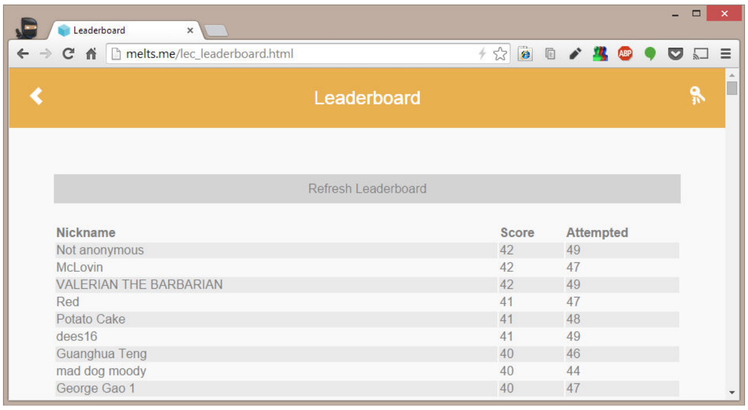

Figure A3: Example of Leaderboard in MeLTS

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