THE UNIVERSITY OF NEW SOUTH WALES

THE SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

Utilising Wireless Devices in Lecture-Based Educations

Undergraduate thesis for Bachelor of Engineering (Software)

Jason Huang

Z3374282

Jhua488@cse.unsw.edu.au

Sheryl Shi

Z3375634

sshi897@cse.unsw.edu.au

June, 2015

Supervisor: Salil Kanhere

Assessor: Mahbub Hassan

Table of Contents

Table of Figures

Abstract

Student interactions are limited within a traditional lecture environment and as modern day progresses, the overall quality of the students[1] learning experience decreases. This paper will examine and determine the different methods for increasing student interactions in a traditional lecture based environment through the use of technology. A system based on the design and implementation of a web application that would utilise the use of wireless devices present. This system provides lecturers with the ability to actively engage student learning with technology used within a lecture environment.

Introduction

Different lecture based environments all have different ways of presenting information to a large audience size. However not all the methods that are used can be effective as these lecture based environments would all use a passive learning style, which is not the best style used for students with retaining information. This style of learning presents a loss of student and teacher interactions. Within a small classroom sized environment, the instructors are able to engage with students on an individual basis more freely. Able to determine and comprehend the progress of each individual student, allowing them to teach at a more appropriate speed where each student would be able to benefit. However, with the large number of students in a lecture based environment, lecturers are not able to provide the same kind of engagement with students to determine their progress. Without being physically engaged, students would also find it difficult to remain focused and engaged. In particular, shy students would struggle to speak out during the lecture with large audiences, to ask questions when they are struggling to understand concepts. This reduction of interactions between students and the lecturers would have an impact on the students learning capacity.

Many different approaches have been used to try and solve this issue by using different methods and with different technological applications in conjunction with lectures. Trying to improve the interactions within large lecture based environments. However many of these systems have major flaws, such as the requirement of carrying large hardware devices in order to participate in lecture, reducing the mobility for the students or they are not considered cost-efficient to become implemented in all lecture based environments. There are techniques that do not require the use of technology to improve the students engagements in class, such as test, discussions or utilising exercises. Features that may be used in lecture based environments. There are several applications that have now been developed that are able to help with some lecture environments utilising active learning techniques into the lectures.

With the high rising use of technology, access to mobile devices are able to eliminate barriers and improve individual along with collaborative learning through the ease of use and convenience[2]. The proposed solution that we have suggested, LMSUNSW allows us to use this rising technology to increase the interactions between student and lecturer creating an active learning environment. This solution does not aim to replace current lecture styles non any existing management tools but rather an additional in-lecture application to actively engage students with the lecturers. Based on the research that we conducted, the solution includes features that are more interactive for students. Features such technology-enabled notes collaborations where students are able to share notes taken, live quizzes for students to answer and a personal confusion meter for each student.

Given the increase of mobile devices, a simple web application that can be accessible on all devices was created. Allowing all students to be connected regardless of the type of device they possess and interact together as a class.

This system was trialled on several occasions in real lecture environments where students were able to actively use the application on their own devices ranging from laptops, tablets to mobile phones. In these trials, participation rates were moderate and we were able to gain feedback from both students and lecturer.

Background

Teaching and learning has mostly been teacher focused rather than learners focused. However what the students would do in order to learn would be considered of great importance. Both teachers and learners are of great importance and both have significant influences on their understanding of the different paradigms of teaching and learning.

From a teacher's perspective, the teaching style would be highly important as this would be the main method that a teacher would pass on the information to their students. From a student's perspective, there are multiple patterns found on the way a student would benefit and absorb knowledge to their best.

There are three main paradigm styles that are used for teaching: Individualistic, Competitive and Cooperative[3]. While there are four main types of learning moves that students adapt to: Visual, Auditory, Kinaesthetic and Read/Write [4]

Teaching Styles

With individualistic methods, each individual student is independent and separate from one another in how they learn[5]. This implies that the knowledge and skills are assets that teachers can transfer to the student in an environment where there is no interference.

This type of environment would be found in lectures where the information flow would just become single directional, from the lecturer to each individual student where only the students that are paying attention would be able to fully grasp the information presented. Students that are not engaged would not be able to grasp the content being presented. Students would not be able to interact with one another to share knowledge or answers or ideas.

Another method that would be used with teaching would be the competitive style. Competitive learning style are when one student's goal is achieved however there may be other students who failed to obtain that goal[6]. This is achieved by having the students compete again one another for success. Sometimes these types of learning styles can be utilised in groups or individuals depending on the appropriate environment. However there have been problems with this type of learning style as it can cause stress and anxiety for the student. This style could also prompt cheating and impact on the ability to problem-solve[5].

The Cooperative method, unlike the competitive method requires the students to form into groups or teams and work with all the members in their groups or teams in order to achieve the desired final result. Rather than having only a single student experience success, cooperative method would enable all the students in the groups that have succeeded to experience the feeling of success[6]. This allows students to become more responsible for

themselves and for the other students that are in their groups. This method would also encourage working within a team environment.

System Research

Globally, there have been various researches conducted to utilise active learning into students learning environments within lectures. The results conducted from these researches form majority three different systems: MOOC system, LMS and Student Response System.

MOOC

MOOC stands for Massive Open Online Course where it is able to cater for an extremely large class size, thus the Massive. Its contents are open to all students and are available without the need for entrance exams or enrolments into any form of institutions, thus the Open.

The term Online is due to its primary method of delivering its contents to the students, allowing the seamless integrations of technology. MOOC courses are structured exactly like an educational institutional course where there are a set amount of materials that has to be covered before the course outcome is met[8].

LMS

Learning management systems encompasses all aspects of the learning process, from content delivery, to role attendance to assessment collection, to course administrations. They provide a centralised location for managing and entire course[9].

Originally LMSs were used for managing complex training regimes found in the workplace environment, which is outside the range of educational institutions. Mainly used for staffing and training situations where they are able to education staff members in the workforce, so it would focus heavily on a personalised learning experience with features such as performance tracking tools and adaptive coursework for tailored training.

LMSs are a huge complex system that has tons of features, making it a powerful education tool however in the process it sacrifices much of the convenience and ease of use limiting its usage for the average student.

Student Response

A student response system is a physical implementation for providing students an interaction within a class environments[10]. Initially, physical clickers were used as the implementation of the response system however they were expensive and needed extra infrastructure to operate.

With the rising in technology, there has been a shift from hardware to software implementations of student response systems where students would still be able to interact within the class environment simply through their own mobile devices.

These response systems allows the audience a more subtle feedback channel to the instructor while maintaining the passive teaching environment of a lecture. Engaging the audience in a new way that provides an interactive aspect within the passive environment.

Existing Systems

There are currently many existing systems that can be incorporated into a lecture based environment for the lecture to incorporate an actively learning method. However these systems are more used as a student response tool rather than a system directly developed for the use as an audience response system in a lecture environment. However some of the features can be used to an extent as a student response tool[11].

Some of these systems are:

- Google Forms: they would be able to provide a polling tool for the audience to use
- Piazza: can be used as a real time question bank with discussion forums
- Pinnion: a generalised survey tool and audience response system which can be used in education, healthcare, Real-Estate, etc.

These systems and many more can provide an interactive experience in a passive learning environment without disrupting the large audience size.

Clickers

Student response systems has been developed for many years and are known as Audience Response Systems (ARS) or clickers. These systems allow students to interact with the lecturer in the form of multiple choice questions posted by the instructor. The system would then collect results that students inputted into the clickers, through the use of radio frequency transmitters and instantly viewed[12].

These transmitters require a much higher cost investment for either each student to purchase and bring to class or for the education institution to provide for each class. These clickers have now expanded their product to incorporate a web based clicker which allows mobile devices to be used through WiFi or cellular data network.

Moodle

Moodle is a form of MOOC that is used by schools, universities and other educational organisations from as early as 1999[13]. Extensive number of features of provided to run an entire course, allowing for a versatile website in order to meet the needs of the course. Such as creating forums, instant chat, quizzes, modules and notes.

However Moodle would not be able to be in cooperated into lectures to provide an active learning due to the lack to instant student lecturer interaction. Though there are some useful features that may in utilised for a lecture based environment. The creation of quizzes may be shown or hidden to students would give lecturers the flexibility to pre-create questions and simply release it for students to complete during the lecture.

Another useful feature would be the forums where open ended discussions may occur for students during the lecture. The instant chat feature would allow students to directly talk to all their fellow classmates without physically disrupting the lecture that is being presented when students are uncertain.

New System

A new system will be needed to be developed for the system to be better suited to be used during lectures with the core focus of incorporating actively learning into the lecture based environments where lecturers would be able to actively interact with the students. Previous research and system have all been developed for an out of lecture environment where real-time interaction are not as crucial or for a specific purpose within a lecture.

This new system will contain various features to help create the active learning environment where instant feedback is crucial. No external hardware cost will be required as both students and lecturers will be able to access the system with their won current mobile devices.

Most importantly, the system will be tested in a live lecture based environment where results obtained shall be meaningful to its effect.

LMSUNSW

The aim of the system is:

> 'To provide a mean for students to actively participate and engage with lecturers within the lecture environment through the use of mobile devices.'

The objective of this proposed solution is to provide an assistive and supplementary framework by which the class can engage in a more active and interactive style. The goal of the framework is to deliver to the class a new method of collaboration, cooperation and communication within a lecture transcending the physical limitations of the environment.

The system has features that are assistive, widely used and extensively tested by previous research. Along with some 'new' features that are collaborative elements have been included as well. Features that has been modified to cater for a specific purpose.

The deployment of the system would not affect the traditional teaching style in a negative way. As any negative repercussions would indicate problems in the effectiveness of the software system in terms of its impact to providing active learning.

Our system relies heavily on a technical framework where the solution is designed to run as a web application software system and accessed through various mobile devices available in the lecture environment.

Features

The list of features that we have implemented are outlined below. The implementation of these features will be discussed in further details later in the section.

- In-Lecture Quiz Questions
  These include general MCQs and free response questions along with a general rating system. Lecturer may select to have multiple answers in their MCQs or every have students respond to what they predict a given function may be.

- Anonymous Question Posting
  Students have the ability to ask a question and have it answered by their fellow peers or the lecturer themself. Question posting has the ability to remain anonymous so that students would not have to be shy of being identified when asking a question.

- Confusion Meter
  This meter provides a method of allowing the instructor to quickly glance at the overall confusion of the students about the topic at hand. The students of the audience will be able to individually state whether they understand the content or not along with posting a short message about specifics related to their confusions.

- Peer Editing
  Providing the students of the audience a way to collaboratively create and edit notes in real time. Students with a better grasp of the knowledge being presented to them are able to instantly respond to notes that may not be comprehended deeply or correct incorrect assumptions of the topic.

- Code snippet
  This feature gives the lecturer the freedom to write code style without the need to follow specific structures. May be incorporated in the quiz questions for students to respond to.

- Live Results
  The lecturer is able to view live results from the quiz questions as each students submit their responses. This can be viewed in either free form or in a tally form. Allowing the lecturer to gauge the number of students answer and what each individual student would respond.

- Wordcloud
  Provides a method of allowing t6he instructor to combine the audiences' response on a subject that has no distinctive correct answer. It can be used as a brainstorming tool, where it can accumulate the ideas, opinions, or statements of the audience to provide a quick and easy summative view of the subject at hand.

Design

Utilising existing software would provide a benefit in terms of time saved, however it may not perfectly satisfy the aim as their purpose are sometimes not fully aligned with the goal. OpenLearning and WebCMS2 are both an already existing platform currently used in the CSE faculty within UNSW.

OpenLearning focuses more on collaborative tools that would combine forums and use of wikis into the one application. WebCMS2 possesses a more simple course management tool that provides students with relevant resources such as assignments and lecture slides.

However both these applications place more emphasis on the overall learning support rather than in-lecture assistance, therefore utilising those platforms as a foundation may reduce development time, but it may also restrict the flexibility and freedom of development.

Moodle provides a suitable foundation for our application, however the sheer size and complexity of Moodle may ultimately counteract the benefits it possess.

Alternatively, a completely new application can be created with some features from existing course management tools or software but not based on these tools or software. By developing a new system from scratch, it allows for more flexibility in terms of design choices however at the cost of development speed.

Application

A web application provides users with the flexibility with the type of technology used. Devices such as mobile phones, tablets or laptops would all be catered to for the large audience to access. Incorporated with a wireless network, one that most students would have access to either privately or through most universities, devices would easily be able to connect to the application without any installation needed.

Design Principles

There are a number of principles which would help with the achievement of the projects goals. These are:

Consistency

In the creation of any web application, it is essential that the application maintains consistency throughout the pages of the application. This would contribute to the ease of use of the application for the users, giving them a sense of familiarity throughout the entire application.

The application's original design varied drastically from the final design as the project went through multiple iterations of design changes. In particular at the different stages of feature completion, the design changed in accordance to accommodate the new features.

After observing how the users interacted with the system, changes to the design were further made to provide consistency to the web application. Observing the users were able to help identify the aspects of the application that were difficult to use.

Efficient

As our goal of LMSUNSW is to increase the interaction of students and lecturer in a lecture based environment, it is important to ensure that the system is fast and efficient in its performance. A poorly designed application would imply that each individual students would interact with the application rather than the lecturer and their fellow peers.

Feedback

Instant feedback to the users would allow them to be aware of what is exactly currently happening. Delayed responses would be a bad form of design as it would make it difficult for the users to know if something is happening or not. By focusing on providing user feedback through various means, such as colour changes for buttons or movements of the confusion meter will give the users the sense that their responses have been accepted and acknowledged.

Another form of feedback would be through the "show not tell" principle where the user would be shown what to do through various colour indications rather than reading instructions through a group of text. An example would be during the registration process, the mandatory fields are indicated with an astrict * to differentiate between non-mandatory fields.

Live

One important aspect with an in lecture application would be creating the feeling that the students are connected to other users, allowing different forms of interactions between each other. In our application we have various form of live interactions. A pop up notification would appear on the students screen when the lecturer enables a quiz no matter what they were doing previously. The collaborative note feature is shared instantly between all the users, presenting real time collaboration.

Implementation

The implementation consisted of two different aspects: administration users and student users. These different areas have their own specific target audience and purposes. Ensuring different functionality which will be discussed below.

The GitHub repository can be found here: https://github.com/mrJayson/lmsunsw

Administrator User

Administration refers to the higher level of access for the lecturer both for preparation for, and during a lecture. Rather than creating separate interfaces for the administration for preparation and monitoring during lectures, one simple interface was created for the lecturers to use.

Navigation Panel

The navigation panel allows a lecturer to navigate throughout the application easily. The top navigation bar are permanent buttons while the side half would only be displayed when selected on a mobile device. Otherwise it will always be displayed on the left when accessed on computers. A sample navigation is shown below in Figure 1.

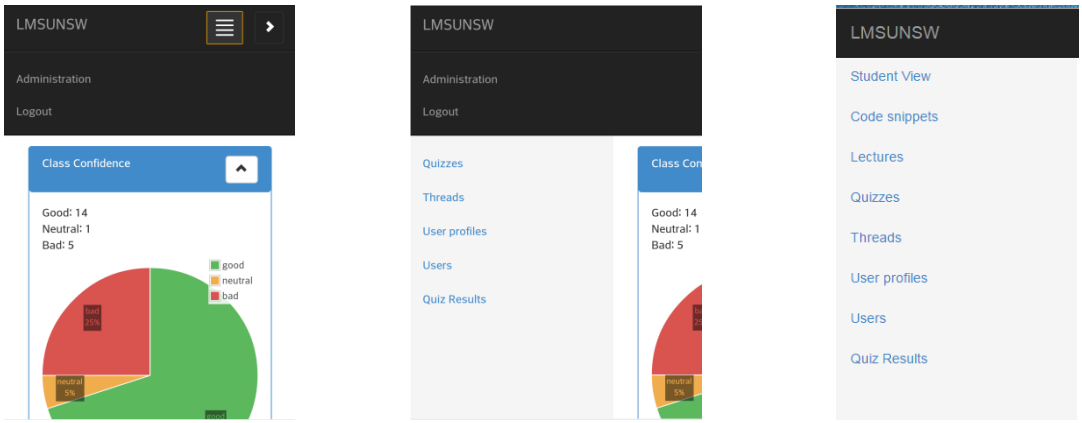


Figure 1 Administrator Navigation

The navigation panel represents the different aspects available in the system.

Student View

This feature will show the administrator how the students view would appear. This feature will present to the administrator a live view of how a student user would view the system. Further details on the student view will be explained below.

Code Snippets

Code Snippets allow the administrator to freely write code style to their own preference for different coding languages without having to follow a rigorous structure. Figure 2 shows the layout of the page when the 'Code Snippet' is selected on the navigation bar. Located on the bottom right would be a button 'Add Code snippet' for creations of new code while the bottom left would show the number of code snippets created already. There are actions that can be applied to the selected code and at this point it is to delete the entire code snippet and having it removed from the database.

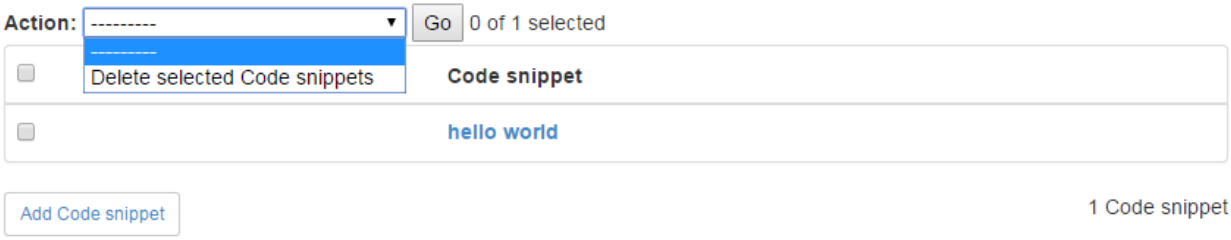


Figure 2 Add new Code Snippet

There are only 3 simple fields that are required. The language of the syntax, the actual code example and the lecture that the code would be shown with. The lecture selection is a dropdown menu of all the created lectures for easy selection

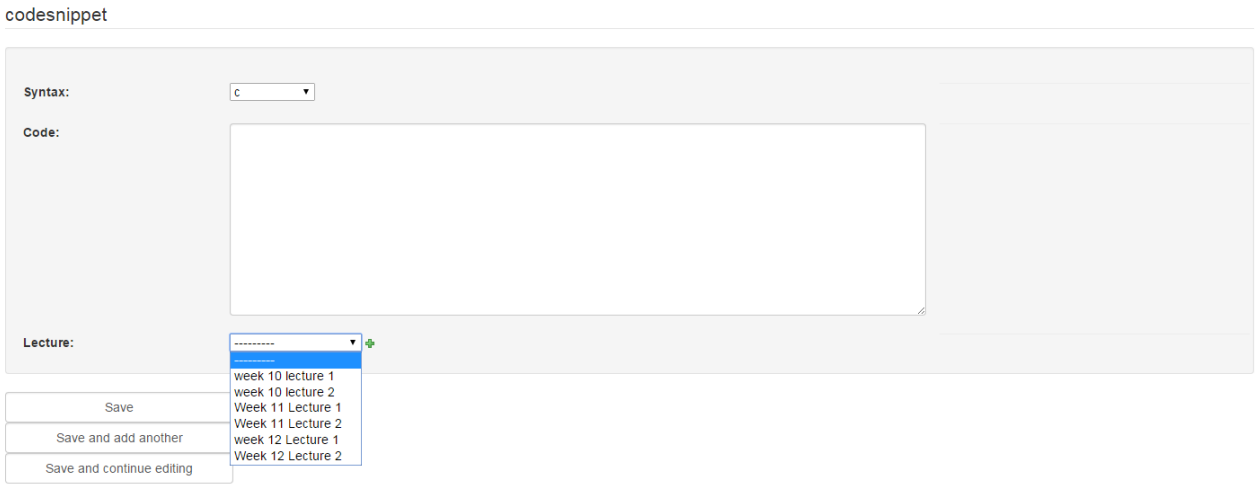


Figure 3 Create new Code Snippet

Lectures

From the navigation panel on the left, an 'Add Lecture' button appears at the bottom which would lead to the creation page for a new lecture to appear shown in Figure 4.

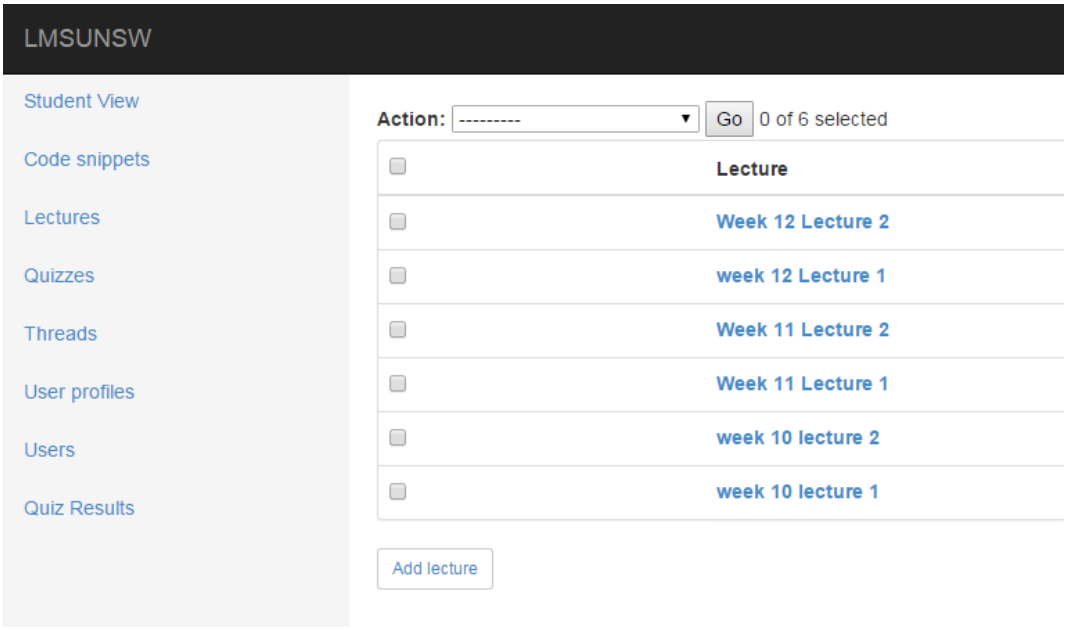


Figure 4 Add new Lecture

Creating a lecture requires a mandatory 'Title' field (e.g. Lecture 12) and an optional embedded link field. This embedded link is a URL of specific 'Google Docs' and if left empty, a default Google Docs page will be created for the specified lecture. This document would be accessed by all students to collaboratively take notes.

As shown in Figure 5, an optional field has been provided where the lecturer may provide their own notes. This can be submitted in either file form or a URL link to lecture notes already provided online.

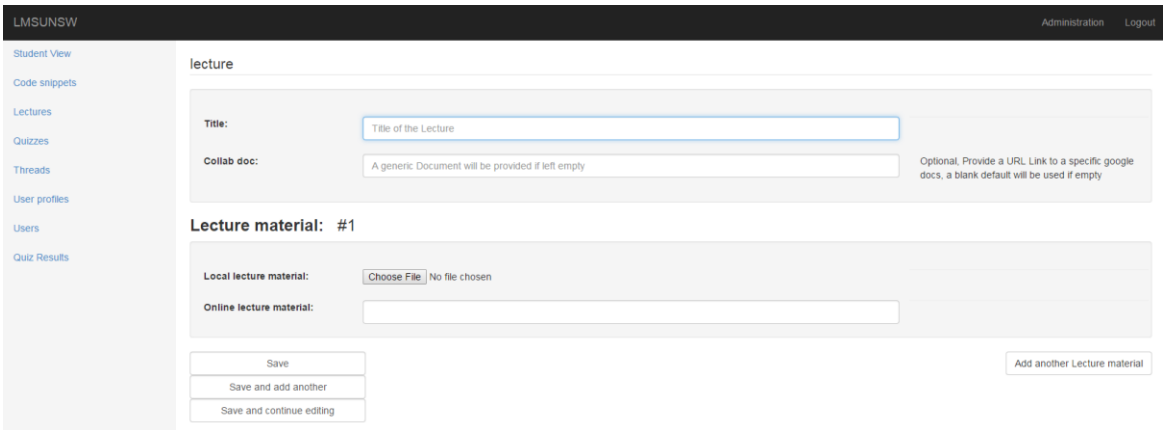


Figure 5 Creating new Lecture

As seen in Figure 05, the buttons located at the bottom of the page 'Save', 'Save and add another', and 'Save and continue editing' is added for convenience during preparation time when bulk preparing.

Once saved, each lecture would appear similar to Figure 6 and an additional option of 'Delete' appears, which would allow deletion of this particular entity. Some entities in the system have variable length assets attached to them, such as an arbitrary number of lecture slides attached to a lecture. The associated buttons allow the administrator to control that.

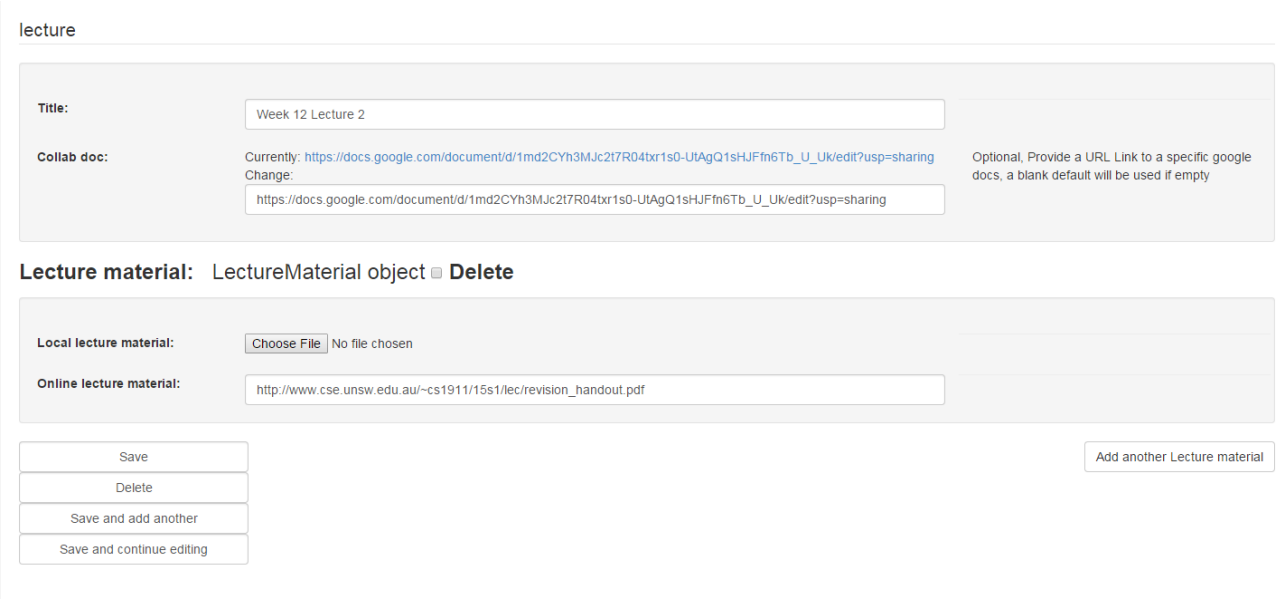


Figure 6 Modifying Lectures

Quizzes

Each new quiz creation would start here. The lecturer would be able to view previously made quizzes and change their visibility status for the students in this panel as well. For consistency, all actions such as 'Add __' are located at the bottom left of the page and all previously created materials are listed above for easy access. Same for 'Lecture' and 'Code Snippet', quizzes also gives the lecturer the freedom to perform 'actions' for selected quizzes. In this case the deletion of a quiz.

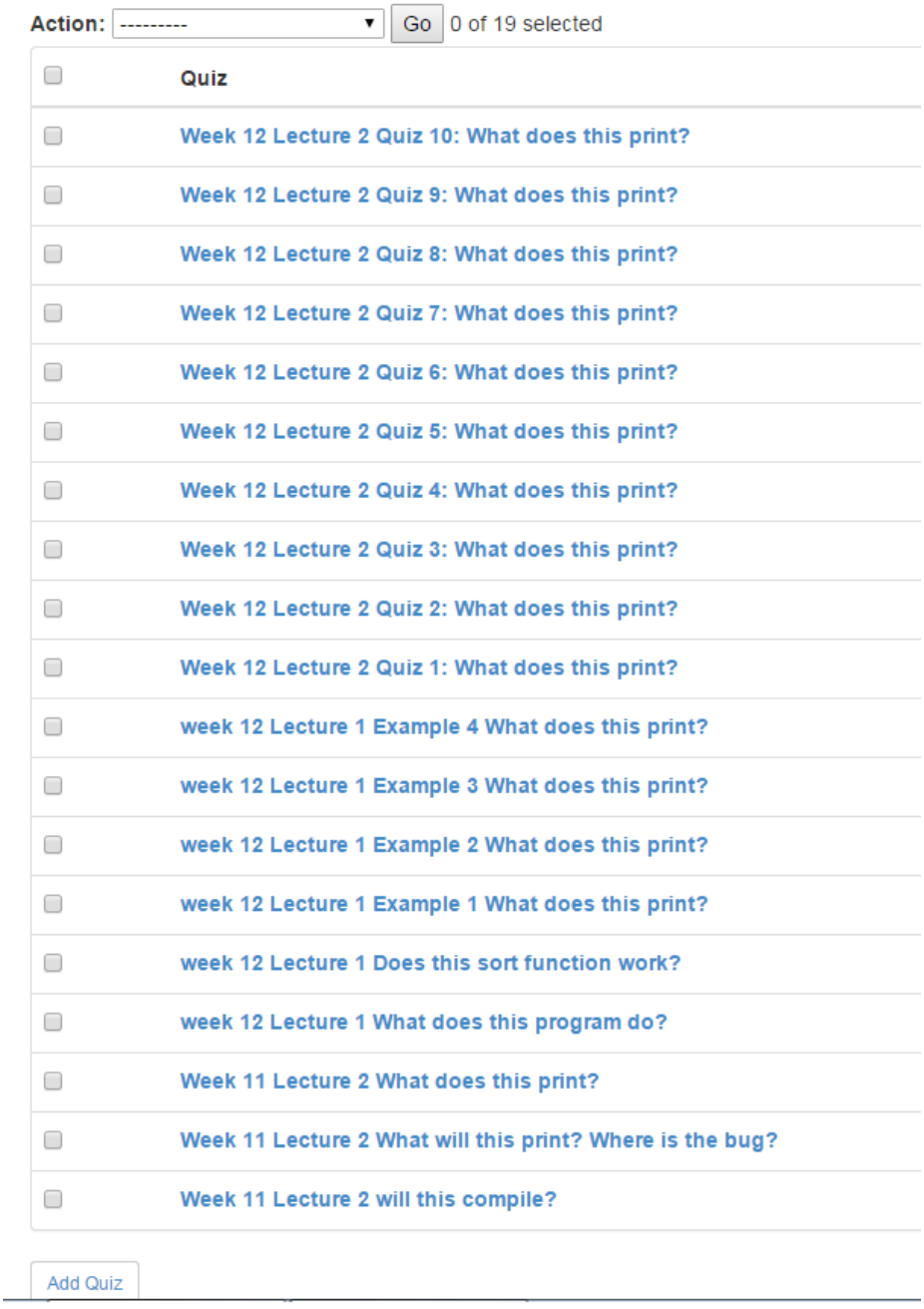


Figure 7 Quiz Page

A quiz can be created by selection the 'Add Quiz' button on the page and will present a page that asks for a number of fields to be completed. Question refers to the question that is being asked in the quiz which is linked to a specific lecture. The lecture may be selected in the dropdown menu and an optional answer can be provided.

As seen in Figure 8, there is a checkbox called visible. This once checked will make the quiz available for the students to view and complete. Code snippet is incorporated into quizzes so that questions are not restricted.

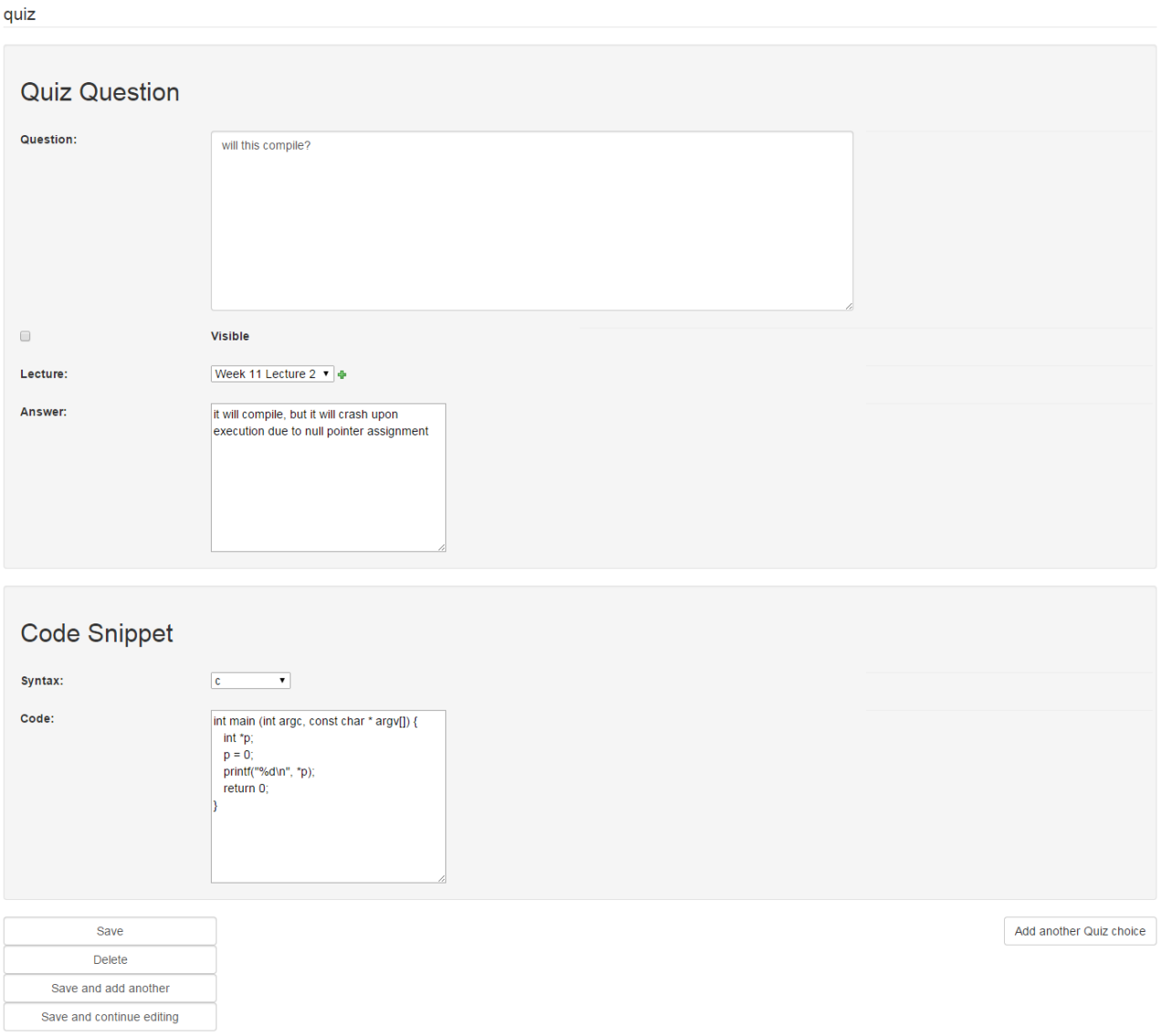


Figure 8 Creating a new quiz

Our system gives the lecturer many forms of freedom for quiz types. If they wish to impose students to select an answer in the form of a Multiple Choice Question (MCQ), then they simply have to add the quiz choices by clicking the 'Add another Quiz Choice' button on the bottom right of the page.

This will give the lecturer the freedom to add in as many choices as they wish, so not restricted to only 4 choices. If too many choices were added, clicking the 'Remove' hyperlink next to the quiz choice number would remove the corresponding choice from the question.

In figure 9, if a correct checkbox was marked in the quiz choice field, the question type would be a MCQ where only one answer is correct. If more than one 'Correct' field was marked, the question would be a multi answer question where the students would choose all the correct answers for the question. If no 'Correct' checkbox was marked, there will be no correct answer given for the question. (E.g. Users rating where there is no correct answer).

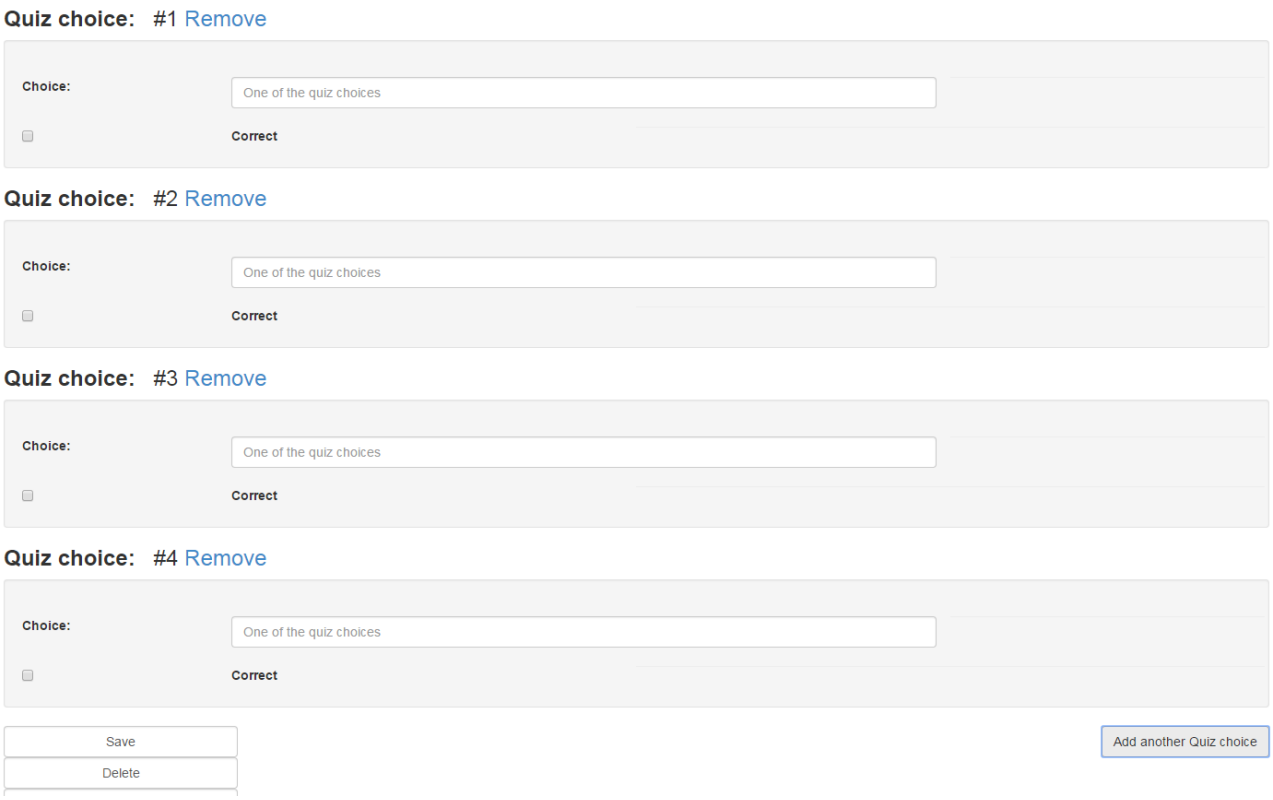


Figure 9 Adding Question Choices

Threads

Threads refers to any questions that are asked by students to their peers and any responses to these questions. The question posting are not just restricted to students, the lecturer would be able to post question to the students as well.

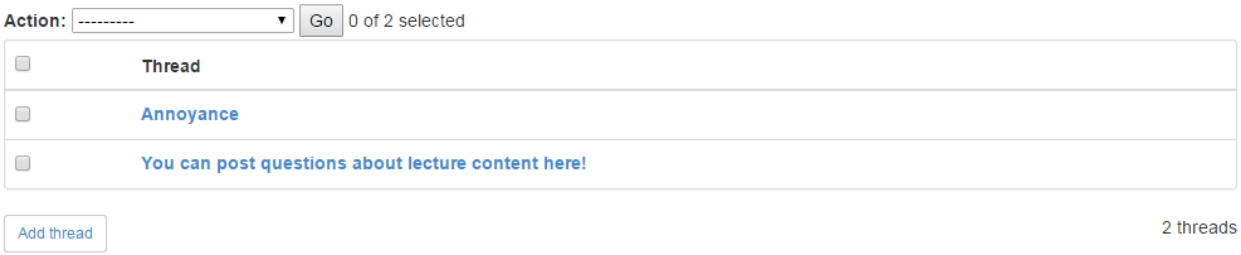


Figure 10 Administrator Adding a new thread

Quiz Results

Quiz Results refers to all the questions that have been created and the responses received by the students. There are two methods of the results being displayed. If the question was a free form question where no question choices were provided, a simple list of all the submitted results would appear below the question selected. As can be seen in Figure 11.

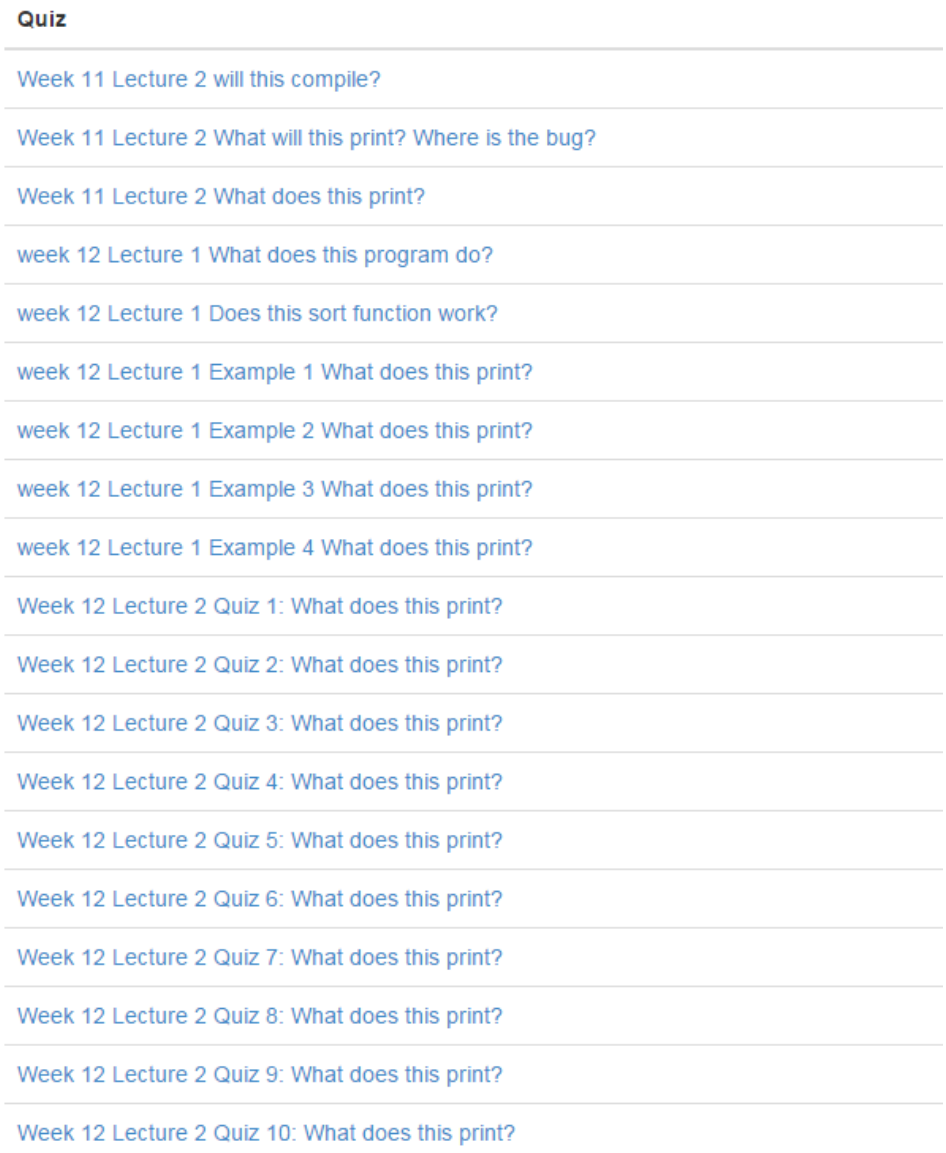
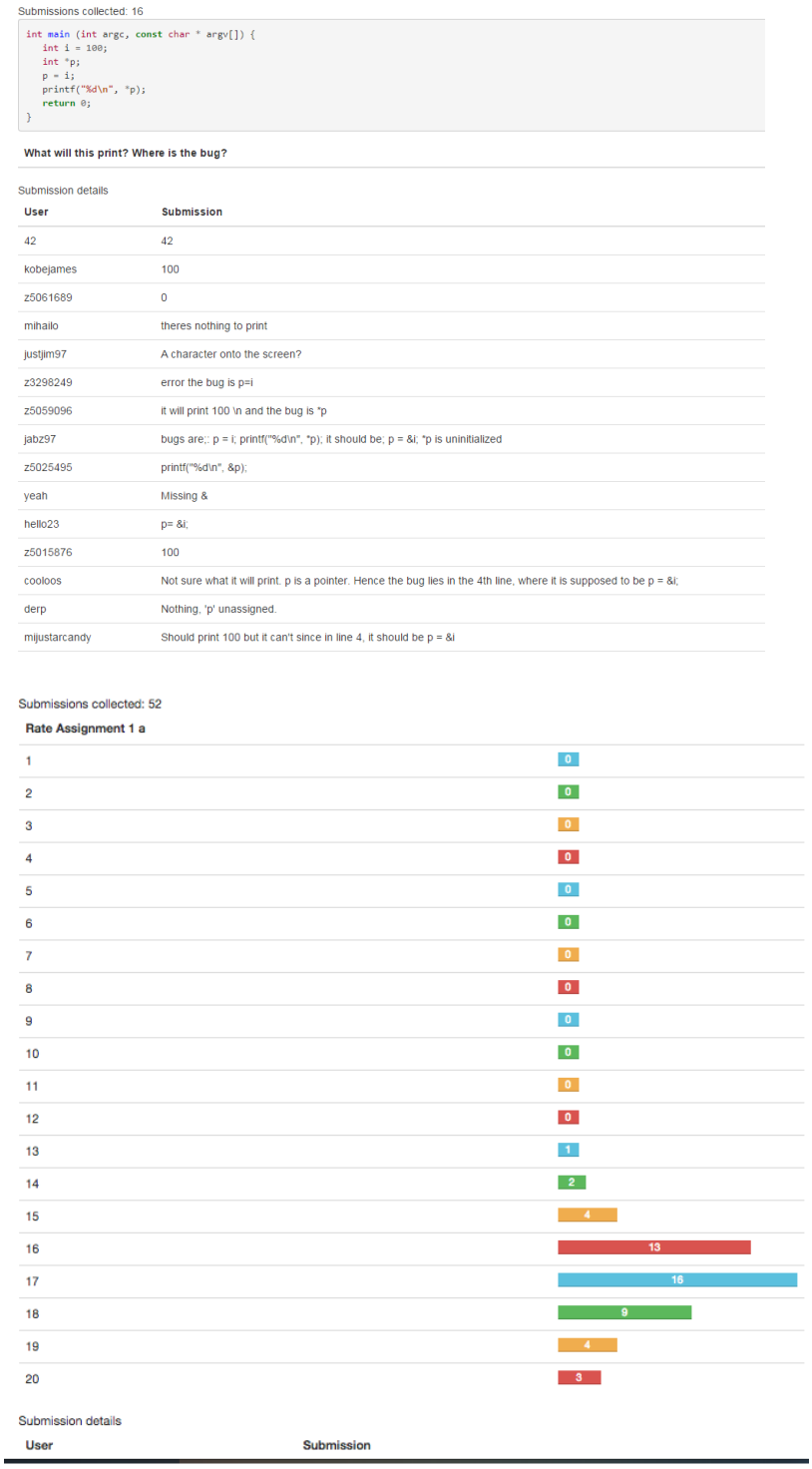


Figure 11 List of quizzes for results

If the question provided was a MCQ or a Multi-Choice question then the results would be displayed in a graph form of all the submissions below the question.



Submissions collected: 16

```
int main (int argc, const char * argv[]) {
   int i = 100;
   int *p;
   p = i;
   printf("%d\n", *p);
   return 0;
}
```

What will this print? Where is the bug?

Submission details

User	Submission
42	42
kobejames	100
z5061689	0
mihailo	theres nothing to print
justjim97	A character onto the screen?
z3298249	error the bug is p=i
z5059096	it will print 100 \n and the bug is *p
jabz97	bugs are;: p = i; printf("%d\n", *p); it should be; p = &i; *p is uninitialized
z5025495	printf("%d\n", &p);
yeah	Missing &
hello23	p= &i;
z5015876	100
cooloos	Not sure what it will print. p is a pointer. Hence the bug lies in the 4th line, where it is supposed to be p = &i;
derp	Nothing, 'p' unassigned.
mijustarcandy	Should print 100 but it can't since in line 4, it should be p = &i

Submissions collected: 52

Rate Assignment 1 a

Submission details

User	Submission

Figure 12 Detail view of free-form and MCQ quiz results

Confidence Meter

The confidence meter is an indication from the students to the lecturer, about their level of understanding of the topic being discussed in the lecture. This is a live meter that gets updated every second and is displayed in a pie graph with colours for the lecturer to view. The meter is displayed on the dashboard page for the administrator, which is the home page.

As seen in Figure 13, for students who have raised that their confidence is bad. The lecturer is able to locate the general area that these students are seated through the use of the seating location mentioned above.

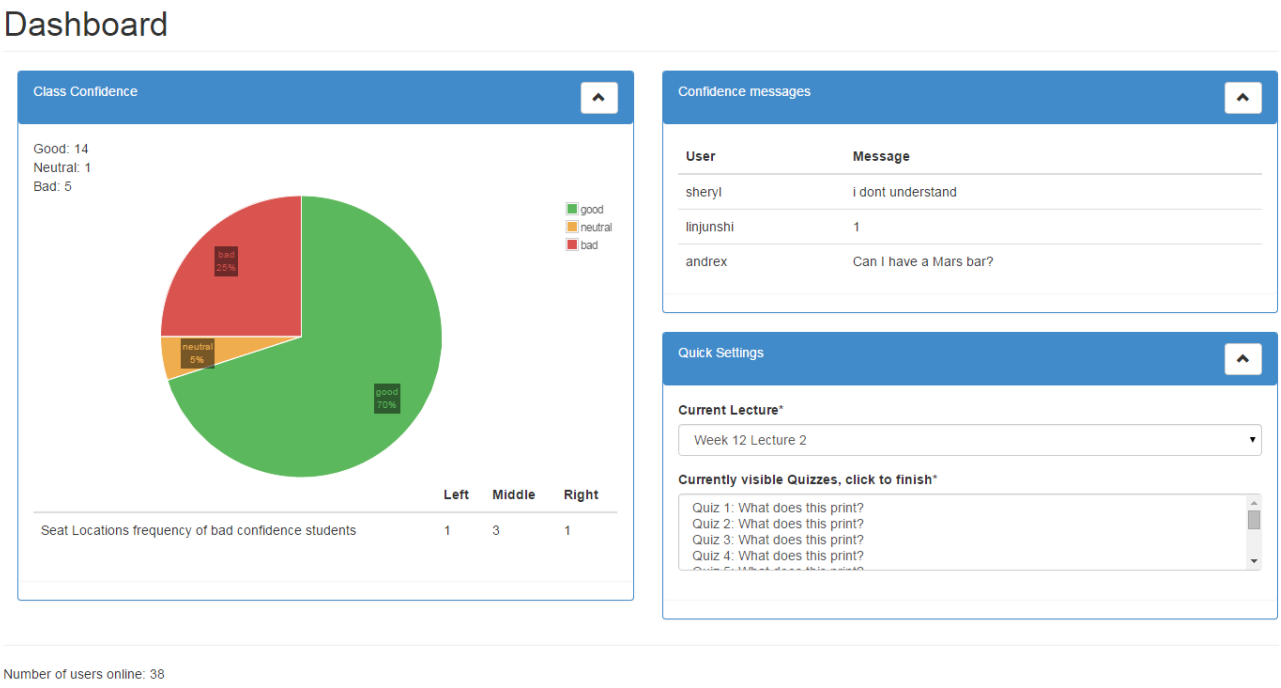


Figure 13 Administration Dashboard with Confidence Meter

Beside the confidence meter, there is also a small message board provided for the lecturer to view any messages in particular they wish to notify the lecturer. Messages such as going 'too fast' or 'not understanding arrays', a message that would give the lecturer and idea of why they are not confident to follow. This feature was added in later after trial runs began by the lecturer himself.

Student Users

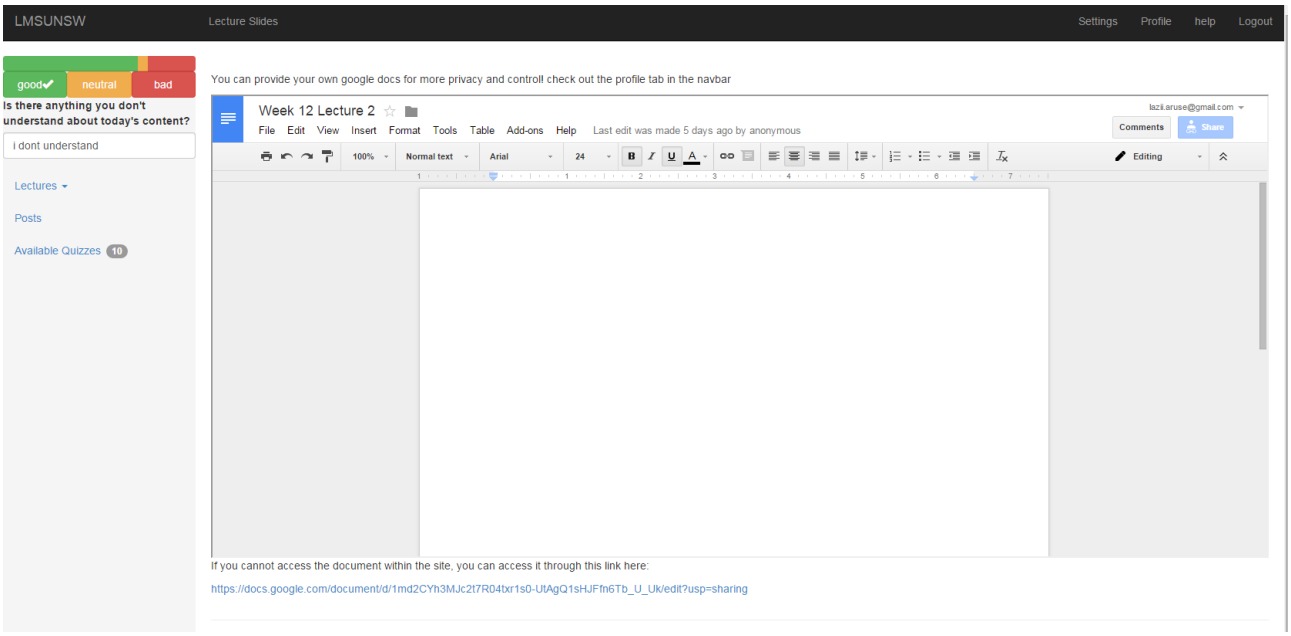


Figure 14 Collaborative Document View

The default student view can be seen in Figure 14. A clean simple navigation bar is permanently found at the top and the left side of the page. The top navigation bar in black features any extra materials that may be provided by the lecturer shown on the left and seen in Figure 15 below. In Figure 16, a lecture slide is provided for the current lecture (Week 12 Lecture 2). The left side of the top navigation bar allows the users to modify their profile and change their own settings.

The side navigation bar would always be located on the left where the confidence meter would be easily accessible to the students at the top.

Once students have logged in, they would be able to view the latest lectures Google Doc to collaborate with all their fellow students. This document is the same as a regular Google Doc so a sense of familiarity is given to the students for immediate use.

Lectures

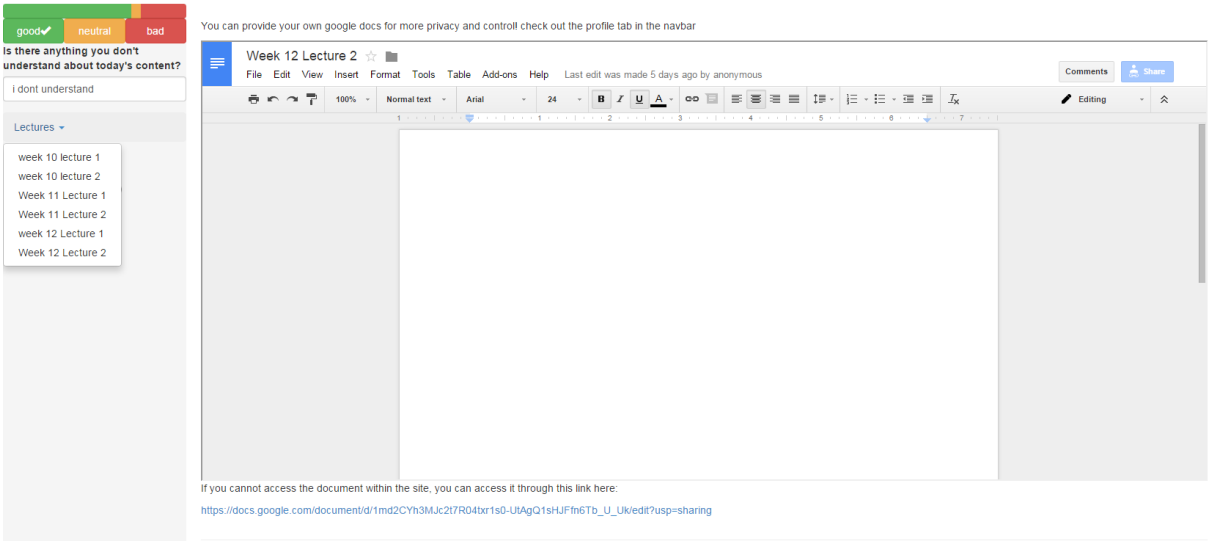


Figure 15 List of Lectures on the sidebar

By default, the newest lecture created by administrator would be shown on the home screen for student users. However if they wish to view previous lectures, the 'Lectures' found on the left navigation panel would appear with a list of all the previous lectures for the student to select.

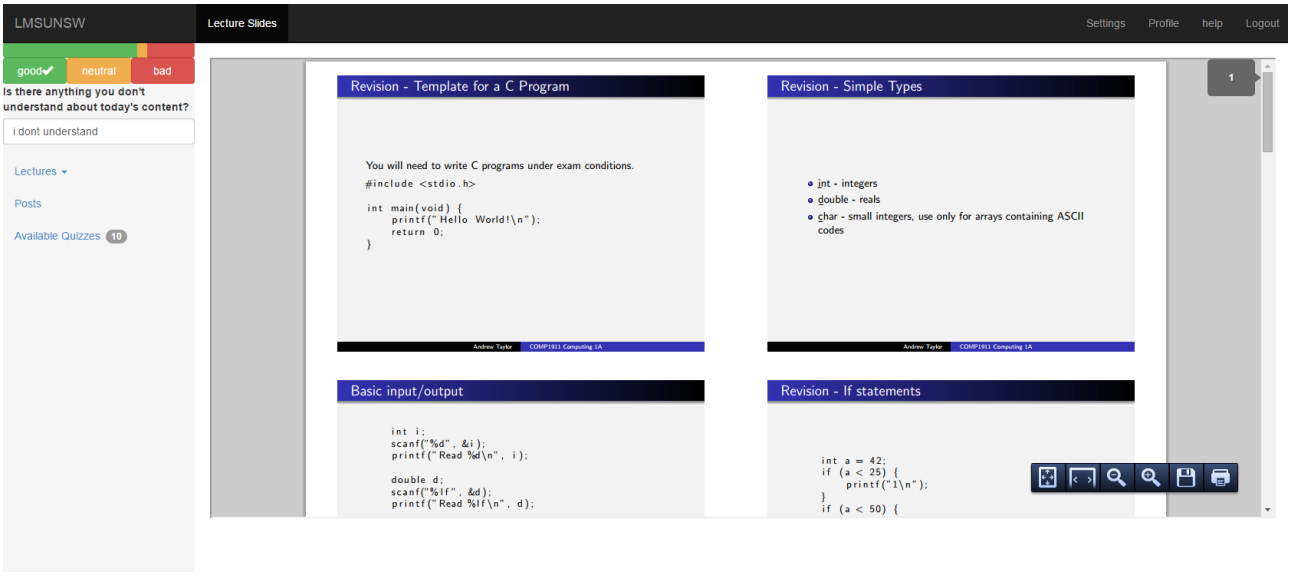


Figure 16 Students view of embedded Lecture Slides

Posts

As mentioned earlier, students are able to post or reply to questions posted either by their fellow peers or the lecturer. This action can be made through the left navigation panel under 'Posts'. Students are able to view all posts submitted regardless of the lecture that the post was asked.

Available Questions

'Available questions' will only appear if there are questions that administrator has opened for the students. When a quiz is opened for students to complete, a pop-up notification is displayed on the screen to notify students of an awaiting question.

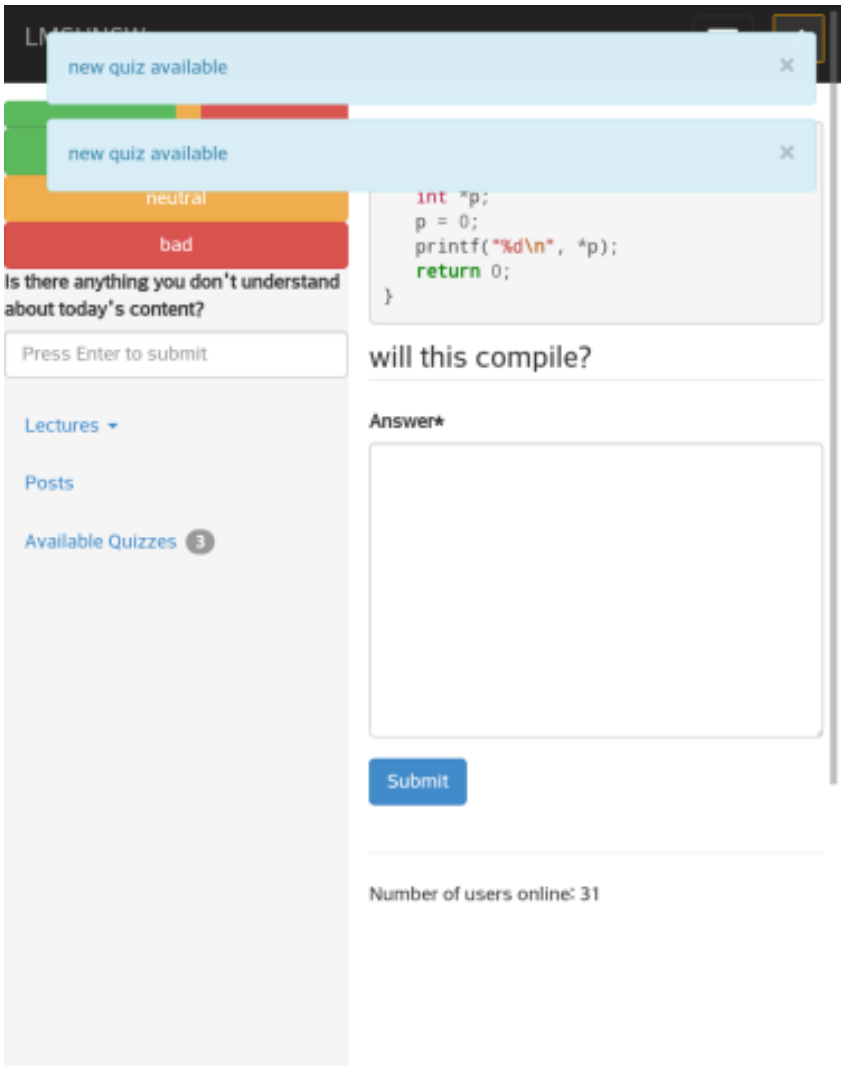


Figure 17 Quiz Notification

Students are able to submit their answers through the submit button and if it is a MCQ question, they will be notified immediately if their submitted answer was correct or not.

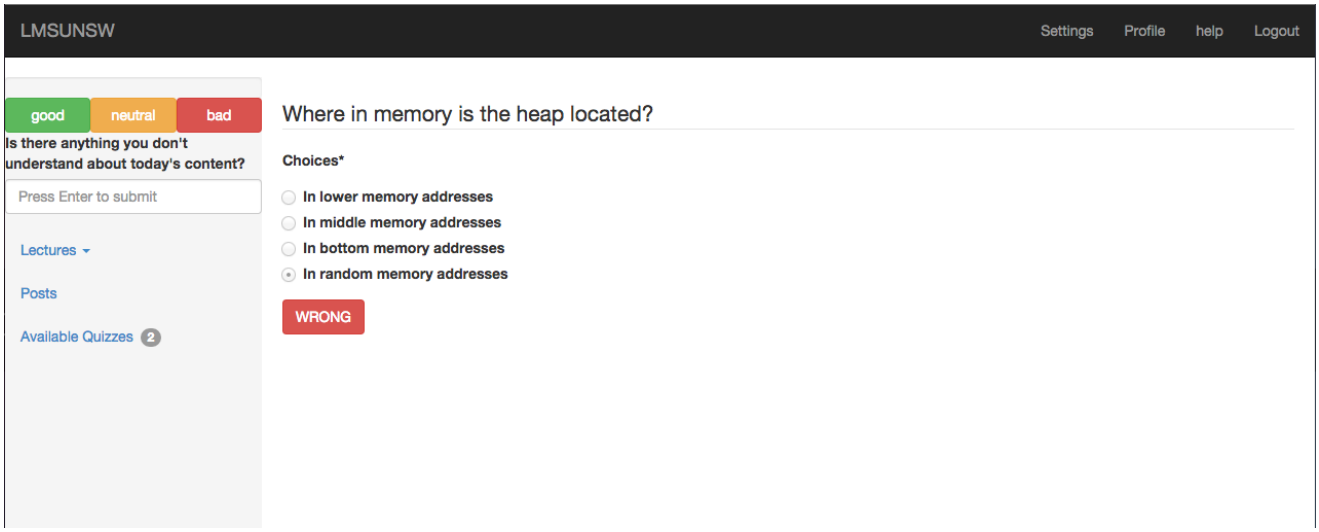


Figure 18 Quiz Submission

Mobile View

The interface is adaptable to any size screen due to the flexibility of CSS in changing layouts according to the screen dimensions.

Both students and administrator are able to access the application using a smartphone or tablet. The interface is largely similar since the functionality of the system remains the same regardless of the device it is used on.

To optimally utilise the little space there is on mobile device screens, the sidebar and top navigation bar is minimised away by default leaving the main content of the page unobstructed from view and can be opened back into view whenever needed.

Figures 1 and 17 show the system from a mobile device's point of view.

Schedule

This section outlines how development of this application was approached.

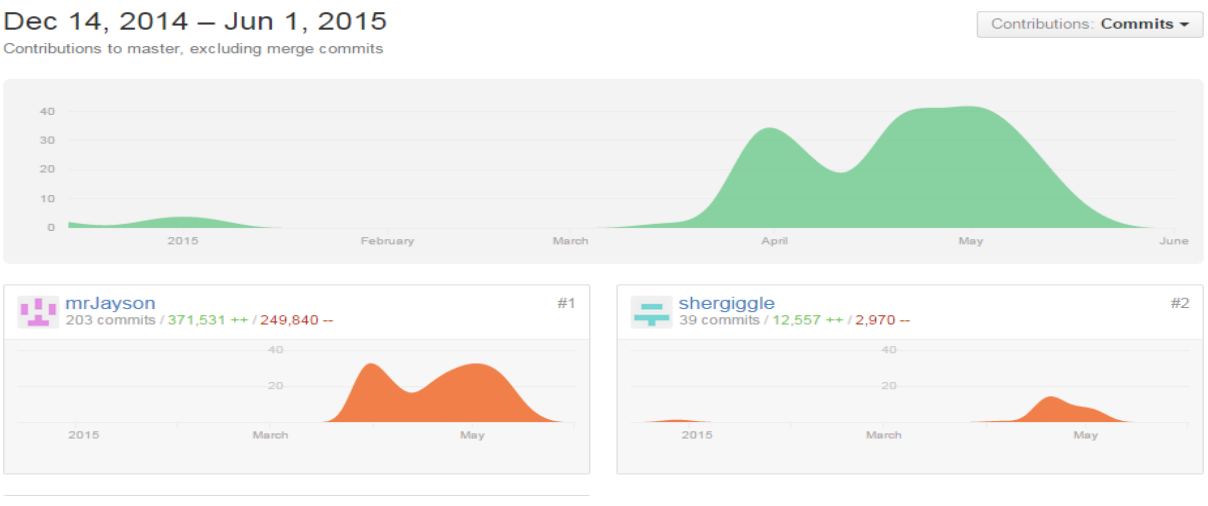
Requirements for the system were expected to change from when they were first written. To adopt an agile software development methodology would allow any change in requirements to easily be adapted into the system, which was the approach we followed. Agile software development methodology involves the iterative development of both the requirements and solution and a development that would facilitate the system to be tested on a subset of working features which would allow these features to be added in slowly. The amount of work increased as a result, however it ensured that our development process was flexible for changes and modifications.

It was unclear as to how the users would interact with the system, making it difficult to create a useful and ease-of use system so all designs were kept plain and simple. Agile methodology ensured that there was a always a working product that could be tested at any point after each iteration, thus resulted in a more complete and better application.

Throughout the development of the system, testing ensured that each feature worked as specified on a local host. This allowed for modifications to be made and tested easily rather than deploying the changed on the server to test.

Once majority of features were completed, a live testing in a real lecture environment was taken. This allowed for real data to be collected with how users actually interacted with the application along with the different feedbacks provided by the users. This testing process resulted in some major changes to the user interface and features that were not seen while developing. These changes will be mentioned further down in the report.

To keep track of the development of this system between two developers, we used Github for easy revision control and tracking. Every entry made into Github stated any issues with features or bug present, not just completed features. By using git, it was easy for both partners to keep track of changes made within the code and the purpose of these changes.



Evaluation

To measure the success of the application is to reach the objective of increasing student interaction in the lecture environment. This is a measurement that is difficult to evaluate and largely subjective. Without a large sample size and a long period of usage, results are limited for the evaluation of the success of the application. Thus difficult to provide conclusive results for this application to reach its goals.

Despite this, some measurements of data have been gathered and evaluated to provide some preliminary results in regards to the success of the application. These measurements are:

- **Students participation numbers**
  These numbers would show how many students would log into our system and interactively use the system. As the usage of the application was optional, the number of people who voluntarily opened and used the application was recorded. Out of these users, the number of students who participated in answering questions would determine an average number of users who interactively participated in the usage of the application during the lecture.

- **Confidence Meter usage numbers**
  At the end of each session, the total number of users who actively used the confidence meter was collected through the collections of data dump by Amazon Web Server. These data gives us an idea of the number of users who had clicked on the confidence meter from the start of the lecture till the end along with many other number of usage for different features.

- **Student Feedbacks**
  Another form of measurement that we are using to test the success of the application is through the student feedbacks gathered at the end of the trial runs. These feedbacks provide us with an idea of how the students found the system and what was used and not used.

Live Trials

A total of seven live trials of the application were conducted during a real in-lecture class in week 8-12 with two classes each week. The class chosen for the trial is a CSE first year subject COMP1911 Computing 1A lectures. This subject was chosen due to its non compulsory subject with a large variety of student background knowledge which would provide a larger audience sample.

Despite the fact that the application was designed in mind for computing lectures, the Professor of COMP1911 used a completely different style to the one we initially prepared for. Lecture notes and structures were not a favourite for the professor and the lecture setting was more of a producing live code and showing students rather than following a pre-planned structure.

This caused a few user interface issues as it was difficult for the professor to access the features he required. With these feedbacks from the professor after the first trial, many user interface changes were made in the administrator level to reflect on the feedbacks received.

During the in-lecture trials, many observations were made throughout these trials. These observations included the misuse of our collaboration feature between students and the inactive use of the post threads. The inactive use of the post threads was later realised due to the stand-alone nature of the system. As the system was only used during in-lecture times, students would not require to use the post features as most of their questions are ask out of lecture and within WebCMS, the current system that the class uses.

The misuse of the collaboration feature was observed at the first few runs of the trial, however students started using the documentation properly near the end. Collaboration notes included students asking for help on explaining a function that was not understood in the lecture at the time.

Quiz features were not used to their full extent as the Professor mainly used the quiz to create free form questions such as "What does this print?". This related code would always be blank in the system since the question would be shown on the main projector screen and something that was written on the stop rather than a pre-prepared question. However we were still able to obtain positive feedback with the quizzes, especially from the professor himself.

Results, Discussion and Analysis

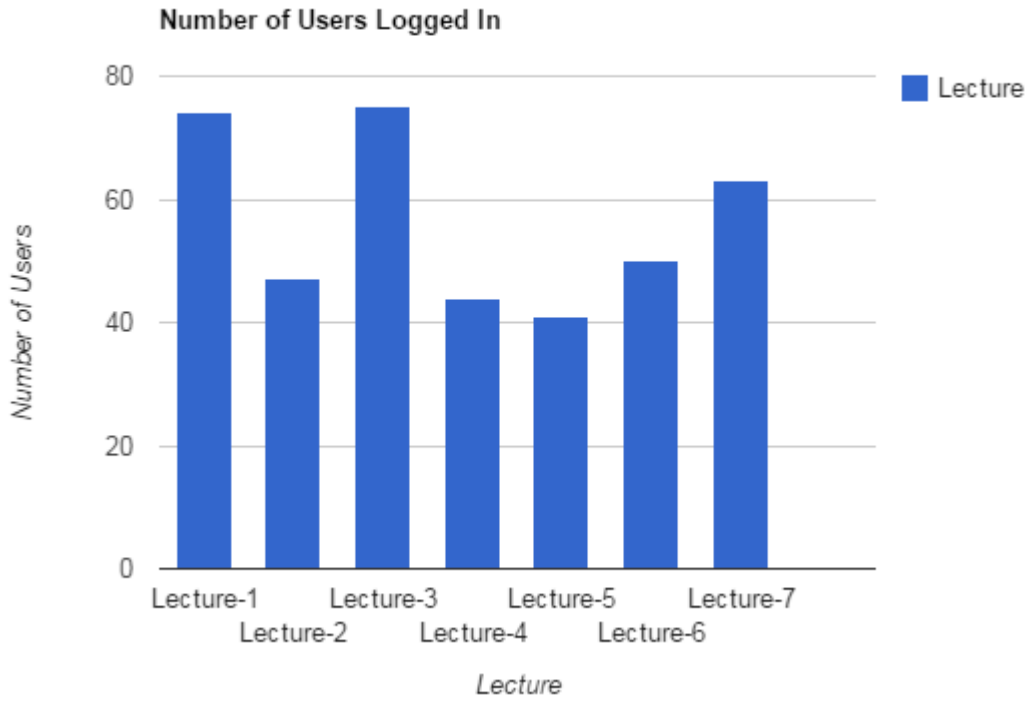
In order to determine if the system used was a success, there must be a criteria for which the data is analysed against. The factors determining success follow these outlines:

- Student engagement level
- Usefulness of feature
- Increased interactivity

Since usage of the application is only optional, the collected data only accounts for students that use the system. The student surveys also were conducted via the application and so only participating student have been accounted for.

Throughout the trial runs, some data has been collected along the way, as well as a final student and lecturer survey on the final lecture run. Both surveys given to the lecturer and the students can be found in the appendix along with the answers that were given by the professor himself. The survey presented for the lecturer was a simple set of questions that reflected on the usage of the application along with features that were favoured along with the ease of use. The student's survey differs a little as there are questions that asked about the mobility of the application along with asking about some of the main features. The student survey results will be broken down into different sections along with the data that was collected through the server.

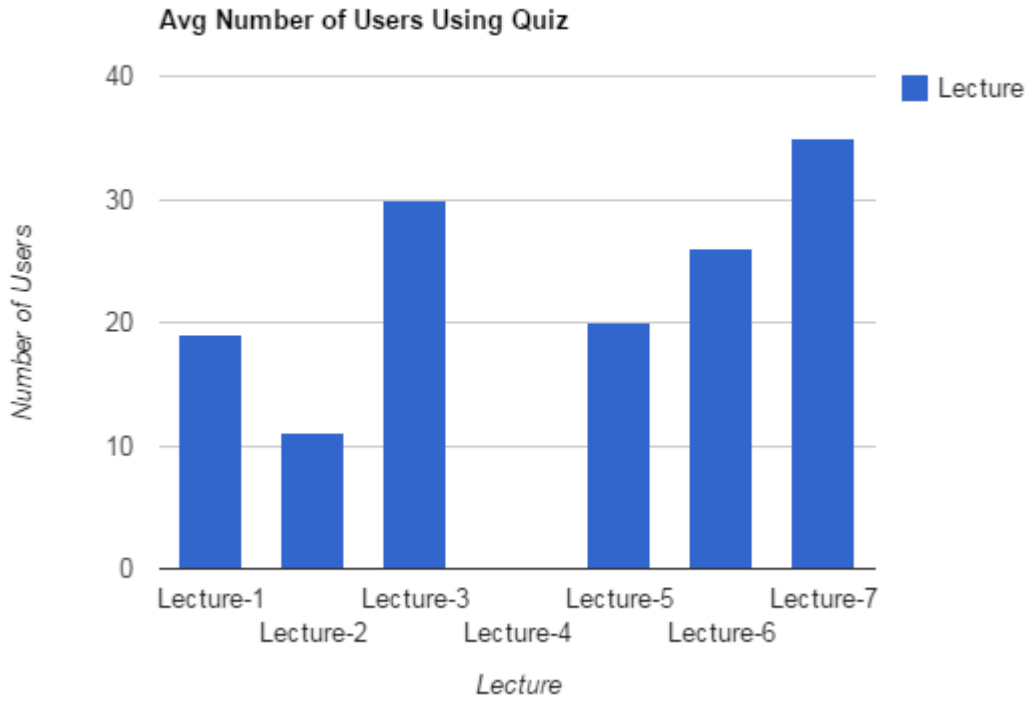
The three following graphs show collected usage data from the lecture.



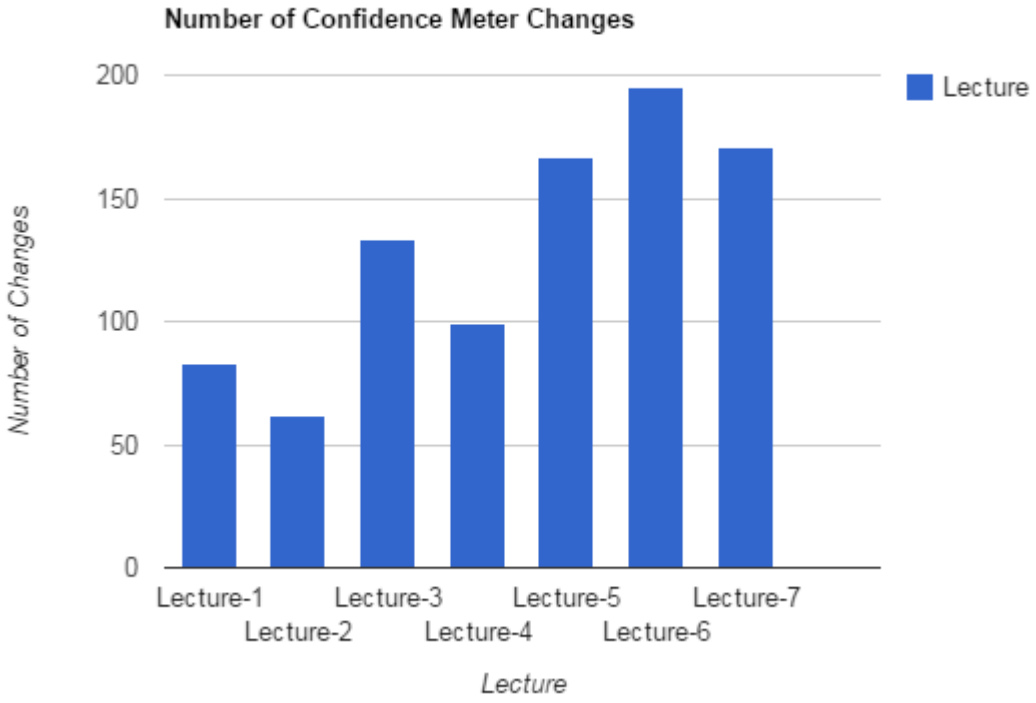
Throughout the trial run, the amount of students participating in the system remained relatively constant. Each lecture there were an estimated 80-120 students present in the lecture and the user logins averages at 55 users each lecture. This places the usage rate at around half the class.

Due to the size of the class, we had expected a large portion of the audience to not participate. We suspect multiple reasons for the data collected.

- The trials were run near the end of semester, the students are less likely to put in the effort to participate.
- The students at the time had an assignment deadline coming up, on the week of the 2nd lecture the students primarily focused on their assignment as opposed to focusing on the lecture content at hand. Their final assignment was also allocated to them in week 11.
- A portion of the class will generally not pay attention and will not participate.



The quiz usage rates appear to vary quite noticeably between lectures, the numbers show the average usage rates for each lecture as each lecture contains multiple quizzes. The first few attempts at performing quizzes faced a couple of technical issues, which would explain the lower usage rates near the beginning of the trials. Near the end of the trials we can see a steady increase in the quiz usage rates as the students and lecturer became more familiar with the system. Lecture 4 shows no quiz usage since the majority of that lecture was spent as an introduction to their final assignment, thus there was no need to perform quizzes during that time.

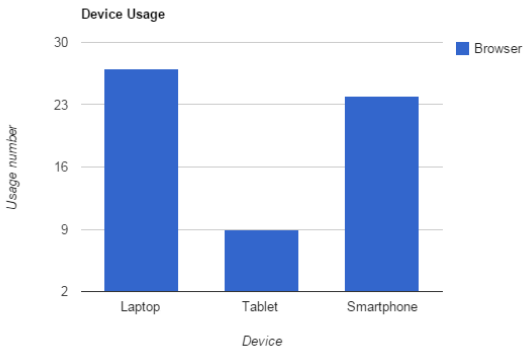


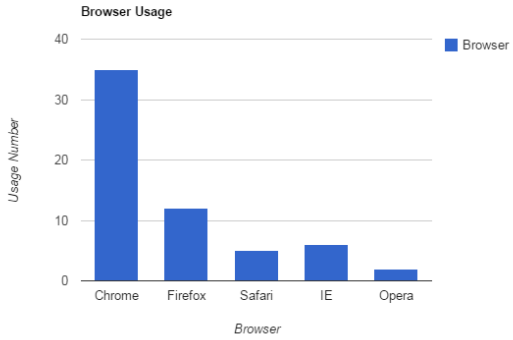
This graph outlines the usage of the confidence meter feature, by recording the amount of times the feature has been used. Recall that the feature consists of three buttons, good, neutral and bad. The initial confidence setting for all users start off as 'good', the student would click on a certain rating depending on their personal understanding. Any change in a student's confidence counts as a change. The graph shows a gradual incline in its usage throughout the trials with a few outlier dips such as lecture 4 which talked about their assignment, rather than any proper lecture content. Given an average of 55 users for each lecture, the average number of times a typical user would change their confidence ranges from 1 to 4 times per lecture. We had expected a slightly higher number since this feedback system is displayed in real-time to the lecturer.

However, as the lecturer was not constantly in-front of the computer while he teaches, there was a delay from when the student selects a button to when the lecturer sees the class' overall understanding. Perhaps if the delay between students clicking the button to when the lecturer recognises the confidence meter, the feedback could occur at a faster rate.

As the collaborative document feature is hosted by Google Docs, there was not a way for any usage statistics to be collected programmatically by our system along with our 'Post' feature. This feature was not used at all by the users so no performance statistics could be collected by our system either.

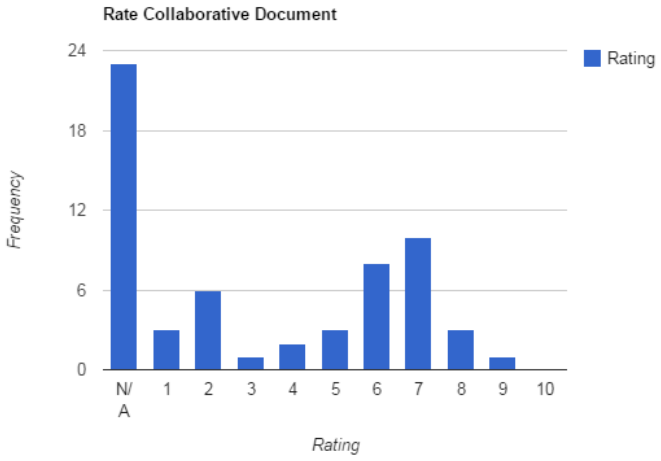
The student surveys were performed in the final lecture. 60 students completed the survey during the break period.



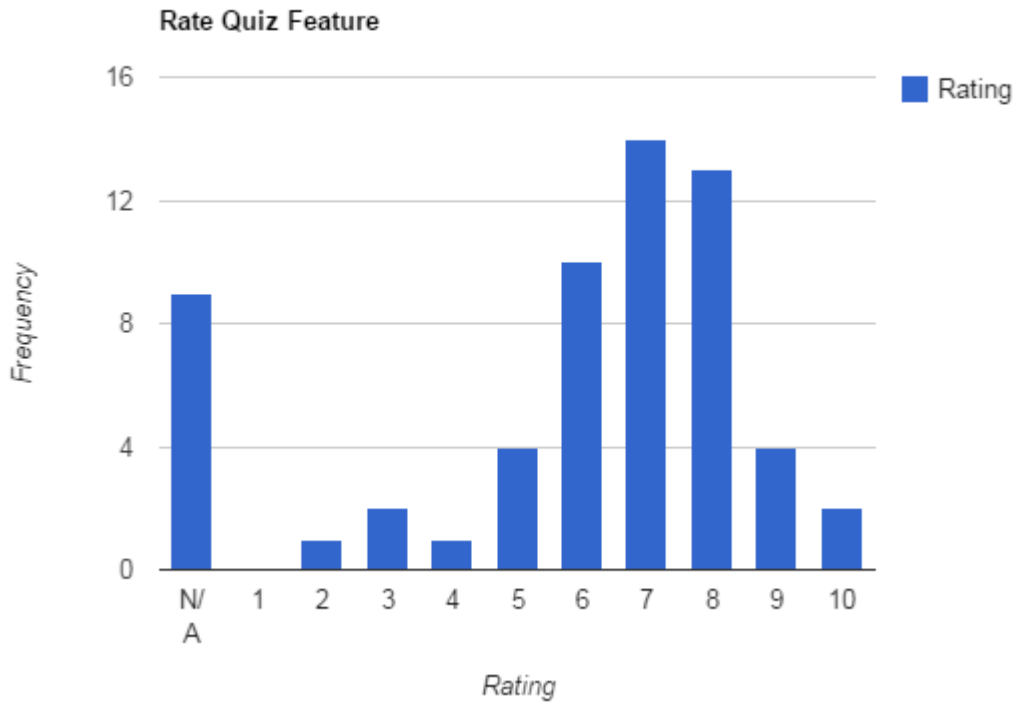


The majority of students accessed the application through either a laptop or their smartphones. In a computing class, where there is a need for a computer that is able to compile code, it is natural to see a high number of laptops present in the lecture. The number of smartphones in the lecture is also expected due to almost every student nowadays owning an internet-capable smartphone. This shows us that both the standard web interface and mobile interface was being used equally as much.

The dominant browser used is Google Chrome, accounting for half of the browser usage. All other browsers are in the minority in terms of usage. Internet Explorer however had many issues displaying our web application with some features refusing to display correctly. The students who used Internet Explorer account for some of the poor ratings for the other survey questions.



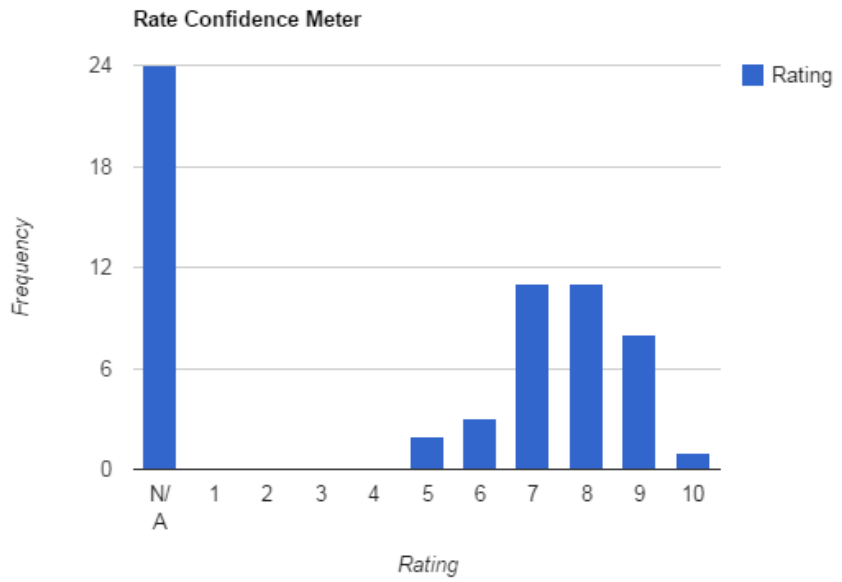
The collaborative document was intended for students who wanted to contribute to the communal lecture group via providing their knowledge to the rest of the class. Approximately 40% did not use the collaborative document which is an anticipated figure. Some students are naturally shy and self-conscious or cannot be bothered at all. The remainder of the students appears to be split into two groups, one that did not like the feature, and the other that rated it as above average. Due to the ability of anonymity in Google Docs, spamming in the collaborative document was prevalent in the beginning and this may be a reason as to why some rated it badly.



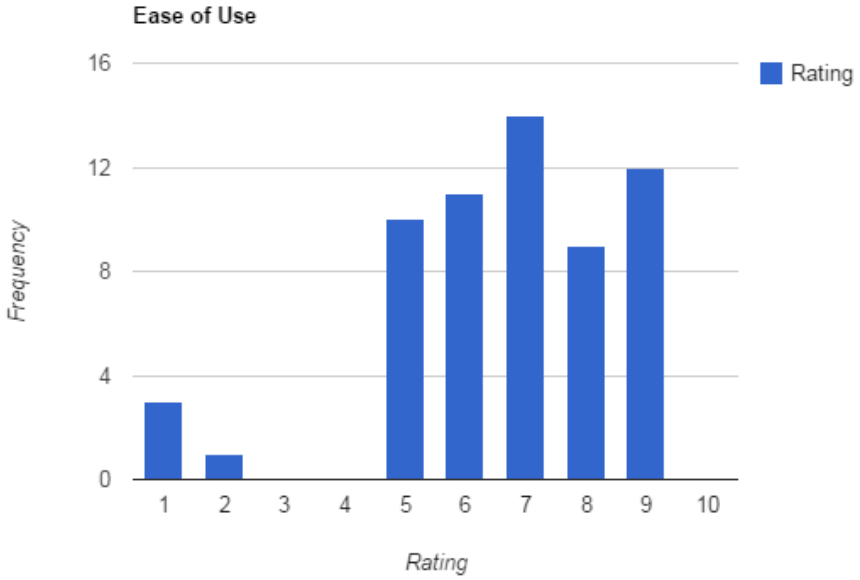
As mentioned earlier, the quiz feature was not used as designed however with minor changes during the beginning of the trial period, it became better structured for the course teaching method. This feature was used only as a rating system and freeform answer questions where majority of questions were "What does this print?". No code snippet were added into the question either as code was shown live on the screen at the front so students were required to have a clear view of the screen in order to understand what the question was asking for.

Majority of students have given this feature a moderate rating between 6-8/10 which is believed to be such due to the minimalistic of various use of the quiz. Students whom presented a higher rating may be those whom are more engaged with the class but were previously shy to voice their solutions. By answering the questions in freeform, they could feel as though they were engaging with the lecturer personally since the lecturer in the trial run liked to comment on some of the student's answers as they were submitted.

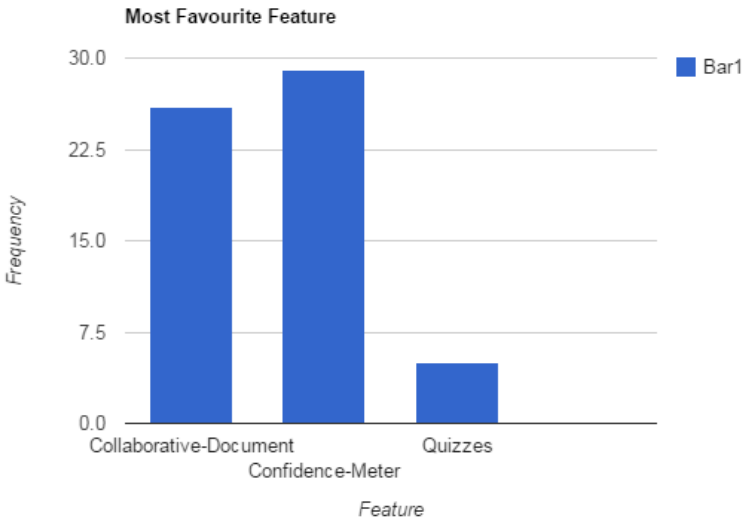
Students with lower feedback rating for this feature could be caused from the confusion of similar named questions. Differentiating between the questions could've been as issue. Another cause for the lower rates could be caused by the browser type that the student had used. As mentioned earlier, there were some issues found when using Internet Explorer with our application.



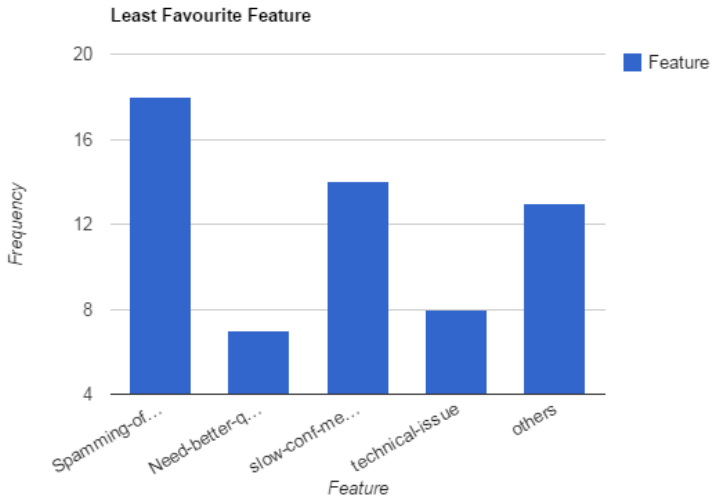
Generally the confidence meter has been rated well, it has been rated as the most used feature in our system and no negative ratings. However approximately half of the students did not use the feature at all. The students that did not use it may rate the feature lower then if they did use it.



The overall ease of use of the system rated quite well. The ease of use encompasses the user interface in terms of screen utilisation, ease of navigation, responsiveness of the system, etc. However since the trial was only run in one lecture at a time. The interface was not designed for multiple parallel lectures and cannot handle such an event. Therefore the easiness of access is currently quite well suited for small scale use, but it does not scale very well. Revisions to the interface must be made in order to accommodate multiple parallel lectures if it ever comes to that.



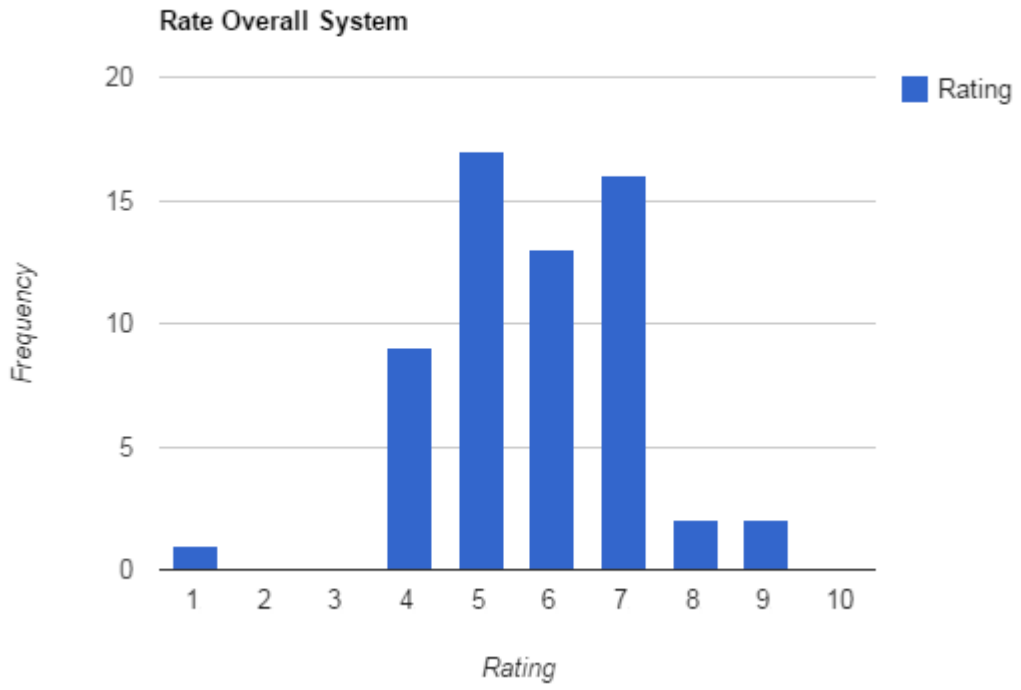
The answers to this question was given in a free-form format, and has been aggregated into these categories. The most popular features are the collaborative document and the confidence meter. They correlate with the other data and match up with the most used features.



Although the collaborative document is one of the most liked features, it is also the most disliked, due to the amount of spamming that occurs that limits it from being used to its full capacity. One missed aspect of the system is the absence of a good question posting system. The Threads and Post was originally intended to serve that purpose, but it seems to not have been executed well enough for students to use it. The second most disliked part of the system was the slow response to the confidence meter, in which the lecturer delayed too long before responding to the issue at hand.

There were also a few technical issues that had been noticed during the trials but has since been fixed.

A list of other minor issues have been stated but not significant enough to be mentioned.



Overall the scores appear to place the system at a slightly above average rating.

Given that this is the first version of the system, and that two of the major features appeared to be actively used and generally well rated shows that this first step that we have taken is one in the right direction.

It is expected that there would be many issues in terms of interface, features, correct usage of features, etc. This illustrates the amount of further work needed in order to make this system truly viable and effective in the real-world.

Future Work

The system so far is very much a prototype since it is essentially the first iteration of the project. There is still much more that could be done to further enhance the effectiveness with additional features or improvement of existing ones.

Integration with existing CMSs

The system initially was intended to function independently from any other system as it was to provide a purely additive benefit to the lecture. However this led to overlap between features of other existing CMSs in use and affected student convenience in terms of access.

The Post and Threads feature in our system is an example of overlap since it performs the same function as Moodle's and WebCMS's forums. The separate management of accounts is also another area of overlap which we found to be a factor in ease of access.

By integrating with current systems, we hope to see an increase in participation of LMSUNSW due to a reduced barrier to entry.

Given that WebCMS and Moodle is primarily aimed at an out-of-lecture experience. LMSUNSW perfectly complements these systems by providing an in-lecture experience while WebCMS and Moodle handles all else outside of lectures.

Expand scope of project to cater to distance learning classes

The system can perform adequately for students physically sitting inside the lecture, where they can hear and see the lecturer. Given the ability for real-time feedback from the system, a potential area of future work may be to develop a real-time learning experience for distance learners not able to physically attend class.

Issues such as relaying a real-time lecture video stream to distance students and recording such a video would need to be solved.

One suggestion would be to utilise the inherent features of smartphones in which they have both a camera and microphone to record the lecture to be broadcast.

If this feature were to be achieved, we hope to expand the range in which the system can be catered to.

Expand scope of project to cater to tutorial classes

The lecture environment and the tutorial environment are distinctly different in multiple aspects. A tutorial's atmosphere and style differ such that the current system would not be useful in that setting.

Tutorials focus more on a hands-on experience and given the small scale of tutorials, many of the features used in the lecture do not translate well. A different perspective such as using the system as a presentation platform, inter-tutorial communication platform, a platform on which to provide competition between tutorial classes, etc.

The tutorial scope is vastly different from the lecture scope and must be researched extensively to understand the nature of them.

Improvement of User Interface

Although the ease of access and User interface rated positively, there is much that can be improved upon. The current interface was designed to be as versatile as possible to function on all devices. However the current interface is still quite simple and basic, any addition of features could easily complicate and nullify its simplistic style. To truly create an intuitive system, the interface should be designed specifically for each platform. Developing smartphone apps may be one approach to the problem where the interface can be easily optimised for convenience and speed.

Generalise features to suit non-computing classes

Given that the trials were performed in a computing class, the initial features and user interface was slightly geared to a computing style. The system can potentially be used for any other class and so it must be able to adapt to those circumstances. Given how each and every field of study teaches differently, research must be conducted to gain insight on how to utilise the system in their teaching styles.

Development of more features

There are a few idea that have not been implemented yet or have been suggested to us for potential features.

In-Lecture Tests

Currently quizzes are single independent activities that finish when the user submits an answer. The idea is to chain link a series of quizzes to create a miniature pop-quiz. This could be used for revision lessons to quickly gauge the audiences understanding.

Taking Attendance

By students logging into the system, a quick attendance count can be made. However anyone can log in over the internet so there must a sort of token system to ensure only legitimate student's attendance can be counted correctly. This feature would work well when integrated with an existing system due to proper accountability of students using either zID or cseID.

Platform for plugins

The initial idea is for community driven plugins to be developed for certain teaching circumstances. An example would be a visualisation of sorting algorithms, a plugin could be developed that would be included in the system for a particular week to help demonstrate the content. For this particular example the solution can be found by searching a video on YouTube. However there may be much more specific use cases of plugins that are designed explicitly for the use in class.

Conclusion

Conventional lectures are a traditional method of providing education to a large audience. However, modern technology has found more effective ways of providing education to students based on the different types of learning structures found. With the decrease of student and lecturer interactivity, students easily lose focus or fear to voice their concerns during these lectures. Some existing research and commercial products have found new methods of utilising technology to address this issue, but these products contain disadvantages such as low usability, low functionality, high hardware requirements or lack effectiveness overall.

The web application 'LMSUNSW' aimed to address these issues of increasing student interaction in lecture-based environments while providing high usability and active learning for student engagements in the traditional lecture-based environment.

Over multiple live in-lecture trials, the application was accessed through various wireless devices owned by students which shows that it is highly accessible to everyone. Results however are inconclusive as the trial period tested was not long enough and not enough students participated in the usage of the system.

This is seen through the inactive use of some features such as posts which may be unconventional to use in a solely lecture based environment. However with such a short period of time a small audience sample, further trials will be needed to provide conclusive results of the application.

Appendix

Lecturer Feedback

What feature did you use the most?

The quiz question e.g. "what does this print".

Also looked at the confidence meter.

How simple was the navigation around the system?

It's simple if you can focus on the web pages.

But it needs to be even simpler because in a lecture you have so little time.

It could for example automatically display summary of answers coming into a quiz questions.

How useful was the overall system?

It adds a useful dimension to feedback from students.

It was limited by its late option in the course.

It would have worked better if students had been using from the start of the course and it would have been more useful anyway in the first weeks of the course.

Overall Feedback.

Definitely a place for a system like this.

Integration into the other web pages for a course need to be given some thought.

Student Survey Questions

Which browser did you use the most?

- Chrome
- Firefox
- Safari
- IE
- Opera
- Other (Please Specify)

  _____

Which device did you use the most?

- Laptop
- Tablet
- Smartphone
- Other (Please Specify)

  _____

Rate the usefulness of the collaborative document

N/A 1 2 3 4 5 6 7 8 9 10

Rate the usefulness of the quizzes

N/A 1 2 3 4 5 6 7 8 9 10

Rate the usefulness of the confidence meter

N/A 1 2 3 4 5 6 7 8 9 10

Rate the ease of use of the system

N/A 1 2 3 4 5 6 7 8 9 10

Rate the usefulness of the overall system

N/A 1 2 3 4 5 6 7 8 9 10

Which part/feature did you like the most?

_____

Which part/feature did you like the least?

_____

Bibliography

[1] Kumar, S. (2003). 'An Innovative Method to Enhanced Interaction During Lecture Sessions', *Advances in Physiological Education*, 27(1), 20-25

[2] Wu, Jen-Her; Tennyson, Robert D; Hsia, Tzyh-Lih. (2010). 'A study of student satisfaction in blended e-learning system environment'. Computers & Education, 55(1), 155-164

[3] McManus, Dead A. (2001). 'The two paradigms of education and the peer review of teaching'. Journal of Geoscience Education, 49(5), 423-34

[4] Kapadia, R. J. (2008). 'Teaching and learning styles in engineering education'. 38th Annual Frontiers in Education Conference, Oct. 2008, T4B-1

[5] Johnson, David W. (1991). 'Learning together and alone: cooperative, competitive, and individualistic learning' Englewood Cliffs, 2nd Edition

[6] Oloyede, E. O; Adebowale, O.F; Ojo A.A. 'The effects of competitive, cooperative and individualistic classroom interaction models on learning outcomes in mathematics in Nigerian Senior Secondary School' ISRN Education, 2012, 2012

[7] Leopold, Lisa. (2012). 'Prewritting tasks for auditory, visual, and kinesthetic learners'. TESL Canada Journal, 2012, 29(2), 96-102

[8] Pappano, Laura. Novemeber2, 2012. 'The Year of the MOOC'. New York Times. Accesed 18th October 2014

[9] Watson, William R.; Watson, Sunnie, Lee. (2007). 'An argument for clarity: what are learning management systems, what are they now, and what should they become?'. TechTrends, Springer Verlag (Germany), 51(2), 28-34

[10] Blood, E.I. Gulchak, D. (2013). 'Embedding "clickers" into classroom instruction: Benefits and Strategies'. Intervention in School and Clinic, March, 48(4), 246-253

[11] Brandy, Angel. 'Alternatives to physical clickers in the classroom' April 10, 2012. Princeton University

[12] Eberly Center 2013. 'What are clickers and how do they work?' Carnegie Mellon University, Pittsburgh

[13] Moodle 2013. 'History', Moodle, Perth