UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

Utilising Wireless Devices in Lecture-Based Educations

Thesis Report, Part A

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2 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.

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. However not all methods suggested are cost-efficient to become implemented in all lecture based environments or are not mobile enough to be used with a large audience. There are several applications that have now been developed that are able to help with some lecture environments where active learning techniques can be incorporated 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 [1]. The solution that we have suggested allows us to use this rising of technology to increase the interactions found in a lecture environment. Our solution would allow students to be able to interact with the lecturer, allowing students to give their lectures more attention and interaction with the lecturer.

3 BACKGROUND CONTEXT

Teaching and learning has mostly been teacher focus 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 3 main paradigm styles that are used for teaching: Individualistic, competitive and cooperative [2]. While there are 4 main types of learning modes that students adapt to: Visual, Auditory, Kinaesthetic and Read/Write [5].

4 TEACHING STYLES

With individualistic methods, each individual student is independent and separate from one another in how they learn [4]. 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 single directional, lecturer to each individual student where only the students that are paying attention would be able to fully grasp the information presented by the lecturer. Students would not be able to interact with one another to share knowledge or answers.

Another method that is used with teaching would be the competitive style. Competitive learning styles are when one student's goal is achieved however the other student's failed to obtain that

goal [3]. This is achieved by having the students compete against one another for success. Sometimes these type 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. Also prompting cheating and the ability to problem-solve [4].

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 results. Rather than having only a single student experience success, cooperative method would allow all the students in the groups that have succeeded to experience the feeling of success [3]. This allows the students to become more responsible for themselves along with the other students that are in their groups, along with working in team environments.

4.1 Learning Modes

Visual learners are students who would reply on visual stimulants to help remember and understand the contents that are being presented. These learners are not well suited with facts and figures [5]. Stimulants such as diagrams, images, charts, films, etc. Such learners would sometimes have trouble remembering verbal instructions as they could sometimes tune out when they are trying to pay attention. As such, these learners would not be best suited when in a traditional teaching environment as these environments would be highly focused on verbal instructions from the lecturer.

Auditory learners are students who would benefit the most from a traditional teaching environment as the information would be presented to the students by simple verbal communications [6]. These learners are students who would be able to maintain interest and attentive through the verbal communication that presents the information to them. A passive learning environment would be suitable for auditory learners as lecturers would mainly present their information to the students through a verbal role.

Read and or write learners are those who would be able to benefit the most through text forms or stimulants that are presented to them. Unlike visual learners where the stimulants required are to be visual images or such and auditory learners where the stimulants are to be verbal, read and or write learners would be able to just absorb information through the text that is presented to them. They would process the text at their own pace and sort through the information based on their own understanding of the text.

Kinaesthetic learners are those who would learn through physical experience. By completely engaging themselves into the learning activities, these students would acquire information through the participation of experiments or drama presentation or any other form of active activities [6]. Kinaesthetic learners are more attentive to active learning environments where the students would be able to interact with each other and the teachers and engaging in activities such as reading, discussions or analysing and evaluating questions.

4.2 Similar Research

Some similar research areas that are able to incorporate students into a more active learning environment would be the MOOC system, LMS and Student Response System.

MOOC stands for Massive Open Online Course where it is able to cater for an extremely large class size, thus the acronym Massive. Its contents are open to all the students and are available without the need to entrance exams or enrolments into any form of institutions, thus open. The term Online is due to its primary method of delivering its contents to the students, allowing a seamless integrations of technology. MOOC courses are structured exactly like educational institutional courses where there are a set amount of materials that has to be covered before the course outcome is met [8].

Learning managements 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 an 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 educate 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.

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

4.3 Existing Systems

There are currently some existing systems that can be used as a student response tool rather than a system as these systems were not developed directly for the use as an audience response system however some of their features may be used to an extent as a student response tool [7].

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.

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

5 PROPOSED SOLUTION

We have recognised both the advantages and disadvantages of learning in a lecture-based environment, and grounded on this knowledge we aim to provide a solution to the pitfalls whilst maintaining all the benefits of a lecture environment setting.

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 deployment of the system should 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 solution would heavily rely on a technical framework as the solution will be designed to run as a web application software system and accessed through mobile devices available in the education setting.

5.1 FEATURES

The list of features that are planned for implementation in our system have been chosen carefully to provide maximal effectiveness in achieving the goals set out. Some features have been derived from existing systems due to their proven effectiveness and others have been designed based on the findings from the literature review.

5.1.1 Core Features

The core features are features we believe will provide the most value to the system. These are the features we expect to be used the most frequently and extensively.

5.1.2 In-Lecture Quiz Question

The purpose of this feature is to provide a method of allowing the instructor to promptly test the audience's concrete understanding of the content and gain an understanding into the learning state of the audience. There are many additional aspects to this feature such as timed responses, real-time results collection and public display, participation recorder, etc.

The quizzes generally perform best when the answers are distinctly right or wrong, as the system would provide instant auto-marking.

Variations of the quiz formats may be:

- True/False Questions
- Standard Multiple Choice Questions
- Fill in the Blank Questions
- Numeric Questions

The process of this feature begins with the opening of the quiz question event, the students will be able to select one of the designated answer slots and submit an answer, the answers are sent and accumulated for instructor only or public display.

The expected impact of this feature would be a lengthened attention span of the audience and increased student interactivity and participation within the lecture.

5.1.3 Word Cloud

The purpose of this feature is to provide a method of allowing the instructor to combine the audiences' response on a subject that has no distinctive correct answer. It can also 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.

A simple word cloud would be limited to single word responses to allow for easier aggregation of misspelt or similar meaning responses. Given the range of responses available, some form of input restriction would be needed to keep the word cloud concise enough for effective display.

The expected impact of this feature would be a lengthened attention span of the audience and increased student participation within the lecture.

5.1.4 Anonymous Question Posting

The purpose of this feature is to provide a method of allowing the audience to discreetly question the instructor or audience without explicitly disrupting the lecture flow. Shy students generally do not want to draw attention to themselves by taking the focus of the classroom from the instructor to themselves by asking a question in class. This feature provides a method of communicating to the instructor anonymously and therefore safely. This is intended to break the initial communication barrier of speaking out in class, this feature may not be entirely suitable to fully facilitate an in-depth discussion on a subject.

The question posting feature should occur in real-time as time is a key factor as the question might become out of context if the question is delayed too much.

The expected impact of this feature would be an increase in student interactivity and participation as they are allowed a new channel of communication with their peers and the instructor.

5.1.5 Confusion Meter

The purpose of this feature is to provide a method of allowing the instructor to quickly glance at the overall confusion of the audience about the topic at hand. The Students of the audience will be able to individually state whether they understand the content or not, the collective results will be displayed as a percentage of the class who understand the content, giving the instructor an indication of whether they are utilising their time effectively or not.

The expected impact of this feature would be an increase in the audience's attention span as less time is wasted in ineffective teaching since the instructor is able to identify when their teaching method is ineffective and can change methods.

5.1.6 Peer Editing

The purpose of this feature is to provide a method of allowing the students of the audience to collaboratively create and edit notes. Students with better understanding are able to create notes publicly for those who may not comprehend the content as well, giving them another

interpretation of the content which may help them to understand. Student are also able to edit each other's notes if there are any mistakes found and slowly produce a set of high quality notes. Each addition or edit into the peer document will be tagged with the author so there is traceability and accountability for any vandalism or misuse.

The expected impact of this feature would be an increase in peer interaction by allowing a portion of the learning material to be generated and presented by their peers.

5.2 Additional Features

The additional features are features we believe provide a supporting role to the overall function of the system, these features implicitly provide value to the system that the students or instructors may not directly observe.

5.2.1 Role Attendance

The system can mark role attendance based upon the user login to the system, given that all students who use the system will have to login, the system can accomplish this with ease. However this feature may become complicated when system adoption rates by the students are not 100%, thus the role attendance feature may be rendered useless.

Another issue will affect the effectiveness of this feature is mapping the user account to a physical student if external user accounts such as CSE accounts are not integrated.

5.2.2 Participation Recorder

User adoption rates can be incentivised with participation marks allocated to those who effectively utilise the system's features. A participation recorder feature will be used to determine the allocation of marks if participation marks are awarded. Given the goal is to increase adoption rates, the student who do not choose to use the system must not be penalised and so the points awarded by be extra points only. The participation recorder may be used in conjunction with other user adoption rate schemes such as user participation rankings and etc.

5.2.3 Data Export and Analysis

Data collected by the system, containing information such as participation data, most popular feature, most clicks required feature, attendance and etc. can be analysed or exported out of the system. Simple analytical functions can be applied to the data or it can be exported and be analysed more deeply. This feature is required to be able to assess the effectiveness of the system in achieving the goals set out.

5.2.4 External User Accounts Integration

User accounts data such as CSE accounts, Google Accounts or Windows Live accounts can be imported and integrated into the system to utilise an already existing account structure so students do not have to create a new account with a new name. The purpose of this is to eliminate a barrier to entry into the system by allowing a bypass through the registration process, thus improving adoption rates. Standard account creation will still be available for use and external accounts will only serve as a foundation of account data.

5.3 Design and Implementation

To satisfy the needs to complete the project, there are several methods that are available:

- Utilise existing systems and modify them to fit our needs.
- Utilise an existing software foundation and develop on that platform.
- Develop a new system from scratch.

Utilising existing software would provide a benefit in terms of time saved, however it may not perfectly satisfy our needs as their purpose are sometimes not fully aligned with ours. OpenLearning is an already existing platform currently in use within UNSW, however they place more emphasis on overall learning support rather than in-lecture assistance, therefore utilising that 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 possesses. Developing a new system from scratch allows for more flexibility in terms of design choices, however at the cost of development speed.

With developing from the ground up, there are much more technical considerations that are associated since there is more flexibility given. Some of the design choices that must be made are:

- Deployment and hosting platform
- Architecture of the application
- Development framework
- Database choice

5.3.1 Implementation Platform

The focus of the system revolves around in-lecture support, and so the usage rates of the system will spike during class hours and drop dramatically outside of class hours. Therefore quick scalability to support the volatile user load is required. Deployment of the application on a University server is an option, but the maintenance effort involved with managing scaling is not an appropriate use of our time as all the time should be invested into developing the application instead. Hosting the web application on a cloud service will offer the scalability capabilities needed to satisfy the scalability requirements without any need to invest in additional hardware support.

5.3.2 Application Architecture

Given that the system is designed as a web application, a web application framework must be applied. The MVC pattern is a simple and effective design pattern that we believe is sufficient and suitable for the web application's needs. The MVC pattern will provide abstractions between business logic, Graphical User Interface, and the model and database, allowing for a modular approach to development.

Given the level of interactiveness between clients of the system, a push-based framework must be used to allow for more responsive communication between clients and the server.

5.3.3 Development Framework

Web applications can be developed on a variety of frameworks and languages and each provides its advantages and disadvantages to the development table. Python's Django is an open source web application framework which follows the MVC pattern of design. Django has been chosen as

there is a widespread base of documentation available and although other frameworks satisfy that criteria, we have chosen Django as we favour Python as a language.

5.3.4 Database Choice

The database requirements of this application is expected to be relatively low, as client interaction is the main emphasis. Persistent data is not required as much and a simple database will suffice. PostgreSQL is a SQL based database management system which is compatible with Python and Django and can fulfil all the requirements of the system.

5.3.5 Implementation Framework

Each member of the team will develop independently from one another due to the lack of expected overlapping free time, it will allow each member to develop at their own pace and control their own time management to an extent. The workload is split according to features implementable, not backend/frontend since the application features are modular, the corresponding interface of each feature will be subsequently managed by the person developing.

5.4 Deployment Framework

The deployment phase will occur after the implementation phase is complete, as a working software system is required for the deployment of the system. The deployment phase will encompass the deployment of the system and the management of the trial runs.

A course running in 2015, S1, preferably a computing course must first be chosen to host the system during lectures. A candidate course would have a reasonably large amount of students for a larger potential sample size, wide variety of topics to test the range of the application's capabilities, appeal to an audience with mobile devices.

Once the course has been chosen, the content must be prepared onto the application. Given this would be a trial run, the instructor will be assisted by us in generating content for the class to allow for the full potential of the features to be utilised. The exact trial time period will also be decided according to the course schedule.

The trial period will last for approximately 4-5 weeks depending on the amount of collected data, during the trial period, data will be collected at the end of each session via surveys and system data. The data will be examined in order to determine if changes are needed to improve the system. This occurs until the trial period is over which by then all the data will be aggregated and analysed in preparation for the final report.

5.5 Evaluation and Analysis Framework

In order to evaluate the effectiveness of our system towards influencing lecture participation, satisfaction, attention span and knowledge retention, data must be collected before, during and after the trial period in order to understand the full effect of our system. Many previous research investigations did not place enough emphasis on collecting data points for analysis, providing a much more restricted view of the application effectiveness. Data will be collected after each lecture and quickly evaluated in order to determine if there are any changes that are to be made.

The evaluation sample size can only be limited to the number of participants of the trial, therefore it is imperative that the participation rate be maximised to achieve a larger sample size.

Data for evaluation will be sourced from the following locations:

5.5.1 User Surveys

User surveys are heavily subject to heavy bias as surveys of this nature attempt to quantify a qualitative aspect of the system. As each user will have different thresholds or interpretations of a measurement, numerous surveys must be taken in order to gain a more objective view through more data points

Surveys are planned for both students and instructors occurring at the end of each lecture. Feedback after each lecture may be used to further enhance the system in terms of user interface or features, which will in turn affect the effectiveness and usability of the application.

Given the user surveys require manual input from the users, and the frequency of the surveys needed. A portion of time must be allocated at the end of each lecture in order to acquire the data. Considerations must be made into the complexity of the survey so the time taken will be minimal.

User surveys are planned to cover all aspects of the application, including data that can be collected within the system, so that a comparison between perception of the users and reality can be made.

5.5.2 Application Usage Data

Users engaging in the system can have their actions recorded in order to gain an implicit perspective of the user that may not have been aware of, such as time spent on a feature, delays between clicks, usage frequency of features, etc.

The metrics gathered can provide an indication regarding the usability and simplicity of the user interface or effectiveness of the feature in a lecture environment. Data is recorded automatically during the trial runs, and can be accessed at the end of each lecture are analysed in conjunction with user surveys to gain a better insight into the usefulness of the application.

5.5.3 Student Course Grades

One of the key goals of the system is to enhance learning and knowledge retention. Assessment grades of participant users may provide a reflection as to whether the application is a success in enhancing learning. The lower frequency of data points gathered may render the data useless as there are many other factors that can contribute to a student's grade variations. Therefore the trial run must occur at a suitable time in order to better capture only the effects of the application

on the grades. Multiple data points for each student will be necessary to establish a graph over time.

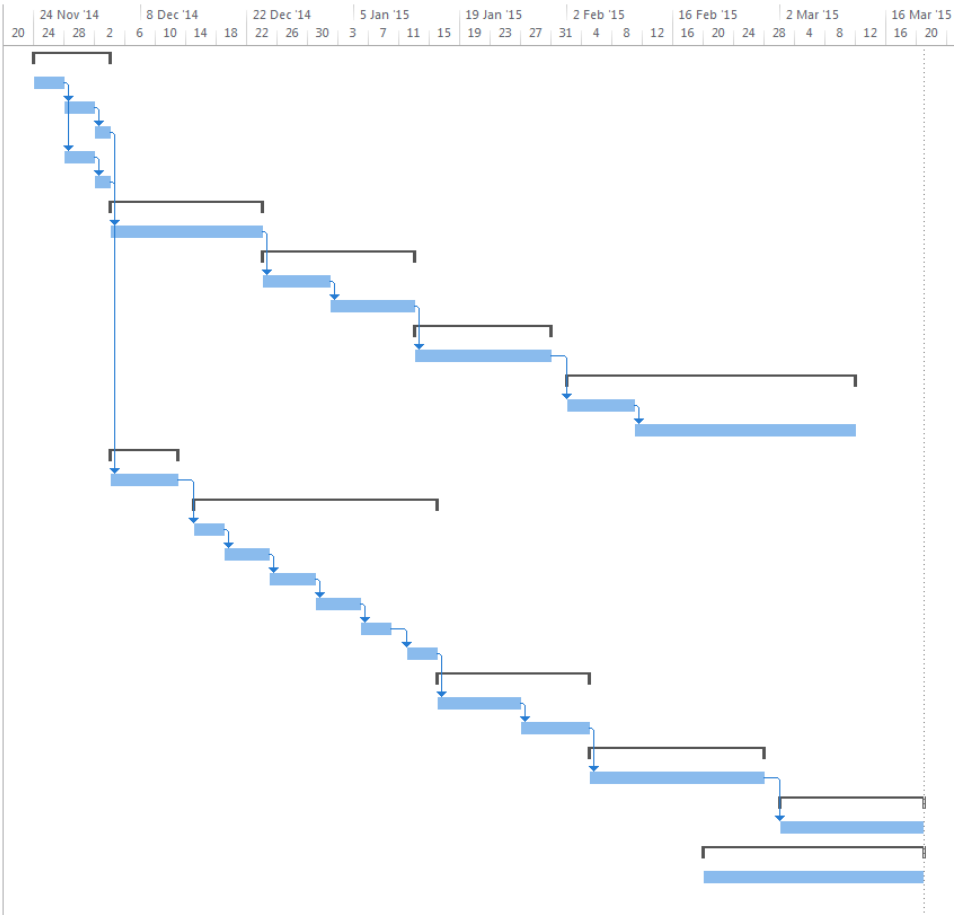
6 SCHEDULE

The deadline for the thesis is due in June of 2015, giving development, testing, trial run and analysis over 8 months worth of time. Starting at the end of the academic semester of 2014, S2, implementation will begin following the implementation project schedule. This schedule applies only to the development and implementation of the application, the deployment phase is detailed under the Deployment Plans section.

The implementation is planned to span over 17 weeks from the beginning of the summer break up to the 3rd week of 2015, S1. The duration of each of the tasks attempts to take into account factors such as: the expected difficulty of the feature, the expected amount of external work load unrelated to the thesis, and the learning curve of new technology. Given that both of the members are primarily preoccupied with a full-time job over the 17 weeks, only a couple of hours each day can be allocated towards the development of the application.

The last 3 weeks of the implementation period, the beginning of 2015, S1, integration testing will be conducted to ensure the overall system functions and performs acceptably in time for the trial run. Unit testing will be conducted throughout the implementation period to ensure each modular feature can perform correctly independently.

Task Name	Duration
Administration Framework	**8 days**
Web Application set up	4 days
Implement user accounts	2 days
Implement user accounts interface	2 days
Implement 'classes' feature	2 days
Implement 'classes' interface	2 days
Role Attendance	**14 days**
Implement role attendance	14 days
Confusion Meter	**14 days**
Implement confusion meter student side	7 days
Implement confusion meter instructor side	7 days
Peer Editing	**14 days**
Implement peer editing	14 days
Data Export and Analysis	**28 days**
Implement data export	7 days
Implement data analysis	21 days
Participation Recorder	**7 days**
Implement participation recorder	7 days
In-Lecture Quizzes	**24 days**
Implement True/False	4 days
Implement MCQ	4 days
Implement Fill in the Blank	4 days
Implement Numeric	4 days
Real-Time Results Collection	4 days
Implement display	4 days
Anonymous Question Posting	**14 days**
Implement anonymous question posting	7 days
Implement question notification	7 days
Word Cloud	**17 days**
Implement word clouds	17 days
Account Integration	**15 days**
Implement account integration	15 days
Integration Testing	**21 days**
Integration Testing	21 days



7 CONCLUSION

The use of lectures is prevalent worldwide and is an effective means of education to the masses. The nature of lectures also presents many drawbacks due to the sheer size and loses many of the benefits of a smaller size education setting. Technology is being used today to solve some of the problems surrounding lecture-based teachings and empowering them further such as MOOCs, however there is relatively little development for lecture specific software.

Therefore a solution has been proposed in order to attempt to satisfy this technological gap. By drawing knowledge from previous research and existing solutions, we plan to develop a software system that will resolve the issues whilst maintaining the benefits of lectures to further empower lecture-based education.

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