A Lecture Comprehension Indication System

MICI HALSE and DAVID KENYON
Rhodes University

Many students resist lecture interaction. They often lack the confidence to ask questions, ask a lecturer to slow down, repeat something, or explain a topic further when they are unsure of the subject matter. A lecture comprehension indication system based on the literature was created to address this matter. Prior to the testing of this system, students were asked to complete a questionnaire to gain insight into interaction in lectures. The results gathered from this showed that students resist interaction for many reasons such as lacking confidence, fearing their peers and lecturers, not wanting to offend the lecturer and other concerns to name a few. The system was tested for 2 weeks during Computer Science 112 lectures. Subsequently, students were asked to complete a second questionnaire to determine the perceived value of the system. The responses from students showed that they perceived the system as valuable. It gave the students the ability to interact anonymously with a lecturer at any time during class and throughout a course. Students believed that it also gave confidence to shy students and provided students with an easier way to interact in lectures.

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1. INTRODUCTION

Many students resist lecture interaction. They often lack the confidence to ask questions, ask a lecturer to slow down, repeat something, or explain a topic further when they are unsure of the subject matter [6]. Lecture comprehension indication systems have come about to address this issue. A lecture comprehension indication system can encompass social emotional feedback and task feedback in lectures. Within social emotional feedback there are positive reactions and negative reactions and within task feedback there are questions and attempted answers [4]. It is a tool that gives students the opportunity to access a networked message board where they are able to post feedback about the lectures at any time during the course. This differs from traditional feedback which tends to be at the end of a semester or at the end of a course. There have been many implementations of these systems; they vary in how they are implemented and the features they offer [9] but many have proven to be successful in improving students' experiences of courses [12]. A lecture comprehension system was created using a website, mobile phones and a Windows application for the lecturer to view posts. Before the system was tested, a questionnaire was sent out to gain insight into students' interaction in lectures. The system was then tested for 2 weeks during Computer Science 112 lectures. Students were asked to complete another questionnaire to determine whether they believed it added value to lectures

2. RELATED WORK IN LECTURE COMPREHENSION INDICATION SYSTEMS

The many different approaches taken when creating one of these systems is shown in the following section. All of the following systems have commonalities. The system was based on the strengths and weaknesses of the previous implementations. Some of the features of lecture indication systems include a live and lecture specific system where students can express whether they are content, engaged, bored, have a question or just have something that they would like to say.

2.1 Audience Response Technology in Large Lecture Classes

A study was carried out by MacGeorge et al. to determine the effectiveness of audience response technology (ART) within large lecture classes. ART is also commonly known as “audience feedback” or “clicker” technology. The audience response technology is used more as a questioning method than a general feedback method. MacGeorge et al. state that in all the studies that they reviewed, ART was consistent with respect to a positive influence on classroom engagement. A problem arises in the fact that most of the evaluations of ART technology have been carried out within classes composing of engineering, science or maths students. The reason why this is problematic is that these students tend to have an affinity towards technology.

To begin the study, MacGeorge et al. selected three large classes in the Spring of 2005. Students used pads that connected to a signal receiver via radio frequency. The students had to enter a 2-digit code on entry into the lecture venue so that the device could connect to the receiver. The ART system was limited in the fact that it could not receive general feedback from the students. Students were asked questions and they could answer anonymously on one of these pads. Results of the answers would then be displayed for the class to see.

During the semester, students were asked to complete online surveys based on their opinions of the software. The results of these surveys showed that students found the use of ART enjoyable. They also felt that it was easy to use and resulted in an improved knowledge about student performance, lecturer expectations and course material. The surveys also tested to see whether students felt that the implementation of ART could possibly be hurting their results (grades) and this was seen to be false. Student perception of the system did not change over the semester; however some students did have a negative opinion of the system's effect on their grades towards the end of the semester.

2.2 Backchannel

Backchannels are generally instant messaging or text based chat systems that allow dialog amongst people in a space sharing an experience [8].They have a wide variety of purposes and add value to the front channel.

According to Harry et al. backchan.nl is a web based system that allows students to pose questions for the lecturer. Students can vote for the questions that they feel are the most imperative for a lecturer to answer. The questions that had the most votes are then projected onto the screen.

To test the effectiveness of the backchan.nl system, an implementation of the system was carried out during a conference in the department of Comparative Media Studies at MIT. The system was limited in that audience members could only access the system on their laptops. This is problematic as many students do not bring laptops to lectures.

Posts were ranked on a mathematical formula that created a list of the top ten posed based on quantity of votes and recency. At the time, the current top ten posts were displayed on a screen for all the audience members to see and a monitor for the speaker/moderator. When a user logged in, they had to provide credentials such as their name and affiliation. The system was anonymous but these credentials prevented double-voting.

Volunteers were asked to give feedback on the system and comments included: the system “gave [audience members] opportunities to participate in direct ways.” [8] Another audience member stated that “the ability of people to vote for what they were interested in was great.” [8]

To get people to use a backchannel system is challenging; to remedy this problem, one must constantly be reminded that the system is in place. In the implementation of backchan.nl at MIT, the reminder was the projection of the top ten questions on the screen [8].

2.3 Backstage

According to Pohl et al., passivity is one of the biggest problems in education. As class size increases, social barriers tend to arise that make students feel uncomfortable, for example when commenting on discourse or posing questions. Computer-mediated backchannels solve this problem as students can engage in collaborative activities [18].

Backstage is a dedicated backchannel which promotes active participation and awareness amongst the students and lecturer similar to the implementation of Harry et al. using a micro-blog.

A micro-blog is a commonly used form of media for backchannels. Due to the fact that micro-blogs are brief, students write their messages in a concise manner. Students also reflect more on their messages while typing them instead of saying them. This results in a deeper understanding by them and by other students that read them.

The Backstage backchannel includes a public, private as well as anonymous form of communication. Students can refer to other students in the class by using the “@” character. This is commonly used in IRC clients and Twitter and so will not be unfamiliar to students. Pohl et al. state that anonymity lowers the barrier to participate in backchannel communication. This is a common opinion in most of the literature on student interaction systems. Students approve or reject messages to the lecturer by use of a rating scheme. This is very similar to Harry et al.'s voting method. Highest rated messages and messages that are commonly referred to using the “@” symbol will be posed to the lecturer. The decline of relevance will also be subject to an aging process and so, older messages will lose rating over time if they are not constantly referred to or rated.

Backstage poses a question to the lecturer with a corresponding percentage. This percentage stipulates the quantity of students that asked the question.

The backchannel system provided lecturers and students with a system of instant feedback.

2.4 Lecture Comprehension Enhancement Application

Zhan et al. created a lecture comprehension application that incorporates auto-grouping and question sharing. The problems that Zhan et al's system intended to solve included test results not being returned in time, instructors not being aware of students' level of understanding, students' insecurity about their learning level, students lacking the confidence to ask questions as well as text-based questioning taking too long for students to write and lecturers to view. The application gave students the ability to post questions anonymously and for lecturers to quickly grasp the students' understanding [18].

Students could view lecture material within an interface created for them on their laptops. Questions that were related to certain slides could be posted. This results in the lecturer being aware of which slide students were referring to. The lecturer receives slide number frequencies so that slides that are commonly misunderstood could be addressed first. Lecturers can receive text messages that are also grouped by slide number. While the lecturer gives a presentation, they have the option of an “always-on-top” mini version that occupies a corner of the screen with only slide number frequency information. This prevents wastage of space as well as time wasting as lecturers do not have to minimize the presentation to view a summary of which slides are commonly misunderstood. If necessary, the lecturer can then view details of the queries afterwards [18].

The application also has the functionality that there is real-time questioning so that students answers to quizzes can be graded immediately. Not only does this allow for real-time quizzing, but also the option of lecturers being evaluated [18].

Due to the aforementioned functions, Zhan et al.'s application has the benefit of being effective as well as convenient. To evaluate this, they tested the application in mock lectures and contrasted the average test results. The results showed that the incentive to interact in class improved lecture quality which resulted in higher marks [18].

4.5 NATA

Not Afraid to Ask (NATA) is a computer based system created by Chu et al. that is used to encourage students to ask questions in lectures by reducing the pressure and embarrassment [4].

Due to the fact that questioning is “critical to the development of reflective and meta-cognitive thinking”[4] people examine the knowledge that they have received to improve their learning.

Chu et al. created a prototype of a questioning system to reduce the pressure of asking questions. The NATA system includes “Question Input, Questioning Race, Statistics Report and Data Record” phases [4].

In the Question Input phase, students have the ability to enter questions at any time during a lecture. Usually, students wait for an opportunity to ask questions and during this period of time, the students often forget what they were going to ask. Students can decide whether they would like to ask this question and better formulate it as they have more time to decide the correct wording of their question. During this process, students are encouraged to reflect on their questions and this results in improved critical thinking and meta-cognitive abilities [4].

During the Questioning Race phase, students press the bell next to the question on the interface. The reason why this phase is framed as a race is because it encourages students to be the first one to ask the question [4].

In the Statistics Report phase, students and teachers are able to view the questioning performance of all students. Only students' identification numbers are shown so the system is still anonymous. Lecturers do have a record of which student correlates to which number so that if needs be, the lecturer can find out who posed the question. This tends to be different from all the other implementations mentioned as they are focus greatly on anonymity [4].

The Data Record phase stores details of questions so that students and lecturers can review these questions after the lecture. Lecturers can identify where students are having difficulties so that they can adjust their teaching style or pace accordingly. If students read the questions, it might stimulate their question asking [4].

The NATA system was tested at a private university in Taiwan. Students used the system to pose questions in lectures during midterm presentations. 56 students were split up into 17 groups. Each group gave a presentation of approximately 20 minutes in length. Half of the groups used traditional questioning methods during the presentations and the other half used the NATA system. A study was performed to test the effectiveness of NATA. The results showed that there was a significantly higher amount of questions asked when using NATA compared to the traditional questioning process. The quantity of students who clicked the bell to pose their question was significantly higher than the quantity of students who raised their hands to ask a question. Ninety percent of students felt that the NATA system made it less stressful to ask questions. It was also felt by 87.5% of students that they learnt more about how to ask questions when using the NATA system [4].

4.6 Mobile Lecture Interaction

According to Cruz e Costa et al. the lecturing method of education has the lowest retention rate of all methods of teaching, namely 5%. This is partly due to the low student-lecturer interaction [5].

A system very similar to Harry et al.'s Backchan.nl system was created by Cruz e Costa et al. at the University Of Oulu, Finland. This system is known as the MLI (Mobile Lecture Interaction) application [5].

The similarity lies in the fact that students could pose questions on their mobile phones to the lecturer and the other students could support them by voting for their questions. Unlike the client-side of Harry et al.'s implementation, students ran Java applications on their phones where they could submit, view and vote for questions. The Java application connected to a website which then sent the posed questions to the lecturer on their PC, who could subsequently answer them as s/he felt the need [5].

When tested on 8 lectures using Java-enabled cell phones running the MLI application, lecture interaction improved in a meaningful manner. Owing to the fact that the application ran on students' personal devices, the university does not need to invest in expensive clicker technology such as in The Classroom Performance system [17].

Even though students appreciated the opportunity to interact with the lecturer anonymously, many students were not sure whether this system was a better way to interact with the lecturer. This implementation (in 2008) used phones that ran the Java Micro Edition (ME). The running of Java ME games and applications that are downloaded in the form of a .jar or .jad files [3]is slowly becoming obsolete. Most Smartphones now run their own executables such as .ipa files on iPhone, .apk files on Android, and .cod files on Blackberry [2, 10, 14]. Some of these phones are still able to run JAVA ME applications but it is not commonly done. Therefore, the technology used in this implementation is no longer commonly used unlike in [8, 13, 18] where the applications were created for computers which still have the ability to run this software.

3. METHODOLOGY

The approach taken when creating and implementing the lecture comprehension indication system was to base the system on the strengths of previous implementations[4, 5, 8, 9, 13, 17, 18] and customize it to suit the needs of a Rhodes University lecture. The system was intended to be an inexpensive way for students to communicate anonymously with the lecturer during a lecture and throughout the course. This was done by using mobile phones instead of expensive devices such as the clickers or tabs mentioned in the literature. The choice between using mobile phones and laptops came down to the question of current usage. According to Canalys, Smartphone usage overtook client PC usage in 2011 [15]. Smartphone sales experienced growth of 62.7% whereas notebook sales experienced growth of 7.5%. Therefore, using Smartphones instead of laptops seemed to coincide with current technology trends. The fact that the implementation of this system was being done in a developing country was an influence on the system and as such, the technology incorporated needed to be technology that is currently being used in South Africa. Only 18% of the South African population do not have cell phones [16].

Initially, the system was going to be created for Android devices only. After some thought and reflection, this decision was changed;

the choice of platform on which the mobile application ran came down to the usage share of Smartphones in the class and worldwide trends. Seeing as South Africa is a developing country, the market share is remarkably different to wealthier countries. There are more than 8 million Smartphones in South Africa. There are approximately 300000 Apple iPhones, 2000000 Android devices, and 2500000 BlackBerrys [16].This means that the interaction needed to be available on more than one device. Students were asked to indicate which cell phone operating system they used. This could be used to give an indication as to the usage share of students' cell phones in South Africa. This data was necessary in determining whether having the application running only on Android cell phones would be suitable. The class had a disproportionate amount of Blackberry users; Blackberry tends to be the dominant Smartphone in developing countries due to its low cost [11]. As a result, future work could be done to make the system more accessible and create an application for all platforms or use a framework such as PhoneGap to deploy the application on all operating systems [1]. One could question why an application system was not created for BlackBerry devices; this was due to the fact that international trends were taken into account. BlackBerry shipments have dropped to 2% [7] which shows that creating the system for BlackBerry could be short-sighted.

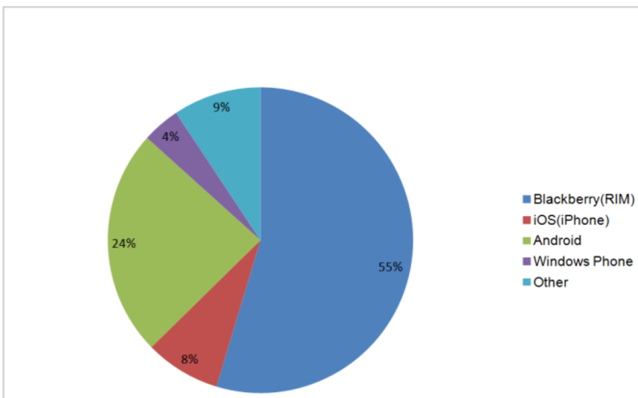

Figure 2: Usage share of cell phone operating systems

Students could use their phones to communicate anonymous feedback to a website via an Android mobile application or mobile website [Fig. 3]. The feedback could be directed as: questions, general feedback and answers, interest in the topic, pace of the lecture, level of engagement and feedback that is not time sensitive. This way, the feedback was grouped on the website depending on what students wish to send in. This also gave the students an idea of what is acceptable to send in.

The website sends the feedback to a topmost window that stays in front of the slideshow during a lecturer [Fig. 3]. Students' questions or comments appeared on this window so that the lecturer could address problems, questions or feedback as they arose. The window displayed student feedback in 30 characters or less. This feature was incorporated so that students needed to be succinct, allowing the lecturer to glance at the window and not waste time reading long messages. Lecturers could revise what feedback was sent in during a lecture by visiting the website [Fig. 3]. They could also view messages that are sent in that are not time sensitive. This meant that if the lecturer missed anything in the lecture they are still able to address it. For example, if a topic is commonly misunderstood and many students are sending in posts at the same time, it is possible for the lecturer to miss some of them. As a result, lecturers were able to view all posts after the lecture as they are saved in a database and viewable on the website.

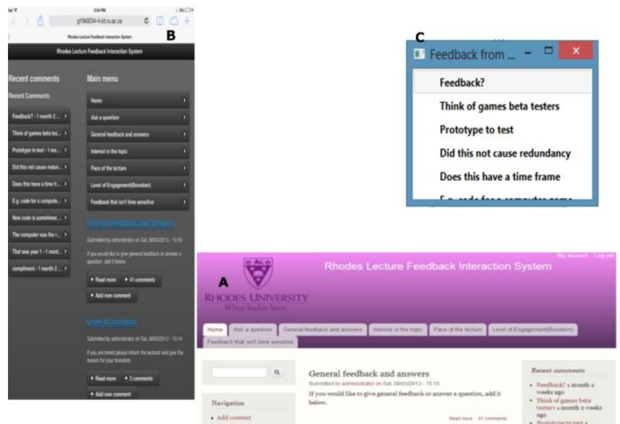

Figure 1: Specification of the system

4. RESULTS

From the eleventh until the sixteenth of August, a pre-implementation questionnaire was run during Computer Science 112 practicals. The following set of results was collated from responses to the questionnaire. The results are intended to give some insight into students' interaction in lectures.

Students' indicated that their interaction in lectures is limited no matter what type of interaction it is [Fig. 2]. The results substantiate the claim that students often lack the confidence to ask questions, ask a lecturer to slow down, repeat something, or explain a topic further when they are unsure of the subject matter. The diverging bar chart for interaction in lectures shows that there is a proportion of students who interact in lectures but there is a greater proportion who do not. The average percentage of students who do not interact in lectures in different ways is 71.2% which indicates that there is enough evidence to show that students resist interaction in lectures [Fig. 2]. This statistic includes interaction by means of asking questions, answering them, giving feedback, commenting on their level of engagement (boredom) and commenting on the pace of the lecture.

Once the system had been implemented in the class for two weeks(26 August - 30 August; 9 September - 13 September), a second questionnaire was made available to students. This questionnaire was accessible from the 16th until the 20th of September during Computer Science 112 practicals. The questionnaire was designed to assess the value of the system from the students’ perspective and help determine its potential value in future classes.

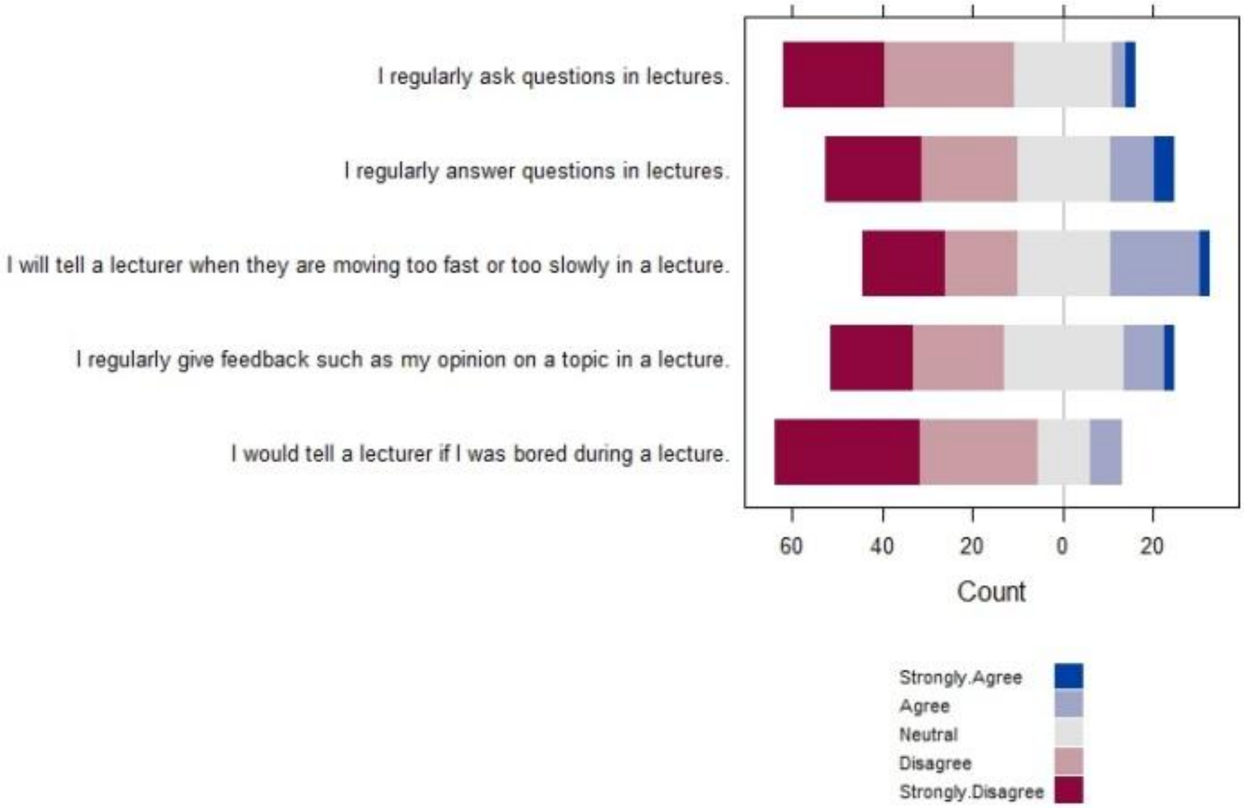

Figure 3: Interaction in lectures

The data collected from the evaluation of the system was reassuring and substantiated the hypothesis that such a system could increase lecture interaction for students who resisted it. More than half of the respondents thought that the system should be used in future classes as the percentage who agreed with this was 66% [Fig. 4].

The design feature of having a word limit seemed to be too restrictive for students and as such, future implementations should address this issue. As mentioned previously, this design choice was made to ensure that lecturers did not have to read long messages that could be distracting.

Most students found that the system was easy to use and easy to connect to. Although this is true, the students felt that there was not sufficient WiFi and cell phone signal in the lecture venue. The percentage of students who believed there was adequate cell phone and WiFi signal was 56.5%; the fact that just under half of the sample found that the signal was not sufficient is concerning as this could indicate that these students could not connect at times when they needed to. This could have negatively affected the data as to the extent students wished to use the system. The Rhodes University IT department is working on WiFi signal in lecture venues and so this could be less of a problem in future trials.

There were many benefits of using the system but according to the students, the main benefits included the fact that it made it easier to interact in lectures. Students' feedback on the system included comments such as: *"The system gives easier interaction between the lecturer and the students.", "Allows for lecture interaction without disrupting the lecturer's flow or train of thought."*, and *"It makes student- lecturer interaction easier as students remain anonymous."* The comment *"it is very helpful in the way that we can communicate with the lecturer and provide helpful hints to improve the lecture."* suggested that it also gave the students an easy way to give suggestions to improve the lecture. Another benefit that some of the students believed to be true was that the lecturer's train of thought was not disrupted when students interacted or asked questions. This reduced the disruption of flow during the lectures. According to the lecturer, this was untrue as the system tended to be very distracting.

The anonymity seemed to be both beneficial and a liability with the system. It was beneficial as students believed that it allowed them to answer questions without their identity being revealed. This resulted in an easier way to ask questions that they believe to be "silly", and gave confidence to the shy students. Many of the students mentioned this: *"it was easy to communicate a question without your identity being known as some people may be too shy or think their question is silly, therefore made it easier to ask question.", "It could be that shy people were able to ask questions, but then again you can always approach the lecturer or the class rep", and "Students who are too shy to ask questions in class now have a platform in which to do so."*

There were three main downfalls of the system according to the student's responses. The first downfall was that the system seemed to be distracting. Students felt that typing messages meant that they lost track of what was going on in the lecture. Reading what other students had typed also seemed to distract students and hence they would lose track of what the lecturer was speaking about. This was shown in the following student opinions: *"Questions are not filtered for relevance to the lecture material. It distracts the lecturers", "Too distracting , and people start asking funny questions and we end up*

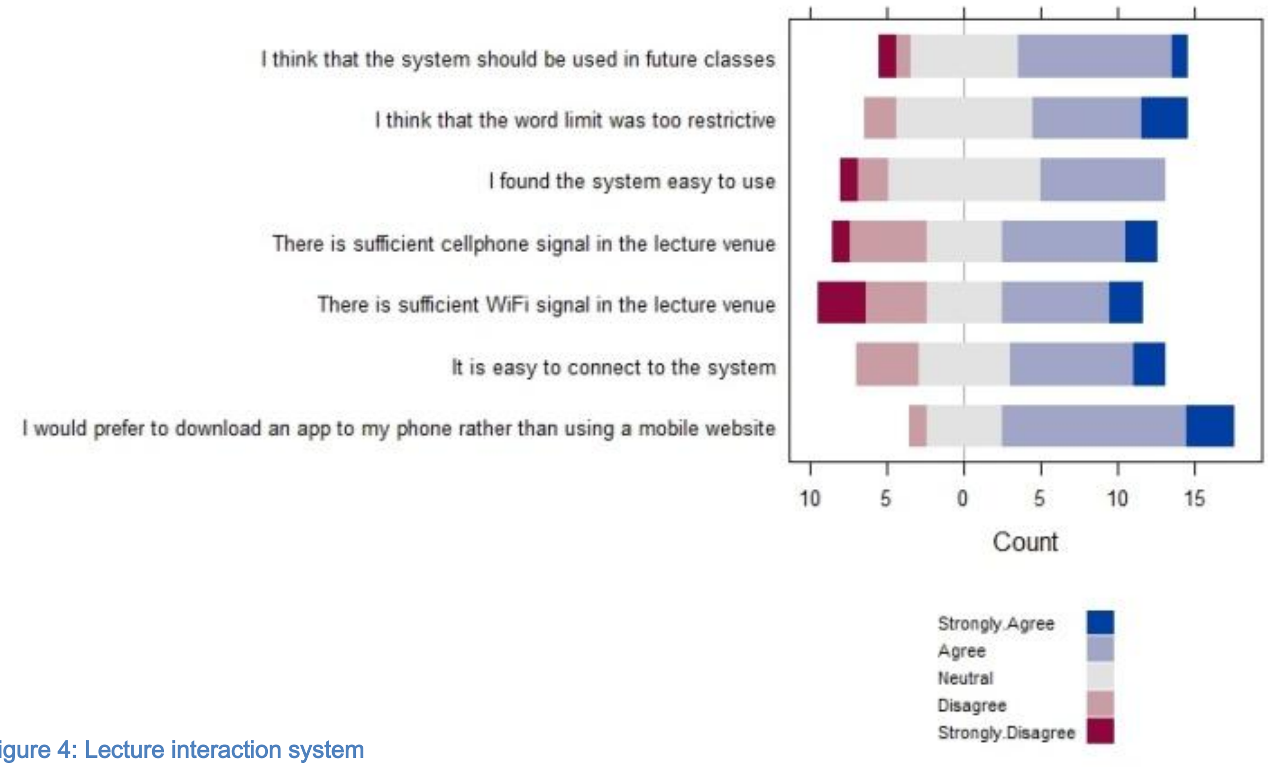

Figure 4: Lecture interaction system

losing the value of the lecture. People tend to think it twitter or something and they just go overboard", *"Typing out a message is distracting, ie I miss what the lecturer is saying while my head is down and I'm texting"*, and *"it is very distracting - end up watching the screen more than listen to the lecturer. Also it hampers the lecturers' thoughts/teaching as they get interrupted."* This could be remedied with a moderator; a student or teaching assistant could moderate comments before they are sent to the lecturers' client. This would prevent distracting and unnecessary posts from appearing.

The second downfall was the fact that the posts were anonymous and as such, students could post whatever they wanted. This resulted in funny or offensive posts being sent in. Not only could this have a negative effect such as offending the lecturer or students but it also distracted the class. This was mentioned by a few students: *"i personally think that the anonymous part of the app made it easy for students to take advantage of the app and play the fool, i was also present for some very rude remarks made to the lecturer when it had nothing to do with her lecturing and style of teaching or the actual note."* and *"the anonymity of the messages allows people to post unproductive things on the message board which is really irritating."*

The third downfall was accessibility; it seemed as though some students found it difficult to access the system due to cell phone and WiFi signal in the venue. Some students also found the system difficult to use even though there was a large proportion who did not find this so. Students mentioned: *"It works using the internet and reception isn't always good in certain venues"* and *"The application is too complicated to use and virtually inaccessible."*

5. CONCLUSION AND FUTURE WORK

Due to the economic need for large lecture classes, teaching and lecturing methods have been adapted to ensure that students receive a valuable education. Students' interaction in lectures is limited due to social pressures and lecture classes have increased in size. Lecture comprehension indication systems came about to remedy this problem.

These systems incorporate many functionalities to ensure that lecturers are aware whether students are grasping concepts or not, and facilitating the answering of questions. The systems differ in implementation and what they can do because academics have contrasting opinions on what is necessary.

To understand the need for these systems, a greater insight into students' interaction in lectures has been acquired. The data showed that students resist interaction in lectures for a variety of reasons including lacking confidence, fearing their peers and lecturers, not wanting to offend the lecturer and other concerns.

Once insight into interaction in lectures was acquired, a lecture comprehension indication system was created. It was implemented in Computer Science 112 lectures for a period of two weeks and the value of the system was tested.

The data showed that students perceived the system as valuable. It gave the students the ability to interact anonymously with a lecturer at any time during class and throughout a course. Students believed that it also gave confidence to shy students and provided students with an easier way to interact in lectures.

Although the system was proven to be valuable, there were downfalls which included the fact that the system was distracting; the anonymity allowed posts which did not add value to the lectures and the accessibility of the system restricted students who wished to use it. It is for these reasons that there is scope for future work.

Before posts appear on the lecturers' client, moderation could occur. This would ensure that distracting posts and messages that do not add value to the lecture could be filtered out. This would mean that a person would need to be dedicated to reading posts and forwarding them to the lecturer. The problem arises in that it could be seen as unfair to expect a student to do it as it is time-consuming and distracting. As a result a teaching assistant such as a tutor could be asked to perform the task.

Another addition that could add value would be to introduce visual indicators into the system. Posts which do not need verbal interpretation such as level of engagement (boredom) and interest in the topic could use visual indicators instead of text display. For example, graphs could be created on the pallet window so that if students are no longer interested in the topic or are bored, the graph could show this. The student mobile application would need to be changed to incorporate a scale that students could change so that the graph changes accordingly.

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