A literature review of lecture comprehension indication systems

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Contents

Abstract In the past two decades, e-learning has shown to be a valuable area of study when it comes to education. There are many techniques and technologies used to facilitate teaching that fall into the field of e-learning. Lecture comprehension indication systems are situated in this field. The following survey of literature explores and compares implementations of these systems and their use to complement teaching.

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. Lecture comprehension indication systems have come about to address this issue. This paper describes a basic introduction into the field of e-learning. It also introduces the approaches used in lecture comprehension indication systems and defines the concepts commonly used within these systems. There have been many implementations of these systems; they vary in how they are implemented and the features they offer. Towards the end of this review, some of these implementations have been described and contrasted.

2 Traditional learning theory

According to Ranson et al.[19] learning is a social creation that is facilitated through discovery and understanding of the world around us and ourselves. Our knowledge is enlarged when something new enters our experience. Learning can also develop skills which will result in an enlarged capacity to interact with the world around us. There are different layers of learning depending on what is discovered, be it, new knowledge, skills, concepts or attitudes. Understanding occurs when one reflects on the knowledge they have obtained. To understand, people need to recognise the complex interdependence of factors and qualities which are distinctive about a subject.

Learning is a conscious activity that depends on the enabling of internal rewards as well as self-motivation. This is due to the fact that we cannot unwittingly acquire new knowledge without using "reflective" energy on it. Learning requires some struggle to make sense of a topic even though understanding can sometimes come easily. People are unable to learn without the sense that is is necessary and purposeful and thus taking the responsibility to achieve what is required in the learning process.

A key characteristic of learning is conversation. Learners are speakers and listeners; they are part of social creation that is conversation. An assumption

of this discourse is being open: students have to allow their prejudgments to be challenged and hence have to be open to difference. Students need to develop an understanding of others and admit the existence of better perspectives or options. By challenging other beliefs and understandings, students are shown the shortcomings of their own. Reason and rationality emerge when students partake in dialogue with others.

Institutions such as universities are involved in the process of learning by leaving their mark on the emotions, thoughts and identity of students. Institutions shape students and alter their confidence and sense of place by altering their lives.

The capacity to learn is the main characteristic that will determine the quality of peoples future. If people keep learning as the main part of our existence then we will continue to increase our capacity for knowledge, the differences amongst communities will be a source of understanding and institutions will be able to respond effectively and openly to change.[19]

3 E-learning

E-learning is commonly thought of as the use of technology and electronic equipment to aid in the process and execution of education [22, pp. 1]. It is at the forefront of education and it is the way that education is changing. e-Commerce and e-Business are commonly spoken about but e-learning is becoming an increasingly used term in business as it is a good investment[22, pp. VIII]. In academia, higher education is now faced with the problem of competition. This competition is local and global and so Universities need to stay up to date with educational methods[12]. According to Jones et al.[12] e-learning supports a student orientated learning model and it helps support the current changes in education. E-learning is also encouraging collaboration and symbiosis amongst different professional groups. This increases the respect and understanding of the different groups. It has proven to enrich and improve the development of courses. [12]

According to Tavangarian et al.[23], the use early e-learning methods were flawed as the primary motivation to incorporate it into training was return on investment(ROI). Another flaw was that the focus of e-learning was used to map traditional learning activities onto a digital environment. This means that educational process requirements as well as the needs of learners have not been at the forefront of research into this field. Tavangarian et al. is of the opinion that if one states that e-learning is similar to the aforementioned definition, the adoption of electronic media in teaching or education, then it is too broad as one could then say using a microphone within a lecture could constitute e-learning.

A more accurate and tighter definition of e-learning is :

> "All forms of electronic supported learning and teaching, which are procedural in character and aim to effect the construction of knowledge with reference to individual experience, practice and knowledge of the learner. Information and communication systems, whether networked or not, serve as specific media to implement the learning process."[23]

There are two basic types of e-learning that are commonly compared. They are known as synchronous and asynchronous e-learning and are differentiated by time-difference when using educational resources.

3.1 Asynchronous e-learning

Asynchronous e-learning is performed when participants cannot communicate at the same time. Asynchronous e-learning provides flexibility as it allows students to use resources at any time as their use is not stipulated by time constraints. It is therefore self-paced learning and as such is subject to learners self-motivation. Asynchronous e-learning can be collaborative and are regularly pre-produced or recorded.[11] For example, common formats are e-mail, forums, Web-based training, Podcasting, DVD, recorded lectures and discussion boards[10]. Hrastinski states that learners have more time to process information when using asynchronous methods. Students answers to questions are not expected to be immediate and so, they have more time to comprehend the message given by a lecturer or peer.

One of the unique benefits of asynchronous learning, is the fact that students are able to control the order in which they access content. This method of e-learning works well for students who learn effectively by thinking and understanding content on their own. Asynchronous e-learning methods are more widely used than synchronous methods and it can be said that their popularity comes from the fact that two parties do not need to be available at the same time.[14]

3.2 Synchronous e-learning

Synchronous e-learning can reduce frustration as questions and answers can be asked and answered immediately. If there is not a noticeable time-delay between participants, then the learning is said to be synchronous[10]. According to Hyder et al. [11] all descriptions of synchronous e-learning tend to incorporate the use of Web conferencing software to aid interactive, live events facilitated through the Internet. Synchronous e-learning is scheduled on regular occasion but can also be open to the option of being impromptu. It also tends to be collaborative, collective, and learners can use the resource simultaneously. Examples

of synchronous e-learning are videoconferencing, LVCs(live virtual classrooms), Webinars and live chat.

According to Hrastinski[10], synchronous communication increases psychological arousal which increases motivation. This is due to the fact that the learning is live. Students felt that synchronous learning was "more like talking" [10] which made students feel more at ease when it came to covering complex issues.

Both synchronous and asynchronous learning are effective in reducing the problem of geographical barriers[14]. Hence, they are valuable tools for distance education.

3.3 Limitations of e-Learning

Not all types of training and education work well with technology as the main medium. According to Maldonado [16], it is very important to have motivation from lecturers, parents and peers to learn; due to the fact that a large proportion of e-learning uses are based on autodidacticism: self-motivated learning. Students who cannot motivate themselves struggle to use e-learning effectively. E-learning also cannot replace learning where face-to-face interaction is necessary. Technology is changing, and so the scope of e-learning and how we can use technology to support learning is also changing [22, pp. 2]. There are many benefits of e-learning as intranets and the Internet provide students with forms of learning that they previously would have had to travel to receive; learning can therefore take place in one's home or office whenever the necessity arises. Streaming multimedia makes learning more engaging and the fact that students are allowed to take courses from universities and schools that are at a distant location from them adds great flexibility.[22, pp. 2]

According to Hrastinski[10], students can often feel isolated and not part of a learning community when using e-learning. This is a vital part of collaboration and learning. Another fallback mentioned is that it tends to be difficult to get students to collaborate on online forums when classes are small.

Although synchronous methods are said to increase psychological arousal, both asynchronous and synchronous methods can decrease it as students cannot read body language or facial expressions[10]. This can result in students being unsure of responses and reduce their motivation.

4 Blended Learning

Blended learning is learning that is done by effectively combining different teaching styles, modes of delivery and types of learning. It is being facilitated by

transparent communication amongst everyone that is involved in a course.[7] To ensure that this learning method is effective, it is imperative that all learner characteristics such as abilities, attitudes, physical, perceptory and sensory skills, as well as prior knowledge, are taken into account. Blended learning incorporates a variety of environments such as lectures, self-paced study, workshops, simulations, interactive multimedia and online collaboration.

There are four models of blended learning: the rotation model, the flex model, the self-blend model, and the enriched-virtual model. [21]The rotation model is a program where students "rotate" on a schedule between learning styles. One of these learning models needs to be e-learning.

The second model, the flex model, is a program where lecturing and content are delivered mostly by online means. Students can work on a fluid schedule between online content. Students are also able to converse with an on-site lecturer when the need arises.

The self-blend model is a program where students take some courses entirely online (with the lecturer only available through online methods),while taking other courses in traditional learning environments.

The enriched-virtual model is a learning experience where students take all their courses online but do have some lectures in a traditional learning environment. These models are not the only way that blended learning can take place and often, learning is facilitated through a combination of them.

A model of blended online learning is shown in Figure: 1.

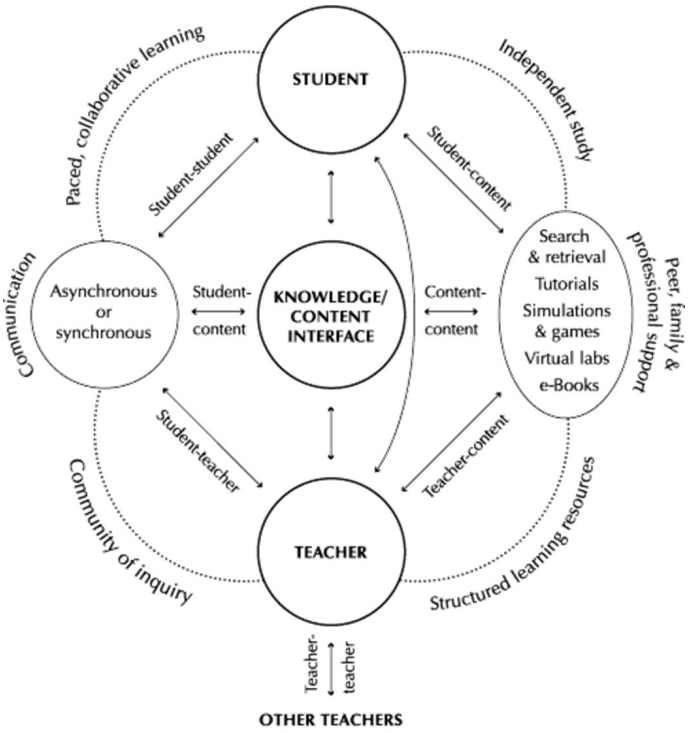


Figure 1: A Model of Online Learning [3]

5 Large Lecture Classes

Wolfman et al.[25] state that it is a common opinion that large lecture classes are born due to economic restrictions. They are an economic result of a problem that results in a difficult task to overcome. With many students enrolling in a course, lecture venues have become exceedingly barren and uninviting. Other problems that have arisen is that lecturers find it difficult to become acquainted with students and students often seem bored due to the impersonal and one-sided environment[9].

Large lecture classes have also added to the social pressure that effects student interaction in lectures. It is due to these problems that innovative methods of education need to be incorporated into traditional education.

6 Student Interaction in Lectures

There is often a lack of student interaction when lecturing is the main method of instruction[20]. According to Robb[20] "Within this environment, the student is a passive recipient of information, and dependent learning is promoted." Lecturers who encourage student interaction foster more motivation among students.

As it stands, lecturers are often unaware of how well students are grasping concepts in a lecture. This is because there is often not a large amount of engagement by students during the class. Students rarely have 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. Many students at universities fill in student feedback questionnaires towards the end of a semester for a range of subjects. According to Kember et al.[13], these questionnaires are used to improve the quality of the education. Educators can note their faults in teaching through these questionnaires and can make improvements to their teaching styles to address these faults. This should result in a better quality education and learning experience. It is also sometimes seen as an obligation by university administrators to gain the opinions of students.[17] The problem is, this is just hypothetical and according to Kember et al.[13], there is no evidence to prove that these questionnaires actually help or make any contribution to overall learning or education quality. Another issue is that the students are offering feedback on their experience of the course at the end and so, the knowledge the lecturer gains from the feedback can only be used the next time s/he lectures. This does not benefit the class that gives that feedback, only the next group of students.

7 Types of Feedback in Lectures

There are two main types of feedback in lectures namely, social emotional feedback and task feedback[5]. Within social emotional feedback there are positive reactions and negative reactions. Positive reactions occur when students either show solidarity, agree with other participants, or show passive acceptance. Negative reactions occur when students disagree, show tension, show antagonism, ask for help, or assert themselves.

In task feedback, there are questions and attempted answers. Attempted answers include suggestions, opinions, confirmation or giving topic-related information. In contrast to this, questions occur when students ask for orientation, information, confirmation, repetition, topic technical information, evaluation, analysis, or suggestion. [5]

8 Lecture Comprehension Indication Systems

A lecture comprehension indication system can encompass social emotional feedback and task feedback in lectures. It can take the form of synchronous e-learning or asynchronous e-learning or both depending on when the feedback is given. If the system is used during the lecture then it is said to be synchronous whereas if it is used to give feedback not in real-time then it is said to be asynchronous. 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. There are also implementations which incorporate clicker or audience feedback technology such as the option by MacGeorge et al.[15] This differs from traditional feedback which tends to be at the end of a semester or just at the end of a course. A system such as this has proven to be successful in improving course content[18].

There are many different approaches taken when creating one of these systems as shown in the following section. All of the following systems have commonalities. 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.

9 Past implementations

9.1 Audience Response Technology in Large Lecture Classes

A study was carried out by MacGeorge et al. [15] 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.

MacGeorge tested to see whether demographics effected the results of the study and although there were minor differences, it was not statistically significant to prove that demographic differences had an impact on the use of these devices.

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.

According to MacGeorge et al. their study was more focused on diversity than previous studies and took factors such as race and gender into account. They did find that these demographics were not statistically significant in the trial and hence did not affect the results. MacGeorge et al. are of the opinion that in future trials, instructors methods of using ART should be considered. The conclusions drawn from this study showed that the benefits of using audience response technology in large lecture classes are great enough for the technology to be used as a common method in education.

9.2 Backchan.nl

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 frontchannel.

According to Harry et al. [8], 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

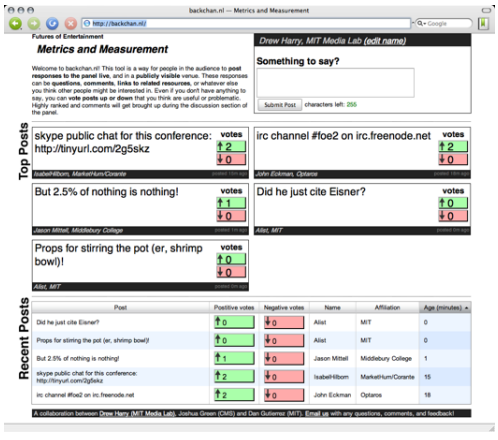
monitor for the speaker/moderator. When a user logged in, they had to provide credentials such as their name and affiliation. The system was anonymous but these credentials prevented double-voting. For clarification on how the interface worked, refer to Figure: 2

On occasion, members posted advertisements and publicized their own backchannels. These posts did not score well and hence did not have an effect on the overall working of the system.

During talks, most of the popular postings were content based such as "What's the role of Social Media in advertising and Convergence Culture?". Surprisingly their were also posts that were based on public sentiment such as "Can we make sure some more questions from the board get answered this time? xthxbai." and a post on the temperature in the lecture venue. Sarcastic and funny questions did not get sufficient votes to be placed in the top ten. This shows that the system was effective as a medium for interaction among the audience and presenters. On regular occasion, presenters would combine many questions into one central broader theme but still acknowledge the source of the questions so them members could know which questions were being answered.

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

To get people to use a backchannel system is challenging.[8]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.



(a) Backcha.nl's web interface

(b) Projected top ten posts shown on the small screen.

Figure 2: The implementation of Backchan.nl[8]

9.3 Backstage

According to Pohl et al. [2], 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.

Backstage is a dedicated backchannel which promotes active participation and awareness amongst the students and lecturer similar to the implementation of Harry et al.[8]. Pohl et al. quotes Professor Deborah Ball who states that "Students' opportunities for learning are reduced when their role is mainly that of spectators in large lecture classes." This tends to be a problem in large lecture classes. As a result, Pohl et al. used a micro-blog system to overcome this social barrier.

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 included 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 IRCs 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[8] 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. Not only is this rating used to determine which messages are the most relevant but also to give students' status. When students messages are given a high rating, their status on the system increases. The students status can then be used as a weight on the backchannel.

The backchannel also gives students the chance to give lecturers their opinion on pace. The pace field has two notifications namely "too slow" and "too fast". During the lecture, these notifications are aggregated and shown on the lecturers' presentation screen.

The backchannel system therefore provided lecturers and students with a

system of instant feedback. It could have possibly been beneficial to add in more of these generic feedback features such as understanding indicators.

9.4 Lecture Comprehension Enhancement Application

Zhan et al. [26] 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.

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 lecture 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. The three interfaces available are shown in Figure: 3.

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.

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. Once again, the fact that the application created was intended for computer use, the system was limited to students who bring their laptops to class.

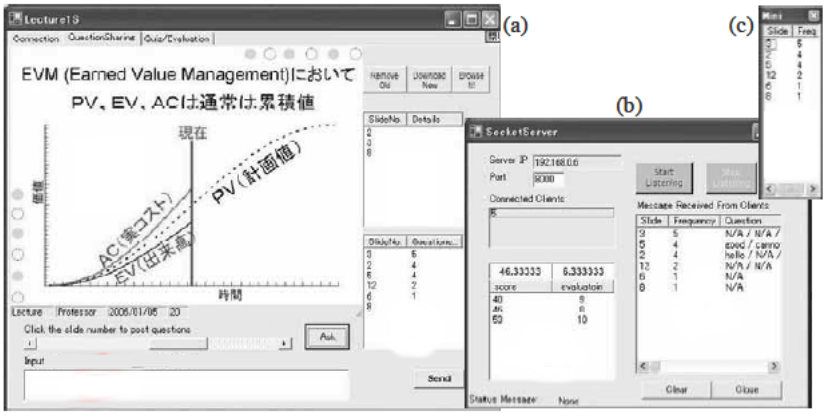


Figure 3: Lecture Comprehension Enhancement Application Interfaces

9.5 NATA

Not Afraid to Ask(NATA) is a computer based system created by Chu et al. [5] that is used to encourage students to ask questions in lectures by reducing the pressure and embarrassment.

Due to the fact that questioning is "critical to the development of reflective and meta-cognitive thinking"[5] people examine the knowledge that they have received to improve their learning. Students are not able to truly think, learn and understand unless they question.[1]It is therefore problematic that students do not ask questions in class.

According to Chu et al., the main reasons that students do not ask questions in class is that there is severe pressure. The pressure stems from four sources, namely cultural background, teachers, peers and personality. For cultural background, it is said that certain social-cultural perceptions prevent students from questioning lecturers as it is seen to be rude. In contrast, students sometimes do not have the opportunity to ask lecturers questions as the lecturers' teaching style does not give students the opportunity. The problem of peers stems from the fact that students sometimes receive unpleasant feedback from classmates and so they do not want to ask questions for fear of what their peers will say. Students who are self-conscious or shy also tend to not participate as they feel anxious speaking in public.

It was for these reasons that 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.

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.

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.

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.

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.

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.

Due to the fact that over 95% of the students felt that they would like to use the system again in the future, it can be seen that NATA is an effective method to increase students' willingness to ask questions.

A failure of the system was that it was not used for general feedback such as in the Backstage system or the Backchan.nl system.

9.6 Classroom Performance system

A powerful and revolutionary support tool as described by Ward [24] is the Classroom Performance System(CPS). Unpublished results by Ward showed that the "technology-empowered classroom" was more interactive than the traditional classroom by over 1000%. This statistic has the possibility of being overzealous, but is a definite indicator of interactivity in a technology-empowered classroom. The CPS is a clicker based system where students are given a response pad that connects with the lecturers' computer. Students can use these response pads to answer verbal questions asked by lecturers when they feel the need. This can be done without embarrassment.

Currently, there are 7000 classes in the United States, United Kingdom, Puerto Rico, Canada, Australia, Singapore and the Netherlands that incorporate the CPS into their education scheme. The CPS has the following characteristics that positively augment a lecturers' teaching style; provides both delayed and immediate feedback to the lecturer, it provides a tool for the teacher to engage all students in the class and reduces the effort of analyzing classroom interactivity.

The CPS is more focused on questioning students than on receiving general feedback from them. It does have the functionality for general feedback but the purpose of the review of this technology was mainly to test if the questioning method aided learning. When testing, Ward[24] noted that question repetition improved students' results by up to 29%.

The main benefit was that student engagement increased. This was due to the fact that peer pressure resulted in students answering the questions posed by the lecturer. This peer pressure is subtle as if most of the class is answering questions, students tend to join in and answer the questions as well. Group incentives were also added to the questioning scheme. This does not seem like a relevant addition to the classroom performance system but it did lead to improved motivation. This was done for example by informing students that homework would be reduced if more than 80% of the class participated.

In comparison to the backchannel implementations, the CPS seemed to have more focus on questioning students than on them giving feedback or inquiring about subject matter.

9.7 Mobile Lecture Interaction

According to Cruz e Costa et al.[6] the lecturing method of education has has the lowest retention rate of all methods of teaching, namely 5%. This is partly due to the low student-lecturer interaction.

A system very similar to Harry et al.'s Backchan.nl system was created by

Cruz e Costa et al. [6] at the university of Oulu, Finland. This system is known as the MLI (Mobile Lecture Interaction) application.

The similarity lies in the fact that 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 interface for the student application is shown in Figure: 4. The Java application connected to a website which then sent the posed the questions to the lecturer on their PC, who could subsequently answer them as s/he felt the need. The website running on the teacher's PC is shown in Figure: 5.

When tested on 8 lectures using Java-enabled cellphones 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.[24]

Even though many 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 was performed in 2008 and so the use of Java-enabled phones no longer seems to be a good option. People have moved from mobile phones with the feature of running Java games and applications to Smartphones with their own operating system[4]. Therefore, the technology used in this implementation is no longer commonly used unlike in [8, 2, 26] where the applications were created for computers which still have the ability to run this software.

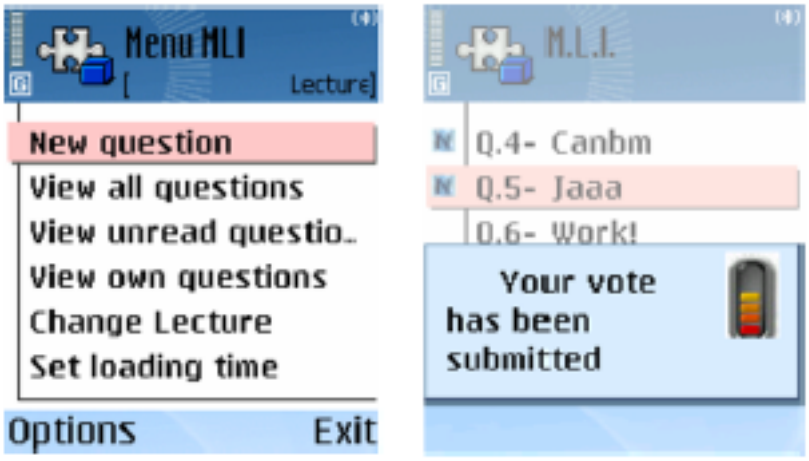


Figure 4: Mobile Lecture Interaction student application

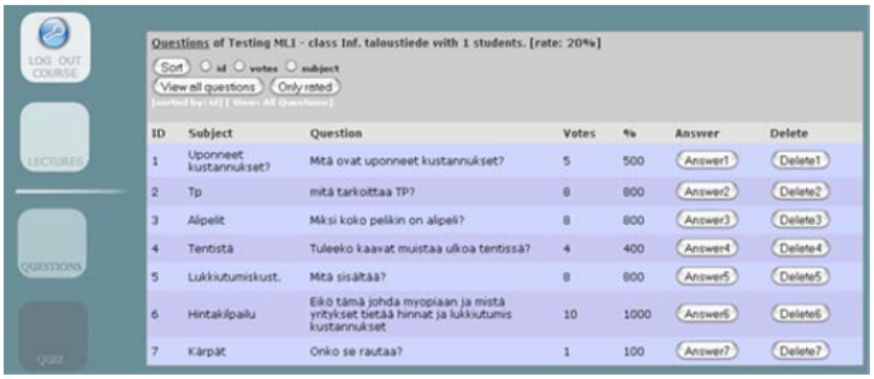


Figure 5: Mobile Lecture Interaction teacher application

10 Conclusion

E-learning is a valuable tool when supplementing traditional learning methods. Blended learning has become widely used to ensure that students receive the best education possible with the resources that they posses.

Asynchronous and synchronous methods are equally valuable in the e-learning process as they both have their strengths depending on the needs of the student. Asynchronous methods tend to work well with students who need to access resources in their own time. In contrast, synchronous methods work well to facilitate understanding and reduce the frustrating effect of waiting for responses.

Due to the economic need for large lecture classes, teaching and lecturing methods have been adapted to ensure that students receive a valuable education. Student's interaction in lectures is limited due to social pressures and lectures 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.

Based on the literature, it is arguable that a good implementation in our context would be one that students could use on their mobile phones in the lecture that would connect to a lecturers desktop application. The system would allow students to post feedback at anytime during the course so that lecturers could understand whether students are content, engaged, bored, have a question or just have something that they would like to say.

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