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Abstract: Discussion-based teaching is popular in several courses because it creates opportunities for students to practice important skills useful for the working environment. In order to make this pedagogy impactful and effective, instructors employ technologies such as online discussion forums and student response systems to conduct and manage classroom discussions. More recently mobile devices have become prevalent and researchers have been exploring how this device can help support education. In this paper we report the innovative use of mobile technology and supporting backend tools to manage classroom discussions. We have implemented a class discussion and management application, LiveClass. This application records the audio of utterances during the classroom discussion which is then converted into text and stored in a data store. The stored information is used to help efficiently grade the class participation, and provide deeper insights to both students and instructor. The analysis of the insights are intended to provide opportunity to the faculty to further improve student learning experience. To evaluate the effectiveness of the LiveClass application, we conducted a pilot run of a case study discussion in a controlled classroom environment. Our experiments enabled us to discover the gaps in the application and identify areas for improvement.

Keywords: in-class discussions, mobile application, speech to text, participation analysis.

1. Introduction

Teachers promote learning in many ways that include lectures, recitation, project work, and others. But among instructional pedagogies that teachers employ, classroom discussion is an important method. The idea of classroom discussion as an imperative for developing students' intellectual art of thinking and communication was proposed by Schwab (1954). Since then many courses in several fields of study have employed various approaches to achieve this goal. Prominent scholars today advocate discussion-based teaching because it creates opportunities for students to practice important skills such as argumentation, critical thinking, and collaboration (Walshaw & Anthony, 2008). Maryellen (2009) has identified a number of benefits of getting students to participate in classroom discussions. It improves student focus and attention, enhances student engagement, motivates students to connect the content, provides opportunity for instant feedback, promotes preparation before attending the class, and helps instructor control the class by calling upon students. Further, it encourages peer to peer learning, gives the opportunity to practice using the language of the discipline, and develop speaking skills.

However, the current method of conducting, managing and grading classroom discussions has a number of limitations (Mello 2010; Pepper et al. 2008; Smith et al. 2009). Firstly, the valuable discussions that happen in the class are not documented, "what is said" is mostly lost by the end of the session. This content created by the students can be a valuable source of supplementary knowledge for students when preparing for the assessments. Secondly, the instructor has to rely on his or her memory to keep track of "who said what" and its relevance or alternatively rely on the Teaching Assistant (TA). This leads to inconsistent allocation of participation scores. Thirdly, the opportunity to analyse the discussion content is lost. By analysing the discussion content, the instructor will be able to gain a better insight into the student learning, that is, "what the students have actually learnt during the session", the "misconception" and the "missing conceptions". This

analysis can identify the stronger and weaker students, and appropriately intervene to enhance learning. However, these challenges are difficult to handle by the instructor as the focus of the instructor in the classroom is to enable the environment that motivates the students to participate. Classroom discussions do not happen meaningfully unless teachers create a supportive classroom environment that is open to questioning as well as to varying perspectives (Walshaw & Anthony 2008). Therefore, there is a dire need for the other approaches which can capture the discussions effectively so that the instructor can analyse the session and make informed decisions.

Research on mobile technology usage in education and teaching emerged in early 2000 (McConatha et al. 2008), when Sharples (2000) discussed the potential for new designs in mobile technologies that could enhance students' learning experiences. Since then, many articles have been published indicating that mobile learning technologies are increasingly desirable in learning environments and to educational institutions (McConatha et al. 2008). Heiphetz (2011) discussed the advantages of using mobile technology for educating students, including making content universally accessible (anytime, anywhere), adapting to student needs, increasing knowledge retention, and encouraging knowledge sharing and gathering. However, these are not the only benefits of using mobile technology. Gottipati et al. (2016) used mobile app for personalised weekly competency tracking models to improve the teaching and learning process. Menkhoff and Bengtsson (2012) found that when blended with traditional instruction, the use of mobile phones in an undergraduate course greatly enriched the learners' experience and produced positive learning outcomes.

This research work attempts to directly address the limitations of the current approaches for conducting and managing classroom discussions. Our application goes way beyond the current technology enablers such as online discussion forums and clickers by providing an automated approach to help capture and analyse the "live" discussions during the classroom sessions. We leverage audio, mobile and speech recognition technologies to design and develop an application for capturing the student discussions and enabling better learning experiences and discussions management in the classroom. We conducted a pilot run of case study discussion in a controlled classroom environment to evaluate our application. Our experiment enabled us to discover the gaps in the application and identify areas for improvement.

The rest of the paper is structured as follows. Section 2 will be devoted to literature review related to the use of technology in class discussions. Section 3 describes our solution model and the details. In section 4, we present the results of the evaluation of the LiveClass application and limitations of the tool. We conclude in Section 5 suggesting some future directions of our work.

2. Related Work

Current research approaches have adopted technology enablers such as online discussion forums and classroom clickers, to manage student participation in class discussions.

Online discussion forums (ODFs): ODFs are widely implemented in university contexts as an important part of the teaching and learning process (Mokoena 2013). Alghamdi (2013) concluded that "the use of online discussion as a supplement to in-class discussion improves students' achievement and learning in higher education, at least in this particular context" (p. 74). Implementing online discussions during in-class sessions will reduce the time for other interactive activities and impacts efficient use of class time. More importantly, online discussions cannot replace the in-class face to face discussions.

Clickers in Classrooms: Over the past two decades, within the academic community, the use of student response systems such as clickers in the classroom has gained popularity (Guaci et al. 2009). However, the clickers limit questions to simple true/false or yes/no answers, multiple-choice responses, or even short answers depending on the specific clicker system employed. They are incapable of handling natural conversation, are heavy to carry, and requires additional maintenance.

Both the technologies have benefits and disadvantages. Online discussion forums are not usually conducted during live classroom sessions. The clickers are used in the live classroom for managing and analysing a highly restricted set of activities. For example, polling students and conducting live quizzes. More recently, mobile devices have been replacing clickers (Stowell et al. 2015, Mandrino et al. 2015). Mobile devices are used for quiz based questions or polling. Mandrino

(2015) used the mobile device for quiz and developed a system that captures the quiz responses. It is limited to only a specific format and analytics is not part of the system. Stowell, 2015 used mobile device for polling participations. When used as a polling device, mobile devices may currently be less reliable than traditional radio-frequency clickers. Similar to Mandrino, 2015, analytics is not part of the tool proposed by Stowell, 2015. In our project, we adopt mobile technology and address some of the limitations of the previous tools by providing mechanisms to capture utterance and convert it into text, analyse the text, and enable the instructor to gain insights from the class discussion through an analytics dashboard.

3. Solution Design

We propose a class discussion application, LiveClass, to manage in-class discussions and to analyse the students' participation. The goal of this application is to collect student in-class discussions using voice recognition tools and convert it into the textual content. Further, the application aims to provide management and analysis of the discussions by both, the students and instructor. Figure 2 shows the overview of the solution design framework that includes the process flow from inputs to the outputs. Users of the application are students and instructors who are the participants of the in-class discussions.
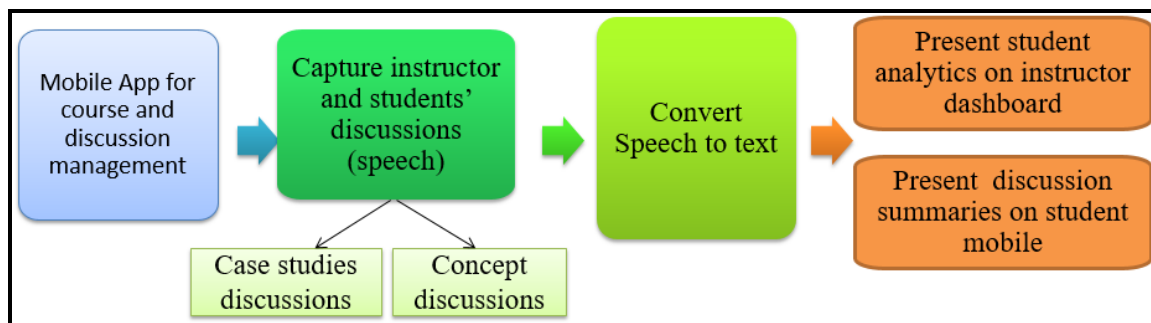

Figure 2: Solution design framework for student classroom discussion management, LiveClass

Using LiveClass, instructor will be able to analyse the data using dashboards and therefore make better informed decisions regarding teaching improvements and classroom participation assessment. Students will be able to get a summarized view of the discussion that transpired during the session. This could then be part of the learning material, one that has been created in collaboration with the student. The implementation of solution design requires devices, application modules and supporting backend technologies. The devices include mobile phones to capture the audio during the class discussions, and web browsers for dashboards. The supporting backend includes databases, server engines such as PHP engines and e-learn tool.

The mobile application, provides an interface for both instructors and students to enable recording of the class discussions. The app provides three main features; login and registration, recording class discussion and course management. Registration includes entry of personal details like name, sex, email, year of admission. Class discussion includes recording and uploading the audio. Course management includes course creation which includes entering the course title, week number, etc., and session management. Session management is the feature that enables the instructors to divide each class into multiple short sessions based on the topic of discussion and can then analyse these sessions individually for gaining deep insights on the students' participation behaviour. Figure 3 shows the mobile user interface for session management and class discussion.

User dashboard contains various student performance reports which provide concise information of student's performance in the faculty's class. The student's participation scores are calculated based on the frequency, length of audio and count of words. The dashboard is created using Bootstrap JavaScript framework, chartJS and Google charts which provide support for the visualization widgets and graphs.

4. Experiments and Findings

At this stage of the project, our main goal is to test the end to end solution and discover the strengths of the application and the gaps that need to be improved. The experiments are designed to answer the following questions.

RQ1: What reports can be generated that can provide meaningful insights to the users?

RQ2: What is the user experience of the instructor (faculty) and the students in using the LiveClass system?
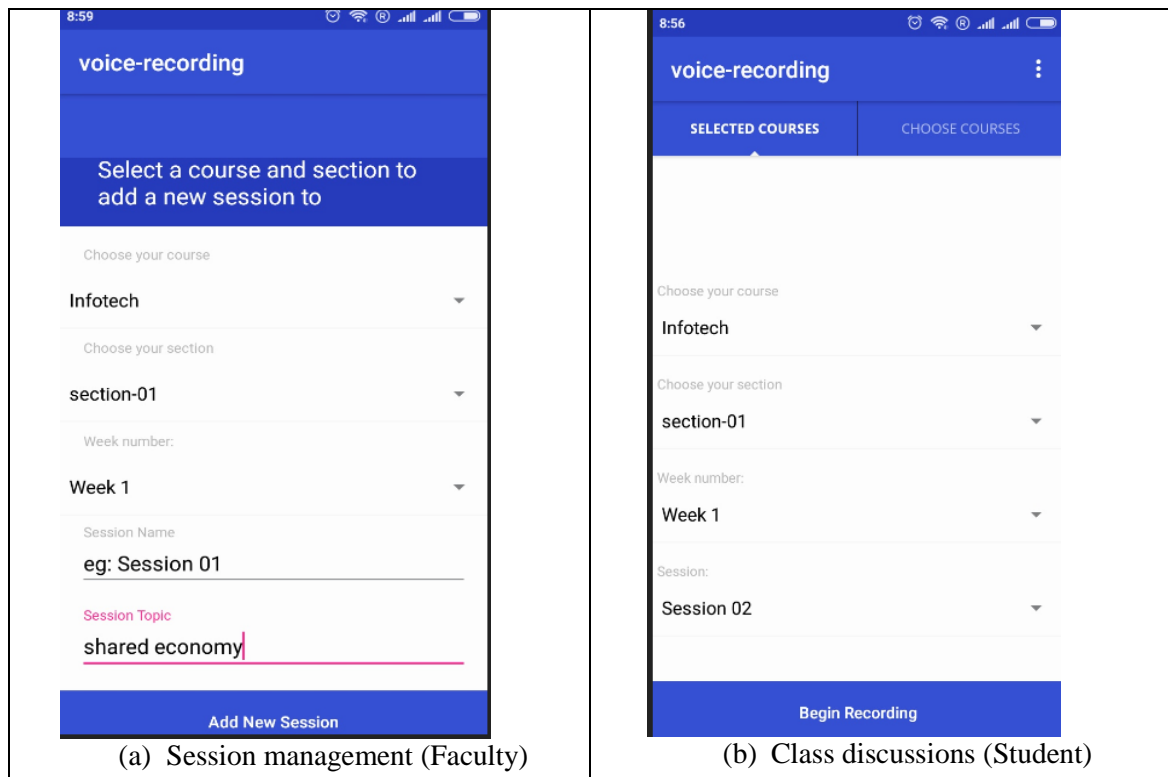

| (a) Session management (Faculty) | (b) Class discussions (Student) |

Figure 3. Mobile application user interface for instructors and students.

We engaged five student participants and a business school professor conducted a case study discussion for thirty minutes. This mock class case study experiment enabled us to test the mobile application API, speech processing APIs and collect the data for analysis. At the same time, we also collected the suggestions from the participants to improve the tool. As noted by Miles & Huberman (1994), "Samples in qualitative studies are usually not wholly pre specified, but can evolve once fieldwork begins" (p.27). This is our preliminary test and as indicated early, our main goal of experiments is to discover strengths and the issues with the LiveClass system.

4.1   Class Discussion Analysis Results

The class discussion analysis reports help to answer RQ1. We would like to study how the collected data can be used for analysing students' participation behaviour in the case discussion. Recall that the application not only collects the speech but also the other information such as course details, students' profile, sessions and time of participation. Several reports can be generated to provide deeper insights to the faculty on the case discussion. Figure 4 shows sample reports on the case discussion analysis.

From Figure 4, we observe that student, S2, had contributed the highest participation compared to others. Though audio time of student, S4, is lowest, the number of words is still higher and this indicates that S4 speaks in a faster pace. Other reports generated include, frequency of the participation, comparison of participation across the students and the session analysis. Session analysis reports indicate how the participations were placed on a time line for the complete case

study over the different sessions. It can aid the instructor (faculty) gain a deeper understanding on students' familiarity with the topic or help in conducting behaviour analysis. For example, if a student participates more in the beginning and not much in the later part of the case, there could be two reasons. Either the student has lost interest in the case or he or she has not prepared well to participate in the later sessions which dig deep into the case topic. The faculty can gather more details to analyse the class room discussion and thus and make informed decisions to improve the in-class case discussion participations in subsequent weeks. To LiveClass system, was able to generate various analysis reports on the class discussions that can providing meaningful insights to both instructor and students.
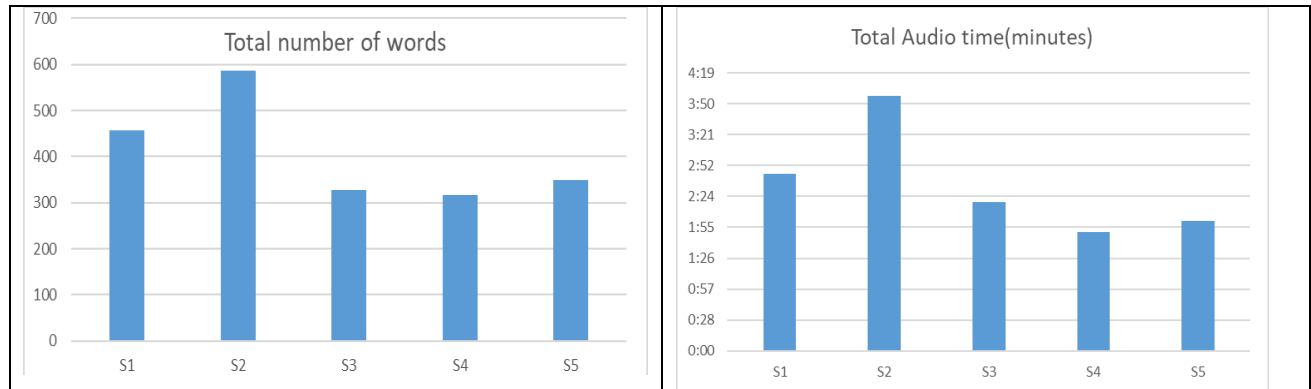

Figure 4. Analysis reports on the students' participation in case discussion.

4.2 Discussions

Our study enabled to discover two types of improvements that will be needed; voice to text improvements and analysis improvements.

Voice to text improvements are related to the audio collection and speech to text improvements. The current algorithms are limited to US accents and hence performs inconsistently across various students in terms of speech to text accuracy. The experiments are conducted on a small group of students and there is a need to study the accuracy on a bigger class size, to at least 30-40 students. The application should also be tested for compatibility on various mobile devices, currently only five different android phones were used.

Analysis improvements relate to generating reports that can provide useful insights to both the instructor and students. Current reports do provide various insights for the instructor. However, the current qualitative analysis conducted only on the words in the text. More advanced text analytics algorithms can be uses to summarise the discussions for each session that can be shared with the students to aid the students in assessment preparations. At the same time, the discussions can be further analysed to identify topics, sentiments, and extract argumentative dialogue interactions.

To answer the RQ2, we also collected the feedback from the professor and students who participated in the mock class experiment. The instructor raised three concerns namely the need for pre-planning, suitability for the course and support for auto grading of class participation. The instructor felt there was a need for familiarisation with the LiveClass system before starting the session. This could help in pre-planning the sessions and setting up the session for better organization of the flow of the case discussion. The instructor alluded that the LiveClass system is more useful when the course involves heavily case study based discussions and may not suit other types of class discussions such as presenting theory, engaging student to debate on a topic, and student group discussions. Current analysis tool only provides insights about each students' participation and the faculty has to manually calculate the scores. The instructor suggested to provide an auto grading feature where the faculty inputs the rules for the grading into the application and the scores are automatically generated using these rules. The students raised concerns regarding the availability of mobile devices and provision for alternative tools, should the mobile device fail. For example, using a web app so that can be launched from their laptops and be used for the

participation in case discussion without having to use the mobile device. They also suggested the need to generate summaries of the case discussions which can help them revise the content covered during the class sessions. These limitations and suggestions are useful future work that we will be undertaking to further enhance the LiveClass system.

5. Conclusion

In this paper, we presented LiveClass, a class discussion management and analysis application. The app helps to collect the in-class discussions using a mobile device and provides dashboards that help faculty and student gain further insights regarding the student participation during the class discussion. It collects the qualitative participation of the students during the in-class case study discussion and stores them as text using audio to speech recognition algorithms combined with database technologies. Future work will be directed towards addressing the current limitations of the LiveClass system and evaluating it using a larger class setting of 25-30 students.

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