Class Pulse: An SMAC Application to Enhance Student Feedback and Interaction

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Abstract. Nowadays mobile devices such as laptops and smartphones have become the main agents for learning in classrooms via participation in polls, multiple-choice questions, and quizzes. Students' comprehension and instructor's pedagogy can be improved by facilitating a platform that supports and enhances feedback and interaction. For this purpose, we propose a social, mobile, analytics and cloud (SMAC) application that facilitates interaction between faculty and students in the form of real-time feedback from students during lecture sessions, and helps students in getting answers to their questions from other students, and helps instructors in analyzing the feedback and interaction within and across lecture session. This paper describes the proposed application functionality and the details of a prototype built for refining the functionality of the proposed application and its efficacy. The paper also presents a summary of the evaluation results of the prototype application by demonstrating it to a couple of senior faculty members and 10 students.

Keywords: Mobile devices, classroom, interaction, real-time feedback, SMAC application.

1 Introduction

Many researchers in the field of education agree that interaction in the classroom enhances students' learning abilities and supports in actively constructing their knowledge [1]. In a typical classroom environment, when the instructor asks a question – to confirm the understanding of the material that was just covered - only a few students respond occasionally as most of them are hesitant or do not like to respond. The instructor quickly moves to the next topic of the lecture session assuming that the students have understood the material covered.

Many studies have concluded that students in an interactive classroom environment get better insights about the topics compared to traditional one-way class environments [2]. Students can broaden their thinking abilities as they see different types of questions asked by their peers. This will also help them get a comprehensive understanding of the topic as they get an opportunity to see various ways to view a given point through the classroom discussions. Promoting interaction in the classroom helps the students learn the subject from each other and most importantly helps them retaining subject. In general, lecture sessions that include discussions students tend to focus more and engage better in the class [3]. Instructors can also alter their teaching approach and content based on how well the students are reacting in the discussions. Finally, they also help in motivating students to prepare better for the next class so that they can actively participate in the forthcoming discussions. Some instructors address this issue by conducting activities such as short quizzes either at the end of or during a lecture session which can also help the students in assessing their learning process [4]. Although tools such as Google Classroom and Moodle can be used for this purpose, such activities not only limit the classroom interaction and feedback to the instructor but also require prior planning and preparation. Functionality such as the Q&A provided in Google Slides presentation mode can be used without any prior preparation. However, the instructor must initiate such activities during the lecture session, and the students are required to visit a specific web page for posting their responses.

In this paper, we propose a SMAC application named ‘ClassPulse’ to:

a) assist students in posting their feedback with reference to the topic(s) being covered during a lecture session,

b) enable students in the discussion of topics covered after the lecture session as a social group, and

c) offer analytics to instructors on the feedback provided in the classroom and subsequent discussion.

A prototype of this proposed application with the feedback functionality was developed and evaluated by demonstrating to a couple of senior faculties and 10 students.

The remaining part of the paper is structured as follows. The following section sets the context by reviewing related literature. We present the details of the functionality expected to be included in the proposed application in the third section. The functionality and implementation details of the prototype built are presented in the fourth section. The details of prototype evaluation by representative stakeholders are discussed in the fifth section. The last section concludes by summarizing the work done and further work planned based on the feedback received from the evaluation.

2 Background

Traditional teaching has always been a one-way path from a teacher to a student. This is called objectivism which is completely teacher-centric, and the student's job is just to understand whatever he is being taught. Objectivism [5] ruled the education system for thousands of years. But people realized that interactive teaching results in much better learning outcomes than the traditional teacher-centric approach. This is termed as constructivism in which students try to interact with each other and with the teacher, ask doubts and express new ideas to gain a better understanding of the subject matter. Constructivism [5] is based on the concept that knowledge is not attained without the involvement of the learner. Students should put in an equal amount of effort in trying to understand the concepts, think further and construct the knowledge he is trying to attain by himself. One of the types of constructivism is active learning which requires students to interpret the facts, build knowledge by participating in activities given by instructors and utilizing their skills.

In short, there are many limitations to the scope of student-teacher interactions in the current one-to-many classroom environment [6]. Students may be hesitant to ask for clarification in real-time during the lecture, fearing embarrassment in front of their classmates. A student may assume that he/she is the only one with the doubt and hence refrain from asking a question. They might feel it is difficult to express the exact point of confusion without being able to pinpoint it on the slide. Finally, the instructor may assume students have clarity in the topic being explained and quickly cover some points, but those same points could be an area of confusion for multiple students.

In the past few years, it has been observed that usage of technology such as mobile phones or laptops in classrooms helped enhance the learning experience of students [7]. The ubiquitous and portable nature of mobile phones has led educators to utilize such technologies in classrooms for enhancing student learning.

Many technology-based approaches are being used to facilitate interactive learning in classrooms. A popular technology among them is clickers – classroom response systems [8][9], which allows the teacher to pose any multiple-choice question such as recall-based, conceptual or application-cased questions on the fly and the students can respond to it by clicking on one of the options from their own smart device. Based on the responses received, the teacher can immediately clarify that particular concept in the same class.

In recent years, classroom presenters have also become popular because people realized that though the replacement of typical blackboard-chalk teaching with slides and presentations has helped in better visuals and understanding, the interaction of students has reduced. Sometimes, they just note down points and try to catch up with the instructor without even bothering about understanding the concept. A typical classroom presenter is an interaction system based on tablet PC developed at University at Washington. Students are given permission to annotate the slides and send them back to the teacher so that the teacher can review and integrate the outcomes into the classroom discussion. Dyknow (Dynamic knowledge) [10] is one such interactive presentation system that facilitates students with authentication and other monitoring capabilities. It adopts a general client-server model where the teacher is the server and the students become the clients. The teacher can send quizzes and get responses from students. Students are also given permission to fill in any information in the teacher's working space.

Another extremely innovative approach, in this regard, is to build a smart classroom environment using IoT technology for behavioural and social analysis [11]. Such a smart classroom will actively observe the students' behaviour, voices etc to conclude the quality of a given lecture. This feedback will help the instructors to constantly improve their teaching style and come up with new methods. This highly advanced approach is based on the notion that it is possible to analyse human behaviour by combining computer and social science. This method requires live capture of audio, motion detection using sensors, screen capturing and should be able to interpret the parameters in real-time. The feedback results will show whether the students are satisfied with the lecture, whether they are able to maintain the same concentration throughout the lecture are other aspects. However, the costs of this infrastructure can be quite high and therefore cannot be easily implemented in a typical classroom.

While the above approaches of employing technology in the classroom attempt to make the sessions interactive and engaging, they come with some limitations and challenges such as effort required for setting up each session and associated infrastructure investments. However, well-designed SMAC applications have tremendous potential in enhancing the students learning and effectiveness of instructors teaching.

3 Proposed Application Overview

The proposed SMAC application is designed to be used by the instructors and students essentially to enhance feedback and interaction – in addition to traditional interaction – during and after lecture sessions. For effective use of this browser-based application during a lecture session in the classroom, the following assumptions are made:

a) Powerpoint or equivalent slides are used by the instructors during the lecture session,

b) the classroom has a computer that is connected to a projector for displaying the slides,
c) access to the internet is available for the instructor and students,
d) the instructor can use his/her smartphone for navigating and viewing the feedback provided by students, and
e) most of the students can use their mobile devices (laptops or smartphones) in the classroom.

The last assumption can be removed when the classrooms are equipped with IoT touch panels placed on the desks of student for providing feedback. Such touch panels can be relatively small sized (four or five inches) with an optional display on which the slide projected can be shown. However, in the remaining part of the paper we assume that the most of the students have mobile devices for providing feedback during the lecture sessions.

Figure 1 illustrates how a typical lecture session is supported by the application that has two different sets of functionalities for the instructor, and one for the students. The instructor loads the slides into the application on the computer for projection at the beginning of the session. It is possible that the session slides are loaded into the instructor's account prior to the lecture session. At the beginning of the session, a session code is generated and displayed – on the first few slides - so that the students can join the session using their mobile devices. With the second functionality, the instructor can use her mobile device (usually a smartphone) for viewing and navigating through the slides and viewing the feedback provided by the students. As the session progresses, the students provide feedback by placing one or more markers on the current slide. The type of markers includes a default marker that has green and red symbols to denote positive (e.g., well-understood or well-explained) and negative (e.g., not clear or needs further explanation) feedback respectively. A student can place markers near the text or diagrams or equations on the slide.

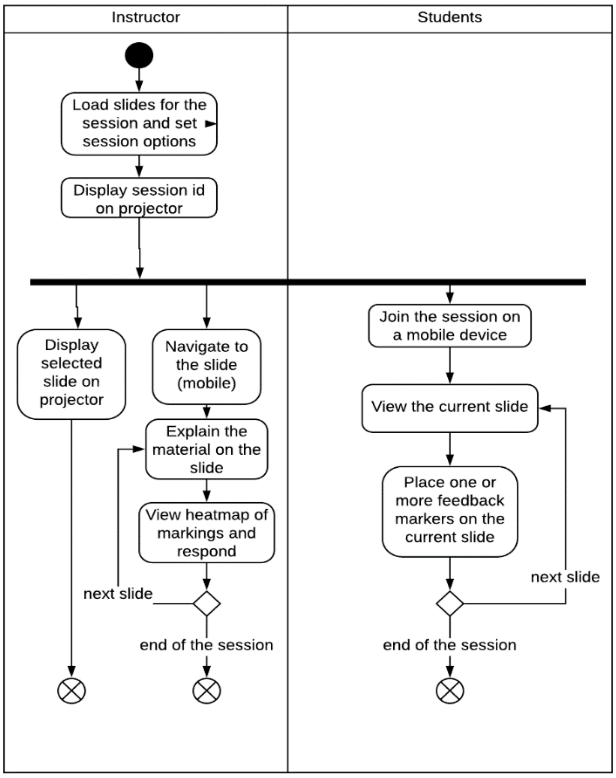

Fig. 1. Activities during a typical lecture session

The instructor – using her mobile device – can view a summary of the feedback (e.g., numbers of green and red markers), and select an option to view a transparent heat map – corresponding to one or more markers - displayed over the current slide prior to moving to the next slide.

In addition to the above functionality, the application includes synchronization of slides displayed, the anonymity option for various types of posting, and usage of images as ad hoc slides. The slides displayed on the students' mobile devices are synchronized with the slides projected so that minimize the need for navigation by the students. The student, however, can also turn off the synchronization and navigate to other slides whenever required. A student can choose to post markers, questions, comments, and responses anonymously. Instructors can use any other images taken on their smartphones as ad hoc slides for receiving feedback. This functionality is especially useful when the instructor would like to receive feedback on the material written/drawn on the blackboard, or for collecting feedback on other images such as press cuttings and student's work on paper.

Thus, the combination of the functionality provided by the application to the instructor and students requires hardly any additional effort for providing the feedback and analysing the feedback. The instructor can also request students, occasionally, to post questions or comments with the markers so that she can go through those for further elaboration of the concerned topic.

The overall functionality to be included in the proposed application can be understood from the class diagram shown in Figure 2. The top left portion of this diagram captures details of course registration. Each lecture session of a course offering is associated with a slides document. Participating students can add markers on specific slides during the session. Any student registered in the course can post questions and comments (Posting class) for other students to post related responses.

The classes MarkerGroup and MarkerDefn facilitate the inclusion of arbitrary sets of markers to enhance the types of feedback to cater to differences in expectations by the instructor. For example, a marker group of three types of marks corresponding to three categories of problems associated with a sample solution depicted on a slide can be used to elicit feedback from the students in terms of problem categories.

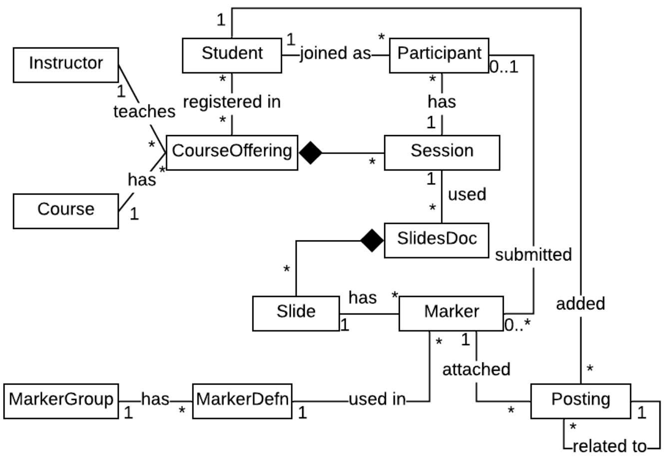

Fig. 2. Key classes and relationships used in the application

After the lecture session, the students can review the slides the initiate discussion by placing markers on any slide with questions and comments attached to those markers. The students can also like (or upvote) questions and comments posted by other students in addition to replying to the questions and comments posted. Thus, this social aspect of the application is expected to extend the interaction linked to specific topics beyond the classroom.

The enormous data – representing the feedback and interactions - collected during various lecture sessions offers great potential for analytics. The proposed application provides analytics on the content covered in a lecture session and across all the lecture sessions conducted so far. These analytics – apart from visualizations of statistical data - can also include dependencies and relationships among the feedback (e.g., different markers, content and students who provided the feedback) that can help instructors in becoming more effective in addressing the students' learning problems.

3 Prototype Implementation

Prior to implementing the proposed application, we built a prototype to understand the efficacy of the key functionalities identified. We planned to demonstrate the key functionality to some representative stakeholders and get their suggestions to make informed decisions on further enhancements to the proposed application.

The prototype design is minimalistic and serves to provide the core functionality to the student of marking on a slide and displaying markings along with comments to the faculty. The functionality for instructors includes – apart from sign up and sign in – uploading of slides in the form of a PDF document (instead of PowerPoint or Google Slides), display and navigation of slides, and viewing the feedback with markers placed by students on various parts of a slide. Figure 3 depicts the functionality corresponding to the display and navigation of slides during a lecture session of a software engineering course that introduces Scrum framework.

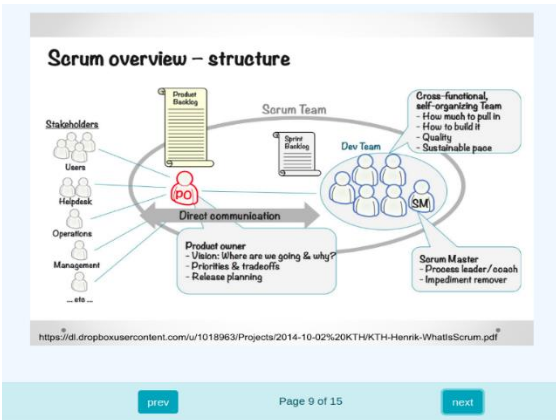

Fig. 3. Sample slide and navigation

The functionality for students includes the display of slides and navigating after joining the lecture session in progress on their mobile devices. The feedback provision includes selecting either a green or a red marker and placing it on the slide. In addition to placing a marker, a student can also associate a question or a comment as shown in Figure 4.

The instructor can view the slides – on her smartphone - along with the markers placed by several students (as shown in Figure 5).

We used the MERN (MongoDB, Express, React, Node) stack to build this application with a MongoDB database hosted on the cloud. The reason for using the MERN stack was that the entire stack is JavaScript and it enables us to build highly efficient browser-based applications that can run on any popular web and mobile operating system. As the student-faculty interaction in the classroom is real-time, we felt this would be the best for implementation.

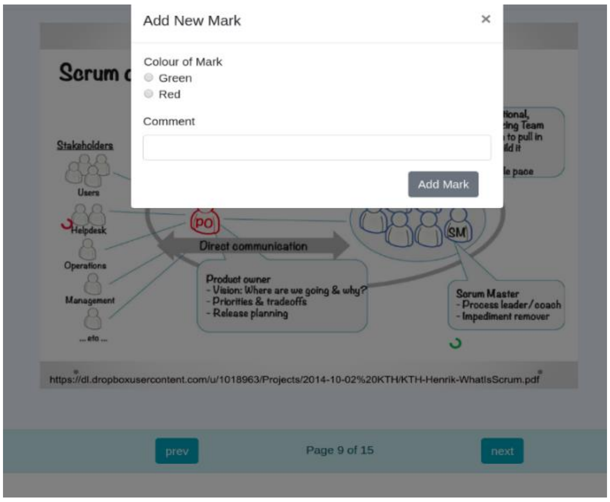

Fig. 3. Student placing a marker with a question

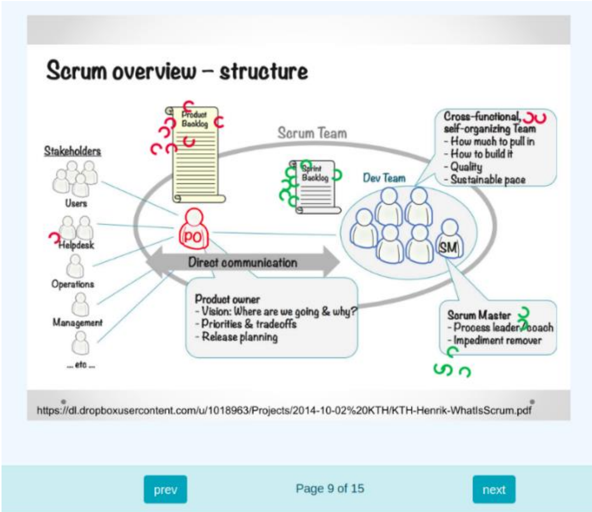

Fig. 4. Instructor screen with markers on a slide

4 Evaluation

The evaluation of the prototype was conducted by demonstrating its functionality to a couple of senior faculty members (Prof. A and Prof. B) and 10 students, individually. Six final year students and four pre-final year students enrolled in multiple engineering and science disciplines at BITS-Pilani Hyderabad Campus have participated in this evaluation.

4.1 Feedback from Faculty Members

After demonstrating the application functionality and explaining the problems that the application intends to solve, both the faculty immediately showed great interest in the deployment of such an application in their classrooms. They shared anecdotes of students having a poor learning experience in the past and wished to use this application to gain further insight into how that could be corrected. They expressed the desire for tools that could give them some quick and early insight into how students were learning in the classroom. They highlighted and reinforced the need for real-time classroom feedback, which is the aim of our proposed application.

Both the faculty members posed questions as to how instructors should go about reviewing the feedback given by students on the slides. Prof. A expressed concern that if a review of the markings made by the students was required after every slide that it would significantly reduce his speed of covering concepts in the class. Although he did acknowledge that it would improve the quality of understanding of concepts. He suggested that a faculty could review the markings made on previous slides after a set of slides or after a given time period such as 20 minutes.

Prof. B also raised a query of how the instructor would know that they should to go back many slides if a student adds a mark there after a long time. It is possible to set up a notification system that can raise a flag if the number of red markings on a given slide crosses a threshold. Although the use of the application trivial, the faculty members suggested that a workshop on how to best utilize the application in the classroom and after the class session.

Prof. A suggested that statistics pertaining to the markings be displayed as counting the markings is not possible in the class. So, a percentage of green vs red markings would be a crude but a useful metric to display. He also wanted as an extension to the current application, a way for students to add markings to a diagram/notes written by a faculty in the class on a smartboard. He also suggested that we could implement a scale of satisfaction for each marking rather than binary markings of just red and green (incidentally the marker types shown in Figure 2 provide this facility as a customized set of markers can be defined for use on a given slide).

Both the faculty members explained their experience with students in the classroom and listed out the different kinds of students that they have encountered in their experience and how they felt this would be beneficial to each one of them. Prof. B explained that different students have different attention spans. Students tend to zone out and their thoughts drift in-between explanation. For some students this might be a few seconds for some it might be 10 minutes. So, faculty can tune the speed of their explanation based on the feedback that they receive. Prof. A pointed out how some students, even if they are not embarrassed to ask a question, they might hesitate because they do not want to disturb the rest of their classmates and the teacher if they feel everyone else understood. At the other end of this spectrum, there are some students who always questions about every topic that is explained if they don't feel satisfied with their clarity of understanding on that topic or if they are curious and think beyond the scope of the lecture. When such students constantly ask questions, sometimes it can delay the class and waste other students' time but if they keep quiet, they may forget their questions. So, this gives them a way to mark it on the slide and they can later discuss it with the faculty outside the classroom.

4.2 Feedback from Students

Many students agreed that class pulse was very thoughtful as it is much better than the general feedback taken once in a semester. Students also expressed that the user interface was very simple and direct. They could find all the options they wanted without any confusion and liked the option (using a red marker) provided to express the difficulty in understanding. Most of the students do not come back and study the topic which has been taught in the class on the same day. So, students felt that such comments will help them remember the subject in a better way.

As the number of lectures per semester are very limited, few of them felt that implementing this in real time will engage all the students in the lecture session but at the same time this will consume a lot of quality time in class. This will also waste the time of students who have understood the concept but are just waiting for the explanation to end. Adding comments and questions, in fact, is a functionality that can only be used after the lecture session.

Some students suggested that including an option to anonymously chat directly with the instructor for any specific slide for clarifications after the lecture session. This option will also not waste time in class as the teacher can always check the queries after class and answer them. Few also suggested adding an option, though not directly relevant to the intended purpose of the application, to take notes on any slide which is visible only to them. This will be for their own convenience to note down a small explanation for any complex aspect presented on the slide.

5 Conclusion

In this paper, we presented the details of a SMAC application which aims to give the instructor a sense of the "pulse" of the class in real-time during a lecture session, and useful analytics after each lecture session. A prototype of the application has been implemented using the MERN stack. We also conducted a preliminary evaluation of the prototype application by demonstrating it to a couple of senior faculty members and 10 students individually.

Based on the evaluation, we are in the process of refining the proposed application functionality before developing the application. We plan to include other functionality to make the application from the user interface and user experience perspective so that the effort required by students and instructors is reduced or eliminated wherever possible. The final version of the application is planned to be tested by conducting controlled experiments in live classroom settings.

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