ClasSense: A Mobile Digital Backchannel System for Monitoring Class Morale

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***Abstract*—Digital backchannel systems have been proven useful for lecturers to gather real-time online feedback from students in a large lecture environment. Nevertheless, the fast pace of a lecture relative to a large audience can make it difficult for the lecturer to process and respond to large amount of feedback in real time. To address this issue, we propose a mobile digital backchannel system ClasSense that allows students to express their emotions during a class and analyses the sentiments of their feedback in real time so that the lecturer can continuously monitor the morale of the student population and respond to the most important concerns students have in common. This paper presents the key design considerations and a pilot study of the proposed system.**

***Index Terms*—backchannel, microblog, mobile device, emotion, sentiment, morale**

I. Introduction

Student feedback is important in a lecture because it can help the lecturer monitor the students' learning behaviors and understandings of the lecture in order to improve teaching and develop effective learning [1]-[3]. However, the challenges of the large lecture format such as large space, isolation, sage on the stage and theatre setting [4] impede students from asking or answering questions, asking lecturers to repeat something or explain a topic further when they are unsure of the subject matter. In other words, this environment does not promote the active learning as recommended in the seven principles for good practices in undergraduate education [5]. One way to make students active and engaged in a large lecture is to create and leverage a backchannel, a supplementary channel for the lecturer to gather real-time online feedback from the students and for the students to interact with each other [6]-[8].

In addition, a student's learning often involves surprise, revelation, delight, outrage and appreciation. Learners do not just learn a new concept; they also feel love, hate, endure, care, and may be thrilled about things in ways they did not experience before [9]. Academic emotions are those that are directly linked to academic learning or classroom instruction and achievement, for example, enjoyment of learning, pride of success, or test-related anxiety [10]. Students' academic emotions and sentiments have a significant impact on both teaching and learning processes [11]-[13] because they are significantly related to students' motivations, learning strategies, cognitive resources, self-regulations, and academic achievements, as well as to personality and classroom experiences [10], [14]. Happy learners are generally more motivated to achieve their set goals throughout the course [15]. Therefore, if the lecturer can detect and manage information about their students' emotions and sentiments in a lecture environment, it is possible for her/him to know and fulfil students' potential needs in time [16].

The usefulness of digital backchannel systems has been demonstrated to supplement the front channel - which is a lecture discourse - in classrooms [17], [18] by providing a virtual space in which students inform the lecturer and other students by sharing their thoughts and engage in collaborative activities without interrupting the current discourse [19]. However, the scattered and sparse nature of posts makes it impossible for the lecturer to draw an up-to-the-moment big picture of students' learning. Also, understanding the emotion and sentiment of students in a large lecture environment is a challenging task for the lecturer. To our best knowledge, no work has been done to address this issue with a digital backchannel system that can give the lecturer more insights into students' academic emotions and sentiments.

In this paper, we propose a mobile digital backchannel system *ClasSense* that allows students to express their emotions and analyses the sentiments of their posts in real time so that the lecturer can continuously monitor the morale of the student population and respond to the most important concerns students have in common. This is the first work that incorporates both emotion expression and sentiment analysis into a digital backchannel system for the purpose of studying the impact of students' morale on learning and teaching in a lecture environment.

The paper is organised as follows: we first discuss some previous work related to mobile backchannel systems and sentiment analysis. After that, we present an overview of the *ClasSense* system, followed by the

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application user interfaces, technical underpinnings and a pilot study. Finally, we conclude the paper with a summary of main contributions and future work.

II. Related Work

A. Digital Backchannel

Mobile devices such as smartphones and tablets provide a good solution for digital backchannel systems because of their ability to run applications and their widespread adoption in classrooms [20]. Following are some of the digital backchannel systems that are available on mobile devices, as represented by Hotseat [21], Backstage [19], ActiveClass [22] and ClasCommons [23].

Hotseat is a mobile backchannel system that supports microblogging style discussions both in and out of a classroom. During a class, the lecturer can use the system to provide questions and comments to the students, who can use their mobile devices to give feedback to the lecturer, read, vote, and comment on posts from other students. Hotseat has a user-friendly interface to enable users to quickly read posts, vote, answer relevant posts, and make favorite posts for later reviews. Each discussion is classified based on posts that are "fresh" (most recent), "hot" (most popular), and "deep" (most discussed).

Backstage is another mobile digital backchannel system that supports different forms of communication between students via microblogging style messages, social evaluation, and ranking of messages by the audience. Backstage emphasises anonymous and pseudonymous forms of inter-personal communication in large lectures.

ActiveClass is a simple client-server application designed to enhance participation in large classroom settings via small mobile wireless devices. Students in a class can use PDA or low-cost mobile devices with wireless connections to anonymously ask questions, answer polls related to the questions, and give the lecturer feedback on the class through a mobile web interface. The lecturer and all students can see lists of the questions and poll results. Furthermore, students can vote on questions which they find interesting to encourage the lecturer to answer those questions.

ClasCommons is a public digital backchannel for building community feelings among students in university courses. Students can post messages to the system through any device with web browsing capability such as web-enabled mobile phones and laptops. Then, the messages will be displayed in real time and in chronological order on a public display in the front of the classroom, which is viewable to the students and the lecturer. Students can respond to the posted messages via the client interface and vote up/down individual messages through 'likes' or 'dislikes'.

Common to these systems is the focus on the feedback management. In other words, the user interface has been specifically designed to make it easy for students to input feedback and read others' posts. However, not much attention has been given to help the feedback consumers, - the lecturers - to easily grasp the aggregated feedback from the crowd and respond to the most important concerns students share in common. For example, posts in Hotseat can only be sorted, such as most recent, most popular, or most discussed, rather than being categorised and combined, and the lecturers using Hotseat and Backstage are unable to quickly gauge the mood of the students in the class and adapt their teaching strategies spontaneously to respond to students' feedback. Instead, they can only read the responses on these systems post-class and react in future classes. Also, lecturers using ActiveClass found difficulties in integrating the system into their lectures as they required teaching assistants to help monitor student activities during the lecture sessions. Similarly, results of the ClasCommons experiments showed that lecturers had difficulties keeping their preferred teaching styles and lecture paces as they were distracted by following students' messages on the public display. In short, current mobile backchannel systems are not capable of providing lecturers immediate and meaningful responses.

B. Sentiment Analysis

Sentiment analysis is within the area of Natural Language Processing (NLP) and is generally defined by Pang and Lee [24] as the computational treatment of opinions, feelings, emotions, and subjectivity in texts. It has been used to discover the sentiment polarity (positive, neutral, negative) and emotions of texts in various genres including news headlines [25], marketing [26], politics [27] and movie reviews [24]. Recently, sentiment analysis has been applied in the educational context including e-learning [16], [28] and students' learning diaries [29].

Regarding the techniques used for sentiment analysis, two main approaches are considered: machine-learning methods and lexicon-based approach [24]. Machine-learning methods are used to classify texts such as movie reviews, which can achieve 82.9% of accuracy with Support Vector Machines (SVM), one of the most popular machine learning algorithms in specific domains of data [30]. However, machine-learning methods require a large training set of data so that the classifier can distinguish between positive and negative patterns of messages.

The lexicon-based approach consists of analysing words in the target text by using a predefined sentiment lexicon - a dictionary of words annotated with their semantic orientation (sentiment polarity and strength) - and executing a function to calculate a sentiment score of the text based on the pre-defined score in the sentiment lexicon. A clear advantage of this approach is that lexicons are more easily available and extensible than training sets and more robust when considering cross domain applications [31], [32]. There are some sentiment lexicons available, such as Senti-WordNet [33] and NRC word-emotion association lexicon currently including positive and negative emotional annotations for 14,182 unique words [34].

Considering the strengths and limitations of each approach, we chose the lexicon-based approach using the

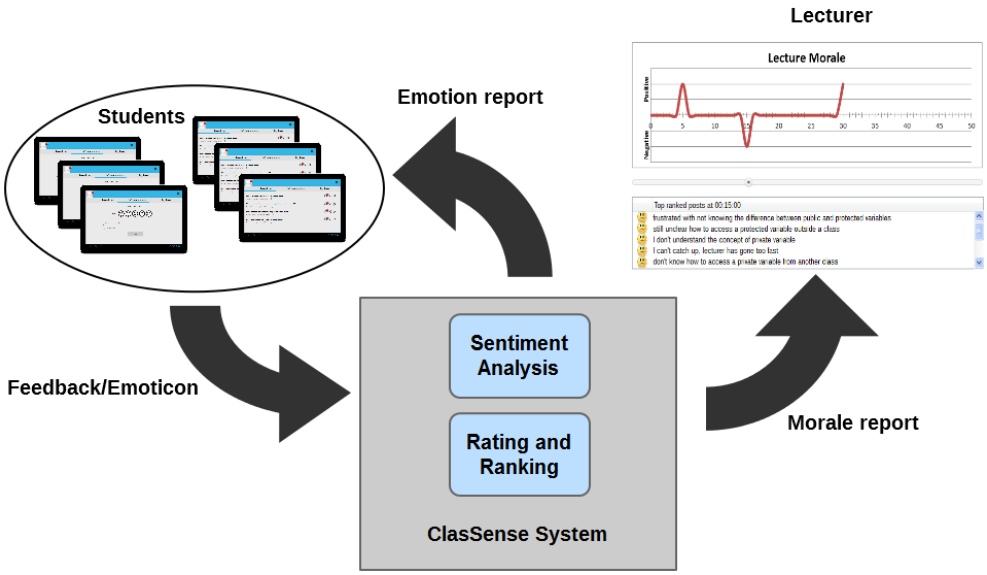

Figure 1. The framework of the ClasSense system

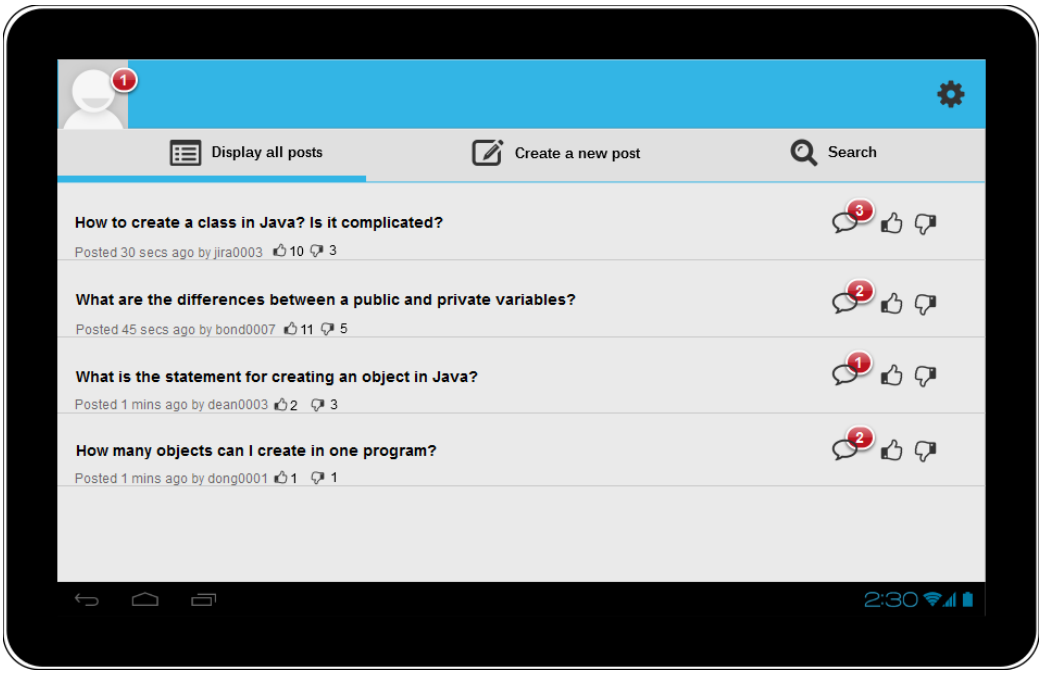

Figure 2. The main screen of the ClasSense mobile application for students

NRC word-emotion association lexicon. Since "positive" and "negative" annotations are directly identified in the NRC lexicon, we make use of this information to classify students' posts.

III. Overview of the ClasSense System

The proposed *ClasSense* mobile digital backchannel system is an attempt to address the shortcomings in existing systems by allowing each student to express their emotions and sentiments in her/his feedback through the *ClasSense* mobile application running on her/his mobile device so that the lecturer can continuously monitor the morale of students and adjust their teaching accordingly in the lecture class. Fig. 1 shows the system's framework including the *ClasSense* mobile application for students, the *ClasSense* console application for lecturer and the *ClasSense* server application.

During a lecture session, a student can provide her or his feedback to the lecturer through *ClasSense* mobile application on her or his mobile device. She or he can also express her or his emotions in their posts and comments by using provided emoticons.

The mobile application uses a microblogging user interface, which has been adopted by recent backchannel systems like Hotseat and Backstage. The *ClasSense* server application analyses students' feedback using a lexicon-based approach as mentioned in the previous section.

The *ClasSense* console application constantly displays the overall lecture morale and the up-to-the-moment top

ranked posts to the lecturer so that she or he can choose when to respond to these posts and/or adjust her or his teaching accordingly.

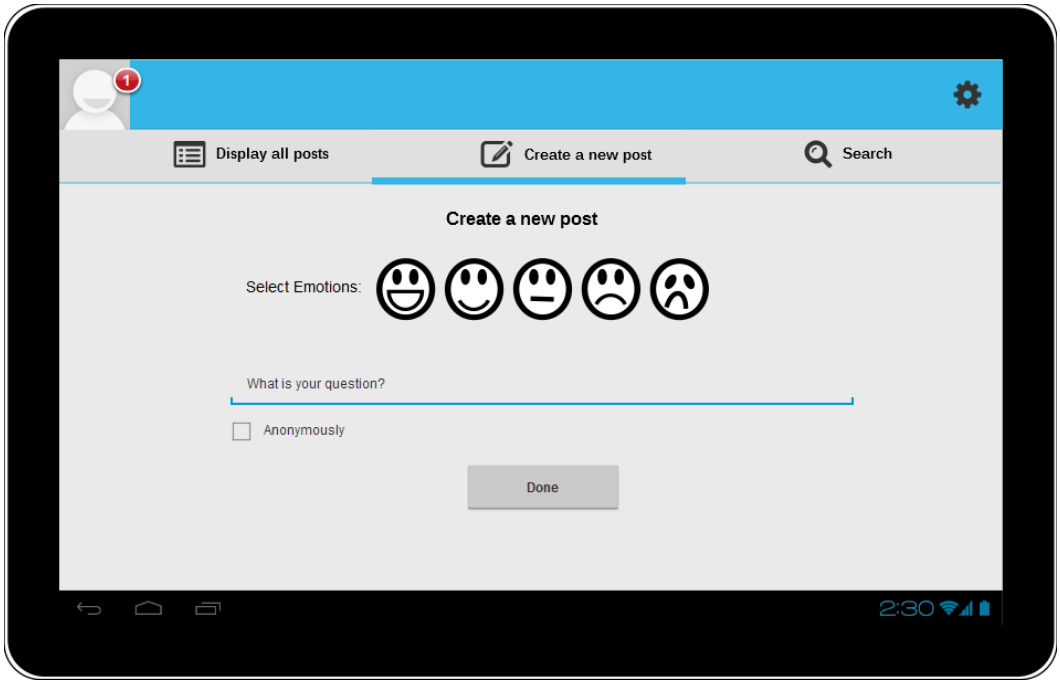

Figure 3. The screen for creating a new post in ClasSense mobile application for students

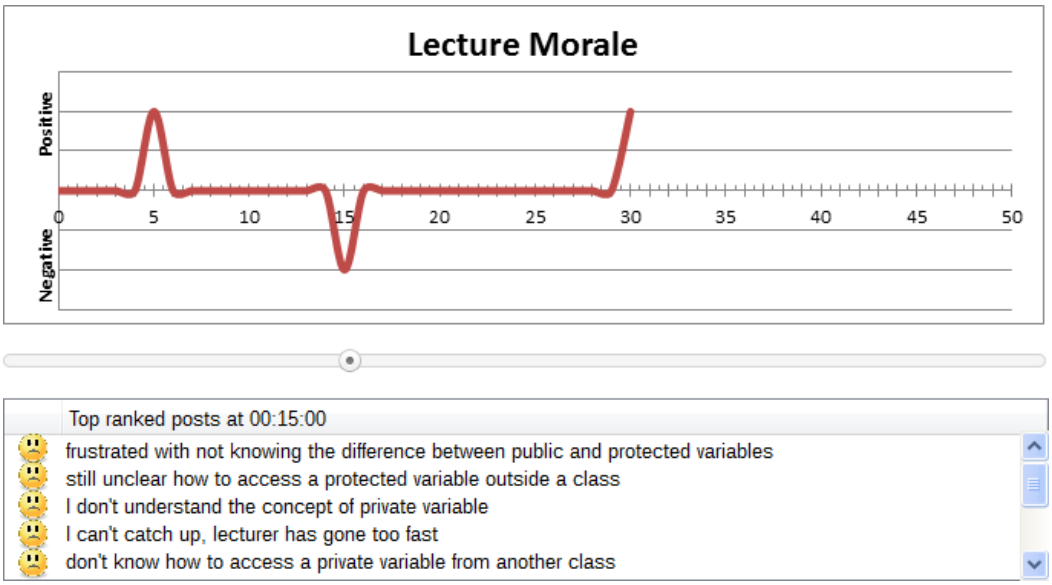

Figure 4. The screen of the ClasSense console application for lecturer

IV. Application User Interfaces

In this section, we present the user interfaces for both the *ClasSense* mobile application and the console application. As shown in Fig. 2, the screen of *ClasSense* mobile application is divided into 5 sections.

First, the contact picture icon with the number in red circle on the top left is for students to access a number of private messages from the peers in their learning groups.

Second, the gear icon on the top right is for students to customise their preferences such as their university profile, their affiliated study groups their preferred avatar, and font and color of their posts.

Third, the "Display all posts" tab shows all public posts from students sorted by recency. For example, the first row in Fig. 2 is showing a question from user "jira0003" asking about how to create a class in Java programming language and how hard it is. Under each question is the information of the user who sent this question (if they chose not to be anonymous), when they sent it and how many students have liked or disliked this question. On the right hand side, students can give

comments by tapping on the comment icon and express whether they like or dislike a post by tapping on thumb-up or thumb-down icons. In the first question, there are 3 comments on it. The number of comments is indicated by the number in the red circle above the comment icon.

Last, as shown in Fig. 3, the "Create a new post" tab is for students to post new public messages and/or express their emotions. In addition, the students can also create private messages for a specific learning peer by using the '@' character. Emotion expression is currently through selecting one of the five emoticons ("very positive", "positive", "neutral", "negative", and "very negative"). Work is ongoing to support automatic detection of emotions through face recognition [35].

Fig. 4 shows a screen of the *ClasSense* console application. It displays students' real-time morale of an ongoing 50-minute lecture and the associated up-to-the-moment top ranked (categorized and combined) posts. The ranking of posts is based on many factors, including number of votes, number of comments, emotions and sentiments of the posts/comments, and so on. The lecturer can also "replay" the history posts in order to respond to critical feedback indicated by the overall morale in the lecture or reflect her or his teaching strategy after the lecture.

V. Technical Implementation

This section describes the techniques used to implement the *ClasSense* prototype system. The *ClasSense* client-side codes (including the mobile application and the lecturer console application) were developed using a jQuery framework, JavaScript and JSON for communicating in a restful way with our Java Web services. In particular, the *ClasSense* console application used a Flot library to display students' real-time morale graph on a web page. Both client applications are easily accessible through a Web browser.

On the server side, calculations on quantitative and qualitative input are made by integrating existing approaches for sentiment evaluation. The current prototype uses lexicon-based sentiment analysis approach [32] to classify microblogging style post across all domains.

We developed a basic sentiment classifier to execute in periodical batches. Every 5 minutes, the posts are batched and pre-processed with a maximum of 1,000 posts. Then, the batch of posts is analysed and classified. The number of positive and negative posts is summarised every 5 minutes and kept in a database in order to display a morale graph to the lecturer.

VI. A Pilot Study

To get an initial idea how the proposed system works in a real lecture environment, we conducted a pilot study in a small class of 20 undergraduate in order to quickly gauge the feeling and usability of the software and understand which features they like or dislike so that we can improve the system in the future. The topic was "Introduction to Java Programming", which was offered to students who were not pursuing a degree in computer science or information technology by the School of Computer Science, Engineering and Mathematics, Flinders University. All the students in this class had tablets (their own or loaned from us) to access the *ClasSense* application and were given written instructions on how to access, navigate and participate in the backchannel discussions using the *ClasSense* application.

Fig. 5 shows that most students (70%) agree that the *ClasSense* mobile application's micro-blogging user interface is easy to express their emotions and feedback.

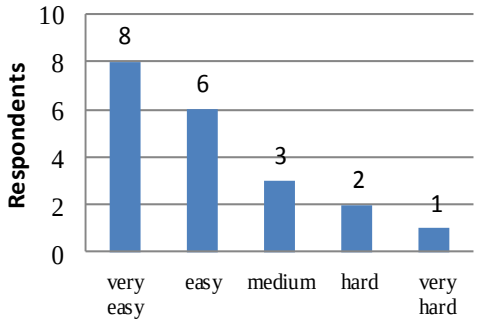

Figure 5. How easy is the user interface of the ClasSense mobile application?

Fig. 6 shows that most students (70%) find it easy to express what they want and communicate their ideas with others.

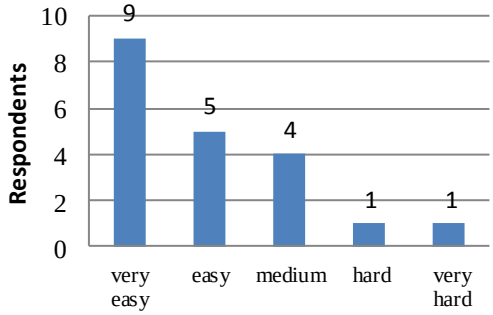

Figure 6. How easy can the ClasSense mobile application be used to express your idea?

Fig. 7 shows that most students (75%) find it easy to convey their feelings and emotions.

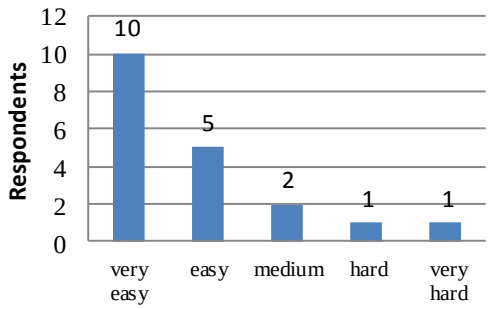

Figure 7. How can the ClasSense mobile application be used to convey your feelings and emotions?

In addition, Fig. 8 shows that most of students (65%) think that the *ClasSense* mobile application distract them

from the ongoing lecture in a very low to low level. However, 7 respondents think that writing their feedback and reading others' posts sometimes distract them from the lecture in a medium to very high level.

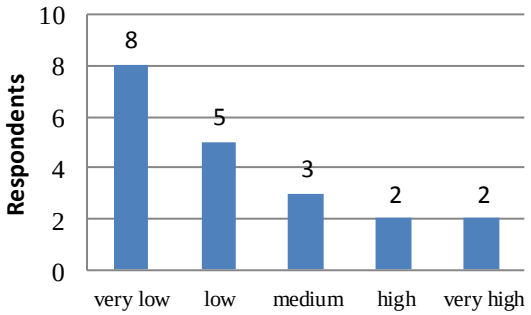

Figure 8. How does the ClasSense mobile application distract you from the lecture?

The lecturer is particularly positive with the system, quoting that knowing the up-to-the-moment morale of students and their feedback helped him adjust his teaching, for example, when he saw the down trend of the morale, he immediately stopped to read the top ranked posts and clarify with the students. The suggestion for improvement are the ability to replay the feedback so that he can "watch" it after the lecture in order to improve his teaching and to sync students' feedback and the lecture slides/topics/talk for playback.

VII. Conclusion and Future Work

Even though current digital backchannel systems are convenient for the lecturer to receive feedback from students in a large lecture environment, we discovered that the fast-pace of a lecture to a large audience can make it difficult for the lecturer to process and respond to the large amount of posts in real time.

In order to address the problem and improve interactions in a large lecture class, we propose a mobile digital backchannel system *ClasSense* that can support students' emotion expression and sentiment analysis, so the lecturer can continuously monitor the morale of the student population and respond to the most important concerns students have in common.

Future work includes implementing replay of feedback and making the application ubiquitous by using emotion detection technologies such as face recognition or gesture recognition.

We also need to do more large-scale formal evaluations to understand how the *ClasSense* system can improve students-to-lecturer and student-to-student interactions in large lectures and also the ramifications of students' morale, emotions and sentiments on learning and teaching in lecture environments.

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