Using Student Perceptions to Design Smart Class Participation Tools: A Technology Framework

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***Abstract*— Our research full paper studies the perceptions of students and proposes technology design framework for smart class participation tools. Participation in classroom discussions has been observed to improve student comprehension and performance. In our contemporary tertiary educational context, student participation is characterised in mainly two forms; in-class discussions and online forums. Both forms of participation generate voluminous amounts of knowledge. However, the present difficulty in capturing and analysing these forms of participation leads to loss of knowledge and insights, which otherwise could be very useful. This study aims to analyse ways to improve data capture as well as data analysis of discussions. In this paper, we take a survey-based approach to study the students' perception of classroom discussions in terms of three components namely effective learning, technology support and grading. Based on the analysis of the survey results, we propose the design of a tool and the administrative requirements needed for in-class participation data capture and analysis. We present our results in the form of a framework for tool design and challenges to be addressed when using technology during class discussions.**

Keywords—class participation, survey-based research, technology in class-discussions, recommendations, tool design framework

I. INTRODUCTION

Class participation in the context of tertiary education takes mainly two forms; in-class discussions and online forums. Dynamic in-class discussions have been attributed to aid in the understanding of course concepts [1]. Participation enables a dialogic condition for students, supports critical thinking and also develops subject-matter knowledge [2]. Here-and-now experiential learning highlighted by Kolb is crucial as it provides students with the opportunity to test and validate their ideas developed during learning contributing to the cognitive skills [3]. On a more social level, students develop an appreciation of the diversity of viewpoints and, if they help each other, the ability to assist others in making informed actions in the course assignments and projects contributes to learning process [4].

One of the key contributions of discussions and participation is the opportunity for students to gather feedback, to comprehend the validity and possibly relevance of one's proposed points [3]. This feedback is important as it enables students to evaluate their performance relative to a specific goal [5]. The way in which feedback is given also affects students' learning [6]. According to Bangert-Drowns et al., feedback that provided learners with elaboration is comparatively more helpful than just an incorrect or correct judgement [7]. The most advantageous form of feedback that should be reiterated to students is that of detailed, specific and descriptive feedback on the topics discussed [6]. The feedback can be provided in various forms such as; consolidated responses from the instructors or the summarized class discussions. However, manually generating such feedback is a tedious and painstaking process. Therefore, there is a dire need for technology-enabled classroom participation management tools so that the knowledge is captured effectively and the feedback is generated efficiently to aid effective learning and grading.

Research into the use of virtual classroom learning environments by Bower and Richards [8] on the topics of computer science indicated that these environments provided increased perceived collaboration, as well as increased learning from peers. Student's performance on e-learning activities also is suggested to be predictive of course success [9]. The proposal of multiple methods of learning such as concrete experience, active experimentation, abstract conceptualization, and reflective observation and understanding [1] requires different technology design and support.

The purpose of this study is to propose recommendations for designing technology solutions to support effective learning from classroom discussions. Classroom discussions are tacit knowledge, and if they are not captured and converted into explicit knowledge, the value is lost. Explicit knowledge examples are videos or recordings or documents. Our aim is to suggest the design requirements of the tool for class discussions that can benefit both faculty and the students to gain insights from explicit knowledge to promote better learning. We took a survey-based approach to study the students' perceptions of class discussions in terms of three components namely effective learning, technology support and grading. The survey questions aim to analyse the knowledge management features required for smart class participation tools. To gather the appropriate data needed to accomplish this goal, we established the following research objectives: first, what are the students' perceptions of knowledge management features such as creating, sharing and using the knowledge and information generated in class discussions and their desire for new technology that can enhance this process, and second, how to formulate recommendations for designing a smart class participation tool based on their perceptions using the latest technology.

Our survey questionnaire framework is focused on three areas namely profile, process and technology. We conducted both qualitative and quantitative (statistical) analysis on the collected survey. Based on the survey results, we recommend design requirements, a technology design framework and the administrative requirements to use the technology appropriately in a given class setting.

This paper is structured as follows. Section II will describe the approaches for preparing, assessing and managing

knowledge in class discussions. Section III provides the literature survey aligned to our work. Section IV describes the research methodology for data collection, survey framework and the analysis methods. In section V, we present our results, findings and analysis in terms of quantitative and qualitative modes. In Section VI, we propose a technology framework and list of recommendations based on our analysis of the survey results and conclude in Section VII.

II. CURRENT SETTINGS IN CLASS DISCUSSIONS

Class participation during discussions plays an increasingly important role in the tertiary education context. It presents students the opportunity to improve and test their comprehension as well as communication skills in a live context. The classroom environment provides a platform which enables learning as well as the sharing of ideas. In this section, we describe the settings of class discussions and the challenges related to data loss in class discussions.

A. Class discussions preparation

Faculty adopt various modes of class discussions and participation; whole class discussion, cold calling, collaborative and group discussions, and online discussions. In whole class mode, the instructor may pose questions, usually relating to a reading or case studies that students have been asked to read in preparation for an open discussion. In cold calling mode, the instructors call on students at random to provide their answers. For collaborative settings, students work in small groups to provide a solution to problems or scenarios posed by the instructor, which could include an element of role play. Students then present their solutions to the whole class group and respond to questions from other members of the class. Online discussion through tools like Moodle is used as a substitute for face-to-face whole class discussion.

B. Class discussions as assessment

In the pursuit to encourage the development of students' communication skills, students in certain educational environments may be graded on their participation in class activities. Participation grading methods vary from class to class and from one faculty member to another. Methods of participation data generated include but are not limited to, live verbal participation, in-class physical submissions (e.g. paper based exercises) as well as in-class online submissions. Instructors create holistic rubrics for assessing class participation aligned to the intended learning outcomes and explain the rubric to students. Different variables such as institution policy or instructor preference results in subjectivity in both participation data collection as well as in participation grading. In certain cases, instructors would need to sacrifice crucial in-class time to record or grade the participation. This results in wasted class time and possibly inaccurate grading as a result of inadequate time to contemplate the quality of the participation.

C. Class participation as knowledge

Participation is a source of data, and it is the expression of the individual student's ideas formulated into the context of the topic being discussed. This data provides key insights that the individual and other students may find useful for assisted understanding or future reference. The participation data from one interaction to another holds crucial information as well. For example, the data pertaining to flow of discussions from one topic to another could assist in deeper understanding of the evolution of topics as well as aid idea generation of students when used in collaboration with the individual's own ideas. This flow may provide useful insights about class discussions and hence needs to be captured for further analysis later.

In this paper, we study the students' expectations from class discussions and participation, and analyse the design requirements of a tool to convert tacit knowledge to explicit knowledge that can be shared with the students after the class in order to support an effective learning process. At the same time, the grading requirements are included in the tool design. In our literature survey, we explore the current classroom education tools to analyse their support and limitations in achieving the three goals; participation, evaluation and knowledge management.

III. LITERATURE SURVEY

Many academics consider class participation as an evidence of active learning or engagement that promotes hard skills such as; learning, critical thinking, writing, appreciation of cultural differences, time management and soft skills such as; interpersonal, listening and speaking skills [10, 11, 12].

According to Petress [12], class participation includes three evaluative dimensions: quantity, dependability and quality. Various class-management strategies promote class participation. However, using classroom participation as an assessment tool is a "double-edged sword." It can cause excessive work for the instructor and feelings of coerciveness by the student [13]. Karp and Yoels concluded that talking too much in class disrupted its balance [14]. Although there are negative aspects of participation as assessment, other studies that support this type of assessment showed students were better prepared and had a greater mastery of the materials [15]. Lyons recommended that explicit performance criteria be established to evaluate class participation, and suggested that this would decrease student anxiety [16]. Peterson examined students' documentation of their own participation, citing portfolios of work produced in the course as evidence of students' engagement [11]. A token economy was instituted to measure class participation. Students were give a token every time they participated and these were exchanged for one point that was added to their next course mark [17]. Mostly instructors employ manual techniques to improve the class participation and student learning. Very few technology tools have been used in the classroom to aid the in-class discussions and manage participations, though there are several education related tools in the market to aid classroom activities. In our survey, we focus only on the tools that support class discussions and analyse them.

Table 1 shows the tools used by instructors based on the survey of students. From Table 1, we observe that the most widely used classroom response systems (clickers) or electronic quizzes are limited by the specific questions designed by the instructor. They are not suitable to capture general classroom discussions on case studies or concepts. Moreover, the students' soft skills are not evident from these tools and they are difficult to maintain. Some tools are easy to use for assessments while others are not suitable for assessments. Online quiz tools are quite popular these days as they are simple to use and provide analytics features for quick analysis of learning in the class. The limitation is again that no new knowledge is created.

TABLE I. TOOLS USED FOR CLASS PARTICIPATION

Techniques or Technologies Enabling In-class Discussions	Benefits	Participation Type	Assessments management	Student skills measurement	Knowledge	References
Clicker technology: Classroom Response Systems	Aid teachers to poll questions and capture answers digitally	Specific questions	Easy to convert to evaluation assessments	Concept skills	No new knowledge is created or captured	[18, 19] Meedzan and Fisher (2009) (Revell & McCurry 2010)
Short electronic quiz on blackboards	Aid in self-evaluation of learning	Specific questions	Easy to convert to evaluation assessments	Concept skills	No new knowledge is created or captured	[20] Nevid and Mahon (2009)
Online quiz tools (kahoot, quizlet, surveymonkey)	Aid in self-evaluation of learning and features analytics	Specific questions	Easy to convert to evaluation assessments	Concept skills	No new knowledge is created or captured	https://quizlet.com/ https://www.surveymonkey.com/
Live chats (discussion forums) (chatzy)	Aids in collaborative learning	Constructive learning	Not easy to convert to evaluation/ assessments	Concept skills	New knowledge is created or captured	http://www.chatzy.com/
Crowdsourcing tools (wiki, dotstorming)	Aids in collaborative learning	Constructive learning	Not easy to convert to evaluation/ assessments	Concept skills	New knowledge is created or captured	https://dotstorming.com/
Mobile devices (quick voice recorder)	Capture the classroom discussions collectively	Constructive learning	Not easy to convert to evaluation/ assessments	Concept skills and soft skills	New knowledge is created or captured	https://apps.apple.com/us/app/quickvoice-recorder/id284675296

Live chats are suitable for open ended discussions and suitable for new knowledge creation and collaborative learning. However, they are not suitable for assessments and knowledge management due to the challenges associated with converting tacit to explicit knowledge. Crowdsourcing tools have similar benefits and limitations as live chats. Mobile devices are becoming more popular as in-class learning devices due their ease of maintenance and availability. Our study is based on using mobile devices and the design of tools using the mobile device to capture the individual student participation in the class. Our research also aims to study the suitability of assessing students' participation and managing the knowledge created from discussions. To design the complete architecture and identify the features of the tool, we need to study the students' perception of such tools and their wish list of requirements. In the next section, we describe our methodology to capture students' requirements to enable better learning from class discussions.

IV. METHODOLOGY

Information systems research that aim to identify requirements for technology based solutions usually adopted three different research methods namely, case study, laboratory experiments and survey-based research methods. Case studies involve examination of a phenomenon in its natural setting and are suitable when the researcher is interested in the relation between context and the phenomenon of interest. Laboratory experiments involve examination of a phenomenon in a controlled setting and are suitable when involving relatively limited and well-defined concepts and propositions that involve individuals or small groups. Survey-based research method involves examination of a phenomenon in a wide variety of natural settings and are suitable when the researcher has a clearly defined independent and dependent variables and a specific model of the expected relationships which is verified against the observation.

In the current work, the authors had a clear understanding of the variables with respect to tool support for class discussions and through the survey intended to verify this understanding against the student perceptions. We adopt the survey-based research method to study the perceptions and requirements and then recommend the tool design for supporting class discussions. To gather the data needed to accomplish this goal, we established the following research objectives:

- Gathering feedback from students about the perceptions of class discussions and the desire for efficient and new technology.
- Analysing survey feedback and formulating recommendations of features for tools to support class discussions.

A. Survey

To gain both the qualitative and quantitative data, and to make well-informed conclusions to our research questions, we used a survey questionnaire framework, as shown in Figure 1. The survey framework consists of three main components; Profile, Perceptions and Process.

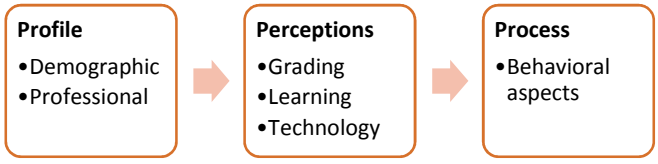

Fig. 1. Survey questionnaire framework

It enables us to cross-tabulate and compare the responses to identify any evident relationships between the answers and demographic factors. The characteristics of participants, such as gender, local vs international and age, are the key

demographics. We also consider professional profile such as the educational background of individuals as well as the year of study at the university.

1) Profile

The demographics of the participants help us determine the factors that affect the answers to the questions.

2) Perceptions

We segment this section into three main categories. Firstly, the learning outcomes or challenges of class participation during discussions. Secondly, the grading process of participation during the discussions, and finally, the technological aspect that we intend to propose to assist in class discussion management and analytics.

Learning: This section of the survey aims to gather data with regards to a student's perception of the learning aspects of class discussions. Here we analyse whether an individual views the participation as a useful method to further help their understanding of the topic and clarifying doubts. We also aim to look at whether students find class participation useful when trying to understand the application of a certain topic or concept. Lastly, we also aim to understand the issues students face with regards to class participation, such as an inability to recall topics discussed, questions raised, the logical flow of a discussion and instructor's feedback.

Grading: This section of the survey aims to discover a student's opinions on the current state of the assessment of participation in class discussions. Analysing its perceived accuracy as well opinions on how assessments should be collected and graded are the key questions [21].

Technology: In this section, we look into the technology and features we could utilize to help aid in class discussion management [22]. We gather the level of comfort individuals have with regards to the recordings of class discussions. For example, whether they would be comfortable with audio or video recordings of discussions. Additionally, we look into the preferences of the features that technology should provide to aid the students learning without the loss of tacit knowledge. Example features include transcripts of discussions and dashboards that provide insights into the discussions [23].

3) Process

In the process component, we aim to collect data that relates to the student's behaviour with regards to participation in class discussions. This section analyses the motivational as well as the de-motivational factors with regard to student's participation in the class discussions. This section will also look into the individual's perception of their participation and how they approach it.

The survey framework seeks to target three aspects of participation namely learning, grading and technology, and seek to understand how these aspects affect student participation. From the analysis of the three components, we aim to recommend both technical design requirements and administrative settings for class discussion tools.

B. Analysis Approach

Once the survey results are collected, the analysis of the results is performed in both quantitative and qualitative modes as some of the questions are numeric and others are text-based selections. We adopt two key analysis methods; descriptive analysis and statistical significance evaluations.

Descriptive analysis: The descriptive statistics measures are used to describe the properties of the samples and the averages, standard deviation, and distributions of variables for the samples.

Test of significance: Statistical significance is a kind of evaluation metric to show the differences between the datasets. The tests report the p-value to measure the strength of the evidence to show that a result is not just a likely chance occurrence. The statistical significance achieved at less than p=0.05 level can refer to statistically significant differences between the data sets, whereas, less than $p = 0.001$ is considered as most statistically significant.

C. Participants

We received 50 responses from undergraduate students. From the profile questions, we derived overall statistics on the participants' demographic and professional profiles. 70% of participants were of the age between 21 and 25, with 56% males. Participants varied from 2nd to 4th years of college study. 44% of participants were from a polytechnic or vocational education, and 43% were from a high school. 58% were locals, and 42% international students.

V. SURVEY RESULTS AND ANALYSIS

A. Descriptive Analysis

The survey was anonymous and conducted online. After the survey was completed and submitted by the students, the data was collected in an excel format and the frequencies of the questions were computed. We also did a manual analysis on text-based questions. We provide both quantitative analysis and qualitative analysis.

1) Quantitative analysis

Recall the survey framework with perceptions and process components. Table II depicts questions for each component and the overall percentage of the agreement/preference and disagreement/non-preference ratings for the questions. All the questions listed in Table II, are scaled from 1- 5. Ratings 1 and 2 are considered as disagree/not-prefer while ratings 4 and 5 are considered as agree/prefer.

From the statistics in Table II, we observe that the learning from class discussions is on average 61% without the conversion to explicit knowledge.

Applying concepts in projects is more challenging and the main issues faced by the students are; remembering the topics and logical flow of the discussions. We also observe that 92% of students prefer anonymity in capturing and storing the data, though 8% of students prefer their names. Hence, auto-grading preference is also low.

We observe that in terms of data capture, audio recording is preferred to video recording. If the grading is compulsory, only 32% of students agree that the grading will be accurate. Finally, only 21% of students are prepared for the class participation and this shows the need for the faculty to motivate the students by demonstrating the value of discussions by using tools to convert the tacit knowledge to explicit knowledge and then walking them through this knowledge repository.

TABLE II. FREQUENCIES OF THE AGREEMENT/PREFERENCE RATING FOR THE SURVEY

Question	Agree/Prefer (ratings 4 or 5)	Disagree/Not Prefer (ratings 1 or 2)	p-value
Perceptions of Learning			
Class discussions aid in learning / understanding/ clarifying a given topic	68%	24%	0.000***
Class discussions help understand factual /theoretical knowledge related to a topic	62%	28%	0.000***
Class discussions help in practical application of knowledge and skills	**54%**	30%	0.000***
Perceptions – Technology			
Would you prefer the audio be recorded tagged with your name?	50%	24%	0.000***
Would you prefer the audio be recorded anonymously?	68%	8%	0.000***
Would you prefer auto-generation of your participation score based on the recorded audio of your classroom discussion?	22%	54%	0.000***
Would you prefer a textual transcript of your audio recording?	52%	18%	0.000***
Would you prefer video recordings of the class discussions	58%	24%	0.000***
Would you prefer a visual dashboard showing your stats of class participation	52%	24%	0.000***
Perceptions – Grading			
Should class participation be graded	42%	36%	0.083*
In your opinion, the scores for class participation you've received are accurate	32%	26%	0.083*
Process- Behaviour			
Are you prepared for classroom discussion sessions?	21%	18%	0.000***
Rate your participation in class discussions	46%	32%	0.005**

2) Qualitative analysis

Apart from the rating scale based questions, we also designed choice based questions with text for perceptions and process. The statistics and analysis of the choice based questions are as below.

a) Perceptions: Learning - Issues with learning from class discussions

The top 3 issues participants faced in learning from class discussions include inability to remember other students' contributions (60%), inability to recall logical flow of discussions (54%) and the inability to recall topics discussed (40%).

b) Perceptions: Learning - Aspects that would help to learn from class discussions.

The top 3 suggested learning aids were a summary of each topic discussion (80%), a summarized report of the entire class discussion for a session (74%) and list of questions with answers (54%).

c) Perceptions: Technology - Preferred insights to be shown on a visual dashboard

The top 4 insights from the dashboard are questions discussed (76%), topics discussed (72%) and answers discussed (72%) and logic flow of discussions (66%).

d) Perceptions: Technology - Effect of recording on a student's participation level.

44% felt recording class participation would not affect their individual participation level with 38% feeling that it would positively affect their participation level. 18% felt there will be a negative impact on their participation level.

e) Perceptions: Grading - Methods that are preferred for grading class participation process.

68% of students felt that the submission of in-class activities was the preferred method of grading class participation. 52% preferred manual capture by teaching assistants, and 44% preferred using technology tools.

f) Process Behaviour- Rating an individual student's participation in class discussions

46% of students felt they performed better than the average in terms of participation with 22% feeling they were average and the remaining 32% feeling they performed below average.

From qualitative analysis, it is evident that the key challenge for learning from class discussions is the loss of the knowledge as it is tacit in nature. All the students mostly preferred technology features such as a dashboard with insights on topics, questions and discussion flow. At the same time, there were 18% of students who perceived that technology may have a negative impact on their participation in the discussions. Therefore, the need for anonymity arises, and for classes where students are uncomfortable with being identified. Hence the tool should provide the feature to allow the instructor to set it to "anonymous mode".

B. Evaluation by Test of Significance

Analyses via the statistical significance assists in comprehending the evidence of our observations. Table 2,

column 4 shows the statistical significance information for all the numerical scoring questions.

We observe that for the two questions, "Should class participation be graded" and "In your opinion, the scores for class participation you've received are accurate", the results are not statistically significant. For all other questions, the results are highly significant. Other than the perceptions on the grading, the results on learning and technology, are statistically highly significant. For comparison statistics, we didn't observe any strong relationship between the profile factors and the perceptions answers. Hence, we skip the details of the profile and perceptions impact study.

VI. RECOMMENDATIONS

In this section, we identify the design requirements for the solution based on the findings of the student perception survey. We use both qualitative and quantitative analysis to discover the requirements. We then propose recommendations for the design of the technology tools in supporting class discussions management and analytics. For this task, we rely on the latest technology advancements in mobile, speech and analytics areas. Maximizing the benefits of technology in classroom discussions involves the support of both instructors and students. Therefore, in the end, we also propose recommendations on administrative settings to introduce technology in discussions.

A. Design Requirements for the Solution

Recall that the main goal of our research is to recommend the technology design of a tool for supporting classroom discussions that captures tacit knowledge, converts it into explicit knowledge and finally share the insights with the stakeholders, faculty and students. Based on the analysis of the survey results we first identify the design solution requirements of the tool for supporting classroom discussions. Table III shows the findings from the student perception survey and corresponding features that need to be designed. Following is a brief description of the features that need to be implemented:

- Registration and login* - Administration feature for users for secured login and authorization. This feature enables the management of people and their access levels to the tool.
- Registration for users and courses* - Administration feature for setting up the courses and people. This feature enables the management of courses and, registering the faculty and students to courses. Usually, this data is imported from the existing school databases.
- Session management – Feature to setup the sessions for each course by weekly or by term.
- Recording management – Feature to capture the students and faculty in class discussions from mobile devices.
- Audio storage management – Feature to store the discussions data from all the users for further processing.
- Speech to Text – Feature to convert audio files to text for applying analytics.
- Course management – Feature to setup the courses, timings, and other related attributes.
- Student Management - Feature to setup the students and related attributes.
- Participation analytics- Feature that generates the participation insights for course or students.
- Topic analytics – Feature to generate the topics from the discussions as well the statistics for course or students.
- Concise summaries – Feature to generate the topic based summaries from the discussions for course or students.
- Question & answers – Feature to generate the QA aspects from the discussions on course concepts or students.

B. Technology Design Recommendations

Using the list of features that need to be designed, we propose the technologies that need to be used for implementing the solution as shown in Fig 2. Fig 2 describes two integrated user applications; mobile app and web app. Both the applications are designed with separate interfaces for instructor and students. Instructor will have an overview of the class while students have restricted features. We describe each application in detail in terms of technology and in terms of the tool features. The backend server provides the necessary architecture to seamlessly integrate both the applications for ease of use and effective data management.

1) Mobile application

Features of the mobile app enable the instructor and student to login, register for the courses and sessions, record the voice and convert the speech to text. Once the text is generated, the data is pushed to the backend server to be stored in the database server for the web application to process and generate insights. The design tool proposed in Figure 2 is based on android servers [24, 25, 26]. The similar architecture can be extended to other operating systems. The main APIs useful for this app are described below;

- Resource layout: A layout resource defines the architecture for the User Interface (UI) for activity by user or a component for display. The XML format is used to define the layout.
- SpeechRecognizer: An API to stream audio to remote servers to perform speech recognition.
- Recognition listener: An API used for receiving notifications from the SpeechRecognizer when the recognition related event occurs.
- Volley: It is an HTTP library that makes networking for Android apps easier and faster. JSON is used as a request and response format. Shared preference manager API enables to share the data from mobile app to the external web servers. In our case, the backend server provides the external web server for integration.

2) Web application

The web application enables the students and faculty to visualize insights of explicit knowledge in user-friendly formats [27]. The features include registration, course management, student management, and analytics such as; participation statistics, topics, questions and answers and concise summaries.

TABLE III. TOOL FEATURES BASED ON FINDINGS FROM PERCEPTIONS

Findings from Perceptions	Tools Features
Prefer the audio be recorded	• Recording management • Audio storage management
Prefer auto-generation of participation score based on the recorded audio	• Participation analytics
Prefer a visual dashboard showing stats of class participation	• Course management • Student Management
Inability to remember other students contributions	• Topic analytics, • Concise summaries
Inability to recall logical flow of discussions	• Questions and answers
Inability to recall topics discussed	• Topic analytics
Summary of each topic discussion	• Topic analytics • Concise summaries
Summarized report of the entire class discussion for a session	• Concise summaries • Session management
Questions discussed and answers discussed	• Questions and answers
Topics discussed and logic flow of discussions	• Topic analytics • Concise summaries

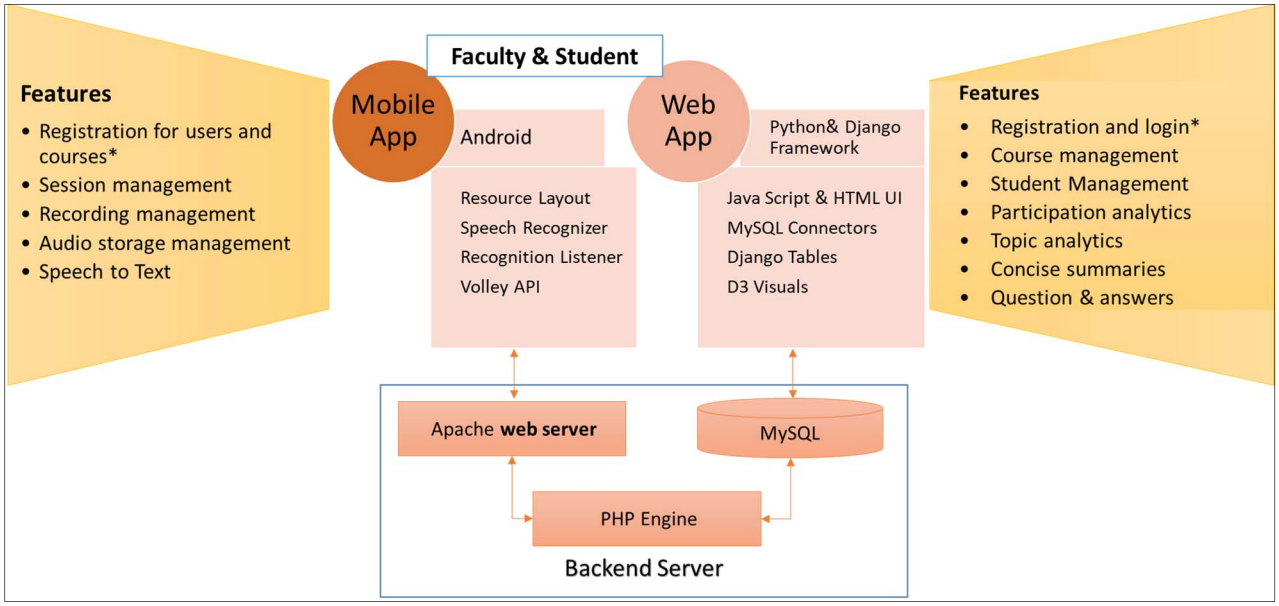

Fig. 2. Design of the tool for classroom discussions to capture the discussions and provide insights

The design tool proposed in Figure 2 is based on the Python Django Framework [28]. Django is a Python-based free and open-source web framework which enables to build web applications in a model-template-view architecture format. The main APIs useful for this app are described below.

JavaScript and HTML UI: The UI is developed using HTML and CSS, which are part of Javascript framework. Stacking Django and Javascript web frameworks to build modern web apps is one of the best ways to integrate backend and frontend operations.

MySQL Connectors: Django by default, works out-of-the-box with relational database management systems such as MySQL. The connector is an API to connect and retrieve data from the database.

Django tables: Tables is an API for creating HTML tables and enables them to easily access the data for processing and presentation.

D3 Visuals: D3 is a Javascript library that uses the data from HTML tables to create interactive charts. D3 supports different types of charts for useful and effective visualizations.

3) Backend server

The backend server plays an important role in integrating the web and mobile applications. It is a web server that receives the requests from mobile app to store the text (converted from the audio) to the database, MySQL, with the details, of the course, students, sessions and time. The web application pulls the data from the database, processes and presents to the users. It also pushes the processed data to the backend server to store into the database for optimized performance of the server.

C. Administrative Recommendations

Although there are many benefits of using educational technology, there are numerous challenges associated with technology. Educators must learn to effectively use the technology as a teaching aid and organizational tool, for it to help them present material in different ways, plan their lessons

more efficiently and distribute their notes more easily. To avoid the ineffective integration of technology into a lesson plan, educators need to choose the educational technologies that best support the learning activity that will be used in the lesson [29]. Sometimes, technologies like computers and tablets can create distractions for students and force the educator to compete for the students' attention [30]. Managing the challenges of classroom technology and realizing its full benefits requires both good decisions by instructors and effective integration of technology into the classroom design.

From the survey, we observe that the students have some reservations on grading classroom discussions and using technology for discussions. Recommendations for the instructor to enable better outcomes from class participation were proposed by several researchers [31, 32, 33, 34].

In terms of grading, firstly, the rubrics aligned to the course should be set and shared with the students. Secondly, students should be exposed to various types of discussions as described in Section 2. In terms of technology, firstly, if the students are comfortable with anonymity, the instructor should respect it and use the tool with anonymous settings. Secondly, auto-grading should be done with clear settings on the tool. For example, a balance of quantity vs quality of feedback from instructor on the discussion should be incorporated into the grading.

Finally, educating the students on the benefits of the tool by providing them with discussion summaries and topics based question and answer transcripts may motivate the students to willingly adopt technology in classroom discussions. Additional challenges can be in terms of different mobile phone models and versions, API performance, Wifi settings and interference noise. These should be addressed to the extent possible during the detailed implementation phase.

VII. CONCLUSION

Through the survey, we have observed that a majority of students agree that class discussions help in multiple ways to support their learning process. We have also found that key issues from the current manual approach to managing class discussions and participation relates to the loss of knowledge created during the discussions due to inability to convert tacit to explicit knowledge. On the part of the students, while most students remember their contributions there is a lack of comprehension of the logical flow of the discussion topics and also lack of recollection of contributions of other participants during the discussion.

We have observed that list of question and answers, and discussion summaries are the most important tool features that participants felt would aid their learning. The analysis from the survey results has helped us focus on the issues that concern the students when designing of technology solutions for supporting classroom discussions along with additional administrative settings that will be needed.

The proposed recommendations will guide the development of tools that can target these specific areas of concerns. We are currently working on the detailed design of the architecture to implement the tools for class discussion management and analytics.

REFERENCES

[1] And Baker, A. C., Jensen, P. J., & Kolb, D. A. (2005). Conversation as experiential learning. Management Learning, 36, 411–427.

[2] Frijters, S., ten Dam, G., & Rijlaarsdam, G. (2008). Effects of dialogic learning on value-loaded critical thinking. Learning and Instruction, 18, 66–82.

[3] Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development (Vol. 1). Englewood Cliffs, NJ: Prentice-Hall.

[4] Brookfield, Stephen D. and Stephen Preski11. 1999. Discussion as a Way of Teaching: Tools and Techniques for Democratic Classrooms. San Francisco: Jossey-Bass.

[5] Ilies, R., & Judge, T. A. (2005). Goal regulation across time: The effects of feedback and affect. Journal of Applied Psychology, 90(3), 453–467.

[6] Lipnevich, A., & Smith, J. (2008). Response to Assessment Feedback: The Effect of Grades, Praise, and Source of Information (ETS RR-08-30). Princeton, NJ: ETS.

[7] Bangert-Drowns, R.L., Kulik, C.-C, Kulik, J.A., & Morgan, M. (1991). The instructional effect of feedback in test-like events. Review of Educational Research, 61(2), 213-238.

[8] M. Bower, D. Richards (2005), "The Impact of Virtual Classroom Laboratories in Computer Science Education," in Thirty-Sixth SIGCSE Technical Symposium of Computer Science Education, St. Louis, Missouri, USA, pp. 292-296.

[9] Essa, A. & Ayad, H. (2012). Improving student success using predictive models and data visualisations. Research in Learning Technology. 20. 10.3402/rlt.v20i0.19191.

[10] Howard, J. R. & Henney, A. (1998). Student participation and instructor gender in the mixed-age college classroom. The Jfaournal of Higher Education, 69(4), 384-405.

[11] Peterson, R. M., 2001, Course participation: An active learning approach employing student documentation. Journal of Marketing Education, 23(3), 187-194.

[12] Petress, K. (2006). An operational definition of class participation. College Student Journal, 40(4), 821-823.

[13] Armstrong, M., & Boud, D. (1983). Assessing participation in discussion: An exploration of the issues. Studies in Higher Education, 8, 33-44.

[14] Karp, D. A. & Yoels, W. C. (1976). The college classroom: Some observations on the meanings of student participation. Sociology and Social Research, 60(4), 421-423

[15] Beekes, W. (2006). The "millionaire" method for encouraging participation. Active Learning in Higher Education. 7, 25-36.

[16] Lyons, P. R. (1989). Assessing classroom participation. College Teaching, 37(1), 36-38.

[17] Boniecki, K. & Moore, S. (2003). Breaking the silence: Using a token economy to reinforce classroom participation. Teaching of Psychology, vol. 30, no. 3, pp 224-227

[18] Meedzan, N., & Fisher, K. L. (2009). Clickers in nursing education: An active learning tool in the classroom. Online Journal of Nursing Informatics, vol. 13, no. 2. Accessed 23 March 2012, http://ojni.org/13_2/Meedzan_Fisher.pdf.

[19] Revell, S. M. H. & McCurry, M. K. (2010). Engaging millennial learners: Effectiveness of personal response system technology with nursing students in small and large classrooms. The Journal of Nursing Education, 49(5), 272-275.

[20] Nevid, J. S., & Mahon, K. (2009). Mastery quizzing as a signaling device to cue attention to lecture material. Teaching of Psychology, 36, 29-32

[21] Bandura, A., & Locke, E. A. (2003). Negative self-efficacy and goal effects revisited. Journal of Applied Psychology, 88, 87–99.

[22] Andresen, M. A. (2009). Asynchronous discussion forums: Success factors, outcomes, assessments, and limitations. Educational Technology & Society, 12, 249–257

[23] Falakmasir, M. H., & Habibi, J. (2010). Using Educational Data Mining Methods to Study the Impact of Virtual Classroom in E-Learning. Computer Engineering Department, Sharif University of Technology.

[24] Android Developer Reference, http:// developer.android.com/reference/java/util/zip/packagesummary.html

[25] L. Gomez, I. Neamtiu, T.Azim, and T. Millstein. Reran: Timing- and touch-sensitive record and replay for android. In ICSE '13.

[26] X. Wei, L. Gomez, I. Neamtiu, and M. Faloutsos. ProfileDroid: Multi-layer Profiling of Android Applications. In MobiCom'12.

[27] O. Zaïane (2001) "Web usage mining for a better web-based learning environment," in the conference on advanced technology for education, Banff, Alberta, pp. 60-64.

[28] Django Framework, https:// buildmedia.readthedocs.org/media/pdf/django/latest/django.pdf

[29] Harris, J., & Hofer, M. (2009). Grounded Tech Integration: An Effective Approach Based on Content, Pedagogy, and Teacher Planning. Learning & Leading with Technology, 37, 22- 25.

[30] Chowdhury, M. (2006). New Technologies in New Media Classroom. Paper presented at the Information Technology Based Higher Education and Training, 2006. ITHET '06. 7th International Conference, Ultimo, NSW

[31] Dallimore, E.J., Hertenstein, J.H. and Platt, M.B. (2006). Nonvoluntary class participation in graduate discussion courses: Effects of grading and cold calling. Journal of Management Education 30(2), 354–377.

[32] Dancer, D. and Kamvounias, P. (2005). Student involvement in assessment: a project designed to assess class participation fairly and reliably. Assessment and Evaluation in Higher Education, 30(4), 445–454.

[33] Sutton-Brady, C. (2010). Assessing Methods to Improve Class Participation. In 2010 EABR & ETLC Conference Proceedings, Dublin.

[34] Weaver, R.R. and Qi,, Jiang (2005). Classroom organization and participation: College students' perceptions. Journal of Higher Education 76(5), 570–601.