

## ClassNote: Facilitating in-Class Active and Collaborative Learning

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**Abstract:** In this paper we present a work-in-progress of development of web-based system, ClassNote, designed to support in-class active and collaborative learning activities. Through the use of web and mobile interfaces the application aims to aid instructors in their multi-faceted role in a classroom to support students in collaboratively working together and facilitates peer learning through sharing of solutions. Given that through this effort, we aim to tackle two main challenges - facilitate in-class learning activities and generating an effective feedback system, we have chosen Microsoft OneNote and Microsoft Power BI as engines to serve these purposes respectively. We report on the development of the application which aims to replace paper based active and collaborative learning activities along with provides analytics for better understanding of learning patterns of students.

## INTRODUCTION

Over the past couple of decades, technology has played a major role in promoting active and collaborative learning within the classroom. Active learning involves the engagement of students and educators in the learning process through design, problem solving, decision-making, investigative activities, or reflections [1-7]. Collaborative learning involves joint intellectual effort by groups of students who are mutually searching for meanings, understanding, or solutions [8]. The fusion of these two pedagogies can be characterized as people working together on a learning exercise that encourages application, analysis, and synthesis of course topic(s) to solve or create something, and to meet certain learning objectives throughout the process. Evidence suggests that such pedagogies could be deployed effectively in promoting student learning in both small classes and larger ones; and can be used for courses originally designed as traditional lecture-based courses. [5,6]. Technology however doesn't replace the class activities; rather it complements them by directly addressing the curriculum and participating structures to enhance learning [1][4][7]. Technology aids the instructors in efficiently letting the students know what they are doing and how that is relevant to their learning. In addition, it provides a medium for the students to discuss and work together, which not only provides them with a wider exposure to peers' experiences but also helps them to be self-critical about the work they are doing and how it could be made more relevant to the context. An instructor plays 4 different roles [9] in the process of active and collaborative learning. These roles are:

- Pedagogical role: educating the students about the subject to be discussed and taught.
- Managerial role: administrative and procedural tasks required to facilitate the activities to be performed during the collaborative learning process.
- Social role: social aspects where the instructor tries to achieve oneness such that the cognitive learning process is not affected.
- Technical role: indulging in activities that are technology-based, in order to be prepared beforehand for the collaborative activity.

In this paper, we report the work-in-progress of development of ClassNote, an active and collaborative environment for in-class teaching, to support active and collaborative learning among students in a university course and to aid instructor in all the above four roles. The objectives of ClassNote are (i) To allow instructor to create and manage active collaborative learning activities (Figure. 1) (ii) Support various types of questions for the activities (e.g. design-thinking, diagramming, descriptive writing, fill-in-the -blanks, Freehand sketching) (iii) facilitate students to think, pair or group and share work (Figure. 2) (iv) provide visualization of the responses submitted to aid understanding in learning patterns of the classroom (Figure. 3) (v) facilitate real-time notifications to students about the latest class activities (Figure. 4). These are achieved through design and implementation of a web-application for instructor, to create and manage activities, to give feedback to students and to analyze student responses, a web and a mobile-application for students to collaborate and respond to the learning activities (individually as well as in a group), submit their responses and view other students' responses

and a robust cloud server to store, manipulate and retrieve data and provide synchronization mechanisms to the application.

## CONTEXT

The landscape of technology that can be used to support active and collaborative learning is vast and varied. Many commercial tools as well as research lab tools are available that can facilitate real-time and asynchronous text, voice, and video communication; assist in basic group activities, like polling, discussions, task management, scheduling, planning, routing, and tracking; support co-creation of content by enabling groups to modify a common artifact in real-time or asynchronously; allows sharing, searching, tagging resources. Some of the research lab tools include quiz taking [10], real-time feedback to lecturer with regards to quality of lecture [11], sketching over slides [12], group learning through shared workspaces [13], collaborative notetaking [14]. There are some free tools like Google Docs, Trello, Asana, etherpad, that are commonly used for course work communications. Here we present a learning application that provides the following for in class interactions: (i) Instructor initiated learning activities during lecture, (ii) group submissions by students, (iii) sharing solutions among all, (iv) a rating mechanism by students, (iv) analytics e.g. how many students participated in an activity; how many activities attempted by each student etc.

ClassNote, conceptualized for in-class interactions among students and instructors in a highly interactive class, facilitates instructor-student and student-student interactions through web and mobile interfaces. Its setup is envisioned as a (i) a web interface for instructors (ii) a web interface for students (iii) a mobile interface for the students for real-time notifications (iv) an administrative utility (v) provision for data persistence (vi) analytics

We explain the system in context of its use in teaching of a course on software engineering. The lessons typically include in-class collaborative learning activities, known as Active Learning Exercises (ALEs), which facilitate e.g. Collaborative Ideation, Collaborative Storyboarding, and Collaborative Solution Analysis.

Currently, these in-class activities are conducted in a traditional manner, without the significant involvement of any electronic medium. The instructor uses differently colored activity sheets to differentiate between the various ALEs. Subsequently, students form groups and then submit their respective team ALE sheets on which they have scribed their team responses so that the lecturer can keep a track of their attendance. Students then have to manage their activity sheets after the instructor returns them, in order for revision in future. Evidently, there is a lot of administrative inconvenience on both, instructor and student end.

ClassNote aims to enhance learning outcomes by:

1. Reducing class time required for administration of activities (ALEs). As stated earlier, class time is spent collecting and distributing activity sheets. Since the instructor spends less time on such administrative activity and minimum time is required for explaining the activity (since the student can read the activity description when allowed access), more time is spent productively during lesson.
2. Enabling collation of students' responses for every activity (ALE). A student can see the various responses by his/her peers and gauge how his/her own response can be improved.
3. Allowing easy review of peer responses. Instructor can now facilitate in-class critique over certain responses.
4. Enabling instructor to track student progress and understanding through viewing student responses.
5. Reducing paper consumption for collaborative activities. With ClassNote, the ALEs will be made available to registered students through a web interface.

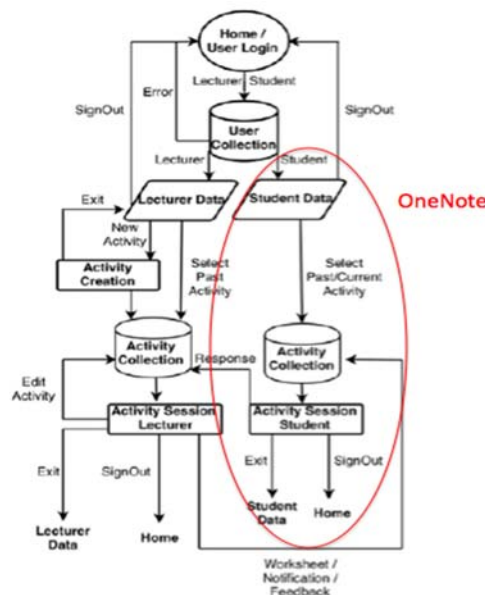


Figure 1: Application Flow Diagram

## PROTOTYPE

Based on a contextual inquiry and participants/target group observation with an

instructor and students of a Software Engineering course, we have scoped the functionality and specifications of ClassNote to provide for the following features:

- An instructor is able to allow student access to particular ALE to enable collaboration/participation during the course of the lesson.
- Student responses are stored for future viewing by both instructor and students at any point during the course of the module **(provided by Microsoft OneNote)**
- An instructor is able to view students' answers collectively for an activity (with each answer matched to a particular student identity).
- A student is able to view his/her peers' answers for a particular activity in a collated manner. **(provided by Microsoft OneNote)**
- A student is able to view his/her own collated answers for all the activities of any particular lesson. **(provided by Microsoft OneNote)**
- Instructors should be able to access ClassNote on web and mobile platforms.
- Instructors should be able to create and view visualisations out of aggregated student responses **(provided by Microsoft PowerBI)**
- (optional) Students can view visualisations of all student responses for related ALEs **(provided by Microsoft PowerBI)**

The application flow can be seen in Figure 5.

ClassNote is being built using Meteor, an open source development platform. Bootstrap is considered for enhancing responsiveness to the application. The user specific, app specific and activity specific data is stored in separate MongoDB instances. For prototyping, the application is hosted on a cloud server that facilitates prototyping and testing. The server acts as the instructor portal (server in a client/server architecture). Separate instances of the application are run on multiple client devices in order to depict the instructors in a classroom scenario. The devices, hence serve as the instructor portals (clients). The instructors can log in to the application using their University credentials. An application session is then created for each login. The devices are connected to the server through a local network, same as the server's and hence a two-way communication channel is established. The application allows for the creation of different types of ALEs by the instructor.

The students then view the ALE and the related content and can submit responses and receive the corresponding feedbacks on Microsoft OneNote. The students also have the feature to view the responses of their peers, edit their earlier responses and re-submit responses. The lecturer has the ability to create ALEs on the fly, can deploy ALEs either in whole, per module, per question or all questions within an ALE in bulk, fetch the student responses from OneNote on the fly, can submit individual or group feedbacks and see the statistical analysis of student responses in PowerBI. It is to be noted that all communication and subsequent application updating occurs in real time. The above functionalities thus help in creating an in class active and collaborative learning environment to enhance instructor efficiency and student productivity.

**Microsoft Azure Services** are used to host OneNote application and facilitate information exchange between OneNote and ClassNote. Figure 6 below helps to illustrate this integration.

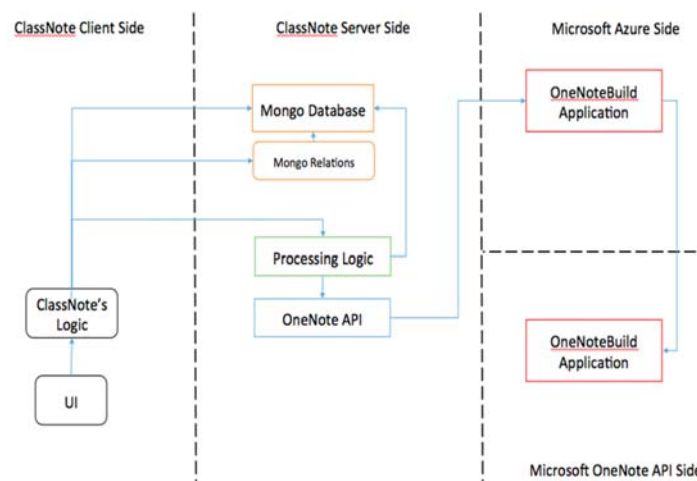
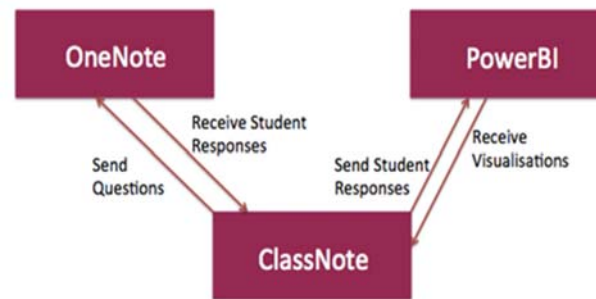


Figure 2: Integrating ClassNote with OneNote

Power BI comes at play after students have responded to their questions. Lecturers can then pull these responses from OneNote, in the form of a json string, and store in within ClassNote's database. After processing the aggregated set of student responses and reformatting them, another json file of the processed responses set can be retrieved, to be pushed into Power BI dashboard. The workflow is shown above in Figure 3.



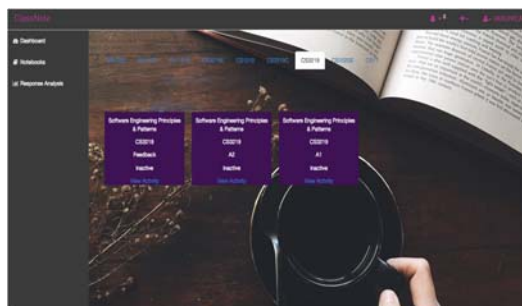
**Figure 3: Component Interaction**

Upon receiving processed student responses in the Power BI dashboard, lecturers can then use its tools to create different visualisations for different response types. For example, for short or long text answers, a word cloud visualisation can be used to show the popular keywords used by students and highlight the outliers, which were not as popular as well. For true or false responses, pie chart can be used. Here's an example of visualisations of sample student response data (Figure 4):

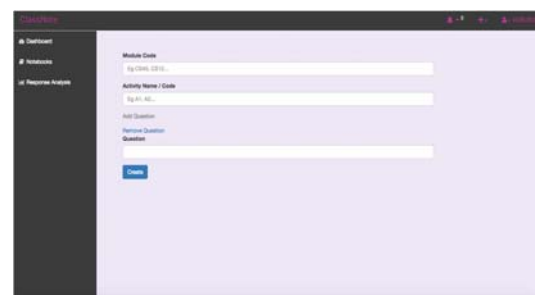


**Figure 4: Student Response visualisation in Power BI**

The interface of ClassNote are shown below (Figure 5-8):



**Figure 5: ClassNote Dashboard**



**Figure 6: ALE creation**

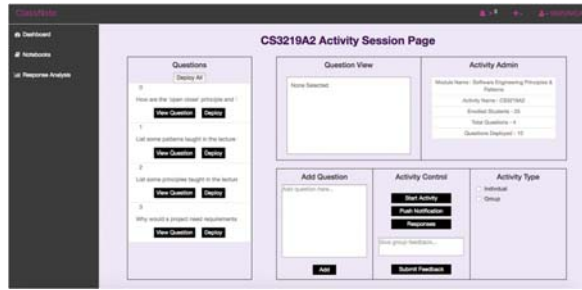


Figure 7: Activity Session Page (For each ALE)

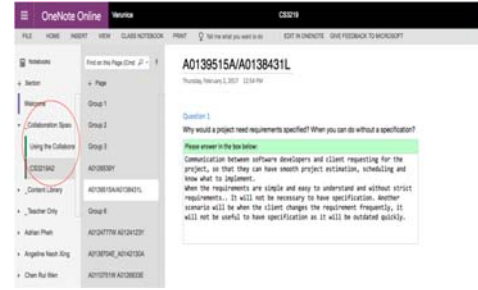


Figure 8: Group in-class ALE in OneNote

## EVALUATION

Pilot user testing of ClassNote was done with the aim to test the workflow of the system and user-centered interaction design. There were 4 sets of participants as follows:

1. Pair of students
2. Module facilitators (as Module facilitators)
3. Module facilitators (as Students)
4. A class of 20 students

There were 3 rounds of testing that was carried out. First round was with a small group of 4 students to evaluate the use of OneNote and its integration with ClassNote. And in the third round, the test was carried out with a class of 20 students.

In the second round, 2 module facilitators were invited to play roles of facilitators and of students to evaluate both the lecturer's portal (ClassNote) and students portal (OneNote). This was done since these facilitators could provide direct reviews of the ClassNote portal which they will be using, as well as share insights and expertise of whether or not the student portal is able to match the needs of learning, and how the students can potentially react to such an interface.

At this point it is important to note that these rounds of testing were only carried out to test ClassNote, and the integration between ClassNote and OneNote. Developments on the integration with PowerBI side is pending testing.

For each round of the three rounds of testing, 2 kinds of in-class activities were carried out - individual activity and group activity. Each activity comprised of 2-3 questions, which were deployed one-by-one and at one go, mimicking an actual classroom scenario. Pairwise testing was done for these factors in order to maintain conformity in the testing. These were the pairs used:

- Individual activity, one-by-one question release
- Individual activity, bulk question release
- Group activity, one-by-one question release
- Group activity, bulk question release

Across all participants, it was observed that they preferred having a virtual platform for in-class collaborative learning as compared to the traditional method of using pen & paper. There were varying reasons for it, such as:

1. No switching required between a device and papers - since they were taking notes on their devices during class time
2. Reduces effort greatly of module facilitators to aggregate student responses and analyse them
3. Learning from peers made seamless with easy reference to peers' answers using OneNote
4. Better initialiser for group formation and group activities since there is a shared platform
5. Improved quality of student answers due to transparency of answers amongst classmates
6. Improved attention span due to transparency of answers amongst classmates

7. Useful tool for students as it allows keeping of answers for their reference
8. Reduced lag time for feedback exchange between all involved parties
9. One-stop view of modules, activities, questions and student responses for module facilitators - increases ease to carry out in-class activities
10. Easy navigation in both portals

However, there were some downsides highlighted during the testing as well, such as:

1. Lag time in OneNote - especially during group formations and group activities
2. Conflict handling was not satisfactory - often new changes did not override old ones and even got lost
3. Missing response analysis within the ClassNote portal
4. Editing of module name within ClassNote was not intuitive
5. Activity creation within ClassNote required user to fill in unnecessary fields

In a discussion with a Microsoft representative, the above issues were highlighted for their consideration.

Responses collected from this testing were used for further work on PowerBI integration with ClassNote, in the later course of the project.

## CONCLUSIONS AND FUTURE WORK

In this paper, we have reported work-in-progress of a tool being developed for conducting studio style courses which are effectively taught [15-18] with in-class active and collaborative learning pedagogies. However, the reach of this tool will not be limited to just studio style courses and its features could be used in any interactive classroom.

In the near future, further developments will be done, aiming for the most optimized usage of Microsoft's tools to aid in-class collaborative learning. This can be easily done by automating the uploading of processed student responses data as well as automating creation of visualisations - all by using *Power Embed*, a method of integration of Power BI services with a web application. Efforts of manually uploading this data set into Power BI dashboard and manually creating visualisations can be cut down.

In addition, **Microsoft Azure Stream Analytics** can be used together with **Microsoft Azure SQL Database**. Student responses from OneNote can be stored into database directly, hosted on the cloud and using **Stream Analytics**, we can live stream the visualisations and how they change at realtime as and when the students answer. Student responses then need not be fetched by the middleman - ClassNote, and then sent to Power BI's dashboard. However, before creating visualisations for these responses, they still have to be processed. This can be done before saving the responses data into Azure SQL database or after retrieving it and before pushing it into Power BI datasets.

Student responses, at the same time, will be saved in a reliable source from which they can be retrieved for the reference of both lecturers and students. Live streaming of data within Power BI, with the help of Stream Analytics can help lecturers get a real time view of the class' understanding of topic(s) covered in class. We believe that some of the most effective classroom solutions come from instructors and working with educators closely throughout the formulation, design and evaluation of research, and development is the surest way to make research and tools work in real classrooms. Currently, the design and prototyping of this tool uses contextual design methodology and participatory design approach with a single instructor and a 25 students of an Software Engineering course, in a real-classroom setting. Next, the prototype will be evaluated in (i) a real-classroom of an Human Computer Interaction course with an instructor and 40 students (ii) with 1-3 instructors and 20-50 students of non-design courses through demonstration of the system followed by a survey or interview. The next iteration of the prototype will be based on the evaluation findings.

Last but not least, a research agenda is planned to create a better learning experience for students. The approach is to be as methodical as possible, taking one piece, implementing it and then measuring, and adjusting it. Learning science findings are not cut and dry. We are fundamentally boiling it down to measuring human interactions, in a methodical manner. Instructors have to synthesize them, in the context of the curriculum and classroom experiences, through small experiments to find out how far they can adapt the findings to achieve the set learning outcomes in their classrooms.

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