

Peer Based Learning Application

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**Abstract**

Pupil to teacher ratio in Africa is measured at 40 according to UNESCO report, this has led to the need of solutions that will aid the teacher while learning in the classroom and be able to bridge the gap. Intelligent tutoring system (ITS) is one of the potential solutions to help aid the teacher by taking over some of the teacher's tasks e.g. grading and monitoring students' engagement while in class. One challenge with ITS solutions is that it does not work well in non-structured domains which makes its hard to be applied to all subjects in primary education. This limitation has forced ITS solutions to be focused only in structured domains e.g. Math's and Physics and less in non-structured domains that dependent on different context based explanations. This paper attempts to solve this challenge by incorporating peer based collaboration with ITS solution by using crowd sourced peers will aid non-structured domains by leveraging on human input. This solution would enable users to get questions by question recommendation and they can interact and ask each other questions. In addition to improving students' performance, for future work the data from peer based collaboration can be used by a machine learning agent that learns on how to provide question by question recommendation for questions that students have failed.

*Keyword:* Intelligent tutoring systems, Peers, Collaboration and Learning

### **Introduction**

(Smith, 1992) notes that “Collaborative learning” is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together. It is a mode of learning where learners don’t learn in the traditional teacher centered approach e.g. a classroom setting, but it’s a learning where learners get to learn from others either in groups or one on one. The rise of this mode of learning can be attributed to lack of effective learning in normal classroom centered learning, where the teacher usually focuses on imparting their knowledge/understanding of a concept. This approach is limited due to different learning styles e.g. slow learners and hence usually affects learning in a normal classroom setting, with such limitations students have opted to peer based learning.

Peer learning has been identified as an effective way to improve students’ performance (Safqat, 2011) (Stanford, n.d.), this is because the student feels more at ease to share knowledge and ideas with their classmates which improves their confidence. Also, peer to peer learning is helpful to both students taking part: by explaining to other students, the students who understood it develop their exposition skills and in turn help them to understand better and never forget (ITWORX EDUCATION, n.d.). cornell.edu (n.d.) emphasizes that for effective collaboration to happen the activity must be based on the following four principles

- a) The learner is the center of focus
- b) There must be interaction amongst the members of the group
- c) The use of structured approaches in learning should be incorporated into learning because it aids and accelerates learning.

Cornell.edu (n.d.) also gives some of the modes of collaborative learning which are: Stumping your partner, think-pair-share, lecture catch up, case study and team based learning amongst others. All these can be either administered in physical environment or online in a large group or between fellow learning peers, nus.edu (2013) defines peer learning as where students learn with and from each other without any guidance or authority from their instructors, peers can explain a concept to a fellow peer better because their language and understanding that can be related, this will in turn help them understand and grasp clearly.

### **Problem Statement**

UNESCO reports that 29.8 million children in sub-Saharan Africa dropped out of school in 2011, globally this represents 57 million children are out of school (UNESCO, 2013). Performance and engagement are known to be highly predictive factors contributing to dropping out of school (Center for Public Education, 2007). These factors have led to schools reducing the number of students per class to ensure that the teacher can monitor closely each student's performance and be able to identify disengaged students. Pupil to teacher ratio in Africa is measured at 40 (World Bank, 2016), this still affects performance which end up contributing to the high dropouts of students in Africa.

The use of teacher aiding solutions e.g. intelligent tutoring solutions(ITS) can be used with the goal of improving students' performance. One challenge with ITS solutions is that it does not work well in non-structured domains which makes its hard to be applied to all subjects in primary education. Structured domain are subjects that given their questions they have clear answers and there are no disparities e.g. Math's, on the other hand non-structured are those that solutions can be argued differently based on contexts. With these two domains what technology

solutions can be integrated with ITS to aid the teacher and improve students' performance across both domains? Can out of school students benefit from the solution to learn non-structured subjects?

### **Proposed Solution**

#### **Overview**

Peer based learning can be added to ITS solutions and students can leverage on peers for free text questions or vocational lessons to guide and recommend on which question answers are best to learn from and to share any learning materials. Students in school are only limited to students they are in contact with, leveraging on the rise of mobile penetration uptake students will be exposed to other students' peers from other schools which will improve their interactions and learning. The benefits of using mobile devices for ITS outweigh the use of computer based platforms because mobile devices provide access to myriad sensors that can be used to improve education solutions e.g. using microphone for noise detection and monitoring students' activity. This is also evident from the wide adoption of tablets in schools to provide personalized learning and improve engagement between the teacher, student and parents. For example, some counties in the US e.g. Baltimore in Maryland and countries like Kenya are also planning to roll out tablet for each of the students in elementary schools (Kasey, 2015) (Zurier, 2014) (Moses, 2016). The proposed solution will incorporate peer based learning in ITS delivered on Mobile to leverage on the wide adoption of mobile either in school, home or on the go. This solution will have the following features

- Instructors/Teachers access as moderators and not allowed to answer, just approve or comment on students answers.
- Students can attempt the quizzes at their own time or ask specific questions.

- Other students can get to grade other students and instructors can moderate
- Students can ask other peers questions or post any vocation skills for others to benefit.
- Students view their quiz performance with question by question recommendation of which other students can help them if they have failed or their method needs improvement.
- The application will have best performance view where best students in various subjects/topics are shown to act as motivation and encouragement to others.

### System Architecture

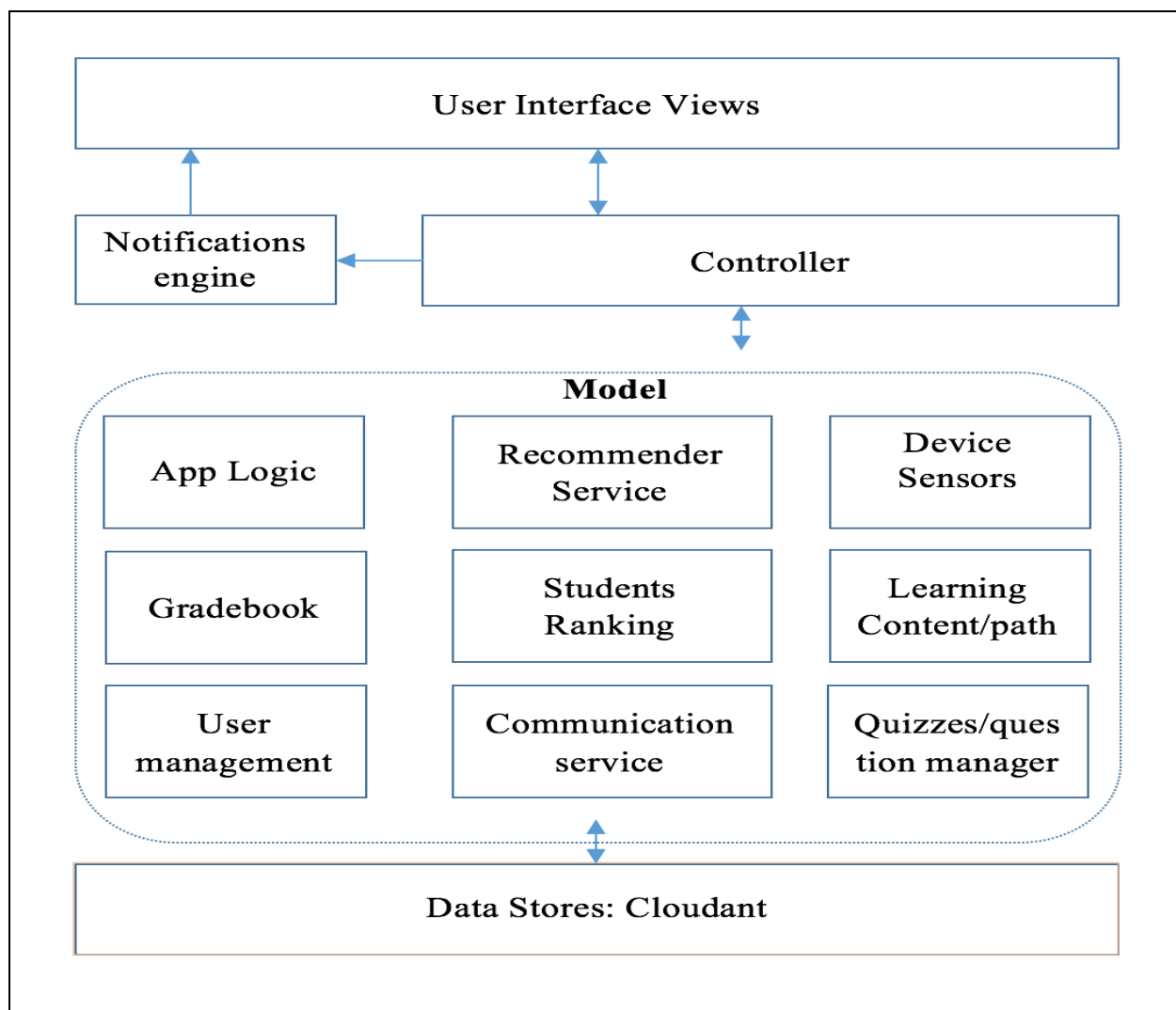


Figure 1. System architecture - Showing all the components that the system has.

Figure 1 above shows all the components of the system; the following section describes each component in details:

a) User interface views

This is responsible for handling all the views required for the applications. The views are used to by the controller to present any data and collect any given information from the user.

a) Notification engine

It's used for sending specific and targeted notifications to the users via the views, these notifications are ways whereby the systems notify users on any events going on in the application e.g. new questions or quizzes uploaded.

b) Controller

This is what controls which views is shown and coordinates with the model to get the right data required for the different views.

c) Model

This is the main part of the project which hosts the different features that the application has.

i. App logic

All requests that come in to the model from the controller go through the app logic which will be responsible for executing or invoking the required services.

It's also what has the workflow of the application from signing up to how to access the different services.

ii. Recommender service.

This is used by instructors to recommend best answers for either general questions or quiz answers, answers that are recommended by instructors is what the system uses to suggest to students who failed those specific questions and need guidance on what to follow to learn

iii. Devices sensors

This is an interface that is used by other services to leverage on device sensors e.g. sound and screen sensors. The system has three input modalities: Voice input, normal input text and scratchpad interface. Voice input leverages on device microphone and scratchpad input leverages on screen sensors to capture text as like when one is writing on a normal book.

iv. Gradebook

This is where all the users get to see their results if they have taken the quizzes, also in this feature they can get question by question recommendation especially for questions that they have failed and they need suggestion on some of the best answers. To suggest best answers gradebook service uses recommender service to get answers that have been recommend by instructors or that have highest number of votes from other students.

v. Students ranking

This is where students get to see their overall ranking, this is only available if the students have shared their quiz results to ranked against others. This is meant to act as a motivator and get to know who did well and if they have any specific questions they can ask the best student directly using communication service.



vi. Learning content.

This is a feature that allows all the users to upload any learning materials that users can use them to learn, it's also used to create any quizzes that might go alongside the materials uploaded or they might be independent quizzes.

vii. User management

This service is used to manage users with different roles e.g. students or instructors. It's also used to enroll the users and captures their basic demographic details which is used for sending notifications and direct targeted communications.

viii. Communication service.

This is used for sending specific messages amongst users in the system, for instance where one needs to send a message to another user communication service will leverages on user management to identify specific people and send the message to them.

ix. Quiz/questions manager

The system uses this to manage all the quizzes create and questions. This is helpful when there is a communication thread that are linked to one question or one of the quiz questions.

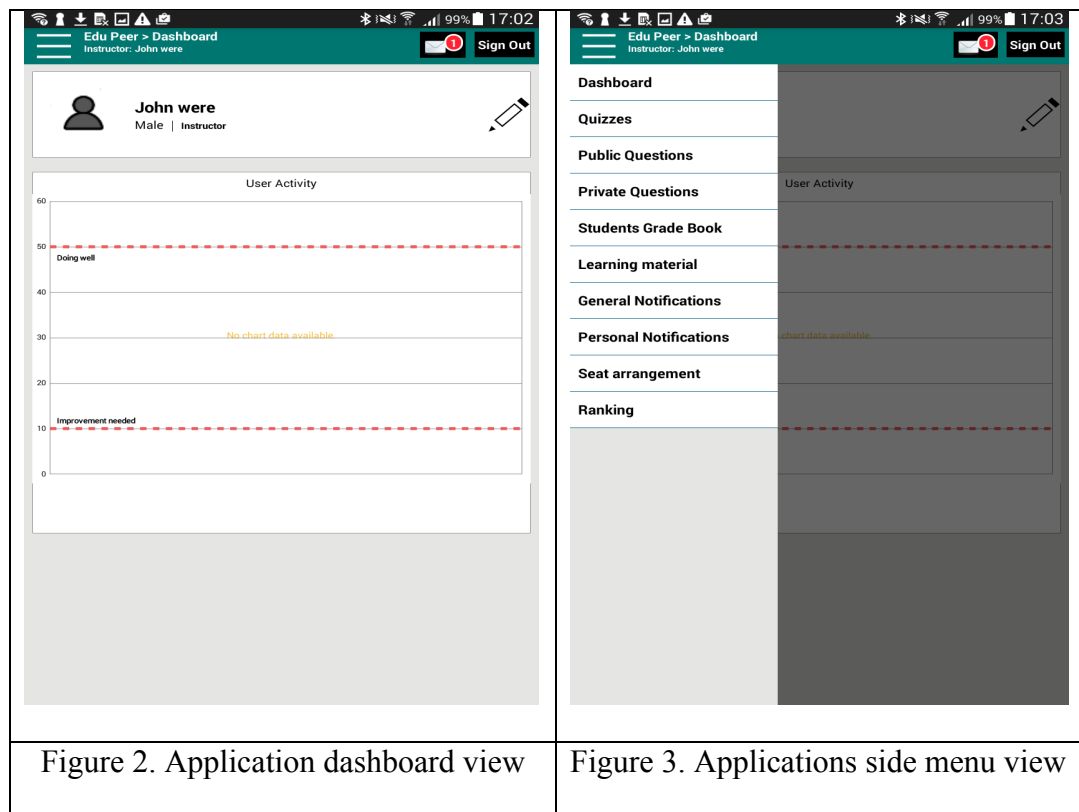
## **Implementation**

The mobile solution was implemented on android platform and was optimized to run on mobile phones that run android version 2.3 and above. Android was chosen for the client application due to the flexible SDK, Android Development Tools (ADT) and availability of support from several developer communities online. The following section describes the some of the specific features that of the application.

- i. Dashboard View

Figure 2 below shows the dashboard of the application, this is where the applications logs the user activity and plot a line chart for the user for the following activities:

Uploading learning materials, doing quizzes, asking and answering questions. The application assigns different weights to the different activities and they will appear in user's dashboard. Figure 3 shows all the features and functions the applications has when they access the side menu to navigate to other features in the application.



## ii. Quiz View

Figure 4 below shows quiz view where users get to view the quiz which is shown if the users wants to attempt the quiz. The view shows the quiz metadata on top and an option for the student to share their quiz with other students, if the student chooses not to share their work their results will not be used in ranking as well as recommending their answers to other students. The view also has two distinct icons a microphone and note book with a pen, this are used to access any extra details. For microphone its used to listen to a recorded voice while for the note book its used to view scratchpad input as shown in figure 5

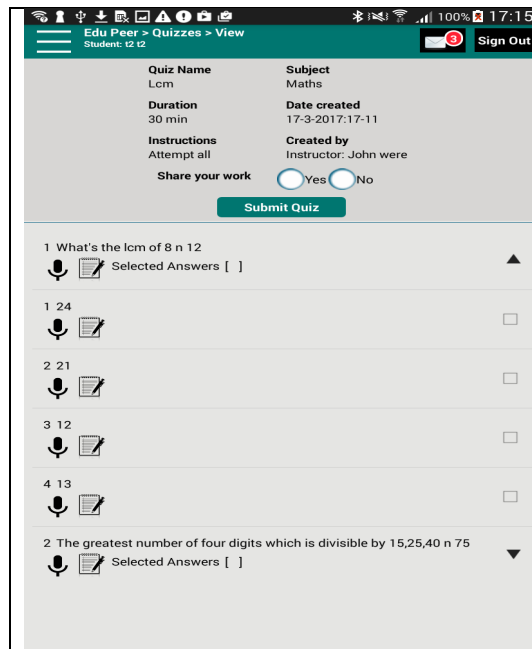


Figure 4. Applications quiz view.

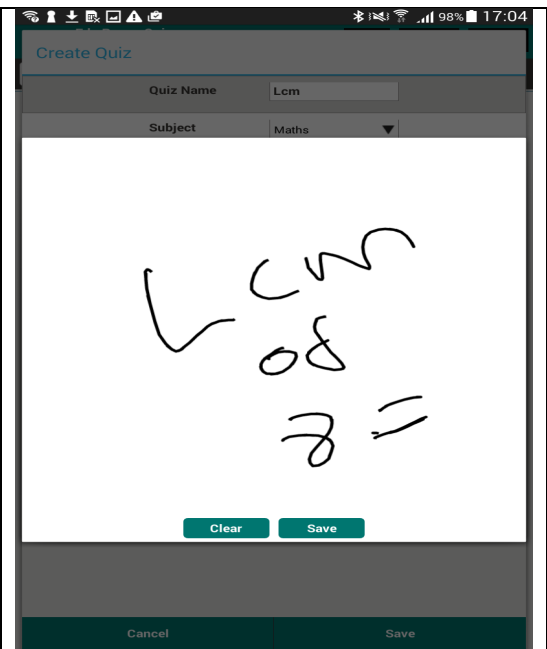
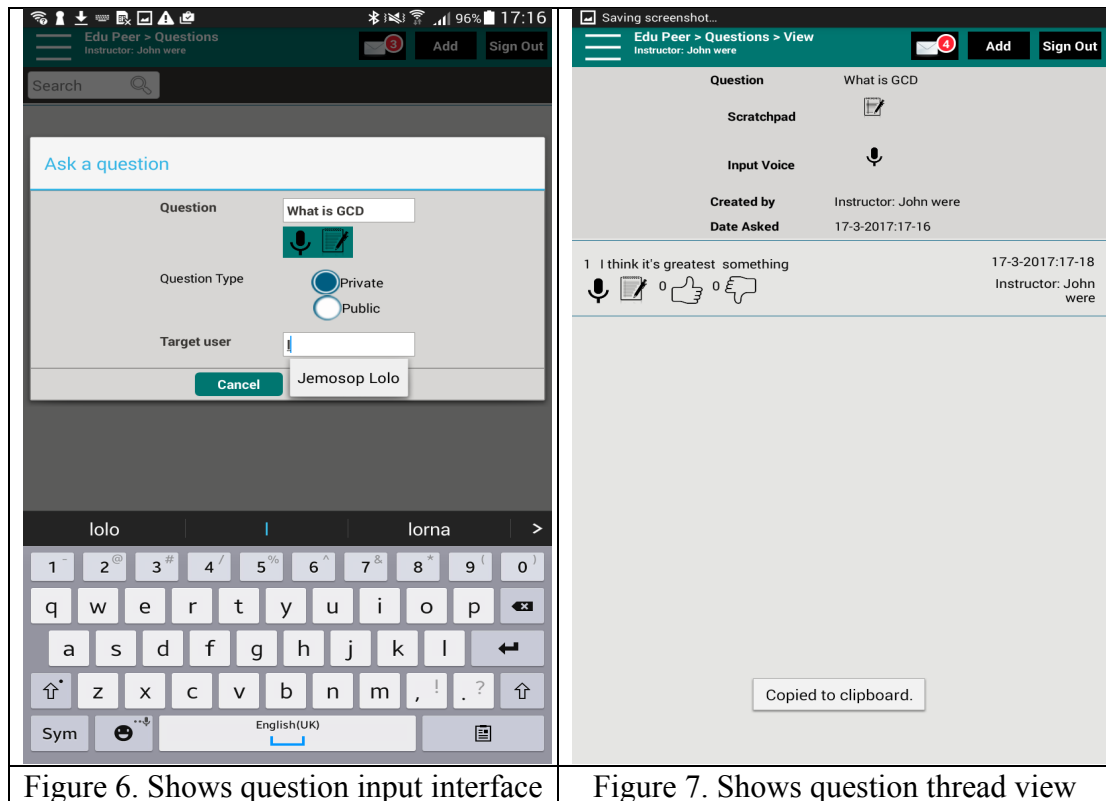


Figure 5. Applications scratchpad view.

### iii. Questions view

Figure 6 shows a view for entering new question which is accessed via side menu options. The view allows the user to either type their question or record voice input or use scratchpad, the green background colors means that use has entered some input otherwise it would be white. Also, users can choose to make the question private or public, if user has chosen private they are required to enter the target user as shown, if public the target user is automatically hidden. Figure 7 shows a view of the same question asked in figure 6 with one response, the response has the two new icons thumbs down and thumbs up will allows users to vote down or up for each question response.



iv. Seat arrangement

Figure 9 shows a list of students and shows which student is paired on the right corner. If the student is not paired with anyone, the instructor taps on one pair icon that is next to the name and it opens a pop up screen as shown in figure 1.8. In this screen, the instructor is shown the list of possible students that the selected student can be paired with. The application also recommends a student based one that has the highest gap in total average grades of quizzes with the selected student. The recommended student is flagged or shown with an icon as shown in figure 1.8 student t2. Despite the recommendation, the instructor is left with the final decision to choose whom to pair with, the system shows the average marks for the selected student and other students that it may guide the instructor to choose another student to pair with if

they wish to. To select a student to pair with, the instructor taps on their choice of student and the application will pair them and return to the initial screen and show the paired students as shown in figure 9.

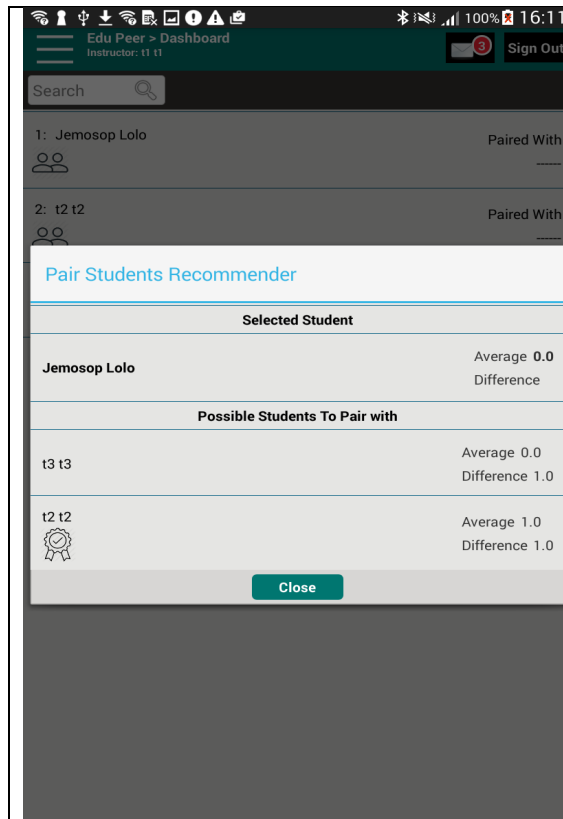


Figure 8. Student pair recommender view

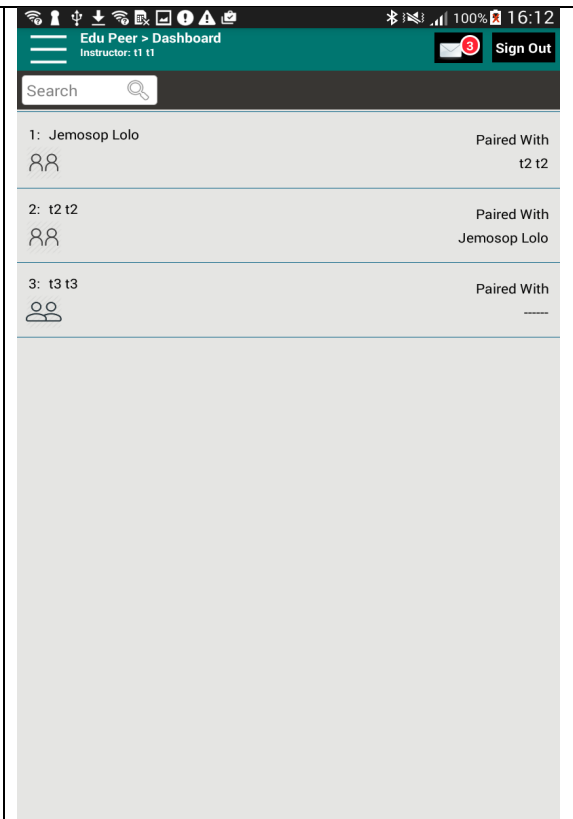


Figure 9. Paired students view

#### v. Question recommendations

The other main feature is where the students can get recommendations questions by question, this is only available for questions they didn't get right e.g. the one shown in figure 10 below. For such questions if they tap on the award icon the system will look for the best answer for them, metrics of finding recommended answer is using

answers that have been approved by instructors. Instructors get to approve by the correct answer by tapping on tick icon as shown in figure 11 below, after approving the background color of that question will be changed to green to show that it's an approved answer by instructors as shown in figure 12. When the student whose answer has been approved sees their quiz results they will see a tick icon alongside their choice as shown in figure 13. The other metric which is used for recommendation is when the correct answer has been given thumbs up and no thumbs down it can be recommended to other students. If the students requests for question recommendation and there is none that instructors have approved and no thumbs up from the students' the application will inform the students to check later as shown in figure 14, but if the metrics described exists and the students taps on recommender icon the one that resembles an award icon as shown in figure 13 where the student failed, the application will pop up the recommended question that matches the one the student has failed as shown in figure 15. The view shown in figure 15 also show the details of the recommended student so that one can reach out to them if need be via direct communications, also it shows a tick icon to show that the question has been approved by instructors, students thumbs up and down is also shown. The students can get to see how they responded and answered the question and they can access their voice recording or scratchpad interface.

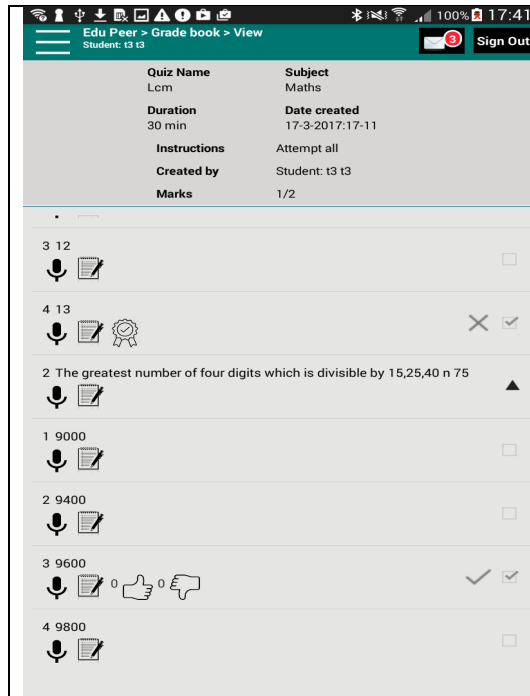


Figure 10. Applications grade view quiz results view

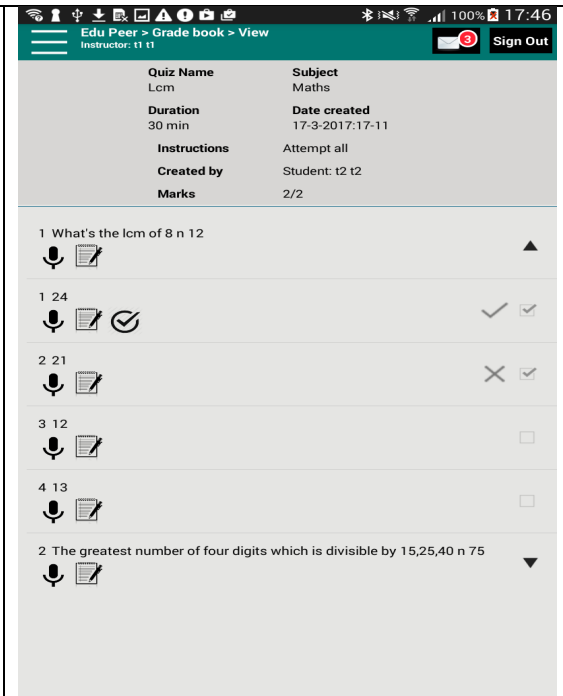


Figure 11. Applications instructors quiz view with an option to recommend the correct answer

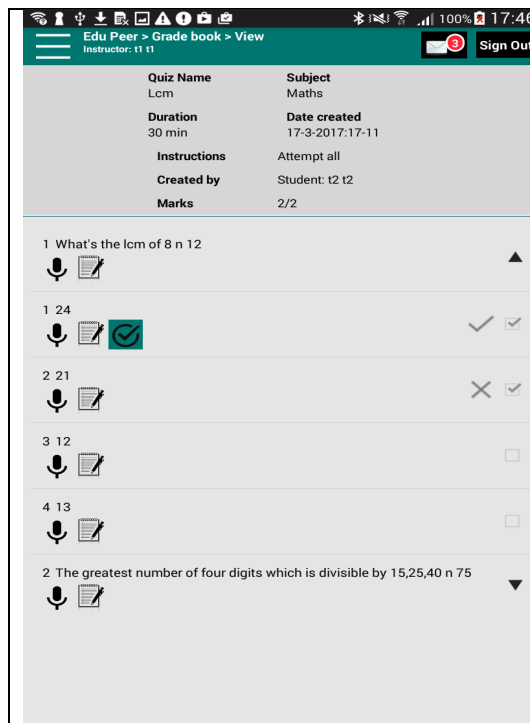


Figure 12. Applications instructors quiz view after they recommend that answer for recommendations

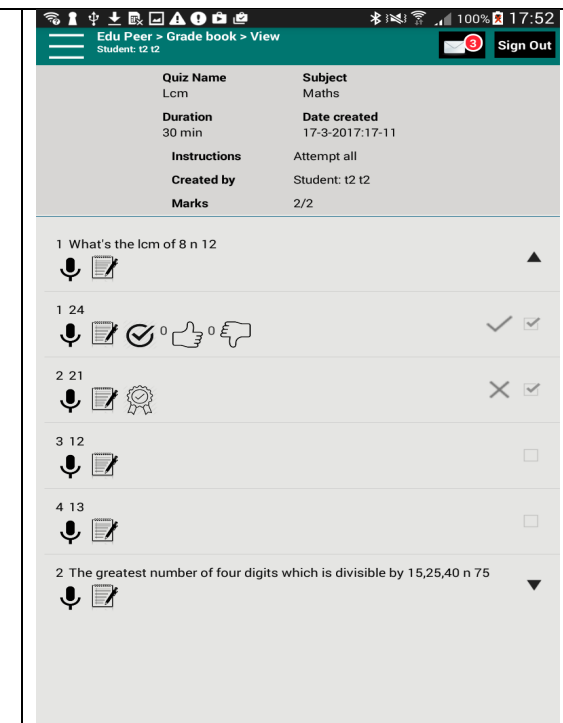


Figure 13. Applications students quiz view showing that their question answer has been recommended for other to view



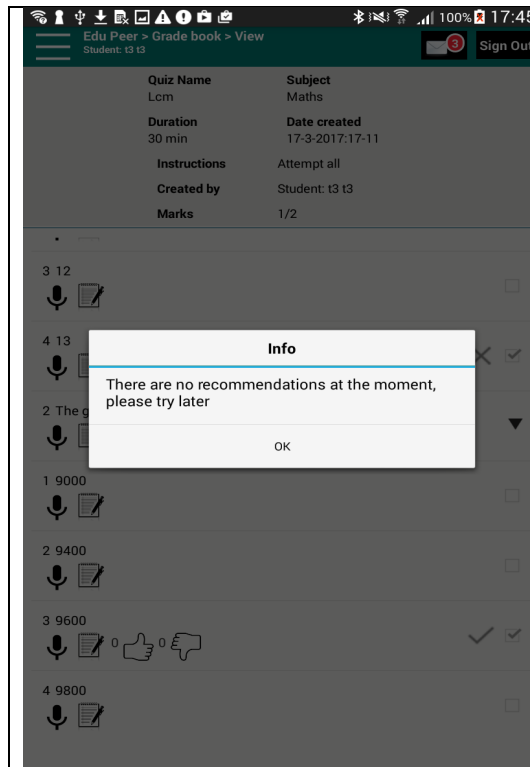


Figure 14. Application view when there are not recommendations to be provided to students.

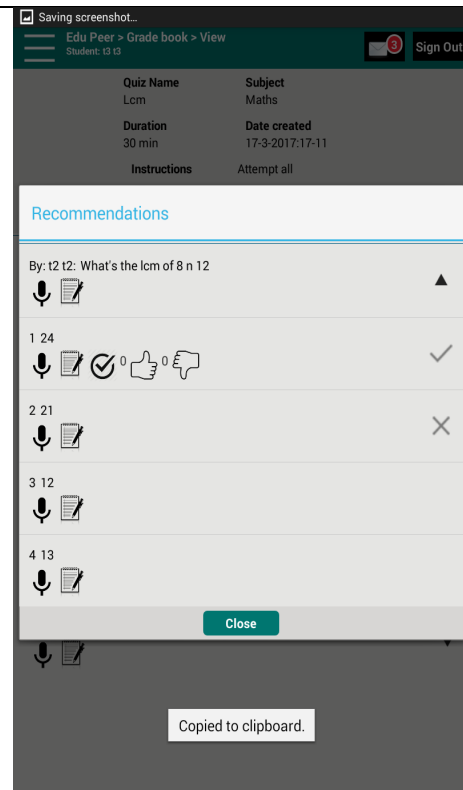


Figure 15. Applications view when the student is presented with recommendations for the questions they failed.

## Demo

The demo was recorded into three parts, using the following link

<https://www.youtube.com/watch?v=BwZ-DmKpNqc&list=PLKaj7LTX6I8Aphe-Bk0yDAS9HI16jzrCC>

one can access the playlist that plays all the three videos. For specific parts one can access using the following link

<https://www.youtube.com/playlist?list=PLKaj7LTX6I8Aphe-Bk0yDAS9HI16jzrCC>

The user documentation is also located at

<https://drive.google.com/file/d/0B43IrGMZgmCoSk9janNtaFRKWkk/view?usp=sharing>

The app can be downloaded from

<https://drive.google.com/file/d/0B43IrGMZgmCoX05lR3hPUWp4YzQ/view?usp=sharing>

### **Related Work**

The following are some of the existing peer to peer tutoring solutions:

a) Cognitive Tutors

This product is from Carnegie learning targeting math subjects in secondary-level schools (Center for Public Education, 2007).

b) SESH: A mobile peer-to-peer tutoring app

This is an application that leverages on providing tutoring on specific courses and people who have taken the course only which is different from the suggested application model. (Michael, 2015)

c) StudyTree (Zioedy, 2016)

Study tree application works like Sesh described above.

d) EduSnap

This application is like a question and answer forum, the suggested solution works differently by focusing only on students helping each other. (Tay, 2014)

### **Novelty**

The suggested solution is different and unique from the existing solutions because of the following reasons:

a) In addition to ITS features the suggested solution will allow students to interact with peers for question/methods clarifications that they did not understand e.g. in a quiz.

Students will get question by question recommendations of students who can explain to

them if they need more clarifications and for math problem the application will share other peers answering approach e.g. via a sketchpad.

- b) The suggested solution offers a feature where students get to ask questions and get to see the best rated answer and method for each question e.g. for science. The metrics for determining best method are time and steps taken to arrive at the correct answer.
- c) The suggested solution can recommend to teachers' students seating arrangement based on their performance with goal of improving each other's performance.

### **Future work**

Quiz question by questions recommendation depends on human input to read and flag best answers and number of thumbs up votes. This process can be highly affected in situations where there are less instructors or they have no time to go through each answer and recommend. This problem can be solved by implement a machine learning based instructor agent that run in the background and analyses the answers and be able to recommend which are the best answers.

### **Conclusion**

The use of peer based collaboration is not only beneficial to student's performance but also to other aspects of a student e.g. Self-directed learning skills, Critical and problems solving skills, Students get to learn and perfect their communication and teamwork skills and finally the process for learning from their peers increases their assessment and critical reflection because they are more relaxed (nus.edu, 2013). Despite the huge benefits of using peer collaboration, this approach can be faced with few challenges e.g. technology limitation in solving some of the problems and some students might not warm up to this approach. Other than the few challenges with the right motivation students can benefit highly.

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