International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2015): 78.96 | Impact Factor (2015): 6.391

Developing and Implementing a Classroom Response System (CRS) on a Local Area Network for the Technical University of Tamale (TUT)

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Abstract: ***Classroom Response Systems (CRSs) are used to motivate and foster questioning and feedback, monitor students participation and to also facilitate the discussions of important concepts within a learning environment. CRS have over the years been implemented in various forms.[4] Initial implementation of CRS were Audience Response Systems (ARS) commonly called "clickers" or "key-pads" in the United States and "handsets" or "zappers" in the United Kingdom. Notwithstanding the popularity of clickers and the increasing popularity of mobile devices over the past years, researchers have explored other ways of implementing all the functionalities of traditional clickers in ways that will make use of the mobile devices. [7] This has eventually transcended in the implementation of CRS on the web. This research seeks to identify the possibilities of implementing CRS on the local area network of the Technical University of Tamale (TUT) taking into consideration the views of lecturers and students sampled to come out with functionalities for the development of the prototype of CRS which was hosted on the existing local area network of the Institution. Simulation and testing was done based on the use cases developed for facilitators and participants. For the purpose of the testing, the system was hosted on our laptop; it was therefore recommended that a dedicated computer should be setup as a server for the application to users. Lecturers and students could also take advantage of the secure wireless internet facility provided by the Institution.***

Keywords: Participation, facilitate, simulation, Information

1. Introduction

1.1 Background and Justification

Classroom response system (CRS) is any system used in a face-to-face setting to poll students and gather immediate feedback in response to questions posed by instructors. Ashley D. (2007). CRS is be the general term used to describe the systems that facilitates the interaction between instructors and students. Class response systems are always used by instructors and teachers to gather information about lessons and students. For example, an instructor may ask students to raise their hands to agree or disagree with a given question. [8][9]

Fostering meaningful engagement among students in large lecture halls has been a long standing problem in formal education. To address this problem, electronic classroom response systems (CRS) have been tested and used in some higher education classrooms in developed countries.[1]

In the twenty-first century, instructors in higher education found themselves confronted with more challenges of maintaining an interactive learning sessions. The traditional lectures are no longer an effective instruction in engaging students in the classroom nowadays as the new generation students have various forms of technologies and gadgets that splits their attention.[8]

In Ghana, there have been discussions on bringing in new technologies to improve classroom teaching and interactions. In an article on improving our educational system with new technologies, Dr. Paul Amuna indicated that, in general, the ministry of education's ambition to bring in 'new technologies' to improve classroom teaching and interaction is to be commended. Yes, we need to adopt technologies which enhance the teaching and learning experiences for teachers and learners alike.

1.2 Problem Statement

Classroom response systems have become very popular in developed countries following its success in improving classroom engagement and participation between students and teachers. In a research review and theory on classroom response and communication systems, Jeremy Roschelle and colleagues (2004) cited that Interest is growing in technologies that generalize and extend earlier "response systems" and "classroom communication systems," and enable teachers to improve instruction in classroom- or lecture hall-sized groups.

CRS are used to motivate and foster questioning and feedback, monitor students participation and to also facilitate the discussions of important concepts. Notwithstanding the popularity of clickers and vis-a-vis the increasing popularity of mobile devices over the past years, researchers have explored other ways of implementing all the functionalities of traditional clickers in ways that will make use of the mobile devices. This has eventually transcended in the implementation of CRS on the web. With CRS systems on the web means they can be accessed via any web browser on any mobile devices, phones or tablets with an Internet connection.[3][10]

This research therefore seeks to identify the possibilities of implementing CRS in a way that will make use of mobile computing devices even without necessarily connecting to the internet.

1.3 Objectives of the Study

1.3.1 General Objective

The main objective of this research is to develop and implement a web-based Classroom Response System in Tamale Technical University that will make use of the mobile computing devices available to students such as phones, tablets, laptops among others.

1.3.2 Specific Objectives

The specific objectives of the study are as follows:

1) To determine whether the current ICT infrastructure in Tamale Technical University can support the implementation of a web-based CRS.
2) To determine the general requirements of implementing a web-based CRS.
3) To developed a prototype of a web-based CRS using requirements of a typical CRS in addition to those that will be gathered from all stakeholders
4) To implement the prototype web-based CRS system on a local area network of Tamale Technical University.

1.4 Research Questions

The research questions of the study are as follows:

1) Will the current ICT infrastructural in Tamale Technical University be able to support the successful implementation of a web-based classroom response system?
2) What are the general requirements for the implementation of a web-based CRS?
3) How can the CRS be developed using typical CRS requirements in addition to requirements that would be generated during the system investigation
4) How would the CRS be implemented on a local area network so that users can get access to it without internet connectivity?

1.5 Significance of the Study

First and foremost, this research will generate greater awareness about the CRS in Ghana. It will also provide useful knowledge to stakeholders about the implementation of classroom response system on their existing network infrastructure. It will also provide useful knowledge in policy formulation concerning the adaptation of CRS in Ghanaian schools.

2. Research Methodology

2.1 System Investigation

The research examines the possibility of implementing a web-based CRS that will be accessible over a local area network and hence to establish the basis for the research, views were gathered from 150 students and 20 lectures randomly selected from the School of Applied Science and Technology of the Tamale Technical University that will form a good basis for developing the system. The following sub-sections presents the views gathered from respondents in relation to the proposed system.

2.1.1 Use of Computing Mobile Devices among Students

Students were asked to indicate the type of mobile computing devices they use or have access to while on campus. They had the chance to make multiple selections. The results is summarise in table1 below:

Table 1: Distribution of the type of mobile computing devices used by students

Type of Device	Number of Respondents	Percentage (%)
Laptop	69	30.1
Smart Phone	126	55.0
Tablet	5	2.2
None	29	12.7
Total	229	100.0

Source: Field Survey, September 2016

From table 1 above, Sixty Nine (69) students representing 16% of the respondents use laptops. One Hundred and Twenty Six (126) students representing 86% of the respondents use smart phones. Five (5) students (3.3% of total respondents) use tablets and Twenty Nine (29) students (19.3% of total respondents) do not use either of the mobile devices. It is worth noting that, most of the students use more than mobile computing device.

It implies that majority of the students have access to smart phones and laptops than any mobile device. This implies that the proposed system should be easily accessible on these devices.

2.1.2 Use of Mobile Computing Devices among Lecturers

Lecturers also indicated the type of mobile computing devices they use or have access to while on campus. Respondents had the chance to make multiple selections. The results is summarise in table 2 below:

Table 2: Distribution of mobile of computing devices used by Lecturers

Type of Device	*Number of Respondents*	*Percentage (%)*
Laptop	12	32.4
Smart Phone	20	54.1
Tablet	5	13.5
None	0	0.0
Total	37	100.0

Source: Field survey, September 2016.

From table 2 above, Twelve (12) lecturers (32.4% of the total respondents) uses laptops. Twenty 20 lecturers (54.1% of the total respondents) use smart phones and 5 lecturers (13.5% of the total respondents) also use tablets. It is worth noting that most of the lecturers use more than one mobile computing device. This means that, all of lecturers use smart phones and more than half of them have laptops. Hence, lecturers will be in position to access the proposed system with ease to enhance teaching and learning.

2.1.3 Assessment of Students by Lecturers

Lecturers indicated the mode of assessment of students they employ during lectures. The results is summarised in table 3 below:

Table 3: Distribution of the Type of Assessment employed by Lecturers

Type of Assessment	*Number of Respondents*	*(%)*
Oral Question Only	0	0.0
Written Quizzes Only	0	0.0
Both	20	100.0
Total	**20**	**100.0**

Source: Field survey, September, 2016

From table 3 above, all the lecturers employ both oral questioning and written quizzes to assess students' performance during lectures. This implies that, the proposed system will play a significant role in assisting lecturers in this direction and will save a lot of time during lecturers.

2.1.4 Effect of the Duration of a Written Quiz on a Lecture

Lecturers were asked to indicate whether the amount of time they spend on assessment during or before lectures significantly affects the rest of the lecture in terms of the content to be delivered. The results is summarise in the table 4 below:

Table 4: Distribution of response on the effect of quiz duration

Response	*Number of Respondents*	*Percentage (%)*
Yes	16	80
No	4	20
Total	20	100

Source: Field survey, September 2016

From table 4 above, 80% of the respondents indicated that the duration of assessments affects the rest of the lecture in terms of the content to be covered. However, 20% of the respondents indicated otherwise. This implies that, even though majority of lecturers assess students during lectures, they however indicated that, it will affects the rest of the lesson in terms of the course content to cover. This information is very important in the system design process because the proposed web-based CRS will be shorten and enhance this assessment process.

2.1.5 Acceptance of the use of a CRS

A system that is meant to compliment classroom interaction should be accepted by all stakeholders Lecturers indicated whether they will prefer to use a system that can allow them to assess students with much better classroom interaction in less time than they usually use. The results are shown in table 6 below;

Table 5: Distribution of responses in relation to the acceptability of the use of a CRS in assessing students

Response	Number of Respondents	Percentage (%)
Yes	20	100
No	0	0
Total	20	100

Source: Field survey: September, 2016

From Table 5 above, all the lecturers welcomed the idea of implementing a CRS on the existing school's network facility to facilitate the process of assessing students to facilitate classroom interactivity.

2.2 System Analysis

[2]The analysis of the system shall consist of three parts. Review of the network infrastructure of the target area to make sure it can support a web-based CRS will constitute the first part. The second part is to examine and outline the appropriate prototype of a web-based CRS application and lastly, to examine the appropriate deployment strategy to adopt Tamale Technical University to make sure users can access it through their mobile computing devices.

2.2.1 The Existing Network Infrastructure of the Tamale Technical University

From the interviews we conducted, covering the entire university is secure wireless network connectivity. Students and Lecturers can access the Internet using their smart phones, tablets and computers through this wireless network. The University also have wired connection in the computer laboratories, two digital centres and offices of all academic departments within the Institution.

2.2.2Requirements of the CRS

The functionalities of the system shall be classified under functional requirements, user requirements and security requirements.

2.2.2.1 Functional Requirements

The system shall have the following functional requirements:

a) It shall provide access via a web-based client.
b) It shall provide access to administrative tools via a web-based client.
c) It shall allow the creation of questions called presentation.
d) It allows at most the entry of multiple choice answers.
e) It shall allow users to schedule time for presentations.
f) It shall generate a unique pin for each presentation created.
g) It shall allow facilitators to identify students by their matrix numbers.
h) It shall allow students to answer questions to presentations anonymously.

2.2.2.2 User Requirements

The system shall have the following user requirements:

A) Facilitators:

1) Facilitators shall be able to create presentations (Questions).
2) Facilitators shall be able to provide a minimum of two multiple-choice answers.
3) Facilitators shall be able to specify the amount of time a presentation should take.
4) Facilitators shall be able to use the system for both formative assessment and summative assessment.
5) Facilitators shall be able to collect participants' identity via matrix numbers.

B) Participants

1) Participants shall be able to join a presentation with the unique pin.
2) Participants shall be able to participate in a presentation anonymously.
3) Participants shall be able to view assessment score in
4) A formative or summative assessment.

2.2.2.3 Security Requirements

The system shall have the following security requirements:

1) The system shall limit access to authorize individuals via the log in function.
2) Facilitators shall be able to revisit only presentation created by them.
3) Facilitators shall not able to collect participants' information if assessment is to be answered anonymously.
4) Participants shall not able to answer question anonymously if personal information is required.
5) Two presentations shall not have the same unique pin.
6) The system shall be configured to monitor and record failed log in attempt to log in to the system.

2.3 System Design

2.3.1 Entity-Relation Diagram for the proposed system

The entity relationship diagram of the proposed system is depicted in the figure1 below;

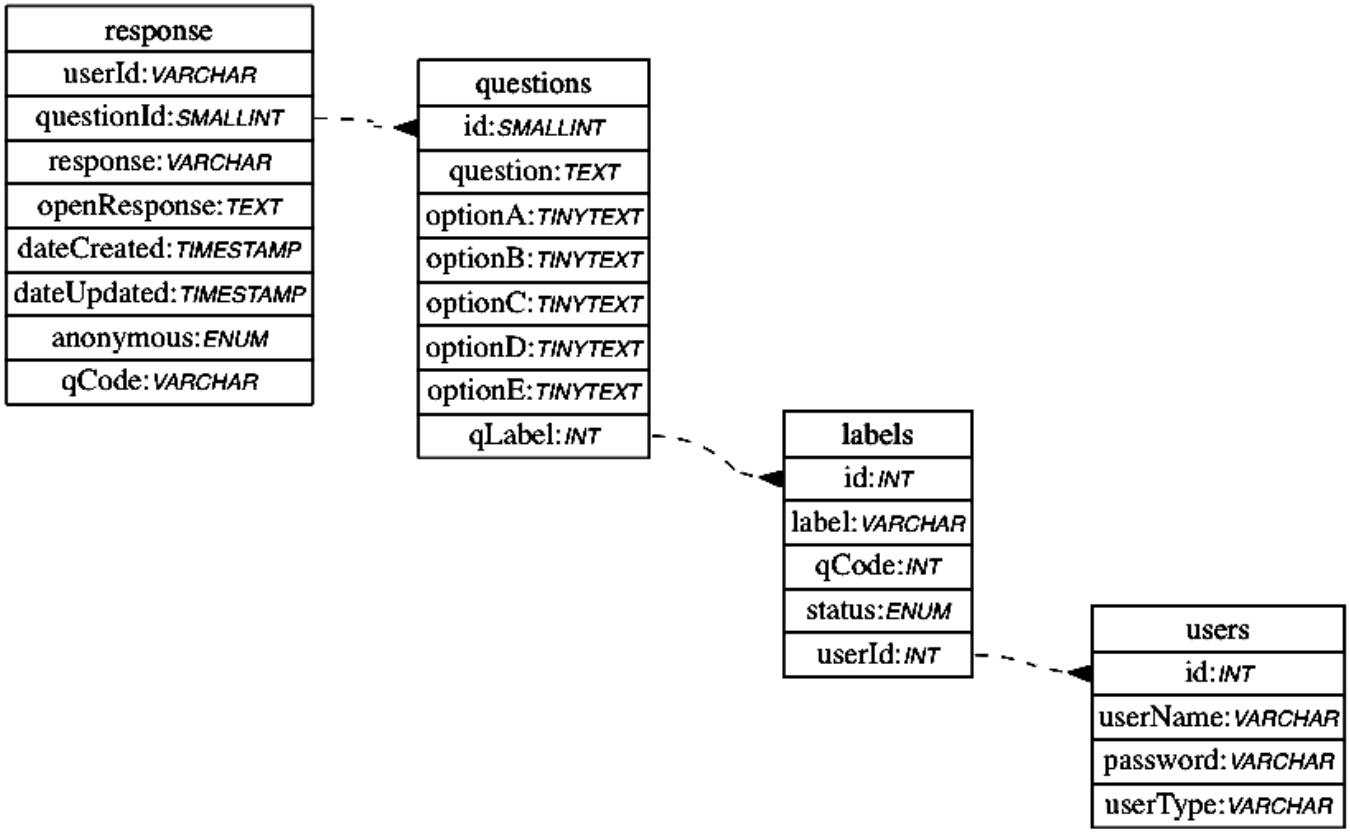
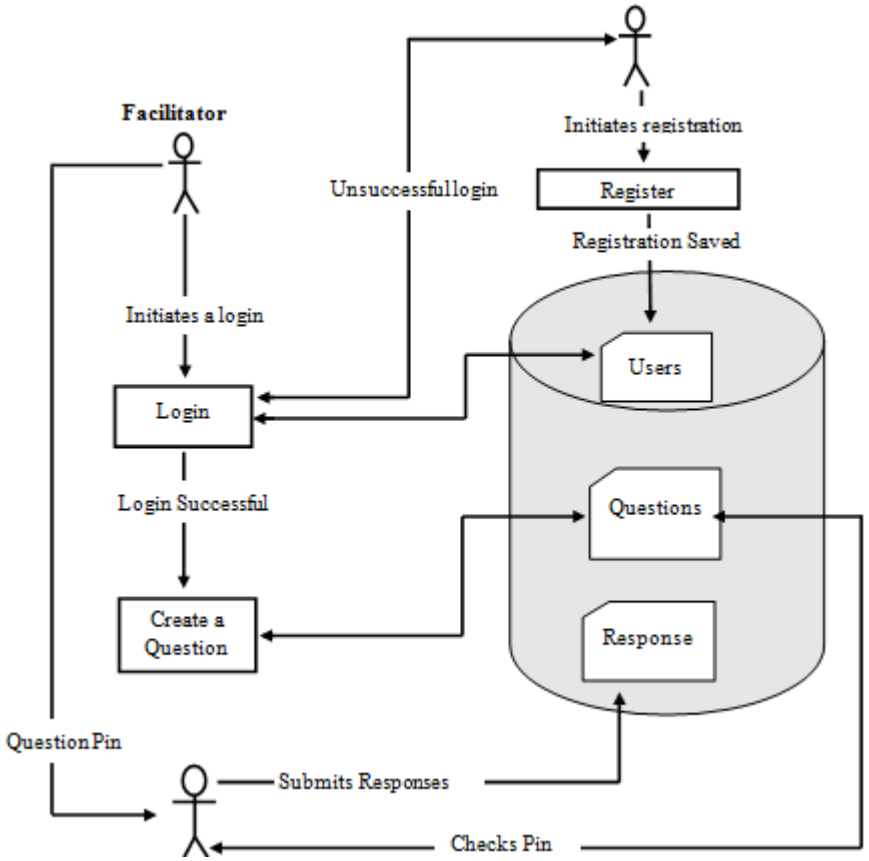


Figure 1: Entity-Relation Diagram for the proposed system

2.3.3 Dataflow Diagram

Figure 2 below shows how data will flow throughout the system. There are two types of users in the system; facilitator and participant. The facilitator user however will have to be authenticated. A successful login will take a facilitator to system dashboard.



2.3.4 Use Cases analysis for the proposed system

Table 6 below shows the use cases for facilitators in the proposed system. These represents the set of interactions facilitators can engage in with the system[5][2].

Table 6: Use case for a facilitator

Use Cases For Facilitators	
Use Case Label	Use Cases
Use Case 1	Login
Use Case 2	Create Presentations
Use Case 3	Add questions to presentations
Use Case 4	View reports and charts of participants' responses
User Case 5	Log out

Table 7 below shows the use cases for a participant in the proposed system. This represents the set of interactions a participant can engage in with the system.

Table 7: Participants' use case

Use Cases For Participants	
Use Case Label	Use Cases
Use Case 1	Join Presentations using the pin
Use Case 2	Provide response to questions in presentations

3. Testing and Simulation

After the system developed, it was vigorously tested to ensure that the system has met all the requirements as specified by users.

3.1 Logging into the System

The facilitator enters his/her email address and password as shown in figure 2 below:

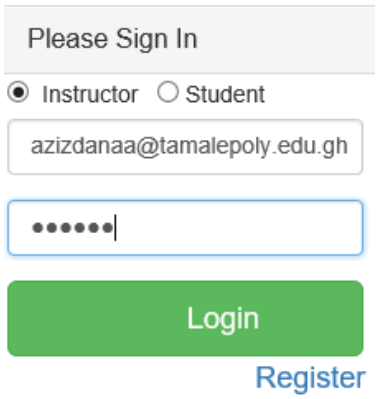


Figure 2: Facilitator login page
Source: System simulation

When there is a successful login, the facilitator is taken to the system's dashboard where presentations can be created. To create presentation, the facilitator will click on the "Presentation" menu on the left pane. This will bring up the interface as depicted in figure 3 below:

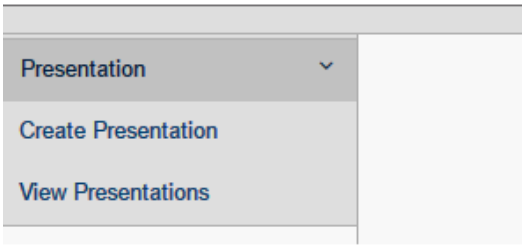


Figure 3: Presentation drop down menu
Source: System simulation

On this page, the facilitator will click on "Create Presentation" to show the interface as seen in figure 4 below:

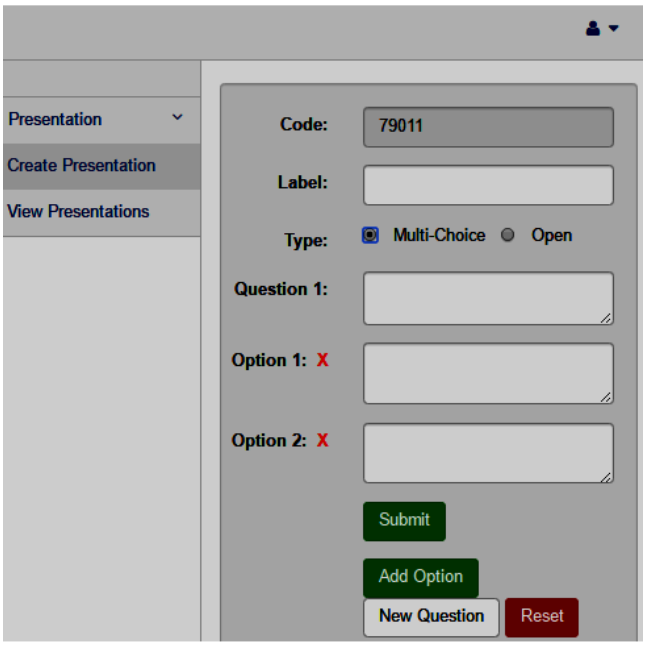


Figure 4: Create Presentation page
Source: System simulation

[14] On this page, a unique code is automatically assigned to each presentation. A label is also created for the presentation by the facilitator. The Label is any name the facilitator wish to use to identify that presentation. The form also allows the facilitator also indicates whether a question is open or multiple choice. The questions and the various options are also added to the presentation. The facilitator can also add more options up to five (5).

3.2 Students joining a presentation

After a facilitator creates a presentation with questions, a unique code which students will require to join the presentation is generated. Thus students are also taken to the log in page shown in figure 5 below:

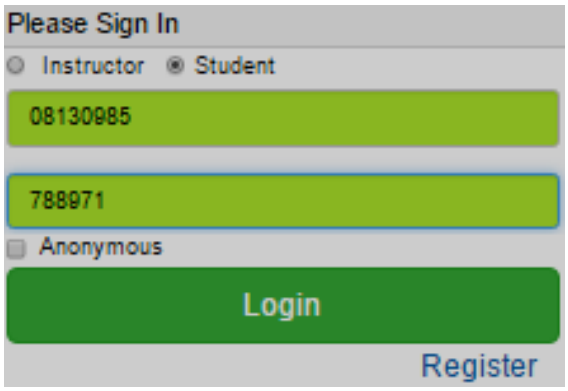


Figure 5: Students' login page
Source: System Simulation

After a successful log in, the student is taken to the available presentations to answer the questions.

3.3 Viewing presentations and Reports

After students submit their answers, facilitators can view the presentation and also view the report attached to each question. In the presentation menu, the facilitator can click on "View Presentation" to display a page as shown in the figure 6 below:

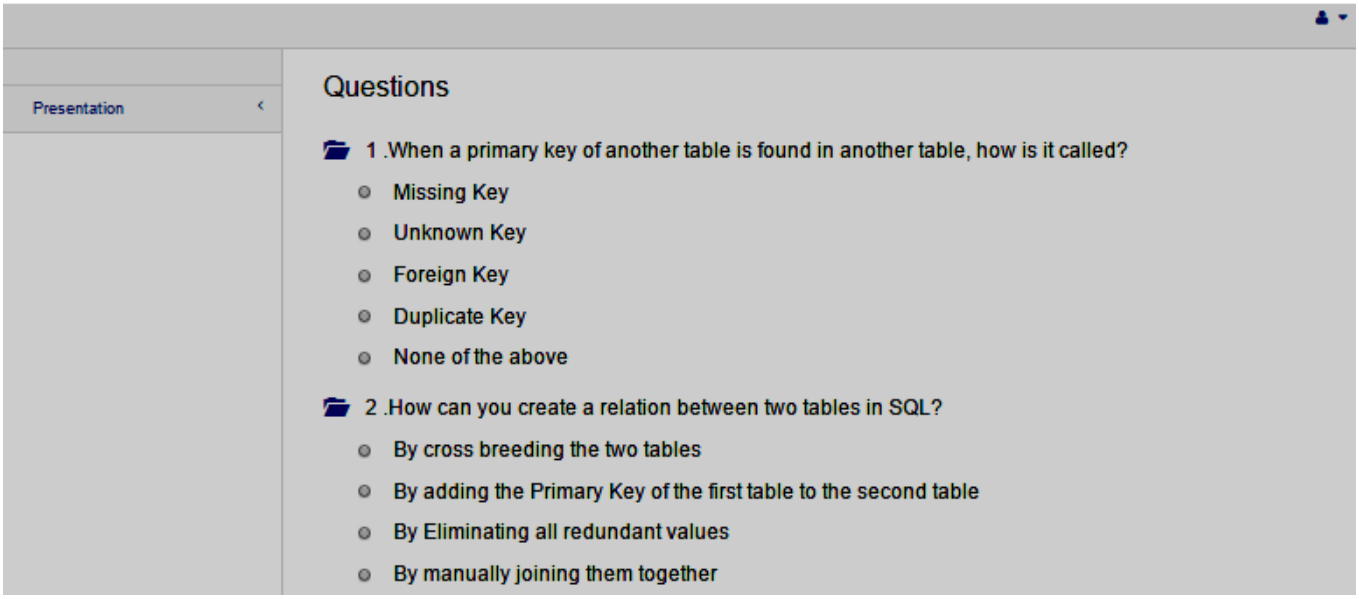


Figure 6: View presentation by facilitator

The facilitator can view the report of how each question was answered by clicking on the blue folder icon attached to each question. When the folder button is clicked, the page in shown in figure 7 below is displayed.

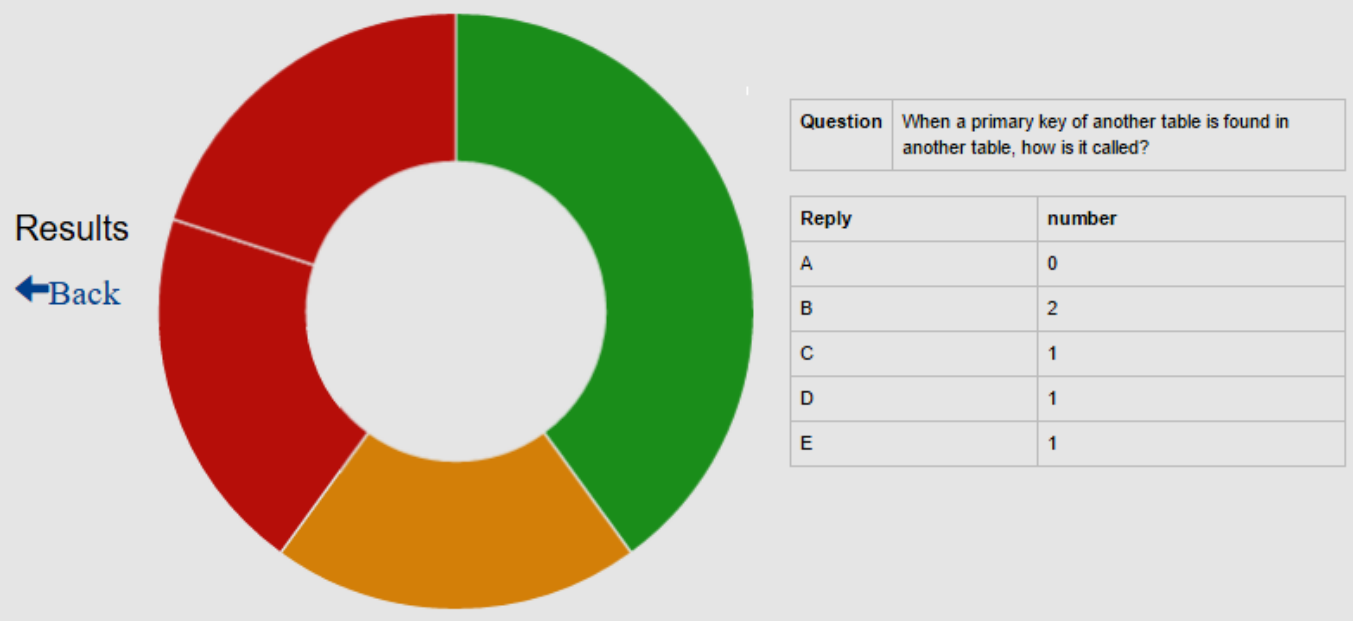


Figure 7: Report for a sample answered question
Source: System simulation

In the page above, the table displayed on the right shows the question as well as the number of students that chose each option. For example, the option B have been selected by 2 participants, option C selected by 1 participant among others.

4. Summary, Conclusions and Recommendations

4.1 Summary of Findings and Conclusions

All lecturers employ both oral questioning and written quizzes to assess students' performance during lectures. This implies that, the proposed system will play a significant role in assisting lecturers in this direction and will save a lot of time during lecturers.

Also, all the lecturers welcomed the idea of implementing a CRS on the existing school's network facility to facilitate the process of assessing students to facilitate classroom interactivity.

Almost all lecturers use smart phones and more than half of them have laptops. Hence, lecturers will be in position to access the proposed system with ease to enhance teaching and learning.

Again, majority of the students have access to smart phones and laptops than any mobile device. This implies that the proposed system should be easily accessible on these devices.

Tamale Technical University is one of the tertiary institutions in Ghana that are following closely the digital information world by providing network and internet accessibility to offices, lecturers and students. About 90% of both students and lecturers have access to at least a mobile computing device. The aim of this project was to implement a CRS on the network of Tamale Technical University, so that it is always be available for use even without internet connection.

Almost all stakeholders welcomed the idea of facilitating classroom interactivity using this proposed classroom response system.[12][13]

From the above findings, Tamale Technical University has a huge advantage in implementing an information system such as a CRS that users can access without internet. This is because of the strong network infrastructure provided by the institution.
Nonetheless, it was successful implementing the core features of CRS similar to those available with the use of clicker devices.

4.2 Recommendation

Based on the findings of the research, the following policy directions are recommended;

1) For the purpose of the simulation, the system was hosted on the laptop. For the system to be used continuously and more effectively, a dedicated server should be used to host the system.
2) Also, special training programs should be organised for both lecturers and students to enhance their knowledge on how to effectively use the system.
3) Students and lecturers should be given access to the Institutions network since most of them complained of challenges in accessing it.
4) Since the system is hosted on a network, the security measures should be enhanced to make it more credible and reliable.
5) Future enhancement should allow the software to automatically grade students and display their reports to them immediately after a presentation.
6) Proper communication channel should be laid down for students to submit their grievances in terms of network

accessibility challenges as well as issues regarding the use of the CRS itself. [11]

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