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Research Article

Using Classroom Response Systems to Engage High School Students in Saudi Arabian Classrooms

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Abstract

Classroom Response Systems are personal response devices that allow teachers to poll a group of students. As the use of technology, including tablets, iPads, and clicker systems, is introduced into Saudi Arabian classrooms, teachers will need to be trained in all the possible uses for the tablets and iPads that will be given to the students. Classroom Response Systems are a natural outgrowth of the type of uses teachers will need to integrate into their now-technological classrooms. The current study looks at the literature on classroom response systems and offers reasoning for the professional development of Saudi teachers in the use of classroom response systems for feedback and discussion in the science classroom. The target audience for this study are the professional development trainers of Saudi Arabian teachers, particularly teachers of high school Biology. Science curriculum has recently been changed in Saudi Arabia, and teachers are searching for ways to coordinate the curriculum with the new classroom technology that has also been recently introduced. Professional development will need to be developed to train teachers in the utilization of the new technology. Training in classroom response systems will be one part of that training. The study includes a link to an author-created training website, which includes videos of examples of classroom response systems in the classroom, interviews with students, sample tests, and guidelines for the purchase of classroom response systems.

Keywords: classroom response systems, high school, students, Saudi Arabia, classrooms.

Introduction

Classroom Response Systems, commonly called "Clickers," are personal response devices that allow teachers to poll a group of students (Fies & Marshall, 2006). Roschelle (2003) suggests that clickers are effective in gathering instantaneous feedback. Many favorable study results (Roschelle, 2003; Kay & Knaak, 2009; Martyn, 2007) make it clear from studies involving university classrooms, where classroom response systems are most often used, that there are benefits that come from using these systems. They can be used to assess pre- and post-lesson knowledge, provide a springboard for class discussion, and collect attendance. Martyn (2007) measured the active learning characteristics of clicker technology and found benefits from student participation in class discussions prompted by clicker data. However, classroom response system technology has had limited use in secondary schools (Fies and Marshall, 2006). Kay and Knaak (2009) conducted an early study in high school science classes which suggested that this technology did not work well in test-taking situations, and that they might best be used in formative assessment situations or as the impetus for class discussion. Kay and Knaak (2009) point out that there are barriers to including classroom response systems in high school classes, including the barriers teachers face using technology, the time needed for developing an understanding of the formative assessment aspects of active learning, and time and skill needed to create questions to gain valuable information from the responses. Yet, the possibilities for their use in high school classrooms remain.

In recent years, many middle schools and high schools have been giving students tablets and iPads to use in their classrooms. An example is how an iPad classroom response system, Socrative, has been successfully used in Oak Park Illinois middle school classrooms. (An interview with Oak Park middle school students can be found in Appendix C.) The type of classroom response system, then, has evolved to an app that can be added to a tablet or a student's smartphone (Mantikayan, Abdullah, & Abdulgani, 2014).

Context

The context that this paper and the accompanying website addresses is the lack of interactivity in Saudi Arabian high school classrooms. From personal experience, I can relate that high school classes are teacher led with very little interactivity in the classroom. Teachers lecture and students listen. Occasionally, the teacher may ask, "Any questions?", but of course, students are so bored that they seldom ask questions. As technology is introduced into Saudi Arabian classrooms, teachers will need to be trained in all the possible uses for the tablets and iPads that will be given to the students. Classroom Response Systems are a natural outgrowth of the type of uses teachers will need to integrate into their now-technological classrooms. In professional development settings, trainers will need to have access to materials that will aid them in creating professional development sessions for high school teachers.

Target Audience

The target audience for this study are the professional development trainers of Saudi Arabian teachers, particularly teachers of high school Biology. Science curriculum has recently been changed in Saudi Arabia, and teachers are searching for ways to coordinate the curriculum with the new classroom technology that has also been recently introduced. Professional development will need to be developed to train teachers in the utilization of the new technology. Training in classroom response systems will be one part of that training.

Goals/Objectives

Classroom response systems will most likely be installed on both classroom computers and student tablets as part of the rollout of new technology in Biology and other science classrooms in Saudi Arabia. The website accompanying this paper (https://sites.google.com/site/wedianclassroomresponsesystems) has been designed to guide trainers in the materials that should be emphasized during the professional development process. However, because the paper is being written in English, and the professional development will be conducted in Arabic, the materials will need to be completely recreated before it can be used in a Saudi Arabian context.

The goal of the website will be to introduce administrators, teachers, and professional development trainers to the benefits of classroom response systems for formative assessment and classroom discussion. The resulting professional development will help teachers understand the value of the immediate feedback and the way the feedback can help teachers who are seeking student understanding of a lesson being taught. It will also help Saudi teachers who have never developed skill in holding classroom discussions find opportunities to discuss Biology lesson information. Included in this paper is a sample Biology test which teachers trainers can use as a model for developing formative assessment. It can be found in Appendix C.

Aim of Study

The aim of this study was to introduce Saudi teachers to the concept of classroom response systems, then to give teachers examples of ways that classroom response systems can benefit their teaching in the science classroom, and to show the benefits of classroom interactivity for both students and teachers.

Review of the Literature

Classroom Response Systems

The Classroom Response System (CRS) is a generic term for a computerized response system that includes hand –held transmitters that students use to send responses, receivers that collect these inputs, and a computer that runs the software which interprets these responses as they are recorded. Other terms commonly used include clickers, or audience response systems (Fies & Marshall, 2006). Deal (2007) describes a non-technical example of classroom response systems as when a teacher has students raise their hand if they agree or disagree with a statement. Another form of non-technical classroom response systems is to hand out cards of different colors and ask students to express their choice by the color of cards. One of the immediate benefits of computerized response systems is the anonymity of the responses. The other major benefit is the immediacy of the response graphs as they are projected at the front of the classroom. Those who have studied classroom response systems see benefits in making classes more interactive and learning more active (p. 2). The majority of the research today shows that CRS when used for quizzes results in better test scores. The research indicates students enjoy using CRS systems, but teachers do not know much about using these to stimulate active learning and discussions.

Deal (2007) discusses the three general categories of activities and equipment involved using classroom response systems in classroom settings: instruction and questioning; response and display; and data management and analysis. The kinds of questions that work well with CRS include simple factual, multiple choice or true false questions, but also questions that "reveal and challenge common misconceptions of a given topic"(p. 2). Deal suggests that the effectiveness in CRS use for instruction and questioning comes from the design of the questions. When used for response and display. This is the student response to the instruction and questioning. When the student responds to the question, his/her anonymous response is shown on the screen, and the student can instantly see how his/her response rates to the other responses. Deal suggests that this encourages "a level of metacognition that might not otherwise occur" (p. 2). This can, and should, encourage class discussion. Classroom response systems allow teachers to save the responses for later analysis and task analysis.

Fies and Marshall (2006) collected and reported on the literature regarding classroom response systems and their potential for use as a mechanism for voting or choosing an answer. Their own literature survey found that the studies on CRS has been confined to effectiveness with individual student responses and for conditions where instructors can see who voted for which answer to a given question. Despite technology glitches, and expense, there were concerns that classroom response systems might not be the technology that would increase class interaction. Their research shows, however, that CRS systems have continued to be used, as feedback, primarily in higher education.

Roschelle (2003) explains further how CRS systems operate. A histogram results from the data gathered so teacher and students can immediately see variations in responses and observe patterns, and then can use the histogram as a reference for a pedagogical conversation. Roschelle suggests that one way to utilize the histogram is to move to small groups and use the results to drive group discussion.

Efficacy of CRS Technology in the Classroom

Two research studies (Yourstone, Kraye, &Albaum (2008); Lantz, (2010)) are concerned with the efficacy of CRS technology since it is widely used in a variety of classrooms across course content, in every size classroom, from lecture halls to tutorials. While many instructors polled in Lantz's study agreed that the active nature of the technology seems like a good idea, many are concerned about dealing with technical problems and that is why they hesitate to use them, However, they do like the anonymity of the system. Additionally, professors who use the technology have seen test scores go up in class settings where they are used. Other findings in Lantz's study include the realization that attention spans increase in classrooms where clicker technology is used (Lantz, 2010).

Classroom Response Technology and Learning Outcomes

While Lantz (2010) focused on the benefits of the use of CRS technology, Yourstone, Kraye, and Albaum (2008) examined the learning outcomes, comparing classrooms taught the same material with and without the clickers. By quantitatively measuring the difference in examination scores, they did find significant evidence that the use of CRS can have an impact on student learning as measured by test scores. The researchers felt that the immediate feedback that the system provided may have made a significant difference in the student learning of the material presented in the lecture.

In a study of CRS pedagogical effectiveness, five university instructors adopted the technology for an experimental class and a control class (Morgan, 2008). Although the author did not find any statistical differences between the two classes, two interesting things resulted; attrition was higher and grades were lower in the classes where CRS were used. This was contrary to all expectations, but again not significant. On the other hand, the study of Terrion and Aceti (2011) in an introductory Freshman Chemistry class obtained quite the opposite results. At the end of the semester, 200 students in the class responded to a survey using both Likert-type and non-Likert type questions to evaluate their perceptions of the system, and its impact on the students' learning and engagement. The results demonstrated that when used effectively, CRS contributed to greater student engagement and enabled professors to enact best practices in higher education pedagogy (Terrion & Aceti, 2011).

Martyn (2007) measured the active learning characteristics of CRS technology by comparing traditional class discussion with the use of CRS. In results similar to Morgan (2008) there was no statistically significant test results in the class conducted with active learning using CRS technology than in the class using the class discussion method of active learning. However, the perception data collected from the students indicated that they perceived value in the use of the system and liked using it. The major advantage Martyn found with the use of CRS is the near or total participation of the students in the use of the CRS, while many students did not participate in the class discussions (Martyn, 2007).

Brady, Seli and Rosenthal (2013) studied if, and then how, student metacognition was affected by the use of CRS technologies. They discovered that response systems elicited higher performance outcomes and improved academic outcomes in general. They also surmised that teachers who used response systems operated on a higher metacognitive level creating greater learning. Blasco-Arcus. Buil, Jernandez-Ortega, and Sese (2013) studied the role of interactivity and learning performance with the use of CRS. Their quantitative study extended the literature by focusing on the consequences of interactivity on improving and enhancing student learning performance. "Active collaborative learning has proven critical in enhancing the student learning experience, as our results indicate that it is a central determinant of learning performance and engagement" (p. 108). CRS engages students in critical thinking about the material, as well as to understand alternative answers. This helps students gain a deeper process of knowledge, or metacognition.

Creating Questions for Active Learning

Beatty, Gerace, Leonard, and Dufresne (2005) suggest that the results of using the technology is no better than the questions that are created for use in the classroom. Teachers find that learning to use the equipment is the easiest part of the process. Forming effective questions is the most difficult part of the process, more difficult than creating an exam or homework problems (Beatty et al., 2005). Studying a basic physics class, Beatty et al. (2005) discovered that rather than using CRS questioning to quiz at the end of a section of the lecture, it was more effective to use interactive questions as they were learning in discussions. They call this approach question-driven instruction. Barnes (2008) reports on a "lecture-free" high school Biology classroom where much of the learning is done interactively through CRS technologies. He includes in his report a sample Biology test which readers can access in Appendix C.

CRS Technology in High Schools

One of the few studies on the use of CRS technology in a high school classroom was conducted by Kay and Knaak (2009). The authors found that secondary school science students did not respond well when CRS technology was used as a summative test-taking tool. Consequently, they suggest that they be limited to use in formative assessment. Additionally, they suggest that the reason for using the technology should be fully explained to the students. Most significantly, teachers need to be aware that time needs to be spent in creating effective questions. Their conclusions were similar to the results of the higher education studies. These included the barriers high school teachers face using technology, time needed for developing an understanding of the formative assessment aspects of active learning, and time and skill needed to create the type of questions to gain valuable information from the responses (Kay & Knaak, 2009).

In a 2013 study, Mantikayan, Abdullah, and Abdulgani (2013) looked at the outcomes of the use of CRS in the high school classroom. The results of their study indicated that while there was little difference in outcomes between students who obtained their instruction through conventional methods, the students who attended classes where CRS technology was used reported having a better experience and learned more. Class was just more fun. Teachers reported that students were more attentive and classroom behavior was better.

Conclusion

CRS technology has value in the classroom by giving teachers immediate feedback on material just learned, aid in assessment, and as an aid in classroom discussion. The hypothesis is that teachers require more technological training and greater understanding of the possibilities for practical use of the technology in the classroom, particularly to stimulate discussion that authentically transfers to both improved understanding and better grades. Once technically learned and applied regularly throughout a course, CRS technology can provide teachers with immediate analysis of student understanding in the classroom and contribute to the teachers own formative changes for each subsequent lesson. Regular use of CRS feedback data in this way can be utilized to formulate questions for further discussion in the classroom before moving onto new content. Both teachers and students will benefit because this technology will drive more teacher guidance of student learning and encourage more student involvement with the content material. This will lead to higher students scores because they understand the material better and from the place where their knowledge gap began.

Needs Analysis

The first step in a needs analysis is for the trainer to gain an understanding of the current understanding of staff regarding experience with classroom response systems. This will be gathered through interviews and a short survey. The survey could be conducted on a classroom response system as an additional way to give teachers experience with response technology. Additionally, interviews with staff and administration will be conducted. This information will be used to guide the trainer in the design of the classroom response system professional development. Both of these assessments will be qualitative in nature.

The interview questions and the survey can be found in Appendix A and B.

Design Decisions

The website, which is the major aspect of this project, was designed to give administration, staff, and trainers the most information possible regarding classroom response systems. Its design is intended to be self-learning. Because of that, it includes sample formative learning quizzes, interviews with students, training videos, samples of classroom response systems, and websites that can help trainers, administration, and staff better understand the concept of classroom response systems, and the many ways in which they can be used.

Analysis of Findings

In Saudi Arabia, the trainer will most likely find that the teachers have very seldom used classroom response systems in their science classrooms. However, teachers who have been educated in the United States' universities might have had experience in classroom response systems. Their responses will give an
indication to the trainer about which teachers, if any, could share their experiences with the rest of the staff.

Usability Test

Before any of these materials can be used or tested, they will need to be translated into Arabic. This includes the interviews, surveys, and all of the website materials. At the writing of this paper, the documents have not been translated, nor have they been tested. Professional technology trainers will develop usability documents, surveys, sampling and assessment tools as well as analysis tools. These documents will form the basis of future study. First, there will be a needs analysis, which will be conducted by Biology staff members at one high school to test the needs analysis. The trainers can adapt the interviews and the surveys according to the findings of the test school. Most likely, the materials will need to be modified for each training that is done so that the trainer will be able to evaluate the needs of the teachers and adjust the initial professional development sessions to match the staff needs. After future development, results will be published to inform trainers of trial results at the test high school.

Conclusions/Reflections

This paper is one piece of the long process to bring technology to Saudi Arabian high schools. Teachers have been teaching science, including Biology, for a very long time in our culture without making changes in curriculum or technique. Recently the Saudi Arabian government decided that changes would have to be made to help Saudi schools and Saudi students become part of the wider world. To that end, they changed the curriculum and spent large amounts of money to purchase technology for the schools

Saudi technologists and educators are being trained around to world to serve in professional development and consultant capacities to aid in this transformation. I am one of those people being trained. I first learned of classroom response systems when I used one in a class in graduate school, and I felt that they could be adopted as part of the way science is taught in the high schools, along with cooperative learning and classroom discussions.

Saudi Arabian culture is collectivist in nature, and my understanding is that when trained, Saudis will respond well to classroom response systems. In my interview with the Oak Park IL middle school students, one of them said that she liked to take the clicker quizzes because she liked to get more answers right than the other students. I found this a very interesting comment, because Saudis tend not to be competitive. On the other hand, the formative assessment strategies will be very beneficial, when they are combined with group discussion. Saudis very much like to discuss things and participate in discussions. It is interesting that this has never been part of the education system.

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Annotated Reference List of Valuable Online Resources about Classroom Response Systems

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Discussion and listing of software that can serve as alternatives to physical clickers or software classroom response systems. The listing includes ways to use GoogleDocs, and several other types of online response systems.

Bruff, D. (2014, March 25). Classroom response system ("Clicker") bibliography. Retrieved from Vanderbilt Center for Teaching website: http://cft.vanderbilt.edu/docs/classroom-response-system-clickers-bibliography/

300+ entry bibliography of information about classroom response systems, including information for general audiences, discipline specific audiences, literature reviews, student perceptions, comparison of vendors and details about mobile devices.

Byrne, R. (2014, March 17). Seven good student response systems that work on all devices. Retrieved from Free Technology for Teachers website: http://www.freetech4teachers.com/2014/03/seven-good-student-response-systems.html#.VYRaD0aotys

The author describes several free student response systems, how they work, and their value in K-12 education.

Classroom response systems. (2012). Retrieved from Cornell University Center for Teaching Excellence website: http://www.cte.cornell.edu/teaching-ideas/teaching-with-technology/classroom-response-systems.html

A brief overview of classroom response systems, why and how they are used, with links to valuable information.

Teaching with clickers. (2015). Retrieved from Engaging Technologies website: http://www.engaging-technologies.com/teaching-with-clickers.html

Very good ideas about how to use clickers (or apps) in the K-12 classroom

Appendix A

Questions for interviews with teachers who have used classroom response systems
What is your experience utilizing classroom response systems?

How did you use it in your classroom?
How easy/hard is the system to set up for the classroom?
What do you see as the advantages of classroom response systems?
What do you see as the disadvantages of classroom response systems?
What was the response of the students to the system?
Did you feel that students were more responsive with the system? Less responsive?
Did you feel that you got appropriate feedback from the students with the system?
Have you tried using a classroom response system that is an app rather than a device?

Appendix B

Classroom Response System Opinion Survey (to be given with clickers)

1. What is your experience utilizing classroom response systems?

a. none
b. once
c. occasional
d. several times during a semester.

If you have never used a classroom response system, you may quit here. Thank you for your response.

2. How have you used it in your classroom?

a. formative assessment
b. summative assessment
c. classroom discussions starter
d. all of the above
e. none of the above

3. How easy/hard is the system to set up for the classroom?

a. easy
b. hard
c. Not too bad
d. I didn't set it up. It was done for me.

4. What do you see as the major advantage of classroom response systems?

a. creates a dynamic classroom experience
b. response systems let me know student understanding of content
c. creates an interactive atmosphere
d. immediate feedback
e. answers are anonymous

5. What do you see as the disadvantages of classroom response systems?

a. doesn't always work properly
b. difficult to incorporate into instruction
c. difficult to set up
d. difficult to formulate response questions

6. How do students like the classroom response system

a. like it
b. don't like it
c. indifferent to it

7. Did you feel that students were more responsive with the system? Less responsive?

a. more responsive
b. less responsive
c. about the same as without the system

8. Did you feel that you got appropriate feedback from the students with the system?

a. yes
b. no
c. don't know

9. Have you tried using a classroom response system that is an app rather than a device?

a. yes
b. no

10. What systems have you used in your classroom?

Comments?

Appendix C: Interview with middle school students using clicker technology (Socrative)

Cecilia and Maya have just finished the eighth grade at Brooks Middle School in Oak Park, Illinois. They are twins. In the fall of the 2014-2015 school year, every student at Brooks Middle School was given an iPad to use for the school year. The iPad was loaded with everything the students would need for the school year, including their textbooks and all the apps required for their classroom use. Loaded on their iPad was the Socrative classroom response system. The Socrative system can be found here: http://www.socrative.com/ The Socrative system has a teacher login and a student login. It is free for educators and students to use.

Interview with Cecilia and Maya

Q: What was the most common use of Socrative?

A: (Maya). We used it mostly for review. Sometimes the teacher used it every day at the end of class. (Cecilia). Yeah, but mostly they used it for review right before a test.

Q: Which classes did you use it for?

A. (Cecilia). We used it for language arts and humanities. We call social studies class humanities class.

(Maya). I think I used it once in Spanish and once in Science, but those teachers weren't the kind of teachers that used something like Socrative.

Q. How did your humanities teacher, for example, use the system?

A. (Cecilia). The teacher used Airplay to display a quiz he had created on the board. Then we logged in with our own series of numbers. That way we were logged in to take the quiz. So, we looked at the question and punched in the answer we thought was right.

(Maya) Then on the board it would indicate whether we had gotten the answer right or not.

Q. Did the teacher then talk about the answers?

A. (Maya) Usually the teacher just recorded the information, but if everyone got the answer wrong, then the teacher would teach the information again.

(Cecilia). Yeah, but the language arts teacher would go over all the questions and sometimes the class would discuss the answers.

Q. Do you think that the Socrative reviews helped you pay better attention in class?

A. (Cecilia). No, because we never knew when we were going to have the review quiz.(Maya) That's true, but it did help when it came time to prepare for tests, because you had the review test right on your iPad and you could look at the answers to help get ready for the test.

Q. Was using Socrative fun?

A. (Cecilia). I thought it was a lot of fun. I'm really competitive, and I liked getting all the answers right. I like being smarter than everyone else.

Appendix D
Sample Biology Quiz for a Unit on Evolution

1) **What did Darwin know about inheritance?**
Choose all that apply.
a) Offspring inherited traits from their parents.
b) Units of heredity called genes passed between generations.
c) The genetic material was DNA.
d) Very little.

2) How might a gene pool change over time?
a) Gene pools become larger over time.
b) The gene pool becomes deeper as Earth ages.
c) The frequency of a particular gene or set of genes may become more or less common in a population over time.
d) Gene frequencies become more common as the environment changes.

3) How does the relative frequency of genes affecting skin color change as one moves north from Africa to Finland?
a) Alíeles causing dark skin become less frequent.
b) Relative frequencies change at unpredictable rates.
c) Gene pool populations become more common,
d} Alíeles causing light skin become less frequent.

4) How would a geneticist define evolution?
a} An appearance ofa new gene.
b) An individual passes on a mutation to its offspring.
c) Increasing gene frequencies in a population.
d) A change in gene frequencies in a population.

5) What is true of genetic mutations. Choose all that apply?
a) They may increase an organism's fitness.
b) They may decrease an organism's fitness.
c} They may have no effect on an organism's fitness,
d) They occur when a DNA sequence changes.

6) Why is there so much variation with a species?

Choose all that apply.
a) Mutations.
b) Meiosis, which generates genetically different gametes {sex cells).
c) Crossing-over during meiosis.
d) Crossing-over during mitosis.

7) What is the frequency in your classroom of widow s peak to no widow s peak (number of people with a widow's peak divided hy the number of people without a widow's peak)?
8) What is true of polygenic traits? Choose all that apply.
a) More than one gene determines the trait.
b) One gene determines the trait.
c) A polygenic trait may have several different phenotypes and genotypes.
d) Polygenic traits have one or two phenotypes.

9) How might speciation occur? Choose alt that apply.
a) A population becomes geographically isolated.
b) A population breeds at different times.
c) The behavior of two very similar species makes them unlikely to mate with each other.

10) How did the Abert and Kaibab squirrels become different species?
a) They began breeding at different times.
b) Their behaviors kept them from mating with each other.
c) They could no longer create viable offspring.
d) There populations became separated by a habitat that both populations could not cross.

11) **If two populations can and do mate and produce viable offspring, what are they?**
a) A single species.
b) Two species.
c) It depends on how often they reproduce with each other.

12) After portion of a population becomes reproductively isolated, what may happen? Choose all that apply.
a) Genes stop flowing between both populations.
b) A mutation may become common in one population, but not the other.
c) Both populations will evolve and change in the same way at the same rate.
d) Two species may form.

13) What did the Grants discover about the medium ground fmches of Daphne Major?
a) They annually migrated off the island and returned to Ecuador.
b) The birds were nearly clones of each other,
c) Variation existed in the ground finch population.
d} When they were starving they picked at the tails of large seabirds and drank their blood.

14) Which birds survived more frequently during a drought?
a) Short-beaked birds.
b) Medium-beaked birds..
c) Large-beaked bird.

Adapted from an article by Larry J. Barnes in the American Biology Teacher (2008).