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Perceptions of the Senior High School Students on the Use of Classroom Response System in Learning Mathematics

Jayson V. Alviar[1],Anabel E. Gamorez[2]

[1]Senior High School Department, Tairan National High School, Ministry of Basic, Higher, and Technical Education-Basilan, BARMM, Philippines,7301.

[2]Department of Mathematics and Statistics, College of Science and Mathematics, Western Mindanao State University, Zamboanga City, Philippines,7000.

ABSTRACT: Classroom Response System (CRS) is one of the educational tools teachers can use to promote active learning and improve student learning. Despite the promising benefits of the CRS, there is less account of its impact in secondary mathematics classrooms as compared to higher education. In this study, a descriptive survey design was used to describe the perception of Senior High School students on the use of the CRS in learning mathematics. Students were exposed to Blicker, a classroom response system tool that uses Bluetooth Low Energy to interact with the teacher. Survey shows that CRS increase students' engagement, interactivity, and students perceived CRS to be beneficial for their learning. Moreover, students favored the CRS' anonymity feature and enjoyed the affordability of the CRS to promote student-teacher interaction through the question-feedback process. The interview shared common themes on the CRS benefits and validated students' claims that CRS attributed to an increase in engagement, interactivity, and learning in mathematics. Overall, the student's perceptions of the use of CRS are overwhelmingly positive and students strongly recommend the use of CRS in other learning areas.

KEYWORDS: Blicker, Classroom Response System, Perceptions, Engagement, Participation, Impact on Learning

INTRODUCTION

Promoting active learning using educational technologies has been the center of research investigations to improve the quality of teaching and learning particularly in mathematics. Having a large number of inattentive and uninterested learners and poor academic performance are some of the challenges mathematics educators are facing today. Underachievers in mathematics have negative attitudes toward the subject not because of its nature, but of how mathematics instructions are delivered. Most of the time, teachers used rote memorization excessively, resulting in poor academic performance [17]. Educational technologies can help address the increasing number of underachievers in mathematics. For years, the integration of technologies into classroom activities has been found to positively impact students' engagement, participation, academic performance, and even knowledge retention [9, 19, 25].

Increasing students' involvement in the learning activities and giving focused and real-time feedback are some important key elements to an active learning environment [6]. To do that, teachers should use the "active student responding" method [27]. Stowell and Nelson [27] cited some of the active student responding method teachers can use in class which includes hand-raising and using paper response cards. However, with large classes, teachers will not be able to closely monitor students' understanding of the lesson since these methods are susceptible to social conformity [27]. Even in a typical mathematics class, it is hard to get the students involved in the learning activities and rarely do you see students participate voluntarily in class discussions. Among the emerging technologies, teachers can use to address these learning challenges and create an active learning environment is the Classroom Response System [13, 21, 25].

Classroom Response System (CRS) is a system capable of polling students and giving instant feedback to the questions posed by the teacher [5]. Classroom Response System, also known to some literature as student's response system [SRS] or audience response system [ARS], or simply "clickers", is commonly used in higher education classrooms with a large number of students since the 1960s [5, 8, 10, 31]. In CRS-supported instruction, the teacher posed questions as part of the instructions then the students can anonymously select their responses to the questions using a clicker or a handheld infrared remote transmitter. The system can instantly collect the responses of the students and present them graphically showing how many students selected each option. In this manner, the teacher can see how well the students have understood the lessons and students will be able to reflect on their learning.

Numerous studies about the use of CRS in teaching show promising benefits in terms of interactivity, engagement, and impact on learning. It is said that "CRS has the potential to keep students motivated and engaged in classroom activities and increase a willingness to learn by discovering their own mistakes" [26]. Stowell and Nelson [27] emphasized that CRS promotes active learning by creating an avenue for student and teacher interaction. Draper & Brown [7] noted three advantages of CRS when being used in class and these include the affordance of the CRS to monitor and check students' understanding in real-time; it allows students and teachers to identify problem areas, and it enables students to focus and think about the lessons. Kay and Knaack [14] found that students who do not actively participate in the class had a significantly higher positive attitude towards CRS. Moreover, Caldwell [3] highlighted that CRS improves the academic performance of students and can increase the achievement of students who are at risk of failing. In addition, students exposed to CRS perform significantly better in assessment than those who did not use CRS in class [24].

Aljaloud et al. [1] conducted a literature review on the CRS benefits and presented three common themes which include interactivity, engagement, and impact on learning. In terms of interactivity, CRS creates a learner-centered classroom [1, 3]; increases communication among students and support for dialogue with the teacher [1, 18]; and improves the instructor-feedback [1, 2, 4]. CRS also increases students' engagement by creating a fun learning environment; increases attendance and reported positive student attitudes; and increases the desire to improve performance by identifying areas of improvement. Moreover, CRS improves the academic performance of students [1].

The laudable feature of CRS made marks on students who had experience instructions using CRS. Students' perceptions of the integration of CRS in the classroom are highly positive. Students strongly claimed that CRS enhanced their learning engagement in class [24, 29]. Students believed that the greater their involvement in the learning process, the higher their learning gain is [29]. Heaslip et al. [11] accentuated that the CRS's anonymity feature increases students' willingness to participate in the lesson. Students felt comfortable participating in class discussions and assert that CRS encourage them to reflect on their own learning. In a similar study, Shaffer and Collura [24] reported that students are more likely to participate and answer questions in a CRS class with a mean of 4.83 compared to the traditional class with a mean of 2.71. The increase in engagement evidently had a direct impact on the academic performance of the CRS class as they fared better than the traditional class in assessment [24]. This means that the use of CRS in the classroom had a domino effect on learners' engagement and their academic achievements.

Surveys show that CRS made class lectures more engaging and interesting compared to traditional classes, it arouses students' interest in learning, it increases student's focus and performance, helps students learn better in class, it enhances the ability to auto-evaluate and critically reflects on one's ability, it improves students' attendance, and reduce attrition rate [3, 5, 6, 13, 22]. In addition, Caldwell [3] and Jones et al. [13] found that students come to school more prepared to learn new materials since they can answer daily questions using CRS. Jones et al. [13] argue that monitoring students' participation increases students' accountability and readiness in class resulting in to increase in students' participation.

In the context of teaching and learning mathematics, similar results were noted by Simelane and Skhosana [26], McCumiskey [16], and Wang et al. [30] when they examined the students' perception of the usefulness of CRS. Students claimed that CRS promotes active learning, and it is useful and effective in improving students' mathematical achievement. The researcher also found that the intervention which implemented CRS technology showed a positive improvement in the student's success rate from 51.4% to 83.8% [26]. Hammil [10] also reported that the student surveys were overwhelmingly positive about using CRS in math classes. Findings show that CRS made the lecture more interesting, it helped students participate with ease, enhanced the clarity of examples, and students preferred using CRS more than listening to lectures only [10]. Students also claimed that they are more likely to get better scores on assessments in CRS class compared to those not using it. Moreover, students highly recommend the use of CRS in math class and in other subjects.

At present, little is known about the student's perceptions of the CRS benefits, particularly in the Philippines. The literature revealed that most studies about CRS are done in higher education and less in secondary mathematics education [10]. Also, previous studies that investigate the impact of CRS on learning and engagement usually employed CRS technologies that require an internet connection and an infrared remote transmitter as a clicker. In this study, the researchers made use of Blicker (which stands for "Bluetooth" + "Clicker"), a "revolutionary classroom response system that uses only Bluetooth Low Energy for students and teacher interaction" [28]. This CRS application was used and is suitable in the context of this study since the school is in a far-flung area with no internet connection. The present study aims to determine the perceptions of Senior High School students on the use of CRS in learning mathematics.

METHODOLOGY

This study employed a descriptive survey design because it "generates data, both qualitative and quantitative, that define the state of nature at a point in time" [15]. The respondents of this study were the fifteen (15) Senior High School students from Tairan National High School, Lantawan District, Basilan Schools Division, Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) enrolled for the School Year 2020-2021. These students were exposed to the CRS for two weeks. The number of respondents was limited to fifteen (15) learners due to the health protocols and social distancing measures set by the Department

of Health (DOH) and the Ministry of Basic, Higher, and Technical Education (MBHTE) being followed by the schools in conducting limited face-to-face classes. There were 11 female and 4 male students whose ages ranged from 16 to 26 years. Most of the students have not heard and used the Blicker as CRS in learning and hence the threat to the internal validity of prior knowledge and experience, or history, was removed. The use of Blicker as CRS is new for most of the students at this school.

Students who were exposed to CRS-facilitated instruction using the Blicker app were surveyed and interviewed using an adapted 5-point Likert survey questionnaire and a structured interview questionnaire from Hammil [10] to determine their perceptions on the use of CRS in mathematics instruction. The survey was subdivided into three themes in terms of Interactivity, Engagement, and Impact on learning. In addition, the researchers interviewed the students to validate if the use of CRS attributed to an increase in engagement and learning in mathematics.

The researchers calculated the mean scores of the survey and interpreted them using the following descriptors: Strongly Agree (4.21-5.00), Agree (3.41-4.20), Neutral (2.61-3.40), Disagree (1.81-2.60), and Strongly Disagree (1.00-1.80). Meanwhile, a thematic approach was used to summarize and present the results of the interview.

RESULTS

All the students in the CRS group were surveyed to determine their perceptions of the classroom response system when integrated into mathematics instruction. The researchers adapted a 5-point Likert scale survey questionnaire with 24 statements from Hammil [10] entitled Perception of the students in using the CRS. The responses range from strongly disagree (1) to strongly agree (5). The researcher calculated the mean per statement and interpreted the results using a descriptive scale. The results of the survey were presented in tables with corresponding discussions.

Table 1. Shows the frequency of students who have heard and used the CRS.

Statement	YES	NO
Had you heard of CRS before this class?	3	12
Had you used CRS before this class?	3	12

As shown in Table 1, only 20% of the students have heard of and used the CRS before this class. These three students who had experience using CRS were participants in the school-based quiz bee where the learning tool was used. Most of the students have no prior experience using the CRS which means that this educational application is new to most of the students.

The researcher subdivided the results of the survey on the perceptions of the students in using CRS into three main themes: (1) engagement, (2) interactivity, and (3) impact on learning.

Table 2 shows the summary of the perceptions of the students in using the CRS in mathematics instruction in terms of engagement. There were six (6) statements in the survey that assess the impact of CRS on students' engagement.

Table 2. Summary of the Perceptions of Students in using the CRS in terms of Engagement

No.	Statement	Mean	Descriptive Ratings
1.	CRS helped me participate in class.	4.80	Strongly Agree
2.	Using CRS helped me to pay attention in class.	4.53	Strongly Agree
3.	Participation with CRS increased my feelings of belonging in this class.	4.33	Strongly Agree
4.	Using CRS made the lecture more interesting.	4.73	Strongly Agree
5.	I enjoyed participating in class with the CRS.	4.33	Strongly Agree
6.	CRS were fun to use in class.	4.67	Strongly Agree
	Overall Mean for Engagement =	**4.57**	**Strongly Agree**

In Table 2, the students strongly claimed that CRS helped them participate in class with the highest mean score of 4.80. Interestingly, students also believed that CRS made lectures more interesting (M = 4.73), it helped them pay attention in class (M = 4.53), and CRS were fun to use (M = 4.67). Moreover, students' sense of belonging in the classroom increased since most of the students were actively participating and enjoying while learning. The overall mean for engagement is 4.57. This shows that CRS encouraged students to actively participate in learning engagement.

Table 3 presents the summary of students' perceptions on the use of CRS in terms of interactivity. The eleven (11) statements categorized under interactivity highlight the question-feedback process and interaction between teacher and students and among students themselves when CRS was used in the instruction.

Table 3. Summary of the Perceptions of Students in using the CRS in terms of Interactivity

No.	Statement	Mean	Descriptive Ratings
1.	CRS helped me get instant feedback on my answers.	4.73	Strongly Agree
2.	I prefer using CRS more than listening to lectures only.	4.13	Agree
3.	I prefer to be anonymous in classes.	4.07	Agree
4.	I like to quickly see if my answer is right or wrong.	4.73	Strongly Agree
5.	With CRS, I like to see how many other students got the correct answer.	4.53	Strongly Agree
6.	With CRS, I like to compare my answer with other students.	4.33	Strongly Agree
7.	Getting feedback on my ideas helps me learn better.	4.33	Strongly Agree
8.	Participation with CRS increased my interaction with the teacher.	4.67	Strongly Agree
9.	Participation with CRS increased my interaction with other students.	4.13	Agree
10.	I am more likely to answer questions using CRS.	4.67	Strongly Agree
11.	Using CRS produced more overall interaction in the classroom.	4.47	Strongly Agree
	Overall Mean for Interactivity =	**4.44**	**Strongly Agree**

In terms of feedback, students strongly valued getting instant feedback on their answers and knowing if their answers are right or wrong with a mean score of 4.73. Students strongly agreed that they liked to see how many students were able to get the correct answers (M = 4.53) and compare their answers with other students (M = 4.33). These indicate that students want to know if they have the same level of understanding as other students in the class. Moreover, the students recognized that they learn better when feedback is given (M = 4.33).

As shown in Table 3, the students strongly believed that CRS increased the students' interaction in the classroom with a mean score of 4.47. Students also claimed that they preferred using CRS more than listening to lectures only (M = 4.13). With the anonymity feature of the CRS, students felt more comfortable interacting with the teacher and other students in the class. Students claimed that they are more likely to answer math questions in the class using CRS than in the traditional class. The overall mean for CRS' interactivity is 4.44.

Table 4. Shows the summary of the perceptions of students in using CRS in terms of its impact on learning.

No.	Statement	Mean	Descriptive Ratings
1.	CRS have been beneficial to my learning.	4.53	Strongly Agree
2.	Using CRS helped me get a better grade in this class compared to not using CRS.	4.60	Strongly Agree
3.	I learn more using CRS than not using CRS.	4.27	Strongly Agree
4.	I study and prepare more when we use CRS in class.	3.60	Agree
5.	Participation with CRS improved my understanding of the math topic.	4.33	Strongly Agree
6.	CRS were helpful in understanding the materials.	4.27	Strongly Agree
7.	Using CRS enhanced the clarity of examples.	4.67	Strongly Agree
	Overall Mean for Impact on Learning =	**4.32**	**Strongly Agree**

Regarding the perceived usefulness of CRS in improving academic achievements, students perceived that CRS have been beneficial to their learning (M = 4.27). CRS helped students understand the lesson better (M = 4.33), enhanced the clarity of examples (M = 4.67), and improved students' understanding of the math concepts presented (M = 4.33). Additionally, students agreed that they study and prepare in advance and claimed that they learn more when CRS is used in class. Moreover, students strongly believed that they are most likely to get better grades in mathematics compared to not using CRS (M = 4.60). The students were certain that CRS can help them get a better score on the mathematics assessment. The overall mean for impact of CRS on learning is relatively high with a mean score of 4.32 which indicates that CRS can influence and improve the academic achievement of students in mathematics.

Overall, the student's perspectives on the use of CRS in learning mathematics were strongly positive with an overall mean of 4.44. The overall mean affirms that students liked using CRS for creative interaction and engagement and perceived CRS to be useful in learning mathematics. It is noteworthy to mention that students strongly recommend using CRS again in this class and would like to use it in other classes as well.

The researchers interviewed the students in the CRS group to determine if the use of CRS attributed to an increase in participation, engagement, and learning in mathematics. Students who were interviewed shared common themes on the benefits of CRS.

When students were asked if they like using CRS in class, most of them responded that they liked to use CRS. One of the respondents explained that "CRS made the lecture more interesting! It increases interaction between the students and teacher

which does not normally happen in the traditional class." This shows that students liked CRS because of how engaging class discussion has become.

Students were asked if CRS help them learn. All students claimed that CRS is beneficial for their learning. A student explicated that "CRS helped me learn and to be focused because you might be selected to explain and solve the problem before the class. It helped me understand math concepts, especially dealing with analyzing and problem-solving." This shows that CRS helped students pay attention in class and improve students understanding of the materials.

Students were also asked if they like that the answers are anonymous. It was found that all the students liked the anonymity feature of the CRS. A student emphasized that "With CRS, I felt more comfortable participating in class discussions, and I don't have to worry about being judged by my classmates whenever I give a wrong answer." This indicates that CRS encouraged students to participate and be involved in the learning process without feeling hesitant for making mistakes.

When asked, "Do you like to get feedback on your answers? Explain?", all the students responded positively and preferred getting immediate feedback on their answers. One student shared, "Getting feedback will help us identify the errors in our solution, correct misconceptions about the lessons, and improve our performance in the class." Students recognized that meaningful feedback could help improve their own learning.

The researchers also asked the students to explain if they like the immediate feedback that the CRS offered. One student commented, "Yes, because through immediate feedback I could correct right away my errors or mistakes and aside from that I could have a chance to interact with my teacher to ask about the lesson if ever I did not understand it clearly." Students felt that CRS increased the interaction between the teacher and students and among students themselves. In addition, CRS provided students with many self-assessment opportunities to improve learning.

Students were also asked if they like to compare their answers to others. One student expounded that "I'd like to compare my answers to other students to see how many of us have the same answers and to see if we are at the same level of understanding." Generally, students liked to know how well the entire class did on a given problem.

Finally, students were asked to give their overall grades for using CRS in the classroom. The researchers asked the students to rate the use of CRS from 1 to 10. All students rated CRS 10 out of 10. Students were highly satisfied with using CRS in mathematics and claimed that CRS promotes active learning and that immediate feedback helped them learn better. Also, students revealed that math lessons were more interactive and fun when CRS is used than the traditional lecture alone.

In general, the student's perceptions on the use of CRS in learning mathematics were positive and the students strongly recommend the use of this tool in other classes.

DISCUSSION

In this study, the perceptions of Senior High School students on the use of the Classroom Response System (CRS) in learning mathematics were examined. The students were exposed to the CRS for two weeks. The researchers surveyed and interviewed the students after the said intervention. The survey highlights three common themes about the CRS benefits: (1) Interaction; (2) Engagement; and (3) Impact on learning.

The use of CRS in mathematics teaching and learning encouraged students to actively participate in learning engagement [10, 16, 26, 30]. Most of the students enjoyed participating in class using CRS which is rare to see in a typical mathematics class. The increase in students' participation can be attributed to the fact that CRS made mathematics lectures more interesting, and it helped them participate in class with ease [1, 7, 10, 16, 27]. Heaslip et al. [11] highlighted that the anonymity feature of the CRS is highly appealing to students which increases students' willingness to participate in the class. Moreover, when students were asked during the interview if CRS help them learn, most of them claimed that CRS is beneficial for their learning. Students claimed that CRS helped them to stay focused and understand math concepts well. Students exposed to the CRS were more attentive and active since their participation is being monitored in real-time [1, 6]. When students' participation in class is being tracked it encourages students' accountability resulting in active participation in class [13]. In addition, CRS increased student sense of belongingness in class since all of the students were actively involved in the learning process. Thus, CRS is useful in increasing students' engagement in mathematics classes [10, 16, 26].

Looking at another interesting aspect of the CRS, students acknowledged the importance of getting instant feedback. The use of CRS helped students reflect on their own learning and enables them to assess what part of the lessons they failed to correctly process. Similarly, students liked to compare their answers with other students to see how well they perform against other students and see if they have the same level of understanding.

CRS' potential to give real-time feedback can induce self-correction among students and encourage learners to be engaged in the learning process to promote maximum learning [6, 12, 20, 30]. The affordance of the CRS to provide immediate and adequate feedback helps teachers to identify students who are struggling in the class, identify which parts of the lesson students have misconceptions about, and address them instantly to help students develop a deeper understanding of the lessons presented [1, 4, 6, 7, 16]. McCumiskey [16] pointed out that CRS can assess how well the entire class performs, provide many re-teaching opportunities, and alter instructions whenever necessary.

CRS do not only strengthen student-teacher interaction but also encourages interaction among students themselves which do not generally happen in a traditional class. Surprisingly, students who do not normally participate in the class discussion were actively engaged and shared their ideas when CRS was used in mathematics class. Students claimed that they are more likely to answer math questions in class using CRS than in the traditional class. The anonymity feature of CRS created an avenue for students to comfortably interact with the teacher and the class without being judged. Students shared in the interview that CRS encouraged them to be involved in the learning process without feeling hesitant for making mistakes. Radosevich et al. [23] emphasized that the question-and-feedback process made lectures more engaging and interactive. Furthermore, the relatively high means shown in Table 3 imply that students perceived CRS to be a beneficial and effective tool to increase students' interaction [1, 10, 26].

In terms of the perceived usefulness of CRS in improving academic achievements, students perceived that their learning in mathematics is greater when using CRS. Students shared that CRS offers opportunities to validate what they have learned and reinforced their understanding with the correct concepts based on the feedback of the teacher. Unlike in a traditional class, interaction is minimal, and students do not usually get as much feedback compared with the class that uses CRS. Students pointed out that CRS enhanced the clarity of examples because of the question-feedback process which helped them understand the lesson even better. Students claimed that CRS helped them to analytically solve problems in mathematics. Giving of adequate and timely feedback plays an important role in developing a deeper understanding of the concepts as early as the end of the lesson [3, 4, 16]. Moreover, students agreed that they prepared more and studied in advance when CRS is used in class. Similar findings were noted by Jones et al. [13] and Draper & Brown [7] that using CRS caused students to change their preparation for the class. Because of this, students were certain that CRS can help them get a better score on the assessment and are most likely to get better grades in mathematics compared to not using CRS. In general, CRS can influence and improve the academic achievement of students in mathematics [1, 10, 16, 24, 29].

Overall, the senior high school students perceived that CRS have been beneficial to their learning. Students were highly satisfied with using CRS in mathematics because it increased their interaction, engagement, and learning. Thus, the students would like to recommend using the same tool again in this class and in other subjects as well.

CONCLUSIONS

Based on the findings of this study, the students expressed strong positive attitudes toward the use of the classroom response system in mathematics, particularly the affordance of the tool to provide real-time feedback, the anonymity feature, the ability to promote greater participation, and the increased interactivity. Students who used CRS in the class claimed that their learning improved by identifying concepts that they had and had not correctly processed, and it helped them get better scores on the assessment. Overall, the CRS can increase interactivity, and engagement, and improve student learning in mathematics.

RECOMMENDATIONS

With the overwhelmingly positive attitudes of the Senior High School students on the use of the Classroom Response System (CRS) in learning mathematics, the researchers recommend examining further the perceptions of the students in a large group of students and considering longer exposure of students to the CRS use. In this study, a relatively small number of students were considered due to the limitation of holding limited face-to-face classes during this pandemic which require schools to follow more stringent health protocols and social distancing measure set by the Department of Health (DOH) and the Department of Education (DepEd) through the Ministry of Basic, Higher, and Technical Education (MBHTE). Furthermore, the researchers suggest using a random sampling technique in selecting respondents.

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