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Enhancing Active Learning through Classroom Response Systems: A Mixed-Method Study with Plickers in First-Year Teacher Education

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Abstract. This study evaluates the effectiveness of Plickers as a Classroom Response System (CRS) in fostering an active learning environment among first-year Education students at Initao College. Specifically, it aims to (1) assess the significant improvement in students' performance in the Principles of Learning lesson before and after using Plickers and (2) examine students' experiences in fostering an active learning environment through this technology. A sequential explanatory mixed-methods design incorporated both quantitative and qualitative methods. The quantitative aspect involved a pre-test and post-test assessment, measuring the learning gains of 20 first-year Education students. The qualitative aspect utilized thematic analysis to capture students' experiences and perceptions of Plickers. The pre-test and post-test, covering 125 quiz points across topics such as Research Designs, Principles of Learning, Elements of Learning, and Child and Adolescent Development, were facilitated using an LED projector, laptop, clicker, mobile phone, and whiteboard. Results revealed a statistically significant improvement in students' post-test scores compared to their pre-test performance (Wilcoxon Rank test, $p < 0.001$). The qualitative findings identified positive emotional responses, increased engagement, and inclusivity as key benefits of Plickers, with students expressing enjoyment, reduced anxiety, and active participation. However, challenges such as time pressure and physical fatigue were noted. The study highlights the potential of Plickers as an effective digital tool in higher education, promoting interactive learning and real-time assessment. Future recommendations include optimizing response time, further integrating technology in teacher education, and exploring the impact of Plickers not only in teacher education programs but also in higher education programs and basic education programs across different disciplines, such as social studies, languages, sciences, and mathematics, to assess its broader applicability.

Keywords: Active learning; Classroom response system; Educational technology; Plickers, Student engagement; Higher education; Teacher education.

1.0 Introduction

Teaching students using Classroom Response Systems (CRS) is a technology-based approach that enables teachers to engage students, assess learning, and promote active participation in the classroom. Plickers is an application that allows interaction between mobile phones with cameras equipped with the use of a Plickers app (Plickers, 2022) for scanning QR codes (Wuttiprom et al., 2017). It is a free and powerful tool that enables teachers to utilize technology for gathering assessment data (Chng & Gurvitch, 2018).

Using this tool in the classroom offers several advantages. It enhances student engagement and participation, develops critical thinking, builds confidence and self-esteem, promotes collaboration, and supports assessment preparation (Mshayisa, 2020; Ruisoto & Juanes, 2019). It consists of printable QR cards that allow teachers to collect real-time formative assessment data without requiring student devices (McCargo, 2017). Teachers use a smartphone or tablet to scan unique paper cards (Plicker cards) held up by students, capturing their answers to multiple-choice questions.

This facilitates instant feedback, fostering student engagement and enabling data-driven instruction that promotes active learning by allowing students to respond to questions, surveys, or assessments in real time. Additionally, Plickers supports formative assessment and differentiated instruction that is affordable and accessible that is easy to set up and use, enhancing communication between students and teachers while creating a dynamic and interactive learning environment.

The objective of this research study is to evaluate the effectiveness of Plickers as a Classroom Response System (CRS) in establishing an active learning environment. Specifically, it aims to (1) assess the significant improvement in students' performance in the Principles of Learning lesson before and after using Plickers as a CRS; and (2) examine students' experiences using Plickers in fostering an active learning environment.

Relatively, Plickers allow teachers to engage even the shyest children in the classroom, providing opportunities for individuals reluctant to participate in regular discussions to actively engage with information, peers, and the instructor (Kent, 2019). This is supported by the study of Elmahdi et al. (2017), which found that employing this tool for formative assessment promotes student engagement, saves time, ensures equal participation, and creates an engaging learning environment. The results also encourage educators to utilize digital tools like Plickers to assess teaching efficacy and student learning.

The use of Plickers can enhance students' motivation and reading comprehension more effectively than traditional teaching methods (Sasmiko et al., n.d.). It benefits both students and teachers by storing students' response data while making learning more engaging and encouraging critical thinking (Charalampos, 2019). According to the study by Shana and Baki (2020), which significantly improved students' progress, continuous use was found to promote positive perceptions, enhance performance, and reduce gaps between high and low achievers. Additionally, Plickers enhances students' vocabulary and engagement by improving their intrinsic motivation in ESL classrooms (Hassan & Hashim, 2021). It has also been used to assess reading comprehension, increasing interactivity and efficiency, ultimately supporting language assessments (Michael et al., 2019). Furthermore, integrating this tool into science and mathematics instruction has received positive feedback, demonstrating its effectiveness in fostering a positive learning attitude across different disciplines (Chou, 2022).

Despite the documented benefits of Plickers in enhancing student engagement, promoting active learning, and supporting formative assessment, moreover, there remains a gap in understanding its specific impact on learning outcomes in higher education, particularly in teacher education programs. Existing studies have primarily focused on its application in general classroom settings, leaving a need for research that explores its effectiveness in foundational education courses such as the Principles of Learning. Additionally, while previous research highlights the motivational and interactive aspects of Plickers, there is limited insight into students' firsthand experiences, particularly their cognitive and emotional responses to this technology. This study addresses these gaps by employing a mixed-methods design, integrating pre-test and post-test assessments with qualitative thematic analysis to provide a comprehensive evaluation of Plickers' role in fostering an active learning environment among first-year teacher education.

2.0 Methodology

2.1 Research Design

This study employed a sequential explanatory mixed-methods design to analyze student learning development, enhancing their active participation across subjects while integrating technology tools in teaching. The quantitative quasi-experimental design was used to measure learning improvement through pre-test and post-test assessments. A random sampling method was employed in selecting the respondents. Additionally, a

qualitative thematic analysis was employed to examine students' experiences and reactions during the integration of Plickers in classroom instruction.

2.2 Research Locale

The study was conducted at Initao College, Initao, Misamis Oriental, 9025, Philippines, focusing on first-year education students enrolled in the Teacher Education Program (TEP). As future elementary educators, these students will benefit from using Plickers as a classroom response system in their teaching practice.

2.3 Research Participants

This study employed purposive sampling, involving 20 first-year education students from the Teacher Education Program at Initao College. These participants were deliberately selected as they are prospective elementary teachers who are expected to apply this technology tool in their future teaching practice.

2.4 Research Instrument

This study utilized an assessment method that was structured from the book titled "The Child and Adolescent Learners and Learning Principles" by Corpuz et al., (2018) to evaluate student performance. The research design included a pre-test and post-test assessment consisting of 125 quiz points covering key topics such as: SET A – Research Designs, SET B – Principles of Learning, SET C – Elements of Learning, SET D – Child Development, and SET E – Adolescent Learners. The assessment process was facilitated using an LED projector, laptop, clicker, mobile phone for scanning answers, and a whiteboard. Each test set consisted of five (5) questions, with each question worth five (5) points.

2.5 Data Gathering Procedure

The study followed specific steps to collect and analyze data. Initially, pre-test scores were recorded. The intervention involved the integration of a technology tool, after which a post-test was conducted, and the results were documented. Following the post-test, students participated in in-depth interviews regarding their learning experiences. Verbatim responses were gathered and categorized into main themes and sub-themes relevant to the study.

Statistical analysis employed the Wilcoxon Rank test, a non-parametric counterpart of the Paired Samples T-test, to measure differences between pre-test and post-test scores. The Shapiro-Wilk test ($W = 0.892$, $p = 0.029$) indicated a violation of normality, making a non-parametric approach more appropriate for accurate comparison. Thematic analysis was conducted using the Colaizzi-Keen method to identify emerging themes from students' learning experiences during the integration of the Plickers technology tool.

2.6 Ethical Considerations

This research study adhered to ethical guidelines to ensure the protection of participants' rights and data confidentiality. This study underwent ethical review and approval by the Ethics Committee in the Office of the Vice President for Research, Development, and Extension Services (OVPRDES) at Initao College, ensuring compliance with established ethical guidelines. Prior to data collection, participants were informed about the study's objectives, procedures, and potential benefits. Informed consent was obtained, guaranteeing voluntary participation. Anonymity and confidentiality of responses were strictly maintained. Additionally, research protocols followed institutional ethical standards, ensuring that no harm or undue influence affected the participants' responses and overall experience.

3.0 Results and Discussion

3.1 Impact of Plickers on Students' Performance in the Principles of Learning Lesson

The effectiveness of Classroom Response Systems (CRS) like Plickers in improving student learning outcomes has been widely explored in educational research. In this study, the impact of Plickers on students' performance in the Principles of Learning lesson was examined through a pretest-posttest design. Plickers provided a dynamic learning experience that encouraged active participation and immediate feedback by integrating real-time assessment and interactive engagement. The following analysis presents the statistical evidence supporting the significant improvement in students' performance after using Plickers as a CRS.

Table 1. *Difference in Students' Pretest and Posttest Scores*

Assessment	n	Mean	SD	Mean Difference	Effect Size	*W*	*p*-value	Remarks
Pretest	20	49.0	11.5	-17.5	-1.00	0.00	<0.001	*Significant*
Posttest	20	63.5	11.0					

Table 1 illustrates the significant difference between the students' pretest and posttest scores in the Principles of Learning Lesson, emphasizing the use of Plickers as an innovative classroom response system. The pretest scores had a mean of 49.0 with a standard deviation of 11.5, reflecting the students' initial knowledge and a moderate level of variability. After the intervention using Plickers, the posttest scores increased to a mean of 63.5 with a slightly lower standard deviation of 11.0, showing both improved performance and greater consistency. The mean difference of -17.5 indicates a substantial enhancement in learning outcomes, while the Wilcoxon signed-rank test, with a p-value <0.001, confirms that the improvement is statistically significant. Moreover, the effect size of -1.00 suggests a large and meaningful improvement in students' performance, indicating that the use of Plickers had a substantial impact on learning outcomes.

The results of this study align with previous research demonstrating the effectiveness of Plickers as an interactive learning tool. Babacan and Güler (2022) found a statistically significant improvement in students' vocabulary achievement when using Plickers, with a mean score increase from 38.70 (SD = 7.84) to 40.85 (SD = 8.85), supporting its role in enhancing academic performance. Similarly, İner et al. (2022) found that 4th-grade EFL learners using Plickers showed a highly significant increase in vocabulary test scores, from a pretest mean of 3.66 (SD = 1.988) to a posttest mean of 11.20 (SD = 2.946), with a paired-sample t-test result of $t(43) = -19.582$, $p < .000$. This suggests that Plickers is particularly effective in boosting specific subject knowledge. Furthermore, Sasmiko et al. (2019) reported that Plickers enhanced students' motivation in English reading comprehension, while Daradkah (2020) found a significant increase in students' motivation across general subjects using Plickers for assessment. Compared to these studies, the present study demonstrated a larger effect size (-1.00), indicating a more substantial learning improvement in the Principles of Learning lesson. This suggests that Plickers is not only effective for motivation and engagement, as seen in previous studies, but can also lead to significant knowledge retention and conceptual understanding when integrated into instructional strategies.

Moreover, Plickers also benefited both students and teachers in multiple ways. For instance, it effectively stored students' response data, making assessment more efficient, while simultaneously making participation more engaging and fostering critical thinking (Charalampos, 2019). Furthermore, research by Shana and Baki (2020) indicated that the continuous use of Plickers significantly improved students' progress, promoted positive perceptions of learning, enhanced performance, and reduced achievement gaps between high and low performers. Additionally, Plickers played a crucial role in improving vocabulary and engagement by enhancing students' intrinsic motivation in ESL classrooms (Hassan & Hashim, 2021). Similarly, it was found to be an effective tool for assessing reading comprehension, increasing interactivity and efficiency in language assessments (Michael et al., 2019). Notably, Plickers has also been successfully integrated into science and mathematics education, where its application generated positive feedback regarding students' overall attitudes toward learning (Chou, 2022). These findings collectively underscore the effectiveness of Plickers in enhancing student learning outcomes across various disciplines, demonstrating its potential as an innovative educational tool that supports both assessment and engagement.

3.2 Students' Experiences Using Plickers in an Active Learning Environment

Active learning thrives on student engagement, participation, and interaction. The use of Plickers as a Classroom Response System (CRS) offers a unique approach to fostering an inclusive and dynamic learning environment. To examine students' experiences with Plickers, qualitative data were gathered through thematic analysis, revealing key themes such as positive emotional responses, engagement and inclusivity, challenges and limitations, and impact on learning. These findings provide valuable insights into how Plickers enhances the learning experience while also identifying areas for improvement in its implementation.

Table 2. *Students' Experience Using Plickers in Creating an Active Learning Environment*

Main Themes	Sub-themes	Significant Statements	General Description of the Theme
Positive Emotional Responses	Enjoyment and fun	- "I felt happy, and it was enjoyable as it was my first experience using Plickers." (Participant 2) - "I enjoyed answering and participating." (Participant 5) - "I loved my experience as a respondent of the Plickers activity. I enjoyed the moment." (Participant 9)	Students found the Plickers activity enjoyable and fun, enhancing their engagement and positive emotional connection to the learning process.
	Excitement and novelty	- "I felt excited and nervous because it was the first time I encountered Plickers." (Participant 3) - "It was overwhelming because it was my first time answering in such an activity." (Participant 16)	The novelty of the activity generated excitement and curiosity among students, making it a unique and memorable learning experience.
	Relief after participation	- "I felt relieved because, after the nervousness and excitement during the assessment, it was fun and very easy to use." (Participant 4) - "After the Plickers activity assessment, I felt relieved because it was done." (Participant 19)	Students experienced a sense of relief and accomplishment after completing the activity, reflecting its engaging but low-stress nature.
	Gratitude for the experience	- "I'm still very grateful and happy because I finally experienced that kind of activity." (Participant 7) - "I appreciate Ma'am for letting us experience Plickers." (Participant 2)	Gratitude was expressed by students for the opportunity to use an innovative tool that enriched their learning experience.
Engagement and Inclusivity	Anonymity fostering confidence	- "I really enjoyed the activity because I could raise my card without getting nervous that my classmates would judge my answer." (Participant 8) - "My answer was anonymous. None of my classmates knew if my answer was correct or wrong." (Participant 11)	Anonymity in the activity encouraged active participation and reduced fear of judgment, creating an inclusive and supportive learning environment.
	Active participation	- "I felt excited because everyone was participating and engaging in the activity." (Participant 14) - "Everybody was participating, and their energy influenced me to join and enjoy as well." (Participant 15)	The activity fostered a high level of participation and collaboration among students, creating an energetic and interactive classroom environment.
	Teacher-student interaction	- "I found it easy to communicate with the teacher. It was engaging, fun, and enjoyable to use." (Participant 20)	The use of Plickers enhanced teacher-student interaction, facilitating better communication and engagement during the activity.
Challenges and Limitations	Physical fatigue	- "My arms felt tired because it takes time to scan the code." (Participant 5)	Some students experienced physical fatigue due to the mechanics of using the Plickers cards.
	Time pressure and speed	- "I panicked because it was too fast, and we had to raise the cards quickly." (Participant 18) - "It was time-pressure for me because of the time limit." (Participant 12)	The time constraints and pace of the activity posed challenges for some students, leading to moments of stress and difficulty.
	Comparison to traditional methods	- "Writing my answer was easier on paper with a pen than using the card." (Participant 17)	A few students compared the activity to traditional assessment methods, highlighting a preference for simpler tools in some cases.
Impact on Learning	Knowledge acquisition and application	- "I learned a lot, including how to use Plickers, and it was a fun activity." (Participant 1) - "It gives me knowledge about how to use Plickers and what it is." (Participant 2)	Students gained new knowledge and skills from the activity, which they found meaningful and applicable to their academic experience.
	Potential for future use	- "Maybe I'll use it in my upcoming internship if I will be in my 4th year." (Participant 4)	Some students expressed interest in applying the tool in their future teaching practice, reflecting its perceived value for practical applications.

The findings from the responses gathered regarding the use of Plickers as a classroom response system (CRS) reveal several key insights into students' experiences. The main themes identified from the interview data are Positive Emotional Responses, Engagement and Inclusivity, Challenges and Limitations, and Impact on Learning.

Each theme highlights different aspects of the students' perceptions and experiences during the Plickers activity, offering valuable insights into how such a technology-based tool fosters active learning.

Theme 1: Positive Emotional Responses

This theme encapsulates the emotional reactions students had during and after the Plickers activity. The sub-themes under this category include Enjoyment and Fun, Excitement and Novelty, Relief after Participation, and Gratitude for the Experience. The first sub-theme is enjoyment and fun. Students found the activity to be enjoyable, which contributed significantly to their positive emotional responses. As Participant 2 shared, "*I felt happy, and it was enjoyable as it was my first experience using Plickers.*" Also, Participant 5 stated, "*I enjoyed answering and participating.*" Similarly, Participant 9 mentioned, "*I loved my experience as a respondent of the Plickers activity. I enjoyed the moment.*" The general description of this sub-theme reflects how the activity fostered a light-hearted, enjoyable learning environment that encourages active engagement. Moreover, the second emerging sub-theme is excitement and novelty. The novelty of the Plickers activity generated excitement among students, making it a memorable and engaging experience. Participant 3 stated, "*I felt excited and nervous because it was the first time I encountered Plickers.*" Moreover, Participant 16 responded, "*It was overwhelming because it was my first time answering in such an activity.*" The excitement was especially evident as students experienced something new, which helped maintain their attention and enthusiasm throughout the activity.

In addition, the third emerging sub-theme is the relief felt after participation. After completing the activity, students expressed relief, particularly those who initially felt nervous or overwhelmed. For instance, Participant 4 shared, "*I felt relieved because, after the nervousness and excitement during the assessment, it was fun and very easy to use.*" This relief was also reflected in the comment of Participant 19, "*After the Plickers activity assessment, I felt relieved because it was done.*" The general description of this sub-theme illustrates how the activity balanced excitement with a low-stress outcome, providing students with a sense of achievement. Lastly, gratitude for the experience emerged as a sub-theme for a positive emotional response. A number of students expressed appreciation for the opportunity to participate in the Plickers activity. As Participant 7 noted, "*I'm still very grateful and happy because I finally experienced that kind of activity.*" Likewise, Participant 2 mentioned, "*I appreciate Ma'am for letting us experience Plickers.*" This gratitude highlights the positive impact the activity had on students' perceptions of learning, particularly for those encountering the technology for the first time.

The positive emotional responses elicited by Plickers align with previous research that emphasizes the pedagogical benefits of classroom response systems. Kent (2019) highlighted how student response systems like Plickers promote active engagement and facilitate immediate feedback, fostering a supportive learning environment. Similarly, Mshayisa (2020) found that Plickers provided opportunities for students to answer formative questions anonymously, increasing participation and reducing anxiety. Additionally, Masita and Fitri (2020) demonstrated that Plickers significantly improved student motivation and participation, reinforcing its effectiveness as an engaging learning tool. These studies collectively support the notion that integrating Plickers into classroom activities enhances the emotional and cognitive experiences of students, leading to a more effective and enjoyable learning process.

Theme 2: Engagement and Inclusivity

The Plickers activity fostered an inclusive environment where students felt encouraged to actively participate without fear of judgment. The sub-themes in this category include Anonymity Fostering Confidence, Active Participation, and Teacher-Student Interaction. The initial sub-theme is anonymity fostering confidence. The anonymity offered by the Plickers activity was particularly beneficial in encouraging students to participate without fear of judgment. Participant 8 explained, "*I really enjoyed the activity because I could raise my card without getting nervous that my classmates would judge my answer.*" Likewise, Participant 11 shared, "*My answer was anonymous. None of my classmates knew if my answer was correct or wrong.*" This sub-theme emphasizes the value of anonymity in promoting self-confidence, as students were free from concerns about their answers being scrutinized by peers.

Consequently, it involves the sub-theme of active participation. The activity encouraged high levels of participation, which was seen as a key factor in its success. Participant 14 noted, "*I felt excited because everyone was participating and engaging in the activity.*" This enthusiastic participation was echoed by Participant 15, who stated,

"*Everybody was participating, and their energy influenced me to join and enjoy as well.*" The general description of this sub-theme reveals that the activity created a highly interactive and energetic atmosphere, where students were motivated to engage actively. Furthermore, teacher-student interaction also emerges as a distinct sub-theme. The Plickers activity also fostered better teacher-student communication. As Participant 20 remarked, "*I found it easy to communicate with the teacher. It was engaging, fun, and enjoyable to use.*" This highlights how the use of technology like Plickers can enhance the interaction between students and instructors, facilitating a more dynamic and engaging learning environment.

The engagement and inclusivity promoted by Plickers align with existing research on student response systems in active learning environments. Chou (2022) found that Plickers encouraged student engagement and active participation, particularly in rural settings where digital resources are limited. Similarly, Wiyaka and Prastikawati (2021) demonstrated that Plickers created an interactive learning atmosphere that facilitated student involvement and strengthened teacher-student communication. Moreover, Babacan and Güler (2022) highlighted how the anonymity of Plickers reduced anxiety and increased motivation among students, leading to higher participation rates. These findings support the argument that Plickers is an effective tool for fostering an inclusive and engaging learning environment.

Theme 3: Challenges and Limitations

While the Plickers activity had many benefits, it also presented some challenges and limitations. The sub-themes identified here are Physical Fatigue, Time Pressure and Speed, and Comparison to Traditional Methods. Primarily, the key sub-theme is physical fatigue. Some students reported physical discomfort during the activity, particularly due to the mechanics of using the Plickers cards. Participant 5 shared, "*My arms felt tired because it takes time to scan the code.*" This suggests that the physical nature of the activity, while engaging, could lead to fatigue for some participants, particularly if the activity is prolonged.

Additionally, time pressure and speed emerge as substantial concerns. The time constraints during the activity were another challenge that some students faced. As Participant 18 explained, "*I felt panic because it was too fast, and we had to raise the cards quickly.*" Similarly, Participant 12 noted, "*It was time-pressure for me because of the time limit.*" The fast pace and limited time for responses created a sense of urgency, which was stressful for some students. Ultimately, the comparison to traditional methods highlights further challenges. A few students preferred traditional assessment methods, such as using pen and paper, due to the simplicity they offered. Participant 17 said, "*Writing my answer was easier on paper with a pen than using the card.*" This sub-theme reflects how some students felt more comfortable with traditional tools, which may have seemed less complicated or intimidating compared to the new CRS approach.

The challenges and limitations of Plickers identified in this study are supported by prior research on the implementation of classroom response systems. Pearson (2020) compared Plickers with other response systems and found that while Plickers increased engagement, some students struggled with the mechanics of using the cards, leading to physical discomfort. Similarly, Chou (2022) highlighted time constraints as a common concern, noting that students in fast-paced learning environments sometimes felt overwhelmed. Furthermore, Babacan and Güler (2022) observed that certain students preferred traditional assessment methods due to familiarity and ease of use. These studies reinforce the notion that while Plickers is an effective tool for formative assessment, considerations must be made to address its physical, temporal, and methodological challenges.

Theme 4: Impact on Learning

The Plickers activity had a positive impact on students' learning, both in terms of Knowledge Acquisition and Application and Potential for Future Use. The first sub-theme is the knowledge acquisition and application. Students felt that they gained valuable knowledge and skills from the Plickers activity, which could be applied to future learning situations. Participant 1 shared, "*I learned a lot, including how to use Plickers, and it was a fun activity.*" Likewise, Participant 2 noted, "*It gives me knowledge about how to use Plickers and what it is.*" This sub-theme highlights how the activity contributed to students' understanding of new technologies and tools for classroom engagement. Moreover, the second emerging sub-theme is the potential for future use. Some students expressed interest in using Plickers in future contexts, particularly in their professional lives. Participant 4 mentioned, "*Maybe I'll use it in my upcoming internship if I will be in my 4th year.*" This indicates that students saw the value in

integrating the technology into their future practices, suggesting that the Plickers activity has long-term potential beyond the classroom.

The impact of Plickers on learning aligns with previous research on the effectiveness of classroom response systems in promoting student engagement and comprehension. Kent (2019) emphasized that tools like Plickers support active learning by facilitating immediate feedback and increasing student motivation. Similarly, Wiyaka and Prastikawati (2021) found that Plickers helped students better understand and retain course material by creating an interactive and engaging learning environment. Additionally, Masita and Fitri (2020) highlighted how Plickers improved students' motivation and participation, reinforcing its role as an effective tool for formative assessment. These studies confirm that Plickers not only enhances students' immediate learning experience but also has the potential for future application in educational and professional settings.

The Plickers activity was successful in creating an active and engaging learning environment for the first-year BEED students at Initao College. The emotional responses, such as enjoyment, excitement, and gratitude, show that students had a positive experience with the tool, fostering engagement in the learning process. The anonymity provided by Plickers, combined with high levels of participation, made students feel included and confident. As it excels in allowing teachers to engage even the shyest children in the classroom that allows individuals reluctant to respond in regular classroom discussions to contribute actively engaging with the information, peers, and instructor (Kent, 2019). This was supported by the study of Elmahdi et al. (2017) that employing Plickers for formative assessment promotes student engagement, saves time, ensures equal participation chances, and produces an engaging learning environment. The results also motivate educators to use digital tools like Plickers to analyze teaching efficacy and student learning. However, challenges like physical fatigue and time pressure should be addressed to improve the experience further. Overall, students recognized the potential of Plickers to enhance learning, both in terms of knowledge acquisition and its application in future educational and professional settings.

In summary, the study investigated the impact of using Plickers, a classroom response system (CRS), in the Principles of Learning lesson. The results showed a significant improvement in students' scores from the pretest (Mean = 49.0, SD = 11.5) to the posttest (Mean = 63.5, SD = 11.0), with a mean difference of -17.5. The Wilcoxon signed-rank test (p-value < 0.001) confirmed that this improvement was statistically significant, highlighting the effectiveness of Plickers in enhancing student learning outcomes. Qualitative data from students' experiences revealed three key themes. First, Positive Emotional Responses indicated that students enjoyed the novelty of Plickers, expressed excitement and gratitude, and found the activity engaging and fun. The low-stress and interactive nature of the tool contributed to an enhanced learning experience. Second, Engagement and Inclusivity emerged as a significant factor, with students appreciating the anonymity provided by Plickers, which fostered confidence and reduced fear of judgment. This led to higher participation rates and improved teacher-student interaction, creating an energetic and inclusive classroom environment. Lastly, Challenges and Limitations were noted, as some students experienced physical fatigue from holding the cards, felt pressured by the time constraints, and expressed a preference for traditional assessment methods. Despite these challenges, students acknowledged the potential of Plickers in supporting knowledge acquisition and expressed interest in incorporating it into their future teaching practices. These findings suggest that while Plickers is a valuable tool for fostering active learning, its implementation can be further optimized to address time management and physical engagement concerns.

4.0 Conclusion

The integration of Plickers significantly enhanced students' learning outcomes and engagement in the Principles of Learning lesson. Its ability to provide immediate feedback, maintain anonymity, and foster active participation created a supportive and inclusive learning environment. While challenges such as physical fatigue and time pressure were noted, the positive emotional responses and high levels of engagement underscore the effectiveness of Plickers as an innovative tool for active learning. This study highlights the potential of Plickers not only in improving academic performance but also in enriching students' learning experiences, making it a valuable addition to modern pedagogical practices. The findings of this study have several implications for teaching and learning in higher education, particularly in promoting active learning and engagement through the integration of innovative tools like Plickers. The significant improvement in students' posttest scores and their positive

feedback highlight the potential of technology to enhance learning outcomes, fostering a more interactive and inclusive classroom environment that caters to diverse learner needs. Additionally, students' emotional responses—such as enjoyment, excitement, and gratitude—suggest that Plickers can positively impact motivation and reduce assessment-related anxiety. This underscores the importance of incorporating activities that balance cognitive challenges with emotional satisfaction to optimize learning experiences. Furthermore, the anonymity provided by Plickers encouraged participation and reduced students' fear of judgment, making it a valuable tool for fostering a supportive and inclusive classroom culture, particularly for shy or introverted learners. However, challenges such as time constraints and physical fatigue indicate that while digital tools can improve engagement, they should be implemented thoughtfully to minimize stress and discomfort. It is important to note, however, that this study has limitations, including a small sample size and limited generalizability, which may affect the broader applicability of the findings. Lastly, students' expressed interest in using Plickers during their future internships suggests that integrating similar tools into teacher training programs can better prepare future educators for tech-integrated classrooms.

To maximize the benefits of Plickers, several recommendations are proposed. First, educators should consider wider adoption of Plickers in classroom activities, particularly for lessons requiring immediate feedback and high student engagement. Second, to address challenges like time pressure, instructors can allow students more time to respond or provide practice sessions before formal activities. Educators should allocate more time to familiarize students with Plickers before using it in assessments to ensure smoother implementation and reduce anxiety. Adjusting the pacing of activities can help reduce stress and improve the overall experience. Third, institutions should offer professional training and development workshops to equip educators with the necessary skills to effectively integrate Plickers and similar technologies into their teaching practices. Fourth, customization for inclusive learning should be prioritized by designing activities that accommodate students with varying physical abilities or learning preferences, such as providing digital alternatives for students unable to hold up cards. Fifth, further research should explore the long-term impact of Plickers on students' academic performance, emotional well-being, and participation across different contexts and disciplines. Additionally, integrating Plickers into teacher education programs can ensure that pre-service teachers become proficient in using innovative teaching tools for their future classrooms. Lastly, educators can enhance collaborative learning by pairing Plickers with group discussions or peer reviews to encourage deeper engagement and critical thinking.

5.0 Contributions of Authors

This study follows the CRediT (Contributor Roles Taxonomy) to clarify the specific roles of each author. Terence Katherine Stephanie R. Gapol, LPT, MM-EM, contributed to Conceptualization, Methodology, Investigation, and Project Administration—initiating the study and playing a key role in conducting the pretest, implementing the intervention, administering the posttest, and facilitating the interview process. Sydney Jay B. Villarin, LPT, was responsible for Data Curation, Formal Analysis, and Validation—handling data cleaning, performing the statistical analysis, and conducting the thematic analysis, ensuring the accuracy and reliability of the study's findings. Pedra A. Baculio, LPT, MAEd, and Ma. Izabel T. Cabasan, CSPE, LPT, MAEd, were involved in Writing – Review & Editing and contributed to the Literature Review, ensuring that the study was grounded in relevant theoretical and empirical research. All authors approved the final manuscript. The authors contributed in complementary ways; however, Terence Katherine Stephanie R. Gapol had a greater role in the study's conceptualization and implementation.

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7.0 Conflict of Interests

The authors hereby declare that there is no conflict of interest about the publication of this paper.

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