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The Effectiveness of Bee-Count Card on Learners Engagement in Mathematics

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A B S T R A C T

Teachers use diverse strategies to engage kindergarten learners effectively. This research emphasized the importance of integrating play-based approaches in teaching. The purpose of this study was to determine the effectiveness of a play-based approach on learners' engagement in Mathematics. The survey was conducted on two (2) teachers and 38 kindergarten learners, with the material assessed by 3 LRMDS Coordinators. Respondents were selected using Convenience Sampling. The t-value in the control group was 4.818944 with a significance level of 0.00012, while the t-value in the experimental group was 16.445502 with a significance level of less than 0.00001 Both groups rejected Ho, signifying a significant difference. The paired t-test in the Post-Survey in the Control and Experimental Group, t-value yielded -16.85427 with a significance level of less than 0.00001. Therefore, the study concluded a significant increase in engagement. Future researchers may prolong the study to assess how well the Bee-Count Card integrates into Mathematics and whether its effectiveness remains consistent or evolves.

Keywords: *play-based, bee-count card, engagement, and mathematics*

1. Introduction

Education is a fundamental human right crucial for personal and societal development, offering children essential cognitive and social skills. Recent years have seen a growing acknowledgment of play-based approaches in early childhood education, recognized by UNICEF (2018) as vital for fostering children's creativity and understanding of the world. Despite the emphasis on academic standards, integrating play into learning is crucial for holistic development and future readiness. Yet, further research is needed, particularly regarding its efficacy in teaching complex subjects like mathematics (Moore, 2020). Alignment of play activities with children's developmental needs, as emphasized by NAEYC (2020), is essential for maximizing benefits and fostering meaningful engagement in learning.

Considering these considerations, ongoing efforts are required to evaluate the effectiveness of play-based approaches and identify the most suitable play activities for different age groups and learning objectives. By prioritizing teacher training and resource allocation, educational institutions can create environments that effectively harness the power of play to enhance learning outcomes. Nevertheless, careful attention must be paid to the implementation of play-based approaches to avoid potential pitfalls and ensure that activities are tailored to children's abilities and interests. Through a comprehensive understanding of the role of play in education and its impact on learner engagement, educators can create enriching learning experiences that foster holistic development and prepare children for success in school and beyond (Dzamesi & Heerden, 2020).

1.1 Statement of the problem

The general problem of the study is: "How may an Effective Play-Based Approach be developed to Increase Learners' Engagement in Counting and Recognizing Numbers in Mathematics?"

Specifically, the study seeks answers to the following questions:

1. What Play-Based Intervention Materials were developed to increase the engagement of the learners?

2. How was the Bee-Count Card as an Intervention evaluated by the Experts based on the:

- Manual

- Instructional materials

3. How was the Bee-Count Card effectively implemented in the classroom?

4. How was the level of engagement of Learners in Mathematics described before and after implementing the Bee-Count Card?

5. Was there a significant increase in the Engagement of the Learners in Mathematics after the implementation of the Play-Based Approach?

1.2 Purpose of the study

The purpose of this study is to examine the effectiveness of using the Bee-Count Card, a play-based approach in enhancing learners' engagement in Mathematics.

1.3 Research hypotheses

H01. There's no significant increase in the implementation in Learners' Engagement using the Bee-Count Cards implemented in the Experimental Group.

H02. There's no significant relationship between Play-Based Intervention and Learners' Engagement using play activities.

2. Methodology

2.1 Research Design, Population and Sample

The study utilized a Descriptive-Developmental Method to craft a play-based intervention for kindergarten engagement. This method, defined by Gay (1992), involves systematically collecting data to understand subjects' status, providing detailed portrayals within specific populations. It facilitated a thorough examination of developmental processes, filling knowledge gaps and providing nuanced insights. Additionally, a Quasi-Experimental Design was employed, utilizing a survey questionnaire for data collection. The researchers utilized the ADDIE Model to create instructional materials, emphasizing the dynamic nature of the research area and the need for deeper insights.

A.   Analyze

The play-based intervention in the classroom aimed to enhance student engagement by introducing educational games. Using "Bee-count cards" with numbers 1 to 20, akin to bingo, the study sought to make learning numbers enjoyable and interactive for kindergarten students. Replacing standard cards ensured better recognition. Students' excitement for playing games likely contributed to increased focus and attention during lessons.

B.   Design

The researcher laid out Bee-Count Cards using applications that could be used in making cards like bingo. The layout was printed using magnetic film to ensure its durability. The Bee-Count cards were ready and could be used with the help of magnetic cards and small magnetic pieces to put in the number/color that the teacher would call.

C.   Development

Using applications that could be used to create bee-count cards, the researcher first laid down a set of Bee-Count cards. To ensure endurance, the layout was also printed using sticker papers pasted in magnetic films and used photo tapes to make it more presentable and durable. Lastly, the Bee-count cards were prepared and ready to use with the aid of \magnetic pieces with the image and shape of bees to be used for numbers. Based on the findings of the observations provided by the teachers, the Bee-count cards were updated.

D.   Implementation

A prepared lesson plan was provided to guide the topic and contents of the lesson, which was also given to teachers who observed the researchers teaching the topic, incorporating both the traditional teaching approach and the use of play intervention. In addition to the prepared lesson plan, a manual was given to the teachers as well. Meanwhile, every learner had a "Bee-Count Card" and magnetic pieces placed on the numbers the teacher called during rote counting or when using the spin-the-wheel application.

E.   Evaluation

After finishing the play, the researcher who implemented the game evaluated and checked the students' cards if the learners followed the game or if they put the bee-shaped magnets on the right numbers and colors.

In addition to the Descriptive-Developmental design, this study will also incorporate a Quasi-Experimental Design. Quasi-experimental designs, akin to experimental ones, evaluate causal hypotheses by testing interventions such as programs or policies against predetermined indicators. Unlike experimental designs, quasi-experimental designs lack random assignment, relying instead on methods like self-selection or administrator selection for assignment to conditions.

The researchers used Convenience Sampling in which researchers chose participants that were most convenient to access and to be included in the study. In this study, the Teachers and the Learners in Kindergarten from Rufino A. Cruz Memorial School were the target population of the study. The researcher targets all the Teachers who are the advisers of the kindergarten learners who observed and answered the survey if the play was effective for the learners, while the kindergarten learners are the target users of the play. Two (2) teachers answered the survey questionnaire based on their observations about the engagement of the learners before and after the implementation of play-based intervention or the "Bee-count cards", eighteen (18) learners from the control group and twenty (20) learners from experimental group, total of thirty-eight (38) learners from two (2) sections in morning session participated, used the play activity and answered the questionnaire prepared by the researchers in the study and make themselves available to be part of it. The researchers chose Rufino Elementary School as the study site due to an observation indicating a lack of emphasis on utilizing a play-based approach to teaching within the institution. Additionally, respondents from both the experimental and controlled groups were selected by the kindergarten advisers. This decision was necessitated by the fact that the school comprises only two sections from kindergarten. To ensure the quality of the materials used, researchers conducted validation by presenting them to three (3) Learning Resource Management & Development System Coordinators from various schools. These coordinators were selected to provide diverse perspectives and insights into the suitability and effectiveness of the materials for educational purposes. Their feedback and assessments contribute significantly to enhancing the overall quality and appropriateness of the learning resources.

2.2 Research Instrument, Validity and Reliability

A survey questionnaire was the major instrument used in this study. The researchers used pre-survey and post-survey to measure the engagement of the learners before and after the implementation of the play-based intervention. McLeod (2018) defined a survey questionnaire as a tool to consolidate information from the respondents. It was an efficient way of measuring the behavior, attitudes, preferences, opinions, and intentions of a gargantuan number of target groups which is more convenient than other methods of instruments. The survey questionnaire was conducted face-to-face, which helped the researchers gather data from the respondents as it was the appropriate tool to administer the data gathering for the study.

The questionnaire used a five-point Likert scale and a happy and sad face to better observe the effectiveness of the prepared play-based approach on learners' engagement. When the question earned a mean of 5, it means the observer/respondent is strongly agrees with the effectiveness of the play activity; if 4, the respondent agrees with the effectiveness of the play activity; if it 3, it indicates that the respondent neither agrees nor disagree on the effectiveness of play activity; if 2, it indicated that the respondent disagree on its effectiveness; and if 1, it indicated that the respondent strongly disagree on the effectiveness of play activity implemented and use in the learning process.

There are 3 types of questionnaires distributed, one is for the LRMDS Coordinators, one is for the kindergarten teachers, and one is for the learners. There are different questionnaires distributed to those 3 groups of participants. The LRMDS rating sheet incorporates three key factors, each evaluated on a scale with corresponding verbal interpretations. Participants assessing the materials use a scale ranging from 1 to 4, with 4 indicating "Very Satisfactory," 3 denoting "Satisfactory," 2 signifying "Poor," and 1 representing "Not Satisfactory." The second questionnaire was adopted-modified and distributed to teachers to observe and measure the engagement of the learners and the materials as well before and after the learning process. A Likert scale was used to measure the effectiveness of Bee-Count Cards or the Play-Based Approach implemented in the learning process. The analysis of the play activity implementation employed a scale with five levels, each accompanied by a corresponding verbal interpretation. Participants evaluating the effectiveness of the play-based approach utilized a scale ranging from 1 to 5. A rating of 5 represented "Strongly Agree," indicating strong endorsement of the approach, while 4 denoted "Agree," signifying general agreement. A score of 3 indicated "Neither Agree nor Disagree," reflecting a neutral stance on the effectiveness of the play activity. Conversely, a rating of 2 represented "Disagree," suggesting reservations or disagreements with the approach, while a score of 1 indicated "Strongly Disagree," reflecting strong opposition to the implementation of the play activity.

The third questionnaire was also distributed to learners to support the study and measure their engagement in learning Mathematics before and after the implementation with or without the use of the developed materials. The learners draw a 😊 face whether they enjoy and learn in Mathematics class or 😞 if not based on the researcher's implementation.

2.3 Study Treatment, Data Collection and Analysis

To collect data, a survey was conducted at Rufino A. Cruz Memorial School. A letter was sent to the principal of the selected school to seek permission to conduct the study, and with the approval of the principal, the researcher conducted the game with the learners and distributed the questionnaires to the respondents personally. Afterward, the researchers collected all the questionnaires from the respondents and checked whether all questions were answered. After collecting all the data, the researchers, with the help of the statistician tabulated and tallied all the surveys.

3. Result and Discussion

Table 1. Evaluation of Materials based on Content

Indicators	Mean	SD	Description
FACTOR A. CONTENT			
1. Content reinforces, enriches, and/or leads to the mastery of certain learning competencies for the level and subject it was intended.	4	0	Agree
2. Material has the potential to arouse the interest of the target users.	4	0	Agree
3. Facts are accurate	4	0	Agree
4. The information provided is up to date.	4	0	Agree
5. Visuals are relevant to the text.	4	0	Agree
6. Visuals are suitable to the age level and interests of the target user.	4	0	Agree
7. Visuals are clear and adequately convey the message of the subject or topic.	4	0	Agree
8. Typographic layout/design facilitates understanding of concepts presented.	3.5	0.71	Neither Agree nor Disagree
9. The size of the material is appropriate for use in school.	3.5	0.71	Neither Agree nor Disagree
10. Material is easy to use and durable.	4	0	Agree
OVERALL	**3.9**	**0.13**	**Neither Agree nor Disagree**

Table 1 reveals that most indicators regarding the content received ratings of "Agree" or "Neither Agree nor Disagree," with a notable trend towards agreement. For example, aspects such as the reinforcement of learning competencies, the potential to engage target users, accuracy of information, relevance of visuals, and usability of materials all garnered an average rating of 4, indicating a consensus of agreement among evaluators. However, indicators related to typographic layout/design and appropriateness of material size received a slightly lower mean of 3.5 and 0.17 standard deviation, placing them in the "Neither Agree nor Disagree" category. This suggests a less pronounced consensus regarding these aspects of the material.

With an overall mean of 3.9 and a standard deviation of 0.13 described as "Neither Agree nor Disagree", the data indicates a relatively narrow range of variability among the ratings. Rondina and Roble (2019) found that a game-based learning activity involving students in developing a carnival game improved their understanding of probability concepts. The results suggested a consistent perception among evaluators, leading to the conclusion that the LRMDS evaluator holds a neutral stance regarding the content of the material.

Table 2: Evaluation of Materials based on Other Findings

Indicator	Mean	SD	Description
FACTOR B. OTHER FINDING			
1. Conceptual errors.	4	0	Agree
2. Factual errors.	4	0	Agree
3. Grammatical and/or typographical errors.	4	0	Agree
4. Other errors (i.e., computational errors, obsolete information, errors in the visuals, etc.)	4	0	Agree
OVERALL	**4**	**0**	**Agree**

Table 2, as presented in the study by Serrano (2019), in a literature review written to analyze research and determine whether games are effective learning tools, found that the reviewed research studies substantiated the premise that using educational games in addition to quality game design and elements can positively impact student engagement. Also, shows that all indicators got the same mean which is 4 and "Agree" on the description. The indicators are Conceptual errors, Factual errors, Grammatical and/or typographical errors and other errors (i.e., computational errors, obsolete information, errors in the visuals, etc.) To conclude Factor B based on the overall rating of 4 mean and 0 standard deviation, the material is error-free or appropriate.

Table 3: Evaluation of Materials based on Manipulative

FACTOR C. MANIPULATIVE	Mean	SD	Description
1. Adequate support material is provided.	3.5	0.71	Neither Agree nor Disagree
2. Activities are summarized; extension activities are provided.	3.5	0.71	Neither Agree nor Disagree
3. Suggested activities support innovative pedagogy.	3.5	0.71	Neither Agree nor Disagree
4. Manipulative is safe to use.	4	0	Agree
5. The size and composition of the manipulative are appropriate for the intended audience.	3.5	0.71	Neither Agree nor Disagree
6. Suggested manual tasks within the activities are compatible with the motor skills of the intended users	4	0	Agree
OVERALL	**3.75**	**0.35**	**Neither Agree nor Disagree**

Table 3 shows that most of the indicators rated as Neither Agree nor Disagree than Agree. The indicators that got the same mean of 3.5 and 0.71 standard deviations are Adequate support material provided, Activities summarized; extension activities provided, Suggested activities support innovative pedagogy and Size, and composition of manipulative is appropriate for the intended audience. According to Rahmah et al., (2019) Manipulative movement ability also has an element of play. While the indicators that got the mean of 4 and 0 standard deviations are Manipulative, it is safe to use and suggested manual tasks within the activities are compatible with the motor skills of the intended users. But overall, the mean is 3.75 and the standard deviation is 0.35 which means the manipulatives are described as "Neither Agree nor Disagree".

Table 4: Summary of Evaluations of Materials by LRMDS Coordinators

Indicators	Mean	SD	Description
LRMDS			
FACTOR A. CONTENT	3.90	0.13	Neither Agree nor Disagree
FACTOR B. OTHER FINDING	4.00	0	Agree
FACTOR C. MANIPULATIVE	3.75	0.35	Neither Agree nor Disagree
OVERALL	**3.88**	**0.12**	**Neither Agree nor Disagree**

Table 4 presents the overall indicators, encompassing various factors such as Content, Other Findings, and Manipulatives. The mean for Content is 3.90 and SD of 0.13 described as Neither Agree nor Disagree, Other findings are 4.00 and 0 standard deviations, indicating agreement among evaluators. However, the mean for Manipulatives is slightly lower at 3.75 and 0.12 SD, categorized as "Neither Agree nor Disagree." This score

represents the lowest among the three indicators. The overall mean is 3.88 and the standard deviation is 0.12, suggesting a moderate level of variability in the ratings. This deviation is described by LRMDS evaluators as "Neither Agree nor Disagree," indicating a neutral stance regarding the materials. The "Agree nor Disagree" outcome stems from the discerning observations and recommendations provided by the LRMDS, highlighting the imperative for refining specific elements within our materials, such as fonts, colors, and sizes. This response denotes a recognition of the validity and importance attributed to the suggestions presented, showcasing an openness to constructive critique and improvement. It underscores a deliberate evaluation of the proposed enhancements, acknowledging their potential to elevate the overall quality and effectiveness of our materials. The researchers did not pursue another validation after enhancing the materials because the LRMDS granted them permission to implement the game following the enhancement based on their evaluation, which resulted in "Agree nor Disagree". According to Franklin et al. (2019), the benefits of using games to enrich student learning experiences include enhancing attention, motivation, social skills, engagement, and collaborative learning. It emphasizes the positive impact of incorporating games into educational settings.

Part III. The implementation of the "Bee-Count Card" in the classroom

"Bee-Count Card" is a card game that focuses on counting and mathematical skills. It is incorporated into the classroom to engage learners in an engaging and interactive way, help them remember numerical ideas, and encourage strategic thinking.

Figure 4.

Implementation of the play-based intervention "Bee-Count Card" in the classroom based on the ADDIE Model.

The implementation of the play-based approach in the classroom was successful with the support of a comprehensive Manual that the teacher used for guidance while the learners played the game. But aside from the manual, the researchers used a Lesson Plan that contains the objectives of the lesson. Both control and experimental groups have the same topic in the lesson plan, the only difference is that the experimental group has the integration of a play-based intervention called "Bee Count Card" and the other one is the traditional teaching approach without incorporating play activities.

The researchers conducted the lesson guided by the lesson plan on counting numbers from 1 to 20, utilizing engaging instructional materials. Acting as teachers, the researchers incorporated materials related to bees, such as beehives, honeybees, flowers, and more, to enhance the learning experience. After the discussion, every student received a card along with 20 small magnetic pieces, which they then utilized in their play activity. In addition to engaging in rote counting based on the competencies, the researchers introduced a game using a spin-the-wheel application sourced from the internet. This game aimed to assess the children's familiarity and recognition of numbers from 1 to 20, as well as their ability to classify colors using the Bee-Count Card to win. The colors utilized in the Bee-Count Card by the researchers seemingly had no discernible impact on the instructional process employed. The decision to employ primary colors was solely based on their alignment with the Learning Competencies prescribed for kindergarten education. Additionally, these colors will serve as the foundation for teachers to determine the winner based on the color patterns established as the game instructions for that day. Mulyono (2021) stated that the implementation of good learning, fun, and making students active in learning is a factor that can increase their learning motivation.

Part IV. The evaluation of teachers' and learners' engagement before and after the implementation of the play-based approach.

The evaluation of teachers' and learners' engagement before and after the implementation of a play-based approach involves assessing the level of involvement and interaction of both educators and students in playful learning activities, measuring changes in engagement levels from the pre-survey to the post-survey phases.

Table 5: Teachers Pre-Survey in Controlled Group

Indicators	Mean	SD	Description
1. Students are excited about math class.	5	0	Strongly Agree
2. Students enjoy learning new concepts in math class.	5	0	Strongly Agree
3. Students find math class easy to understand.	5	0	Strongly Agree
4. Students pay close attention in math class.	1	0	Strongly Disagree
5. Students think math class is interesting.	5	0	Strongly Agree
6. Students enjoy taking math classes.	5	0	Strongly Agree
7. Students desire an extended math discussion.	5	0	Strongly Agree
8. Students volunteer to participate when it comes to math discussion.	5	0	Strongly Agree
9. Students respond to questions in math class.	5	0	Strongly Agree
10. Students enjoy math activities.	5	0	Strongly Agree
OVERALL	**4.6**	**0**	**Agree**

Table 5 shows that pre-survey results were conducted on teachers before conducting the study to see the learner's engagement in mathematics. Teachers strongly agree with the mean of 5 that the students are excited about math class, enjoy learning new concepts, find math easy to understand, think math class is interesting, enjoy taking math classes, desire extended math discussions, volunteer to participate in math discussions, respond to questions in math class, and enjoy math activities. According to Fatou & Kubiszewski (2018), The instructional support developed during student-teacher interaction in a classroom setting determines the engagement level of a learner. However, there's one indicator where teachers strongly disagree with the mean of 1, which is that learners pay close attention in math class. The overall average rating across all indicators with a mean of 4.6, indicates that teachers generally agree that there is high engagement of the learners, but it is not that perfect because of the learner's attention in Mathematics.

Table 6: Teachers Post-Survey in Controlled Group

Indicators	Mean	SD	Description
1. Students are excited about math class.	5	0	Strongly Agree
2. Students enjoy learning new concepts in math class.	5	0	Strongly Agree
3. Students find math class easy to understand.	5	0	Strongly Agree
4. Students pay close attention in math class.	5	0	Strongly Agree
5. Students think math class is interesting.	5	0	Strongly Agree
6. Students enjoy taking math classes.	5	0	Strongly Agree
7. Students desire an extended math discussion.	5	0	Strongly Agree
8. Students volunteer to participate when it comes to math discussion.	5	0	Strongly Agree
9. Students respond to questions in math class.	5	0	Strongly Agree
10. Students enjoy math activities.	5	0	Strongly Agree
OVERALL	**5**	**0**	**Strongly Agree**

Table 6 shows the Post-survey in the Controlled Group rated by the teachers, with a mean of 5 described as "Strongly Agree" in all indicators, in which learners are excited about math class, enjoy learning new concepts, find math easy to understand, pay close attention in math class, think

math class is interesting, enjoy taking math classes, desire extended math discussions, volunteer to participate in math discussions, respond to questions in math class, and enjoy math activities. However, he confirmed the importance of teachers' roles in providing a learning environment full of activities and interactions among students, which help in maintaining a positive implication toward mathematics (Daher, 2020). Overall, the post-survey results in controlled groups, there are still increases in and perfect rate without the use of the play-based intervention.

Table 7: Teachers Pre-Survey in Experimental Group

Indicators	Mean	SD	Description
1. Students are excited about math class.	5	0	Strongly Agree
2. Students enjoy learning new concepts in math class.	5	0	Strongly Agree
3. Students find math class easy to understand.	5	0	Strongly Agree
4. Students pay close attention in math class.	5	0	Strongly Agree
5. Students think math class is interesting.	5	0	Strongly Agree
6. Students enjoy taking math classes.	4	0	Agree
7. Students desire an extended math discussion.	5	0	Strongly Agree
8. Students volunteer to participate when it comes to math discussion.	5	0	Strongly Agree
9. Students respond to questions in math class.	5	0	Strongly Agree
10. Students enjoy math activities.	4	0	Agree
OVERALL	**4.8**	**0**	**Agree**

Table 7 shows the teacher's pre-survey about the engagement of learners in the experimental group. Most of the indicators got the mean of 5 described as strongly agree wherein learners are excited about math class, enjoy learning new concepts, find math easy to understand, pay close attention in math class, think math class is interesting, desire extended math discussions, volunteer to participate in math discussions, and respond to questions in math class. As of Siddiqi (2018), he advocated for improved instruction-based classroom learning. There are two indicators where teachers rated "Agree" with a mean of 4 which are students enjoy taking math classes and students enjoy math activities. The overall average rating across all indicators is 4.8, indicating that teachers agree before conducting the study, that there is still needed to develop and enhance the learner's engagement

Table 8: Teachers Post-Survey in Experimental Group

Indicators	Mean	SD	Description
1. Students are excited about math class.	5	0	Strongly Agree
2. Students enjoy learning new concepts in math class.	5	0	Strongly Agree
3. Students find math class easy to understand.	5	0	Strongly Agree
4. Students pay close attention in math class.	5	0	Strongly Agree
5. Students think math class is interesting.	5	0	Strongly Agree
6. Students enjoy taking math classes.	5	0	Strongly Agree
7. Students desire an extended math discussion.	5	0	Strongly Agree
8. Students volunteer to participate when it comes to math discussion.	5	0	Strongly Agree
9. Students respond to questions in math class.	5	0	Strongly Agree
10. Students enjoy math activities.	5	0	Strongly Agree
OVERALL	**5**	**0**	**Strongly Agree**

Table 8 shows the teachers' post-survey with the mean of 5 described as strongly agree which learners are excited about math class, enjoy learning new concepts, find math easy to understand, pay close attention in math class, think math class is interesting, enjoy taking math classes, desire

extended math discussions, volunteer to participate in math discussions, and respond to questions in math class. The overall average mean across all indicators is 5, indicating that teachers strongly agree that Bee-Count Cards have a positive impact on student engagement in mathematics. Overall, the post-survey results for the experimental group reinforce the positive perception of Bee-Count Cards as an effective tool for promoting student engagement in mathematics. Ge and Ifenthaler (2018) provided insights into the concept of game-based learning and its integration into educational practices. This implies a minor difference in thoughts about these parts of the mathematics learning process, suggesting that not all learners find each aspect equally engaging or pleasurable.

Table 9: Learners' engagement both in Controlled and Experimental Groups before the conduct of the study (Pre-Survey)

	Control Group		Experimental Group	
Indicators	**HAPPY**	**SAD**	**HAPPY**	**SAD**
1. I am excited about my mathematics classes.	35%	65%	45%	55%
2. I enjoy learning new concepts in math class.	35%	65%	30%	70%
3. I find math classes easy to understand.	50%	50%	45%	55%
4. I pay close attention when I'm in math class.	35%	65%	45%	55%
5. I think that math class is interesting.	55%	45%	35%	65%
6. I am enjoying taking math classes.	50%	50%	45%	55%
7. I desire an extended math discussion.	40%	60%	25%	75%
8. I volunteer to participate when it comes to math discussions.	35%	65%	20%	80%
9. I respond to questions in math class.	60%	40%	50%	50%
10. I enjoy answering math activities.	25%	75%	20%	80%

Table 9 shows the percentage of each indicator in a control and experimental group with a happy or sad choice to describe their feeling before the learning process only. The indicators include the engagement of the learners or their feelings towards Mathematics subjects. According to Liu et al., (2021). Educational games may encourage the students to enjoy learning, to feel comfortable approaching a variety of difficulties along the way, and to overcome these challenges with focus, self-assurance, and patience. The data compares responses between a control group and an experimental group regarding various indicators related to their attitudes toward mathematics classes. Across most indicators, the experimental group tends to exhibit lower levels of happiness compared to the control group. While the experimental group shows slightly higher levels of happiness regarding excitement about mathematics classes and paying attention in math class, they display less happiness in areas such as enjoyment of learning new concepts, finding math classes interesting, desiring extended math discussion, volunteering to participate in math discussion, and enjoying answering math activities. This suggests that whatever intervention or treatment applied to the experimental group may have had a negative impact on their overall attitudes toward mathematics classes, leading to decreased levels of happiness and engagement compared to the control group.

Table 10: Learners' engagement both in Controlled and Experimental Groups after the conduct of the study (post-survey)

	Control Group		Experimental Group	
Indicators	**HAPPY**	**SAD**	**HAPPY**	**SAD**
1. I am excited about my mathematics classes.	50%	50%	90%	10%
2. I enjoy learning new concepts in math class.	75%	25%	90%	10%
3. I find math classes easy to understand.	35%	65%	90%	10%
4. I pay close attention when I'm in math class.	70%	30%	85%	15%
5. I think that math class is interesting.	80%	20%	90%	10%
6. I am enjoying taking math classes.	70%	30%	90%	10%
7. I desire an extended math discussion.	55%	45%	80%	20%

8. I volunteer to participate when it comes to math discussions.	40%	60%	90%	10%
9. I respond to questions in math class.	50%	50%	90%	10%
10. I enjoy answering math activities.	60%	40%	90%	10%

Table 10 illustrates the comparison of learners' engagement between a control group and an experimental group after the study, as indicated by post-survey responses. Across all indicators, the experimental group consistently demonstrates higher levels of happiness and lower levels of sadness compared to the control group. Particularly noteworthy is the substantial increase in positive engagement observed in the experimental group. For instance, in indicators such as excitement about mathematics classes, enjoyment of learning new concepts, finding math classes easy to understand, paying close attention in math class, finding math class interesting, enjoying taking math classes, desiring extended math discussion, volunteering to participate in math discussion, responding to questions in math class, and enjoying answering math activities, the experimental group consistently outperforms the control group, with happiness levels ranging from 80% to 90% and sadness levels remaining low at 10%. As of Russo et al., (2018), mathematical games have been found to be a valuable pedagogical tool for promoting engagement and motivation in mathematics. This significant improvement in engagement suggests that the intervention or treatment applied to the experimental group has had a positive impact on their attitudes and involvement in mathematics classes compared to the control group.

Part V. Increase in the Learners' Engagement

The t-test was conducted for the Controlled and Experimental Group to measure the learner's engagement in Mathematics to see the progress and increase in teaching approaches, with or without the play-based intervention or the "Bee-Count Card".

Table 11: T-test form Pre-survey and post-survey of Control Group and Experimental Group

Paired t-test between Pre survey and Post survey of both groups

Variables	T	Sig-value	Decision	Interpretation
Control Group	4.818944	0.00012	Reject Ho	There is a significant difference.
Experimental	16.445502	< .00001	Reject Ho	There is a significant difference.

Table 11 shows the paired t-tests conducted between pre-survey and post-survey data for both the control and experimental groups revealed statistically significant differences. According to Mishra (2019) The two samples' independent t-test, which can be used when the two groups under comparison are independent of each other, and the paired t-test, which can be used when the two groups under comparison are dependent on each other. For the control group, the t-value was 4.818944 with a significance level of 0.00012, leading to the rejection of the null hypothesis (Ho) and indicating a significant difference between the pretest and post-survey results. Similarly, for the experimental group, the t-value was 16.445502 with a significance level of less than 0.00001, again leading to the rejection of the null hypothesis and demonstrating a significant difference between the pretest and post-survey results.

Table 12: T-test in Post-survey on Both Groups

t-test between Post surveys of both groups

Variables	T	Sig-value	Decision	Interpretation
Post survey (control) and Post survey (Experimental)	-16.85427	< .00001	Reject Ho	There is a significant difference.

Table 12 shows the paired t-test conducted between the post-survey responses of the control group and the experimental group yielded a statistically significant result with a t-value of -16.85427 and a p-value of less than 0.00001. According to Wasserstein & Lazar (2016), Paired sample t-test was used for analyzing the pretest and post-test mean scores within the group. As a result, the null hypothesis (Ho), which typically states that there is no significant increase between the groups, was rejected. The table indicates that the outcome for both is "Reject H0." However, the T-test for

the post-test shows that the t-value has increased compared to Table 11, in which the t-value from the Controlled Group was 4.818944 and the Experimental Group was 16.445502. This suggests that the implementation of the Bee-Count Card has had a positive effect on learners' engagement. This indicates that there is indeed a significant difference between the post-survey responses of the control and experimental groups. In other words, the intervention or treatment applied to the experimental group has had a discernible impact on their attitudes or outcomes compared to the control group.

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3.1 Discussion

To highlight the importance of this study and its findings, several recommendations are suggested. Firstly, for the Bee-Count Card, researchers propose enlarging the size of the magnetic cards to improve visibility for learners and using stronger magnets to ensure better adherence to the magnetic pieces. Secondly, in the manual, it is advised to increase text size for readability and select colors that enhance legibility, while also simplifying the card's design to avoid unnecessary complexity. Thirdly, teachers are encouraged to emphasize thorough lesson preparation and proficiency in implementing the Bee-Count Card, including providing clear instructions, managing activity pacing, and addressing potential

4. Conclusion

Bee-count cards have proven to significantly enhance engagement and comprehension in counting from 1 to 20, fostering active learning through interactive activities. Upon review by experts, the materials were generally approved, albeit with a few minor adjustments such as font size and color selection. However, experts acknowledged their potential to increase learner engagement. The lesson plan and spin-the-wheel app played crucial roles in the study's success, providing structure and interactivity, thus ensuring smooth execution and boosting learner engagement. Compared to standard teaching methods, the use of Bee-Count Cards surpassed expectations, captivating learners' interest and enhancing number recognition through interactive features. This highlights their potential to revolutionize teaching practices and improve mathematics education by offering promising opportunities for educators to increase learner engagement and academic achievement. Notably, Bee-Count Cards significantly improved learner engagement in mathematics, fostering increased participation and number recognition, thanks to the incorporation of interactive tools that contributed to creating a dynamic learning environment and achieving positive outcomes.

5. Recommendation

To emphasize the significance of this study and its findings, the following recommendations are made:

1.   In making the Bee-Count Card, researchers suggest using a larger size for the magnetic cards to enhance visibility for learners. Additionally, utilizing stronger magnets can ensure better adherence of the magnetic pieces to the card.

2.   In the Manual, create a larger size to ensure that the texts and contents are easily readable, and select colors that enhance the legibility of the written information. Furthermore, concerning the design and layout of the Bee-Count Card itself, avoid incorporating unnecessary designs.

3.   In utilizing the materials, the teachers should emphasize the importance of accurately preparing the lesson plan and ensuring that they are well-versed in its implementation to effectively deliver the content using the Bee-Count Card including clear student instructions, activity pacing, and addressing potential challenges during gameplay.

4.   Teachers may employ a variety of activities to ensure active engagement and participation of learners when using the Bee-Count Card, fostering deep understanding and collaborative learning.

5.   Future researchers may choose to employ this play-based approach over an extended period to comprehensively evaluate the efficacy of integrating the Bee-Count Card into Mathematics, assessing whether the outcomes remain consistent or evolve over time.

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APPENDICES

APPENDIX A. Instrument of the Study for Teachers.

Republic of the Philippines
BULACAN STATE UNIVERSITY
City of Malolos, Bulacan
COLLEGE OF EDUCATION

Name (Optional): _____

Position/Designation: _____

School: _____

Instrument #1. Systematic Design and Rapid Development of Motion-Based touchless Games for Enhancing Students' thinking Skills
(***Adopted and modified from the study of Altanis, I., Retalis, S., & Πετροπούλου, O. (2018).***

All questionnaire items were measured using a 5-point Likert scale ranging from "strongly agree" to "strongly disagree".

5 –Strongly Agree

4 - Agree

3 – Don't know 2 - Disagree

1 – Strongly Disagree

Please reflect on the degree to which each of the following statements you observed about the engagement in mathematics of the students. Using the scale above, check (✔) the appropriate level of agreement for each item.

Criteria and Short Description	5	4	3	2	1
Q1. **Training and help:** The game provides specific pre/in game instructions.					
Q2. **Effectiveness:** The game's feature is playable and operating well.					
Q3. **Material:** The game utilized creatively crafted and visually appealing for students.					
Q4. **Manual:** The manual provides clear goals and instructions.					
Q5. **Usability:** I'm aware at any time the actions should proceed in the game, because the game fulfills the following characteristics: ● Unique and Clear Goal, Simple and few rules					
Q6. **Usability (sense of control):** The game is easy to use and fulfill the following characteristics: ● Game elements were moving as slowly as needed to allow the player time to react.					
Q7. **Pleasure/fun:** The students was having fun playing the game.					
Q8. **Gameplay (Easy Navigation):** The game was simple and visible enough.					
Q9. **Motivation (Attention):** The game managed to keep students' attention during the play.					

Q10. **Motivation (low penalty)** The low penalty of errors allows the students to be motivated and in order to improve the score.					

APPENDIX B. Instrument of the Study for Learners.

Republic of the Philippines
BULACAN STATE UNIVERSITY
City of Malolos, Bulacan
COLLEGE OF EDUCATION

Name (Optional): _____

Age: _____

School: _____

Instrument #2. Development and Validation of the Science and Mathematics Engagement Scale. *(Adopted and modified from the study of Cash, K., Adelson, J. L., Knight, A., & Snyder, K., 2022*

All questionnaire items were measured using a happy face if the students agree to the statement and sad face if they not agree to the statement.

The survey instrument consists of 12 items to measure if the students enjoyed and learned from the materials. The survey questions were written as follows.

PRE-TEST

Panuto: Iguhit ang masayang mukha 😊 kung sumasang-ayon ka sa mga pahayag at malungkot na mukha naman 🙁 kung hindi.

1. I am excited about my mathematics classes. **(Ako ay nasasabik sa klase ng matematika)**	
2. I enjoy learning new concepts in math class. **(Ako ay masaya sa pag-aaral ng mga bagong aralin sa matematika.)**	
3. I find math classes easy to understand. **(Ako ay nadadalian sa pag-aaral ng matematika.)**	
4. I pay close attention when Im in math class. **(Ako ay masiglang nakikinig at nakikilahok sa klase ng matematika.)**	
5. I think that math class is interesting. **(Ako ay interesado sa pag-aaral ng matematika.)**	
6. I am enjoying taking math classes. **(Ako ay masaya sa pag-aaral ng matematika.)**	
7. I desire an extended math discussion. **(Ako ay nagnanais ng mas mahabang oras para sa talakayan ng matematika.)**	
8. I volunteer to participate when it comes to math discussion. **(Ako ay nagkukusang sumali sa talakayan ng matematika.)**	
9. I respond to questions in math class. **(Ako ay sumasagot sa mga tanong sa talakayan ng matematika.)**	
10. I enjoy answering math activities. **(Ako ay masaya sa pagsagot ng mga gawain sa matematika.)**	

APPENDIX C. Instrument of the Study for the Engagement of Learners by Teachers.

Republic of the Philippines
BULACAN STATE UNIVERSITY
City of Malolos, Bulacan

COLLEGE OF EDUCATION

Name (Optional): _____

Position/Designation: _____

School: _____

Instrument #3. Development and Validation of the Science and Mathematics Engagement Scale. *(Adopted and modified from the study of Cash, K., Adelson, J. L., Knight, A., & Snyder, K., 2022)*

Please reflect on the degree to which each of the following statements you observed about the engagement in mathematics of the students. Using the scale above, check (/) the appropriate level of agreement for each item.

5 –Strongly Agree

4 - Agree

3 – Don't know (Neutral) 2 - Disagree

1 – Strongly Disagree

Criteria and Short Description	5	4	3	2	1
1.The students look forward to math class.					
2. The students enjoy new things in math class.					
3. Most of the time, students complete their math assignments.					
4. Students cause trouble during math class.					
5. Students like their math teacher.					
6. Students listen very carefully during math class.					
7. Students think math class is boring.					
8. Students pay attention during math class.					
9. Students like math class.					
10. Students wish math class lasted longer.					
11. Students get bored when they have to do math.					
12. Students volunteer to participate in math class.					
13. Students finish math work on time.					
14. Students answer questions during math class.					