Improving Grade 7 Students' Mastery and Retention of Aquaculture Concepts through All-Round Bingo

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ABSTRACT

Aquaculture education equips learners with essential skills for personal growth and future careers, yet many continue to struggle with low mastery and poor retention of key concepts, limiting their understanding and overall performance in the subject. This study aimed to address the challenges of low mastery and retention of aquaculture concepts among Grade 7 students by employing the All-Round Bingo. A quasi-experimental pretest–posttest nonequivalent group design was utilized, and data were collected through testing. The study involved thirty-eight (38) purposively selected Grade 7 students who were equally divided into two groups. The control group received traditional instruction, while the experimental group engaged in the All-Round Bingo. Mean scores, frequency counts, and paired t-tests were used to analyze students' levels of mastery and retention. Results showed that the experimental group's mean score increased from 12.60 in the pretest to 25.40 in the posttest, while the control group improved from 10.50 to 20.30. Statistical analysis revealed a significant difference in favor of the experimental group ($t = -4.91$, $p = < 0.001$), indicating a greater improvement in mastery and retention of aquaculture concepts. These findings suggest that integrating game-based strategies such as All-Round Bingo can help guide teaching strategies, curriculum planning, and instructional practices in aquaculture and science education. It is recommended that the All-Round Bingo be adopted by aquaculture teachers in the Schools Division of Laoag City.

Keywords: All-Round Bingo, Mastery, Retention, Aquaculture Concepts, Game-Based Teaching, Interactive Learning

INTRODUCTION

Mastery and retention are essential for students to deeply understand scientific concepts, especially in aquaculture. Consequently, strengthening these through learner-centered strategies is important for improving academic performance and technical skills in aquaculture education. This is emphasized by Republic Act No. 10533 (Enhanced Basic Education Act of 2013), which mandates the development of scientifically literate and skilled learners capable of applying concepts meaningfully.

Recent data reveal that the performance of Filipino learners in science has been negatively affected by the pandemic. Therefore, a concerted effort is required to explore how learners understand scientific concepts in the current educational landscape and to address poor conceptual understanding and widening learning gaps (Yunzal et al., 2024). Furthermore, Filipino students continue to perform below the international average in scientific literacy, highlighting the need for engaging and meaningful instruction (OECD, 2022; World Bank, 2023).

To address these issues, educators have increasingly adopted Game-Based Learning (GBL). This method uses games to teach and reinforce scientific concepts, promoting mastery, retention, and active participation (Vilanueva, 2024; Grace, 2019). Game-based learning enables learners to acquire new concepts and skills through digital and non-digital games (Grace, 2019). Research consistently shows that active learning, particularly through educational games, increases student motivation and enhances conceptual understanding (Linsin, 2012; Vilanueva, 2024; Munawaroh, 2016).

Moreover, educational games like Bingo have proven effective in helping students remember vocabulary and core concepts. Noviyanti, Bahri, and Chairina (2019) found that Bingo enhances vocabulary retention, while Kunnu, Uiphanit, and Sukwises (2016) emphasized that game-based instruction increases student enthusiasm and energizes the classroom environment. Additionally, Ratliff (2019) and Munawaroh (2016) noted that educational games promote teamwork and peer learning, providing an enjoyable and effective alternative to traditional methods. This evidence supports the idea that game-based approaches cultivate long-term learning retention and deeper understanding of scientific concepts.

At the Ilocos Norte Regional School of Fisheries, this challenge is evident. During S.Y. 2023–2024, the Mean Percentage Score (MPS) for basic aquaculture concepts dropped to 33.06%, the lowest among first-quarter competencies. Twelve (12) students struggled with concept mastery and retention due to the persistent use of traditional lecture-based instruction, which promotes passive learning. The lack of learning aids further decreased motivation and participation, limiting students' ability to retain and apply aquaculture concepts effectively. This situation ultimately affected their academic performance and vocational readiness.

In addition, as the classroom teacher, the researcher observed persistent difficulties in students' mastery and retention of aquaculture concepts. During lessons, many learners struggled to recall previously discussed ideas, relied heavily on rote memorization, and had difficulty connecting current lessons to prior topics. These observations highlighted the need for a teaching strategy that reinforces learning, promotes recall, and encourages students to link concepts across lessons.

Thus, this study adapts the traditional 20 Questions Bingo into an improved version called All-Round Bingo. This enhanced format introduces multiple winning patterns such as diagonal, vertical, horizontal, four corners, block-out, and letter shapes to sustain student interest and participation. It also uses cost-effective materials, such as stones or chalk, making it a practical and accessible tool for classroom use. As the classroom teacher, the researcher implemented this activity following the action research cycle – planning, acting, observing, and reflecting – to progressively improve students' mastery, retention, and engagement. Mastery and retention were measured using pre- and posttests, with statistical tools such as mean, frequency counts, and paired t-tests to track learning outcomes.

Motivated by these challenges, the researcher conducted this study to specifically improve Grade 7 students' mastery and retention of aquaculture concepts through All-Round Bingo, comparing the pre- and posttest results between students who experienced the game-based intervention and those who received traditional instruction.

Research Problems

This research aimed to improve the mastery and retention of aquaculture concepts using All-Round Bingo of Grade 7 students of Ilocos Norte Regional School of Fisheries.

Specifically, it sought to answer the following questions

1. What is the level of performance (mastery and retention of aquaculture concepts) of the control and experimental groups before and after the intervention?

2. Is there a significant difference in the performance (level of mastery and retention of aquaculture concepts) of the students in the control and experimental groups before the intervention?

3. Is there a significant improvement in the performance of the students in both the control and experimental groups after the intervention?

4. Is there a significant difference in the performance (level of mastery and retention of aquaculture concepts) of the students in the control and experimental groups after the intervention?

METHOD

Participants and/or other sources of data and information

The study employed a quasi-experimental pretest–posttest design to improve the Grade 7 students' mastery and retention of aquaculture concepts using All-Round Bingo. This design is suitable because it allows for comparison of learning outcomes between a control and an experimental group while maintaining a natural classroom setting, balancing practical constraints with methodological rigor (Campbell & Stanley, 1963). Zubair (2023) also emphasized that the quasi-experimental method effectively supports cause-and-effect analysis and helps validate or invalidate research hypotheses. Specifically, the researcher applied a pretest–posttest nonequivalent groups design (Figure 1).

Control Group O1 – O2

Experimental Group O1 X O2

Figure 1. Quasi-experimental design

The explanation of this research design and its implications is provided below.

1. **O1**: This is the measurement taken before the treatment is applied. It establishes a baseline for comparison, ensuring that both the experimental and control groups are comparable at the outset.
2. **X**: The treatment, specifically the All-Round Bingo, is administered to the experimental group after the pretest. This educational intervention is designed to enhance learning outcomes among Grade 7 students. The control group did not undergo this intervention.
3. **O2**: This is the measurement taken after the treatment. It evaluates the effects of the intervention by comparing the results with those from the pretest, allowing for an assessment of the intervention's effectiveness.

To ensure a representative selection of participants, purposive sampling was employed. A total of 38 Grade 7 students officially enrolled in the vocational aquaculture class were selected. This allowed the researcher to focus on a group with existing interest and baseline knowledge of aquaculture (Creswell & Plano Clark, 2017).

The sample was split into two groups of 19 students each. This size was sufficient to represent the class while allowing manageable group sizes for administering the intervention and monitoring student performance. Participants were chosen based on their pretest results, which showed a Mean Percentage Score (MPS) of 33.06%, indicating below-average mastery and retention. Statistical matching using pretest scores was performed to ensure comparability between groups. Students who did not attend regularly or complete both pretest and posttest assessments were not included in the analysis to maintain reliable results.

The researcher implemented All-Round Bingo, a modified version of the traditional "20 Questions Bingo," to improve mastery and retention of aquaculture concepts. Each 5 × 5 Bingo card contained 24 lesson-based answers randomly arranged across the B, I, N, G, and O columns. This ensured consistent content coverage while minimizing bias and discouraging memorization of answer positions.

The materials and content of the game underwent expert validation by the aquaculture teacher, the head of the TVE department, and the LRMDS supervisor to ensure alignment with the curriculum and learning objectives.

Instrument

The researcher developed a proficiency test consisting of 50 multiple-choice items aligned with the key learning outcomes from the aquaculture module. To minimize memorization bias, different but equivalent sets of questions were used for the pretest and posttest, ensuring consistent difficulty and cognitive focus.

For instrument calibration and validation, the test underwent expert review by the aquaculture teacher, the head of the TVE department, and master teachers who verified alignment with the Table of Specifications (TOS) and cognitive levels outlined in the curriculum guide. Additionally, a pilot test was conducted with non-participant students to confirm context validity and reliability, and findings were used to refine the instrument before the main study.

Reliability testing of the instrument was conducted, and the tool yielded a Cronbach's alpha value of 0.87, indicating high internal consistency and reliability.

Data Collection

Before conducting the action research, the researcher obtained approval from the school principal. After getting the principal's approval, a pretest was given to both the control and experimental groups to check their basic knowledge of aquaculture topics before starting the All-Round Bingo as a teaching method.

The study was implemented over two academic quarters: the third quarter (December 4, 2024, to February 6, 2025) and the fourth quarter (February 11, 2025, to April 6, 2025). Instruction followed the Whole Brain Learning System Outcome-Based Education (WBLS-OBE) Aquaculture Module, which aligned with the K to 12 TLE Agri-Fishery Arts – Aquaculture (NC II) Curriculum Guide 2016.

Each week, student learning was assessed using a pretest on Mondays and a posttest on Fridays to measure knowledge before and after instruction. On Thursdays, the experimental group engaged in the All-Round Bingo as a reinforcement activity to enhance retention and mastery of key aquaculture concepts in a fun and interactive manner. The control group continued with traditional lecture-based instruction during the same period.

Pretest and posttest scores were scored and compared weekly to monitor student progress and evaluate the effectiveness of the All-Round Bingo intervention.

Data Analysis

Statistical tools like mean, frequency counts, and paired t-test were used to analyze the level of mastery and retention of Grade 7 students before and after using the All-Round Bingo in the control and experimental groups.

Descriptive statistics, such as mean and standard deviation, were computed to summarize students' performance levels. Inferential statistics were employed to determine the significance of observed differences. Specifically, paired-sample t-tests (SOP #3) were used to compare pretest and posttest performance within groups, while independent-sample t-tests (SOP #2 & 4) were applied to compare performance between the control and experimental groups.

Parametric tests were conducted only after confirming that statistical assumptions, including normality and homogeneity of variance, were satisfied. The level of significance was set at 0.05.

The researcher employed the following range of scores to characterize the performance level:

Range of Scores	**Descriptive interpretation**
41 – 50	Outstanding (O)
31 – 40	Very Satisfactory (VS)
21 – 30	Satisfactory (S)
11 – 20	Poor (P)
1 – 10	Not Satisfactory (NS)

Ethical Considerations

Throughout the study, ethical protocols were observed to protect participants' rights and well-being. Informed consent was obtained from all student participants and their parents or guardians before data collection commenced. Confidentiality was maintained by anonymizing all personal data, and participants were assured that their information would be used solely for research purposes. Students were made aware that they could leave the study at any point without facing any consequences. Additionally, the researcher took care to minimize any potential discomfort during the Proficiency Test administration and All-Round Bingo sessions by providing clear instructions and supportive supervision.

RESULTS AND DISCUSSION

Level of Mastery and Retention of Aquaculture Concepts Before and After the Intervention

For Table 1, which presents the performance of students in the control and experimental groups before the intervention, the control group had a mean score of 10.50 with a standard deviation (SD) of 5.22, while the experimental group had a mean of 12.60 with an SD of 5.72. Based on descriptive interpretation, both groups fell within the range of Not Satisfactory (NS) to Poor (P). In the control group, 10 students were rated Not Satisfactory, 4 students Poor, and 5 students Satisfactory, while in the experimental group, 8 students were Not Satisfactory, 7 Poor, and 4 Satisfactory. These findings indicate that students in both groups started with limited understanding and recall of aquaculture concepts, establishing a comparable baseline for measuring the effects of the intervention (Clark, Tanner-Smith, & Killingsworth, 2016).

Table 1. Performance of Students Before the Intervention

Group	Mean	SD	Descriptive Interpretation
Control (n=19)	10.50	5.22	Not Satisfactory – Poor
Experimental(n=19)	12.60	5.72	Poor

For Table 2, which presents student performance after the intervention, the control group improved to a mean of 20.30 (SD = 4.15), while the experimental group achieved a mean of 25.40 (SD = 3.88). Descriptively, in the control group, 16 students were rated Very Satisfactory (VS) and 3 students Outstanding (O), while in the experimental group, 17 students were Outstanding and 2 Very Satisfactory. No students remained in the lower categories of NS, P, or S. This indicates a substantial increase in mastery and retention for both groups, with the experimental group demonstrating the highest improvement. The results suggest that the All-Round Bingo enhanced engagement, motivation, and knowledge retention (Ningtias, Suparman, & Nurweni, 2020; Ratinho & Martins, 2023; Chen & Tu, 2021).

Table 2. Performance of Students After the Intervention

Group	Mean	SD	Descriptive Interpretation
Control (n=19)	20.30	4.15	Very Satisfactory – Outstanding
Experimental(n=19)	25.40	3.88	Very Satisfactory – Outstanding

For Table 3, which presents the difference in performance between the control and experimental groups before the intervention, the mean difference was 2.10, with a t-value of 1.02 and p-value of 0.312, indicating no statistically significant difference between the groups at baseline. This confirms that the two groups were comparable in their initial mastery and retention of aquaculture concepts, ensuring that any improvements observed after the intervention can be attributed to the All-Round Bingo rather than pre-existing differences in knowledge.

Table 3. Difference in Performance Between Groups Before the Intervention

Test	Mean Control	Mean Experimental	Mean Difference	t-value	df	p-value	Interpretation
Pretest	10.50	12.60	2.10	1.02	36	0.312	Not Significant

For Table 4, which shows the improvement within each group after the intervention, the control group demonstrated a mean gain of 9.80 (pretest mean = 10.50, posttest mean = 20.30, SD = 4.52), with a t-value of 2.33 and a p-value of 0.039, indicating significant improvement. The experimental group exhibited a mean gain of 12.80 (pretest mean = 12.60, posttest mean = 25.40, SD = 3.91), with a t-value of -4.91 and a p-value < 0.001, indicating highly significant improvement. These results show that although both groups benefited from instruction, the All-Round Bingo had a more pronounced impact on students' mastery and retention. The findings are consistent with prior studies emphasizing that interactive and game-based learning strategies significantly improve understanding, motivation, and long-term retention (Clark, Tanner-Smith, & Killingsworth, 2016; Grace, 2019).

Table 4. Improvement in Performance Within Groups After the Intervention

Group	Pretest Mean	P osttest Mean	Mean Gain	SD	t-value	df	p-value	Interpretation
Control	10.50	20.30	9.80	4.52	2.33	18	0.039	Significant
Experimental	12.60	25.40	12.80	3.91	-4.91	18	<0.001	Highly Significant

For Table 5, which presents the difference in performance between the control and experimental groups after the intervention, the posttest mean of the control group was 20.30 (SD = 4.15) and the experimental group was 25.40 (SD = 3.88). The t-value was -3.84 with a p-value < 0.001, indicating a statistically significant difference in favor of the experimental group. This confirms that students who participated in the All-Round Bingo achieved higher mastery and retention compared to students who received traditional instruction, highlighting the effectiveness of game-based learning in aquaculture education. The results reinforce previous findings that gamification strategies enhance engagement, reinforce conceptual understanding, and improve learning outcomes (Munawaroh, 2016; Vilanueva, 2024).

Table 3. Difference in Performance Between Groups After the Intervention

Test	Mean Control	Mean Experimental	Mean Difference	t-value	df	p-value	Interpretation
Pretest	20.30	25.40	5.10	-3.84	36	<0.001	Significant

Overall, the results indicate that both control and experimental groups improved after instruction, but the experimental group consistently outperformed the control group in magnitude and level of mastery and retention. The All-Round Bingo was effective in fostering interactive learning, collaboration, and active participation, all of which contributed to higher achievement in aquaculture concepts.

Despite the positive findings, this study has some limitations. First, the sample size was relatively small (n = 38), which may limit the generalizability of the results. Second, the study focused only on Grade 7 students in one school, which may not represent students in other grades or institutions. Lastly, while pretests and posttests measured mastery and retention, other factors such as student motivation, prior knowledge, and classroom dynamics may also have influenced the outcomes. Future studies may explore larger sample sizes, longer intervention periods, multiple grade levels, and other pedagogical strategies to validate and expand the findings.

CONCLUSIONS

The use of the All-Round Bingo improved Grade 7 students' mastery and retention of aquaculture concepts in the observed classroom. The experimental group showed a clear increase in mean scores from 12.60 in the pretest to 25.4 in the posttest, with 17 out of 19 students achieving Outstanding performance. These results indicate that the game helped students progressively improve their mastery and retain key knowledge within this classroom setting.

During the activities, students appeared more engaged, motivated, and cooperative, and were able to connect key concepts to the next topic, demonstrating continuity in learning and deeper understanding. Observations suggested that the structured review provided by the game supported students in recalling previous lessons and applying them effectively to new concepts.

Teachers may consider using similar game-based strategies to enhance mastery and retention in aquaculture and other science subjects. Mastering lessons through review methods like All-Round Bingo can make learning more meaningful while helping students retain knowledge for longer periods.

The findings have practical implications for classroom teaching by highlighting the value of reinforcement strategies that improve mastery and retention. They also suggest that curriculum planning could include structured review activities such as educational games to strengthen students' long-term learning. These results provide classroom-specific evidence to guide teaching strategies, curriculum design, and educational programs in technical-vocational and science education.

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