Enhancing Fish Cage Construction Skills: Effectiveness of Climb the Ladder to Aquaculture Success (CLAS) Among Grade 9 Students

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ABSTRACT

Fish cage construction competency in Grade 9 constitutes an essential prerequisite for Grade 10 promotion and TESDA certification for Aquaculture NC II; however, students consistently demonstrate deficient practical skills. This explanatory sequential mixed-methods study evaluated the Climb the Ladder to Aquaculture Success (CLAS), a constructivist, gamified intervention, among 35 Grade 9 aquaculture students at the Ilocos Norte Regional School of Fisheries (INRSF) using total enumeration sampling. A quasi-experimental one-group pretest-posttest design was used to measure practical skill gains, supported by thematic analysis of interviews with six purposively selected participants. The assessment rubric, validated through expert judgment using Aiken's V index (above 0.80) and an excellent inter-rater reliability of 0.85 (95% CI: 0.72–0.93, $p < 0.001$), demonstrated significant improvement from 41% MPS ($M = 8.20$, $SD = 4.10$; "Average") pre-intervention to 91% MPS ($M = 18.20$, $SD = 2.17$; "Closely Approximating Mastery") post-intervention. Distribution analysis showed that 94% of students achieved the top two mastery levels (Mastered and Closely Approximating Mastery), confirmed by a paired-samples t-test (t (34) = 18.22, $p < 0.001$, Cohen's $d = 3.08$; “Very Large Effect”). Assumptions of normality were verified using the Shapiro–Wilk test ($p > .05$). Qualitative themes revealed enhanced motivation, step-by-step mastery reinforcement, task readiness, and practical confidence, addressing cognitive obstacles in sequential skill development. Study limitations include a single-group design and a single-site sample, suggesting future research incorporate control groups, delayed post-tests, and multi-institution sampling. CLAS effectively transforms practical aquaculture competencies, providing a scalable, low-cost model for TVL programs. Its structured gamification aligns with constructivist principles, fostering psychomotor proficiency and engagement essential for fisheries workplace readiness.

Keywords: CLAS, Miniature Fish Cage Construction, Gamification, TVL Aquaculture, Practical Skills

INTRODUCTION

Practical skills in aquaculture involve applying scientific principles and technical knowledge to perform tasks effectively and safely in real-world settings. Republic Act No. 10533, the Enhanced Basic Education Act of 2013, integrates technical-vocational competencies into the senior high school curriculum to produce industry-ready graduates. In line with this mandate, the Technical Education and Skills Development Authority (TESDA) Aquaculture National Certificate (NC) II standards define core competencies that prioritize hands-on skills directly applicable to aquaculture workplaces (TESDA, 2004).

Despite these policy provisions, recent assessments indicate persistent gaps in students’ foundational knowledge and practical performance, which constrain their workplace readiness (Mayor Anunciacion R. Tuazon National School of Fisheries, 2023). Traditional lecture-based instruction often fails to develop the sequential thinking and mastery of procedures required for aquaculture facility construction, particularly in specialized tasks such as fish cage construction. This misalignment between instructional approaches and competency standards underscores the need for innovative, activity-based strategies that strengthen students’ practical skills.

Game-based learning (GBL) has emerged as a promising pedagogical approach that delivers scientific concepts through structured gameplay, balancing conceptual understanding with experiential practice

(Agandao, 2026). Previous research shows that GBL can improve learning performance, enhance recall and application, foster problem-solving skills, and increase motivation in technical-vocational contexts (Kula, 2021; Syafii, 2020; Agandao, 2026; Lagmay et al., 2025; Adipat et al., 2021). Board games such as Snakes and Ladders have been found effective for developing sequential comprehension (Nachiappan et al., 2014; Pradiansyah et al., 2025), a skill essential for step-by-step aquaculture processes. Moreover, students demonstrate strong engagement with games, making this modality an effective medium for promoting learning.

At the Ilocos Norte Regional School of Fisheries (INRSF), Grade 9 students achieved a Mean Percentage Score (MPS) of only 44.00% in fish cage construction during the S.Y. 2024–2025, the lowest among assessed competencies in the fourth quarter. This low performance was attributed to passive lecture methods, limited interactive materials, and persistent disengagement during discussions and hands-on activities, which restricted attention span and participation. Consequently, outputs were frequently substandard and tasks often incomplete, impeding the mastery of sequential procedures essential for fish cage construction.

In response to these challenges, this study adapted Snakes and Ladders into an enhanced instructional board game called Climb the Ladder to Aquaculture Success (CLAS). CLAS is specifically designed to support hands-on activities that require sequential steps, with a focus on fish cage construction. It uses cost-effective materials, including 5 × 5 CLAS cards and a standard dice, making it a practical and accessible tool for public school classrooms. Thus, CLAS was implemented by the classroom teacher-researcher in an authentic instructional setting and served as a motivational strategy while student performance and learning outcomes were systematically monitored.

This study aimed to enhance the practical skills of Grade 9 Aquaculture students in fish cage construction through CLAS, using an explanatory sequential mixed-methods design with a quasi-experimental one-group pretest–posttest approach. The practical skills performance of 35 participants before and after the intervention was compared to determine the effectiveness of CLAS in addressing skill deficiencies and contributing to improved workplace readiness in aquaculture.

Research Problems

This study aimed to enhance fish cage construction skills among Grade 9 students at Ilocos Norte Regional School of Fisheries through the Climb the Ladder to Aquaculture Success (CLAS) intervention.

Specifically, it sought to address the following questions:

1. What is the level of practical skills in fish cage construction among Grade 9 aquaculture students before the CLAS intervention?

2. What is the level of practical skills in fish cage construction among Grade 9 aquaculture students after the CLAS intervention?

3. Is there a significant difference between the practical skills levels of Grade 9 aquaculture students before and after the CLAS intervention?

4. What are the perceptions of Grade 9 aquaculture students regarding the effectiveness of CLAS in enhancing their practical skills and engagement during fish cage construction activities?

METHOD

Participants and/or other sources of data and information

The study employed an explanatory sequential mixed-methods design, with quantitative data collection and analysis preceding a qualitative phase to interpret quantitative findings. The quantitative phase utilized a quasi-experimental one-group pretest-posttest design to measure changes in Grade 9 students' practical skills in fish

cage construction before and after the instructional intervention. This approach suited the identified performance gap and participant characteristics, enabling direct intervention delivery without a control group (Cortez, 2023; Lazo, 2021). Post-intervention assessments indicated improvements after implementation, suggesting intervention-related improvement within an authentic classroom context (Solis, 2023; The World Bank, 2020).

Participants included 35 Grade 9 Aquaculture students from Ilocos Norte Regional School of Fisheries (INRSF) Goldfish and Guppy sections, selected through total enumeration based on their 44% fourth quarter Mean Percentage Score (MPS) in fish cage construction during S.Y. 2024–2025. Representing a single homogeneous cohort despite multi-section origin, the final analytic sample comprised 35 students after excluding eight students due to absenteeism or missing parental consent (Agandao, 2026). Qualitative data were gathered through one-on-one interviews with six (6) purposively selected participants directly involved in the instructional and construction activities. The sample size was deemed sufficient upon reaching data saturation, consistent with methodological evidence suggesting that core themes often emerge within the first six interviews in homogeneous samples (Guest et al., 2006). The transcripts were analyzed using thematic analysis to examine perceptions of instructional activities and engagement.

The intervention featured Climb the Ladder to Aquaculture Success (CLAS) using 5 × 5 cards with lesson-specific questions and sequential steps, advanced via dice rolls indicating "move" or "stop." This gamified intervention was underpinned by a constructivist learning framework, as supported by recent literature (Angraini, Kania, & Gürbüz, 2024).

Instrument

The researcher adopted the validated "Assessment Tool: Miniature Fish Cage Making" rubric developed by the aquaculture teacher during S.Y. 2024-2025, commonly used to evaluate aquaculture student outputs and during school contests at INRSF. This 20-point analytic rubric (5 criteria × 4 points) assessed design, creativity, practicality, neatness, and timeliness on a 4-point scale (4 = excellent, 3 = good, 2 = fair, 1 = poor), with final scores representing the average of four independent evaluators, one aquaculture teacher and three INRSF fishermen with fish cage experience.

For instrument calibration and validation, the rubric underwent expert review and pilot testing with non-participant students to confirm clarity, suitability, and alignment with TVL/NC II standards. Content validity evidence was established using Aiken's V index based on expert judgments, as recommended in recent methodological guidance (Kania et al., 2024), yielding values above the 0.80 threshold for acceptability. Inter-rater reliability testing yielded an ICC = 0.85 (95% CI: 0.72–0.93, $p < 0.001$), indicating excellent evaluator agreement. Confidence intervals and statistical assumption checks (normality via Shapiro-Wilk, $p > 0.05$) further confirmed analytical rigor. Additionally, CLAS card materials received expert validation from the aquaculture teacher, TVE department head, and LRMDS supervisor to confirm alignment with curriculum standards and learning objectives (Agandao, 2026).

Data Collection

Before conducting the study, the researcher secured approval from the school principal. Following this, parental consent was obtained for all 35 student participants. Students were instructed to bring standardized materials for the construction of a miniature fish cage, including a net (30 cm × 30 cm), a bamboo framework (22 inches or 56 cm in length), a floater (250 mL plastic bottle), a sinker (*buli, tingga*, or lead sinker weighing 50 g), and an anchor (weight or *angkla* weighing 100–150 g). These standardized measurements ensured the construction of a stable and proportional miniature model suitable for Grade 9 skills assessment. In cases where materials were unavailable, the teacher-researcher provided them to ensure equitable participation.

The study was conducted over two weeks during the fourth quarter (February 9–20, 2026), utilizing the Whole Brain Learning System–Outcome-Based Education (WBLS–OBE) Aquaculture Module aligned with National Certificate II (NC II) competencies.

Week 1 (February 9–13, 2026**).** A pre-practical test on miniature fish cage construction was administered on February 9–10, 2026 to establish baseline skills. The outputs from the pre-test were evaluated to identify areas where students experienced the most difficulty. This was followed by instructional discussions from February 11–13, 2026, with daily CLAS card reinforcement activities conducted after each session.

Week 2 (February 16–20, 2026). Instructional discussions continued February 16–17, 2026, followed by CLAS card activities after each session. The post-practical test was conducted on February 18–19, 2026, during which students constructed miniature fish cages by applying the concepts, techniques, and strategies learned from the discussions and CLAS intervention. Final evaluation of student outputs was conducted on February 20, 2026 by four independent evaluators.

Data Analysis

Quantitative data from pre- and post-intervention practical tests on miniature fish cage construction skills were analyzed using descriptive statistics, including mean (M), standard deviation (SD), and coefficient of variation (CV), to determine students' skill levels before and after the CLAS intervention. The coefficient of variation, calculated as (SD ÷ M) × 100%, assessed score variability, interpreted as low (<20%), moderate (20–50%), and high (>50%) variability.

To determine the statistical significance of skill improvement, a paired-samples t-test compared pre- and post-intervention mean scores. Cohen's d was calculated to assess the practical significance of observed differences, with thresholds of 0.2, 0.5, and 0.8 indicating small, medium, and large effect sizes, respectively.

In this study, students' final scores were calculated as the average of four independent evaluators' ratings, comprising one aquaculture teacher and three INRSF fishermen experienced in fish cage construction. Each evaluator assessed five criteria: design, creativity, practicality, neatness, and timeliness, using a four-point analytic rubric (4 = excellent, 3 = good, 2 = fair, 1 = poor). Averaging ratings across evaluators enhanced reliability and minimized potential bias.

Raw average scores, corresponding mean percentage scores (MPS), and descriptive equivalents are presented below. The rubric is adapted from DepEd Memorandum No. 160, s. 2012 (Department of Education, 2012)

Mastery/Achievement Level		
Raw Average Score	MPS	Descriptive Equivalent
19-20	96-100%	Mastered
17-18	86-95%	Closely Approximating Mastery
13-16	66-85%	Moving Towards Mastery
7-12	35-65%	Average
3-6	15-34%	Low
1-2	5-14%	Very Low
0	0-4%	Absolutely No Mastery

Qualitative data were collected via semi-structured one-on-one interviews with six (6) purposively selected students, representing diverse pre- and post-intervention gains. Thematic analysis, following Braun and Clarke (2006) six-step framework, was conducted to identify recurring patterns and emergent themes related to students' experiences, engagement, and perceptions of the CLAS intervention.

Ethical Considerations

Ethical protocols were strictly observed throughout the study to protect participants' rights and welfare. Data collection was conducted during the 2025–2026 academic year in full compliance with Division Memorandum No. 443, s. 2025.

Informed consent was obtained from all 35 student participants and their parents/guardians before data collection. Participants received comprehensive information about their rights, emphasizing voluntary involvement and the freedom to withdraw at any time without facing academic consequences (Hennink, Kaiser, & Weber, 2019).

Participant confidentiality and anonymity were maintained through unique ID numbers and pseudonyms. For the qualitative component, audio recordings from individual interviews were securely stored on password-protected devices and deleted immediately post-transcription (TutorChase, 2023). All data remained accessible only to the researcher, with raw datasets destroyed post-analysis per institutional guidelines.

Institutional approvals included principal authorization before implementation. A safe learning environment was ensured through clear instructions, close supervision, and supportive guidance during practical tasks and CLAS activities. Equity was maintained by providing identical interventions to all participants, eliminating implementation bias.

No conflicts of interest existed. The study adhered to DepEd ethical standards for research involving minors.

DISCUSSION OF RESULTS AND RECOMMENDATIONS

Level of Practical Skills Performance Before CLAS Intervention

Before the intervention, Grade 9 aquaculture students demonstrated moderate baseline skill limitations that significantly constrained their miniature fish cage construction performance. Their pre-intervention mean score was 8.20 (SD = 4.10), representing 41% MPS, which is classified as “Average” under DepEd TVL standards (Memorandum No. 160, s. 2012). Distribution analysis revealed 51% (*n*=18) Low, 31% (*n*=11) Average, and 17% (*n*=6) Moving Towards Mastery, indicating meaningful baseline skill gaps. These results indicated notable learning process gaps (Anni, as cited in Ramadhani, 2021), necessitating active, collaborative interventions as recommended by Purnomo et al. (2024).

Table 1. Pre-Intervention Practical Skills Performance (N = 35)

Measure	Mean	SD	MPS	Level
Pre-practical	8.20	4.10	41%	Average

Level of Practical Skills Performance After CLAS Intervention

After the intervention, students achieved substantial mastery. The post-intervention mean score increased to 18.20 (SD = 2.17), representing 91% MPS ("Closely Approximating Mastery"). Distribution analysis revealed 74% (*n*=26) Closely Approximating Mastery, 20% (*n*=7) Mastered, and 6% (*n*=2) Moving Towards Mastery. No students remained in the Average or Low categories.

The reduced standard deviation from 4.10 to 2.17 indicates more consistent high performance across participants after the intervention. Game-based learning activities are documented to boost students' self-confidence, teamwork, and communication skills (Tasya, Vitoria, & Nurmasyitah, 2024; Zuita, Nur'aeni, & Nurgraha, 2020), accounting for CLAS’s dramatic effectiveness. Game-based strategies further enhance conceptual understanding and retention through engaging, hands-on experiences (Behnamnia et al., 2020; Diquito, 2023), explaining the uniform miniature fish cage construction proficiency achieved.

Table 2. Post-Intervention Practical Skills Performance (N = 35)

Measure	Mean	SD	MPS	Level
Post-practical	18.20	2.17	91%	Closely Approximating Mastery

Pre-Post Comparison and Statistical Significance

Paired samples t-test analysis confirmed a highly significant improvement in students' fish cage construction skills after the CLAS intervention. Students demonstrated a mean gain of 10.00 points (SD = 3.25). This improvement was statistically significant, $t(34) = 18.22$, $p < .001$. The computed effect size was extremely large, Cohen's $d = 3.08$, substantially exceeding the conventional benchmark of 0.80 for a large effect.

Learning effectiveness benchmarks internal learning processes through time efficiency, student responses, and concept mastery, serving as the core measure of educational success when outcomes improve (Awalianti, 2025). This aligns with Nana Sudjana's (2006) as cited in Awalianti (2025) view that post-instructional gains enhance cognitive, emotional, and psychomotor development beyond pre-learning baselines. These findings demonstrate CLAS effectiveness in aligning students' practical skills with TESDA NC II performance standards, particularly by addressing cognitive obstacles and supporting sequential mastery development in skill-based learning contexts (Kania et al., 2024).

Table 3. Pre-Post Practical Skills Improvement (N = 35)

Measure	Mean	SD	t-value	Df	p-value	Cohen's d	Descriptive Interpretation
Mean Gain	10.00	3.25	18.22	34	< .001	3.08	Very Large Effect

Students' Perceptions of CLAS Effectiveness

This section presents the emerging themes from students' perceptions of CLAS implementation, focusing on its influence on fish cage construction skills and overall learning engagement.

Theme 1: Enhanced Daily Motivation

All participants reported CLAS made activities enjoyable rather than overwhelming, with daily progression reducing frustration while building confidence. Chris stated: *"I love the CLAS game! Every day after the discussion, sobrang saya ko kasi na-master ko ang topic at natutunan ko ang process sa paggawa ng fish cage."* Gamification research confirms that structured progression enhances technical skills motivation through immediate feedback and achievement systems (Chung & Chan, 2016). Similarly, classroom-based findings in aquaculture instruction have documented increased learner engagement, cooperation, and conceptual continuity when structured, progressive strategies are implemented (Agandao, 2026).

Theme 2: Step-by-Step Mastery Reinforcement

Students consistently noted improved sequence recall under pressure through competitive elements. Lorna shared: *"Yehey! Nakakuha ako ng second place sa fish cage construction! Dati, hindi ko alam ang gagawin, pero dahil sa CLAS, tinulungan akong maalala ang step-by-step process."* Game-based reinforcement outperforms rote memorization for psychomotor domains, with meta-analyses and vocational studies showing significant gains in skill retention, performance, and engagement (Li, Ma, & Shi, 2023).

Theme 3: Task Readiness Development

Self-assessment before advancement bridged home observations to classroom execution. Mark reflected: *"Sa CLAS, na-check ko kung ready na ba ako sa next step… Dati, nakikita ko lang ang tatay ko na gumagawa ng*

fish cage, ngayon, ginawa ko na rin sa klase." This validates TESDA NC II progression models emphasizing competency gates, aligning with gamification's adaptive challenge features in vocational training (Anno, 2025).

Theme 4: Practical Confidence Building

Novices gained courage through repeated low-risk practice. Anna captured this: *"Hindi ako humahawak ng nets at ropes dati. Nakikita ko lang ang mga ito sa fish port, ang daming fish cages doon. Ngayon, nagawa ko na, at natutunan ko pang turuan ang groupmates ko. Imagine that, Ma'am! Hahaha."* Repeated mastery experiences build self-efficacy per Bandura (1997), while recent vocational studies confirm gamification's role in psychomotor confidence and peer teaching in hands-on skills training.

Although the study showed positive results, several limitations exist. The single-group pre-post design without a control group limits causal attribution strength. The rural sample (N=35) from one school of fisheries restricts generalizability to urban or multi-regional DepEd contexts. Self-reported perceptions may contain social desirability bias despite triangulation, and long-term skill retention beyond immediate post-test was not assessed.

Future research should incorporate a control group design and delayed post-test measures to improve causal inference and assess long-term retention. Expanding the sample across multiple institutions would enhance generalizability. Reporting confidence intervals and statistical assumption checks, as demonstrated here, should continue to strengthen analytical rigor.

CONCLUSIONS

The CLAS substantially improved Grade 9 students' miniature fish cage construction skills at Ilocos Norte Regional School of Fisheries, increasing performance from 41% MPS ("Average") to 91% MPS ("Closely Approximating Mastery"). The distribution after the intervention analysis showed that 74% (n = 26) achieved "Closely Approximating Mastery" and 20% (n = 7) "Mastered," while the remaining 6% (n = 2) reached "Moving Towards Mastery," demonstrating that all students attained the top three mastery levels. This confirms the game's effectiveness in addressing practical skill deficiencies and aligning student performance with TESDA NC II competency standards.

Students exhibited enhanced engagement, motivation, confidence, and sequential step connection, reflecting deeper psychomotor understanding. Observations confirmed that CLAS's structured, step-by-step approach facilitated recall and application of fish cage construction skills. Thematic analysis further validated these outcomes, with student perceptions illustrating meaningful learning: Chris reported daily enjoyment, Lorna achieved contest success through improved recall, Mark connected family knowledge to classroom practice, and Anna overcame apprehension in handling materials.

Statistical analysis corroborated these improvements, showing a mean gain of 10.00 points (SD = 3.25), $t(34) = 18.22$, $p < .001$, with an extremely large effect size (Cohen's $d = 3.08$), confirming both statistical significance and practical relevance. The intervention's low-cost materials support scalability while effectively transforming students' practical skills, providing an accessible model for enhancing TVL aquaculture competencies across schools. Its structured, game-based approach aligns with TESDA NC II standards, fosters sequential mastery, and promotes student engagement and confidence in hands-on tasks. Adoption of CLAS by aquaculture teachers is recommended to reinforce psychomotor skills, cultivate collaborative learning, and bridge performance gaps in fish cage construction in aquaculture.

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