

RESEARCH ARTICLE

Development of a Three-Level Instructional Video Set for a Safe Alternative to Traditional Tabata Workouts

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ABSTRACT

College students need safer, progressive methods for Tabata workouts since traditional programs are too intense for some, causing discomfort. This developmental research aimed to design, refine, and evaluate a safe and pedagogically sound three-level modified Tabata instructional video set (adaptive, beginner, and intermediate) tailored for college students with varying fitness levels. Guided by the SAM model, the study followed a systematic process involving analysis of learner needs, prototype development, expert evaluation, iterative revisions, and usability assessment. Three fitness experts from Mindanao provided qualitative feedback using a researcher-developed Instructional Video Evaluation Rubric, while 71 students and 5 PE teachers assessed the final version using the System Usability Scale (SUS). Expert reviewers identified several areas for improvement in the initial prototype, including clarity of presentation, pacing, facial expressiveness, movement synchronization, proper exercise terminology, sequencing, and creative design elements. Guided by this feedback, the instructional video was revised to include accurate technical cues, structured warm-up-main workout-cooldown flow, enhanced instructional clarity, adaptive exercise variations, and refined visual design. Following the revisions, students and teachers rated the final videos as having Very Good to Excellent Usability, indicating strong perceived clarity, ease of use, and user confidence. The study concludes that the modified Tabata instructional video set achieved its goal of providing a safety-oriented, accessible, and engaging HIIT resource suitable for classroom and independent learning settings. Future research may explore experimental testing of fitness outcomes, AI-assisted movement analysis, and the development of an advanced-level Tabata video to complete the progression.

KEYWORDS Tabata training, instructional video, developmental research, Successive Approximation Model (SAM), System Usability Scale, high-intensity interval training, physical education, usability evaluation

Introduction

Physical inactivity remains a significant public health concern among college students, who often struggle to balance academic demands with regular exercise (Pan *et al.*, 2022). As higher education institutions increasingly aim to promote student wellness, instructional fitness materials—especially video-based resources—have emerged as an essential strategy for improving accessibility, motivation, and engagement in physical activity (Fyfield *et al.*, 2019; Choe *et al.*, 2019). However, the effectiveness of such materials depends greatly on their instructional design quality, clarity of demonstration, and usability, underscoring the need for evidence-based development processes (Mayer, 2021; Castillo *et al.*, 2021).

High-Intensity Interval Training (HIIT), particularly the Tabata protocol, has gained prominence as a time-efficient method for improving cardiovascular fitness, body composition, and psychological well-being across diverse populations (Domaradzki *et al.*, 2020; Lu *et al.*, 2023; Guo *et al.*, 2023). In educational settings, Tabata workouts have demonstrated potential to enhance fitness levels while accommodating limited class time and space, making them suitable for school- and university-based PE programs (Duncombe *et al.*, 2022a; Lee *et al.*, 2021). Despite these advantages, improper demonstration, unclear instructions, and lack of progression in fitness videos can increase injury risk and reduce adherence—issues that highlight the importance of structured, pedagogically sound instructional material design (Alekseyev *et al.*, 2020; Kushartanti, 2023; Szymski *et al.*, 2021).

Instructional video development grounded in systematic design frameworks such as the SAM model allows for iterative refinement, alignment with learner needs, and incorporation of expert feedback (Ghani & Daud, 2018; Ablir, 2023). Research shows that well-designed multimedia support enhances motor learning, promotes confidence, and increases adherence, particularly when safety cues, segmentation, and clear demonstrations are integrated (Mayer, 2021; Werner & Gorman, 2021; Zheng *et al.*, 2022). Moreover, usability testing, including the System Usability Scale (SUS), provides a rigorous method for evaluating whether learners perceive the instructional material as clear, intuitive, and engaging (Bangor *et al.*, 2008; Idrisov *et al.*, 2023).

Despite substantial literature on HIIT interventions, injuries in fitness participation, and multimedia instructional design, there remains a lack of validated Tabata instructional materials tailored explicitly for Filipino college students. Local studies seldom integrate expert qualitative evaluation with quantitative usability testing, leaving a gap in evidence-based development of fitness videos suited for higher education contexts. Addressing this gap is essential as universities continue to adopt flexible learning modalities, blended PE instruction, and home-based exercise programs.

Thus, this study aimed to develop, refine, and evaluate a modified Tabata instructional video through expert review and usability assessment. By integrating multimedia learning principles, exercise science guidelines, and structured instructional design, this research contributes an evidence-informed, context-responsive fitness resource for PE instruction in higher education.

Specifically, the study sought to answer the following research questions: (1) What is the experts' feedback on the instructional Tabata prototype video? (2) Based on the feedback, what iterative revisions were made to the Tabata instructional video? (3) What are the teachers' and students' assessment of the instructional Tabata video? and (4) What instructional modified Tabata video may be recommended for tertiary-level Physical Education?

Methods and Materials

This study utilized a developmental research design informed by the Human Factors Theory (Chapanis, 1996), which emphasizes designing materials around users' capabilities, limitations, and safety, and guided by the Successive Approximation Model (SAM) as the primary framework for producing and refining the modified Tabata instructional video set. Developmental research is well-suited to creating instructional materials because it follows a systematic, iterative process that ensures alignment among content, learner needs, and pedagogical goals (Ablir, 2023; Ghani & Daud, 2018). SAM emphasizes iterative design, rapid prototyping, and continuous improvement, allowing instructional materials to be progressively enhanced through repeated cycles of feedback and revision. Literature on multimedia learning, exercise science, and HIIT safety further informed the design parameters, drawing from evidence on injury prevention, effective cueing, and optimal sequencing in workout videos (Alekseyev *et al.*, 2020; Castillo *et al.*, 2021; Lee *et al.*, 2021).

The study was conducted in a state university in Claveria, Misamis Oriental, Philippines, and involved three groups of participants: fitness experts, college students, and PE instructors. Three expert reviewers were selected through purposive sampling, consistent with recommendations for identifying individuals with specialized knowledge relevant to the phenomenon under study (Ames *et al.*, 2019; Engelhard *et al.*, 2021). Experts were required to have at least five years of experience in fitness coaching or program design, demonstrated proficiency in HIIT or Tabata training, and prior involvement in instructional material development in Mindanao. For the usability evaluation, 71 college students enrolled in PE classes and five PE teachers participated. Students had varying fitness levels, aligning with current findings that Tabata-based workouts are appropriate for diverse young adult populations when proper modifications are provided (Lu *et al.*, 2023; Pan *et al.*, 2022).

Ethical considerations were observed throughout the study, following the principles of the Belmont Report—respect for persons, beneficence, and justice. Ethical clearance was obtained from the LC-Research Ethics Committee, and administrative permission was secured from the university prior to data collection. Written informed consent was obtained from all participants, including consent for the supervised performance of the workout; participation was voluntary, and participants were informed of their right to withdraw at any time without penalty and to skip any item or stop if uncomfortable. All data were handled with confidentiality in compliance with the Data Privacy Act of 2012, with identifying information removed and records securely stored.

The Preparation phase—comprising information gathering and an initial savvy start with the researcher and content experts—involved identifying learner needs, safety considerations, and the cognitive demands of video-based instruction. This step incorporated current research on HIIT safety, exercise design, and multimedia learning principles to ensure an evidence-informed foundation (Gibala & Little, 2019; Mayer, 2021; Muñoz & Letouze, 2022). In the iterative Design phase, the researcher developed and progressively refined a storyboard detailing the warm-up, main workout, and cooldown, exercise selection, cueing strategy, video pacing, and visual layout. Design decisions followed established principles such as coherence, signaling, and segmenting to promote clearer learning and reduced cognitive load (Zheng *et al.*, 2022; Werner & Gorman, 2021).

During the iterative Development phase, the three-level video set (adaptive, beginner, and intermediate) was filmed using a high-definition camera under controlled lighting. The three levels differed primarily in movement impact, pacing, and overall intensity: the adaptive version emphasized low-impact, simplified movements; the beginner version used conservative pacing with additional cueing; and the intermediate version more closely approximated the standard Tabata work-to-rest structure. The facilitator

demonstrated each exercise with proper form, pacing, and safety cues while timed intervals followed a modified Tabata structure of 20 seconds of work and 10 seconds of rest, repeated for five rounds per exercise. Video editing included segmenting clips, inserting timers and labels, integrating music with appropriate beats per minute, and adding safety disclaimers. These procedures reflected recommendations on producing pedagogically effective and technically coherent instructional videos (Castillo *et al.*, 2021; Hadijah *et al.*, 2022).

Expert review, conducted within SAM's iterative design–prototype–review cycle, used a researcher-developed Instructional Video Evaluation Rubric that assessed presentation, content accuracy, organization, creativity, technical quality, and adherence to conventions. This rubric enabled structured, criterion-based evaluation, consistent with prior work emphasizing the importance of expert-informed multimedia feedback (Barbosa *et al.*, 2023). Experts provided both numerical ratings and detailed qualitative comments.

Consistent with SAM's iterative develop–implement–evaluate cycle, the process then proceeded through two stages: revision and usability testing. First, all expert feedback was systematically analyzed and translated into concrete revisions, such as enhancing expressiveness, adjusting pacing, correcting exercise terminology, restructuring warm-up and cooldown sequences, and improving aesthetic transitions. This iterative approach aligns with best practices in instructional design, where expert-informed refinement enhances clarity, safety, and pedagogical effectiveness (Bülow & Nørgård, 2024; Kibga *et al.*, 2022). Second, the revised video underwent usability testing using the System Usability Scale (SUS), a validated 10-item tool widely used to assess usability across domains (Bangor *et al.*, 2008; Idrisov *et al.*, 2023). Students and teachers viewed and performed the workout in a supervised PE session before completing the SUS. All items were rewritten as positive statements to avoid confusion and improve response consistency. SUS responses were scored, summed, and converted to a 0–100 usability index following standardized procedures.

Qualitative data from expert feedback were analyzed manually by categorizing comments into thematic areas such as presentation, content, safety, and organization. Each comment was matched with a corresponding revision, creating a transparent feedback–action trail. Quantitative SUS data were summarized using descriptive statistics, and mean usability scores were interpreted according to established benchmarks (Bangor *et al.*, 2008). This mixed-methods analytic procedure ensured a comprehensive evaluation of both instructional quality and user experience.

Results

This section reports the study's findings in response to the four research questions: the experts' feedback on the initial prototype, the revisions undertaken, the usability of the revised video set, and the final recommended instructional videos.

Experts' Feedback on the Initial Prototype

Expert evaluations of the initial Tabata instructional video indicated that while the prototype demonstrated functional potential, substantial refinement was needed to elevate its instructional quality and safety. Using the researcher-developed evaluation rubric, two of the three experts provided numerical ratings (overall criterion means of 3.16 and 4.00), yielding an overall prototype rating of 3.58 ("Very Good"), while the third expert offered detailed narrative feedback rather than scores. Across all reviewers, presentation issues were most prominent. Experts noted limited facial expressiveness, inconsistent energy, and uneven pacing—elements that can hinder learner engagement and clarity in video-based instruction.

Content accuracy was another recurring concern. Reviewers highlighted instances of imprecise terminology, unclear or missing muscle-targeting cues, and occasional inconsistencies in movement

execution. Reviewers also emphasized the need for a clearer structure, noting the absence of a defined sequence from warm-up to main workout to cooldown. While the creative and aesthetic elements of the prototype were found to be limited, reviewers reported no issues with technical video quality such as lighting, resolution, and auditory clarity.

Revisions Made to Improve the Instructional Video

The revisions applied to the instructional Tabata video followed an intentional and iterative process informed directly by expert comments and guided by SAM principles. Enhancements to presentation quality included improved facial expressiveness, clearer vocal cues, and synchronized pacing with the metronome to promote better learner rhythm and adherence.

Content-related revisions addressed inaccuracies in exercise names, corrected muscle-targeting explanations, and strengthened safety cues. The routine was reorganized into a clear warm-up → main workout → cooldown sequence to improve logical flow.

Creativity and design elements were enhanced through improved transitions, varied angles, and clearer visual emphasis while avoiding visual overload. Modifications for different fitness levels were incorporated to strengthen the video's inclusivity and instructional adaptability. Captions, terminology, and documentation were standardized to further improve professionalism and instructional accuracy.

Usability Level of the Revised Video

The System Usability Scale (SUS) assessment revealed that both students and teachers perceived the revised video set as highly usable. On the five-point interpretive scale, students gave an overall mean of 4.34 (SD = 0.74), corresponding to Very Good Usability, while teachers gave an overall mean of 4.92 (SD = 0.34), corresponding to Excellent Usability (item-level results are summarized in Table 1).

Table 1. System Usability Scale Results for Students and Teachers

Item	SUS Statement	Students, M (SD) (n = 71)	Teachers, M (SD) (n = 5)
1	I would like to use the modified Tabata workout video frequently.	4.06 (0.77)	5.00 (0.00)
2	I find the modified Tabata workout video simple and easy to understand.	4.52 (0.67)	5.00 (0.00)
3	I think the modified Tabata workout video is easy to use.	4.51 (0.69)	5.00 (0.00)
4	I can use the modified Tabata workout video without needing technical support.	4.15 (0.80)	4.40 (0.89)
5	The various functions in the video are well integrated.	4.48 (0.63)	5.00 (0.00)
6	The video is consistent in its design and features.	4.45 (0.73)	5.00 (0.00)
7	Most people would learn to use the video very quickly.	4.31 (0.69)	4.80 (0.45)
8	I find the video comfortable and natural to use.	4.49 (0.71)	5.00 (0.00)
9	I feel very confident using the modified Tabata workout video.	4.35 (0.68)	5.00 (0.00)
10	I can start using the video without learning many things beforehand.	4.51 (0.80)	5.00 (0.00)

Overall**4.34 (0.74) – Very Good****4.92 (0.34) –
Excellent**

Students highlighted the clarity of demonstrations, well-paced transitions, and accessible structure as key strengths. Teachers particularly valued the structured sequencing, modification options for different fitness levels, and strong alignment with classroom-based HIIT safety expectations.

Recommended Instructional Modified Tabata Videos

The final recommended instructional material is the fully revised three-level modified Tabata video set—adaptive, beginner, and intermediate—which best addresses learner safety, inclusivity, and varied fitness readiness.

The adaptive-level version supports participants requiring low-impact or simplified movements. The beginner-level video enables gradual skill development with clear cues and conservative pacing. The intermediate-level version adheres more closely to traditional Tabata intensity while retaining safety guidance, making it suitable for learners with greater fitness experience. The exercise progressions for each level are summarized in Table 2.

Table 2. *Modified Tabata Exercises Across Adaptive, Beginner, and Intermediate Levels*

Exercise	Adaptive Level	Beginner Level	Intermediate Level
Torso Twist	Seated twist	Standing twist	Russian twist
Jumping Jacks	Seated march	Step jacks	Fast jumping jacks
Push-Ups	Wall push-ups	Knee push-ups	Full push-ups
Squats	Chair-supported squat	Bodyweight squat	Jump squat

Note. Each video follows a warm-up – main workout – cool-down structure. The main workout comprises these four exercises performed in a 20-s work / 10-s rest format for five rounds; finalized run-times were 19:34 (adaptive), 17:33 (beginner), and 18:05 (intermediate).

The finalized videos were prepared for Intellectual Property Office of the Philippines (IPOPPL) copyright registration.

Discussion

The findings are interpreted below in relation to multimedia learning theory, developmental research principles, and evidence-based HIIT instructional design, following the same four themes addressed in the Results.

Expert Feedback and Instructional Quality

The prominence of presentation issues aligns with multimedia learning research showing that instructor expressiveness, vocal modulation, and visible signaling are important for sustaining attention and supporting comprehension (Mayer, 2021; Werner & Gorman, 2021). The content-accuracy concerns are consequential, particularly in high-intensity formats like Tabata, where form, tempo, and muscle engagement directly influence safety and effectiveness (Gibala & Little, 2019; Lee *et al.*, 2021). The reviewers' call for a defined warm-up to main workout to cooldown sequence echoes exercise science guidelines that emphasize structured progression to support physiological readiness and injury prevention (Lu *et al.*, 2023). That technical quality was adequate while pedagogical elements still required refinement indicates that strong

production foundations do not compensate for weak instructional design (Castillo *et al.*, 2021). Overall, the expert feedback functioned as a formative and essential step in the developmental research process, providing clear guidance for improving accuracy, sequencing, engagement, and safety in the succeeding revision cycle (Sanjaya *et al.*, 2024; Pribadi & Chung, 2023).

Rationale and Basis for the Revisions

The presentation refinements align with multimedia principles showing that clarity, signaling, and instructor presence improve learner focus and instructional impact (Mayer, 2021; Aziz *et al.*, 2023). The content corrections were necessary to support proper form and reduce risk, particularly for novice exercisers, aligning with recommendations for accurate demonstration in HIIT settings (Lee *et al.*, 2021; Lu *et al.*, 2023). Reorganizing the routine into a warm-up → main workout → cooldown structure improved adherence to HIIT programming standards (Barbosa *et al.*, 2023). The aesthetic enhancements are consistent with research emphasizing aesthetic balance for motivation and cognitive ease (Fyfield *et al.*, 2019; Kristiani *et al.*, 2021), and the inclusion of fitness-level modifications further strengthened adaptability (Aziz *et al.*, 2023). Standardizing captions, terminology, and documentation is consistent with best practices in instructional material development (Ghani & Daud, 2018). Collectively, these changes reflect the core developmental research principle that high-quality instructional resources emerge through iterative refinement informed by expert evaluation and evidence-based design (Pribadi & Chung, 2023; Kibga *et al.*, 2022).

Interpreting the Usability Findings

The high SUS means indicate that users found the resource clear, easy to follow, and well integrated (Bangor *et al.*, 2008; Brooke, 1996), suggesting that the revisions successfully addressed earlier concerns and enhanced instructional clarity and navigability. The strengths students highlighted correspond with multimedia learning principles that emphasize clear signaling, coherent sequencing, and visual organization as essential for reducing cognitive load and enhancing comprehension (Mayer, 2021; Kristiani *et al.*, 2021), while the qualities teachers valued are factors shown to be critical for implementing exercise videos in educational settings (Barbosa *et al.*, 2023; Gibala & Little, 2019). The alignment of positive evaluations across both user groups demonstrates that the iterative development process effectively improved both the pedagogical and usability dimensions of the material. Such convergence reflects findings from developmental research showing that iterative design informed by expert and user testing produces materials that are both practical and instructionally robust (Sanjaya *et al.*, 2024; Pribadi & Chung, 2023). These high usability scores support the suitability of the final version for educational use, although they reflect perceived ease of use rather than measured learning or fitness outcomes.

Implications of the Recommended Video Set

The recommendation of the three-level set is grounded in expert-informed revisions, validated usability results, and evidence-based design principles incorporated throughout the developmental process. Developed through SAM-guided refinement, the final versions demonstrate alignment with established requirements for safe HIIT programming and multimedia instructional quality (Afify, 2018; Sanjaya *et al.*, 2024).

Across levels, the design choices map onto established guidance: the adaptive version's low-impact options are consistent with HIIT modification guidelines (Torres-Banduc *et al.*, 2021; Bansal *et al.*, 2023); the beginner version's conservative pacing supports foundational competence and confidence building (Marriott *et al.*, 2021); and the intermediate version's closer adherence to traditional Tabata intensity suits learners with greater fitness experience (Akcan *et al.*, 2021). The strong SUS ratings (Very Good to Excellent) from both students and teachers further support recommending the final versions. High usability is especially important

in exercise videos, where unclear cues or poor sequencing can lead to mistakes and safety concerns (Fyfield *et al.*, 2019; Hussain *et al.*, 2021). The videos' structured progression, consistent visual cues, modifications for multiple fitness levels, and balanced instructional pacing collectively meet the pedagogical requirements for college PE settings.

Beyond the immediate deliverable, the finalized videos provide an academically grounded, contextually relevant, and safety-oriented instructional resource ready for use in higher education. They offer a replicable model for multimedia fitness instruction that addresses gaps in local PE materials, thereby improving accessibility and quality in physical activity education (Domaradzki *et al.*, 2020; Yan & Chen, 2022).

Limitations of the Study

Several limitations should be considered when interpreting these findings. First, the study was conducted at a single state university with participants enrolled in PE classes, which limits the generalizability of the results to other institutions and populations. Second, the expert panel was small ($n = 3$) and the Instructional Video Evaluation Rubric was researcher-developed and not yet formally validated, so the expert-evaluation results should be interpreted with caution. Third, the System Usability Scale was administered with all items reworded as positive statements; while intended to improve clarity, this departs from the standard alternating-item format and limits direct comparison with established SUS norms. Fourth, the study evaluated perceived usability and expert-judged instructional quality rather than fitness outcomes, motor-skill acquisition, or injury and safety outcomes; claims regarding effectiveness and safety therefore rest on evidence-based design and user perception rather than experimental verification. Finally, the modified protocol was not directly compared with the traditional Tabata protocol. These limitations point to the need for experimental and comparative studies, formal instrument validation, and direct measurement of safety and learning outcomes in future research.

Conclusion

The study's findings demonstrate that its primary objective—to develop, refine, and evaluate a safe, pedagogically sound, and user-friendly modified Tabata instructional video for college students—was successfully achieved. Expert evaluations confirmed improvements in presentation, content accuracy, sequencing, creativity, safety guidance, and technical quality. At the same time, both students and teachers rated the final version as having Very Good to Excellent Usability, indicating strong perceived clarity, accessibility, and ease of use.

This study stands out in the academic community because it integrates expert-informed qualitative revisions with quantitative usability evaluation, creating an evidence-based instructional material grounded in multimedia learning theory, exercise science, and HIIT safety guidelines—an approach rarely documented in local physical education research. Its contribution lies in offering a systematically developed and usability-tested, adaptable, and context-responsive instructional resource that addresses the growing need for high-quality fitness materials in higher education.

Future directions include expanding the instructional library by producing an advanced-level Tabata video to complete the existing adaptive–beginner–intermediate progression, integrating AI-supported movement analysis, testing the video's effectiveness on actual fitness outcomes through experimental research, and publishing the copyrighted materials on a broader educational platform to support national PE instruction and future scholarly collaborations.

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RESEARCH ARTICLE

Utilizing Perceptual–Motor Integration and Imagery Training in Enhancing Baseball Batting Accuracy

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ABSTRACT

Batting accuracy is a key skill in baseball that depends on perceptual judgment, timing, and coordinated motor skills. However, many athletes find it difficult to make accurate contact with the ball due to the complex perceptual–motor demands of the task. Grounded in the Perceptual–Action Coupling Theory and Psychoneuromuscular Theory, findings suggest that perceptual–motor training enhances batting accuracy. This study investigated the effectiveness of Perceptual–Motor Integration Training (PMIT) and Imagery Training in improving batting accuracy among junior high school student–athletes. The study used a quasi-experimental pretest–posttest design with 70 male Grade 9 baseball players from a school in Misamis Oriental, Philippines, during the 2025–2026 school year. Participants were divided into two groups, each with 35 students. Batting accuracy was assessed with the Home Run Metrics Test. The interventions lasted six weeks, with the PMIT group performed movement-based perceptual–motor drills, while the Imagery Training group practiced progressive muscle relaxation and visualization exercises. Data were analyzed using descriptive statistics, paired-samples t-tests, and ANCOVA. Results indicated that participants' batting accuracy consistently stayed within the Competent performance level of performance before and after the intervention. However, paired t-test results revealed a significant improvement in the PMIT group with a large effect, while the Imagery Training group showed a significant difference with a moderate effect size. ANCOVA further demonstrated that PMIT was significantly more effective than Imagery Training in enhancing batting accuracy after accounting for pre-test scores. It is also recommended that future researchers examine longer intervention durations, larger sample sizes, and combined effects of perceptual–motor integration and imagery training to further determine their effectiveness in batting accuracy.

KEYWORDS *baseball batting accuracy, perceptual–motor integration, imagery training, sports performance, visuomotor coordination*

INTRODUCTION

Baseball batting accuracy is a defining component of successful performance in interception sports because effective hitting depends on far more than physical strength alone. Batters must rapidly perceive ball trajectory, discriminate pitch location, regulate swing decisions, and execute precise motor responses within fractions of a second, making batting one of the most complex visuomotor tasks in sport (Chen *et al.*, 2021; Gray, 2021; Saijo *et al.*, 2025). Research consistently shows that batting performance is strongly associated with visual tracking, hand–eye coordination, perceptual judgment, and movement timing, all of which shape the batter’s ability to achieve accurate and effective bat–ball contact under severe temporal constraints (Aoyama *et al.*, 2022; Morishita *et al.*, 2025). Because of these demands, improving batting accuracy requires interventions that address both perceptual and motor processes rather than relying solely on conventional physical practice.

Contemporary literature emphasizes that batting accuracy is multidimensional, involving decision accuracy, pitch recognition, biomechanical coordination, and contextual adaptability. Successful batting requires players to interpret visual cues, decide whether and when to swing, and coordinate the kinetic chain efficiently to optimize contact precision (Gray, 2021; Laby & Appelbaum, 2021). Studies on batting performance further indicate that the absence of critical visual information can impair strike discrimination and swing adjustments, highlighting the central role of perception–action coupling in batting success (Douglas *et al.*, 2023; Saijo *et al.*, 2025). Although visual and perceptual skills are recognized as important determinants, findings regarding isolated visual training remain inconsistent, suggesting that broader, integrated training approaches may be more effective for improving actual batting performance (Gray, 2021; Tremblay, 2025).

Despite growing international evidence, empirical research addressing baseball batting accuracy in the Philippine setting remains limited. Existing local scholarship has focused more on assessment development than on intervention-based performance enhancement, leaving uncertainty about how global findings translate into school-based or youth baseball contexts in the Philippines (Bandara *et al.*, 2023; Lacson *et al.*, 2023). Recent initiatives such as the Home Run Metrics Test have provided an ecologically valid tool for measuring batting accuracy among Filipino athletes, demonstrating acceptable validity and reliability for skill differentiation (Gomez *et al.*, 2025). However, practical and context-sensitive interventions that improve batting accuracy in realistic educational and sports environments remain underexplored, creating a substantial gap in localized sports performance research.

One promising direction involves Perceptual–Motor Integration Training (PMIT), which is grounded in Perception–Action Coupling Theory and emphasizes the development of visuomotor coordination through dynamic, movement-based drills. PMIT directly targets reaction time, spatial awareness, eye–hand coordination, and the athlete’s capacity to transform visual stimuli into immediate and coordinated action (Chen *et al.*, 2022; Thieschäfer & Büsch, 2022). Unlike isolated sports vision exercises, PMIT may better replicate the real-time perceptual and motor demands of baseball by combining visual processing with physical execution. Dynamic drills such as evasive-response tasks, shuttle–target striking, and reaction-ball activities may therefore provide more representative learning conditions for improving batting accuracy in youth athletes.

In parallel, imagery training offers a complementary psychological approach based on Psychoneuromuscular Theory, which proposes that mentally rehearsing movements activates neural pathways similar to those involved in physical performance (Jacobson, 1931; Sinha *et al.*, 2021). Techniques such as progressive muscle relaxation and guided visualization may enhance concentration, confidence,

motor planning, and psychological readiness by allowing athletes to mentally simulate batting scenarios before execution (Toussaint *et al.*, 2021; Zisopoulou & Varvogili, 2022). Although imagery training has demonstrated benefits across sport psychology, its direct application to baseball batting accuracy remains less established, particularly among junior high school athletes. This suggests the need to compare physical-perceptual and psychological interventions to determine their relative effectiveness in practical batting development.

In response to these theoretical and contextual gaps, the present study examines the effectiveness of Perceptual–Motor Integration Training and Imagery Training in enhancing baseball batting accuracy among Grade 9 student-athletes in the Philippine school setting. By comparing these interventions through a quasi-experimental framework, the study contributes to evidence-based physical education and sports training practices while aligning with DepEd Order No. 21, s. 2019 and broader educational goals promoting holistic learner development. Furthermore, the investigation supports Sustainable Development Goals 3 (Good Health and Well-being) and 4 (Quality Education) by exploring accessible, school-based strategies that strengthen both physical competence and cognitive readiness in youth sports performance.

Statement of the Problem

This study aimed to determine the effectiveness of perceptual–motor integration and imagery training in enhancing baseball batting accuracy. Specifically, this study answered the following questions:

1. What is the baseball batting accuracy of the participants before and after the interventions?
2. Within each group, do the participants' baseball batting accuracy scores significantly differ before and after the interventions?
3. Which of the two interventions was more effective at improving baseball batting accuracy?

Hypotheses

The study's hypotheses are presented below to guide the researcher in analyzing problems 2 and 3. The significance level was set at $\alpha=0.05$ in analyzing the data gathered using appropriate statistical tools:

Ho₁: There is no significant difference in participants' baseball batting accuracy before and after the interventions.

Ho₂: Neither of the two interventions was more effective at improving baseball batting accuracy.

METHODS

This study employed a quasi-experimental pretest–posttest research design to determine the effectiveness of Perceptual–Motor Integration Training (PMIT) and Imagery Training in enhancing baseball batting accuracy. A quasi-experimental design was appropriate because it allows researchers to examine intervention effects in real-world settings where random assignment may not be feasible (Ravalihasy *et al.*, 2023). The pretest–posttest structure enabled the researcher to measure participants' batting accuracy before and after the intervention period and determine whether measurable performance changes occurred after exposure to the training programs (Azak & Gözen, 2024; Park *et al.*, 2023).

The study was conducted among 70 male Grade 9 junior high school students who were members of a baseball team during the 2025–2026 school year in a school in Jasaan, Misamis Oriental, Philippines. The participants were between 12 and 16 years old and were selected because they were already engaged in baseball training under the supervision of the researcher. They were divided into two intervention groups, with 35 participants assigned to the Perceptual–Motor Integration Training group and 35 participants assigned to the Imagery Training group.

Before participation, parental consent and student assent were secured. A health screening procedure was also conducted to determine the participants' readiness for physical activity. Students who disclosed medical concerns were required to obtain clearance from a licensed healthcare provider before joining the intervention. These procedures helped ensure that participation was voluntary, safe, and appropriate for the physical demands of the study.

The main instrument used to assess batting accuracy was the Home Run Metrics Test developed and validated by Gomez *et al.* (2025). This test measures batting accuracy in a dynamic and game-like setting by requiring each participant to respond to 10 fastpitch pitches delivered within the strike zone by a skilled pitcher. Scores are based on the quality and placement of batting outcomes, ranging from called strikes to home runs. The test also reflects related performance components such as reaction time, consistency, power, pitch recognition, plate discipline, and adaptability.

The Home Run Metrics Test has demonstrated known-group validity and internal consistency reliability (Gomez *et al.*, 2025). In the present study, the researcher conducted an additional pilot test to strengthen reliability evidence. Based on 10 trials, the computed Cronbach's alpha was 0.750, indicating acceptable reliability for research use. Although the Spearman–Brown Prophecy Formula projected that increasing the number of trials from 10 to 20 would raise reliability to approximately 0.857, the 10-trial format was retained because it already provided acceptable reliability while remaining practical for field implementation.

Data gathering followed a structured pretest–intervention–posttest procedure. Prior to the intervention, participants completed a pretest assessment using the Home Run Metrics Test to determine their baseline batting accuracy. An orientation was then conducted to explain the study objectives, procedures, safety rules, and participation expectations. After the intervention period, the same testing procedures were used in the posttest to determine changes in batting accuracy.

The PMIT group underwent drills designed to improve perception–action coupling, reaction time, visuomotor coordination, and spatial awareness. These drills included the Dodgeball Evasive Response Drill, Arnis Shuttle–Target Strike Drill, and Reaction Ball Catch Drill. Sessions lasted approximately 45 to 50 minutes and were conducted three times per week for six weeks. The program progressed from basic execution and controlled responses during the early weeks to faster, more complex, and less predictable movement patterns during the later weeks.

The Imagery Training group participated in sessions lasting approximately 30 to 45 minutes, conducted three times per week for six weeks in a quiet and controlled setting. This intervention was grounded in Psychoneuromuscular Theory and included Progressive Muscle Relaxation and Basic Visualization or Guided Imagery. Participants mentally rehearsed batting actions such as tracking the pitch, timing the swing, and achieving accurate bat–ball contact. Data were analyzed using descriptive statistics for batting accuracy levels, paired-samples t-tests with Cohen's *d* for within-group changes, and ANCOVA with

partial eta squared to compare posttest scores between groups while controlling for pretest performance. All analyses were conducted at the 0.05 level of significance.

RESULTS

Problem 1. What is the baseball batting accuracy of the participants before and after the interventions?

Table 1 presents the frequency, percentage, mean, and standard deviation of participants' baseball batting accuracy before and after the interventions for both perceptual-motor integration and imagery training.

Table 1. Descriptive Statistics of the Participants' Baseball Batting Accuracy Before and After the Interventions

Range	Interpretation	Perceptual-Motor Integration Training							
		PRETEST				POSTTEST			
		f	%	f	%	F	%	F	%
91 - 100	Expert	0	0	0	0	0	0	0	0
71 - 90	Proficient	3	8.571	6	17.14	3	8.571	4	11.43
51 - 70	Competent	16	45.71	28	80	28	80	29	82.86
31 - 50	Basic	16	45.71	1	2.857	4	11.43	2	5.714
10 - 30	Novice	0	0	0	0	0	0	0	0
TOTAL		35	100	35	100	35	100	35	100
MEAN		54.14		62.83		60.63		62.91	
INTERPRETATION		Competent		Competent		Competent		Competent	
SD		11.56		8.89		8.35		6.73	

For the Perceptual-Motor Integration Training group, the pretest mean score was 54.14 (SD = 11.56), interpreted as Competent. In terms of distribution, 16 participants (45.71%) were classified under the Competent level, while another 16 participants (45.71%) were in the Basic level. A smaller proportion, 3 participants (8.57%), fell under the Proficient level, and no participants were classified as Novice or Expert. For the posttest, the mean score of the Perceptual-Motor Integration Training group was 62.83 (SD = 8.89), also interpreted as Competent. The majority of participants, 28 (80%), were categorized under the Competent level. Six participants (17.14%) were in the Proficient level, while 1 participant (2.86%) was classified under the Basic level. No participants were categorized as Novice or Expert.

For the Imagery Training group, the pretest mean score was 60.63 (SD = 8.35), interpreted as Competent. Most participants, 28 (80%), were classified under the Competent level. Four participants (11.43%) were in the Basic level, while 3 participants (8.57%) were categorized under the Proficient level. No participants were classified as Novice or Expert. For the posttest, the Imagery Training group obtained a mean score of 62.91 (SD = 6.73), interpreted as Competent. A total of 29 participants (82.86%) were categorized under the Competent level. Four participants (11.43%) were classified as Proficient, while 2 participants (5.71%) were in the Basic level. No participants were categorized as Novice or Expert.

Problem 2. Within each group, do the participants' baseball batting accuracy scores significantly differ before and after the interventions?

Ho₁: There is no significant difference in participants' baseball batting accuracy before and after the interventions.

Table 2 presents the results of the paired-samples t-test comparing the pre-test and post-test batting accuracy scores of the participants in the Perceptual-Motor Integration Training group and the Imagery Training group.

Table 2. Paired Samples t-test for Pre-Test and Post-Test Scores in Perceptual-Motor Integration and Imagery Trainings

Group	Test	M	Interpretation	SD	T	p	Cohen's d
Perceptual-motor Integration (n = 35)	Pre-test	54.14	Competent	11.56	-6.323*	<0.001	- 1.069
	Post-test	62.83	Competent	8.890			
Imagery Training (n = 35)	Pre-test	60.63	Competent	8.353	-3.441*	0.002	- 0.582
	Post-test	62.91	Competent	6.727			

*Significant at 0.05 two-tailed alpha level. M = mean, SD = standard deviation, t = t statistic, p = probability value, Cohen's d = effect size

As shown in Table 2, the Perceptual-Motor Integration Training group obtained a pre-test mean score of 54.14 (SD = 11.56) and a post-test mean score of 62.83 (SD = 8.890), both interpreted as competent levels of batting accuracy. The paired-samples t-test revealed a statistically significant improvement in batting accuracy after the intervention, $t(34) = -6.323$, $p < .001$. The computed Cohen's $d = -1.069$ indicates a large effect size, suggesting that the perceptual-motor integration training produced a substantial improvement in participants' batting accuracy.

In contrast, the Imagery Training group recorded a pre-test mean score of 60.63 (SD = 8.353) and a post-test mean score of 62.91 (SD = 6.727), both interpreted as competent levels of performance. The paired-samples t-test also showed a statistically significant difference, $t(34) = -3.441$, $p = .002$, although the magnitude of the effect was smaller, with Cohen's $d = -0.582$, indicating a moderate effect size.

Based on these findings, the null hypothesis can be rejected. The results indicate significant differences between participants' pre- and post-test batting accuracy scores, suggesting that their batting performance improved after the intervention period. During the training sessions, the researcher directly observed that participants demonstrated improved swing timing, better bat control, and more consistent contact with the ball during the post-test sessions compared with the pre-test, indicating improvements in batting execution following the training period.

Problem 3. Which of the two interventions was more effective at improving baseball batting accuracy?

Ho₂: Neither of the two interventions was more effective at improving baseball batting accuracy.

Table 3 presents the results of the ANCOVA comparing post-test batting accuracy scores of participants in the Perceptual-Motor Integration group and the Imagery Training group, while controlling for pre-test scores.

Table 3. ANCOVA Summary Table for Posttest Scores with Pretest Scores as Covariate

GROUPS	Adjusted Mean	Interpretation	F(1,67)	p	Partial η^2
Perceptual–Motor Integration Training	64.79	Competent	9.227*	0.003*	0.121
Imagery Training	60.95	Competent			

*Significant at the 0.05 alpha level. Adjusted Mean = estimated marginal mean controlling for the pretest covariate; F = F statistic; p = probability value; partial η^2 = effect size.

Prior to the ANCOVA, assumptions were examined: residual normality was supported by Q–Q inspection, and the homogeneity of regression slopes was confirmed, supporting the suitability of the model. Levene’s test indicated unequal variances, $F(1, 68) = 10.75$, $p = .002$; with equal group sizes ($n = 35$ each), the ANCOVA remained robust to this violation. After adjusting for the influence of the pre-test scores, the ANCOVA results revealed a statistically significant effect of group on post-test batting accuracy, $F(1,67) = 9.227$, $p = .003$. Thus, the null hypothesis can be rejected. The partial eta squared (η^2) value of 0.121 indicates a moderate effect size, suggesting that approximately 12.1% of the variance in post-test batting accuracy is attributable to the intervention type after controlling for pre-test performance. After adjusting for pretest scores, the estimated marginal mean was higher for the Perceptual–Motor Integration Training group ($M = 65.28$, $SE = 1.115$, 95% CI [63.06, 67.50]) than for the Imagery Training group ($M = 61.30$, $SE = 1.115$, 95% CI [59.08, 63.52]). This adjusted difference confirms that, once the initial baseline gap was controlled, the PMIT group attained higher batting accuracy than the Imagery Training group.

Based on ANCOVA results, the null hypothesis stating that neither of the interventions is more effective than the other is rejected. PMIT is more effective for improving baseball batting accuracy. Although the Imagery Training group started higher (pretest $M = 60.63$ vs. 54.14 for PMIT), ANCOVA controlled for this baseline difference. After adjustment, a significant group effect indicated that improvements in batting accuracy differed between interventions. The PMIT group improved, while Imagery Training showed minimal improvement. This indicates PMIT yields greater gains when initial scores are controlled, making it the more effective intervention. These results should nonetheless be interpreted with caution: because the groups were intact rather than randomly assigned and the PMIT group began at a lower level with more room to improve, part of the adjusted between-group difference may reflect regression to the mean and a possible ceiling effect in the higher-starting Imagery group.

DISCUSSION

The findings indicate that both groups generally demonstrated Competent baseball batting accuracy before and after the interventions, suggesting that the participants already possessed functional batting skills prior to the study. This may be attributed to their prior exposure to baseball training as student-athletes, which likely developed their basic swing mechanics, timing, hand–eye coordination, and familiarity with batting situations. Previous research supports this interpretation, showing that athletes with regular sport-specific practice tend to demonstrate stronger perceptual–motor coordination and sport-related performance than non-athletes (Chen *et al.*, 2021). In batting, repeated exposure to pitched balls strengthens visual tracking, reaction timing, and coordinated movement execution, all of which are necessary for successful bat–ball contact (Gray, 2021).

Although both groups remained within the Competent level, the distribution of scores showed meaningful improvement, particularly in the Perceptual–Motor Integration Training group. The PMIT group

shifted from a larger proportion of participants in the Basic level during the pretest to a higher concentration in the Competent and Proficient levels during the posttest. This suggests that PMIT helped improve the participants' batting execution, especially in terms of timing, movement control, and accuracy. Such improvement is consistent with the nature of batting as a complex interceptive skill that requires athletes to rapidly perceive ball speed, trajectory, and location and translate this information into coordinated motor responses (Gray, 2021; Morishita, 2025). The observed improvement supports the view that batting accuracy is shaped by the interaction of perceptual judgment, visuomotor coordination, biomechanical execution, and situational demands.

The significant pretest–posttest improvement in the PMIT group further suggests that movement-based perceptual–motor drills can effectively enhance batting accuracy. PMIT directly trains perception–action coupling by requiring athletes to respond to moving stimuli while executing coordinated body movements. In the present study, drills such as dodgeball evasive response, Arnis shuttle-target striking, and reaction-ball catching likely strengthened the participants' visual tracking, reaction time, spatial awareness, and eye–hand coordination. This aligns with studies showing that perceptual–motor training improves visual tracking, response accuracy, and coordination in sport-related tasks (Chen *et al.*, 2022; Laby & Appelbaum, 2021). Because these drills involve real-time movement responses, they approximate the demands of batting more closely than isolated visual or technical drills (Thieschäfer & Büsch, 2022).

The results are also theoretically consistent with Perception–Action Coupling Theory, which explains that skilled motor performance improves when athletes learn to coordinate their actions with relevant environmental cues. In baseball, hitters must quickly interpret visual information from the incoming ball and convert it into an accurate swing within a limited time window. PMIT may have enhanced this process by repeatedly exposing participants to dynamic visual stimuli that required immediate motor adjustment. This supports the argument that representative training conditions, where perception and movement are practiced together, are important for improving performance in time-constrained interceptive sports such as baseball (Gray, 2021; Thieschäfer & Büsch, 2022).

The Imagery Training group also showed a significant improvement from pretest to posttest, although the magnitude of change was smaller than that of the PMIT group. This finding indicates that imagery training may still contribute to batting performance by improving focus, composure, mental rehearsal, and consistency in movement preparation. Imagery allows athletes to mentally simulate sport actions, strengthen motor planning, and improve attentional control before actual execution (Danon *et al.*, 2021; Sinha *et al.*, 2021). The use of progressive muscle relaxation may have further supported performance by reducing physical tension and preparing participants for more focused visualization (Toussaint *et al.*, 2021). Thus, while imagery training may not directly reproduce the perceptual and physical demands of batting, it appears useful as a psychological strategy for stabilizing performance and enhancing readiness.

The ANCOVA results showed that after controlling for pretest scores, PMIT was significantly more effective than Imagery Training in improving baseball batting accuracy. This finding suggests that batting accuracy may improve more substantially when training directly engages both perceptual and motor processes rather than relying mainly on mental rehearsal. Although imagery training can support confidence, concentration, and motor planning, PMIT provides actual movement practice under dynamic conditions that require athletes to respond to visual information in real time. This distinction is important because batting requires not only cognitive preparation but also immediate perception-based motor execution. Therefore, PMIT may have produced greater gains because it more closely replicated the demands of actual batting situations (Chen *et al.*, 2022; Gray, 2021; Thieschäfer & Büsch, 2022).

With these, the findings support the value of integrating perceptual–motor training into school-based baseball instruction and athletic development programs. The results suggest that PMIT can be used by coaches and Physical Education teachers to improve batting accuracy through drills that develop reaction time, visual tracking, coordination, and perception–action coupling. Imagery training, meanwhile, may serve as a complementary strategy for improving focus, confidence, relaxation, and mental preparation. Together, the findings reinforce the idea that batting accuracy is both a physical and cognitive-motor skill, but greater performance gains may occur when interventions are task-representative and require athletes to coordinate perception and movement during actual practice conditions.

LIMITATIONS OF THE STUDY

Several limitations should be considered when interpreting these findings. First, the study used a quasi-experimental design with intact, non-randomly assigned groups, and the two groups were not equivalent at baseline—the PMIT group began at a lower batting-accuracy level ($M = 54.14$) than the Imagery Training group ($M = 60.63$). Although ANCOVA statistically adjusted for pretest differences, the lower starting point of the PMIT group leaves open the possibility that part of its larger adjusted gain reflects regression to the mean or a ceiling effect in the higher-starting group rather than a pure intervention advantage. Second, the sample was limited to 70 male Grade 9 student-athletes from a single school, which constrains generalizability to other ages, sexes, skill levels, and settings. Third, the six-week intervention period was relatively short, so the durability of the improvements is unknown. Fourth, batting accuracy was assessed with a single instrument, and some performance observations were made by the researcher, which may introduce measurement and observer effects. Future research should employ randomized assignment, larger and more diverse samples, longer intervention and follow-up periods, and, where possible, blinded assessment to confirm and extend these results.

CONCLUSION

This study examined the effectiveness of Perceptual–Motor Integration Training (PMIT) and Imagery Training in enhancing baseball batting accuracy among Grade 9 student-athletes. Using a quasi-experimental pretest–posttest design, the study found that participants in both groups were generally within the Competent level before and after the interventions. Both groups showed significant pretest–posttest improvements; however, the PMIT group demonstrated a larger performance gain and stronger effect size than the Imagery Training group.

Based on the findings, the study concludes that both PMIT and Imagery Training can contribute to improved baseball batting accuracy, but PMIT is more effective when pretest performance is controlled. The stronger effect of PMIT supports the Perception–Action Coupling Theory, as batting accuracy improved more when athletes practiced responding to visual cues through coordinated movement. Imagery Training also supported batting performance by enhancing focus, mental rehearsal, and consistency, consistent with Psychoneuromuscular Theory.

It is recommended that baseball coaches, sports trainers, and Physical Education teachers integrate PMIT drills such as reaction-based ball activities, evasive-response drills, and shuttle-target striking tasks into regular training sessions to improve visual tracking, reaction time, coordination, and batting accuracy. Imagery training, including progressive muscle relaxation and visualization, may also be used as a complementary strategy to strengthen confidence, concentration, and performance consistency. Future researchers may replicate the study with larger samples, different age groups, longer intervention periods,

and other sports to further examine the effects of perceptual-motor and imagery-based training on athletic performance.

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AI Declaration: This study utilized artificial intelligence tools to assist in preparing this article. Specifically, AI assistance was used to help condense the full thesis manuscript into a reduced journal-article format and to refine language quality, clarity, and tone, with human supervision and editing throughout. All statistical results were checked against the author's thesis and its JASP output, and the author carefully reviewed and edited all outputs to maintain academic rigor and integrity.

Data Availability Statement: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Requests for access will be evaluated in accordance with ethical guidelines and data privacy policies.