Validation of the Home Run Metric Test for Baseball Batting Accuracy Measurement

Oliver Napila Gomez[1], Michelle Himulatan[2], Nasroding Bashier[3], Hendely Adlawan[4], Lowelyn Mabandes[5], Gerrom Palasigue[6]

[1] USFD PH OPC

[2] Lourdes College, Inc.; Jasaan National High School

[1,3,4,5] MSU – College of Sports, Physical Education and Recreation

[6] MSU – Institute of Science Education

DOI: https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0098

Received: 17 February 2025; Accepted: 21 February 2025; Published: 21 March 2025

ABSTRACT

This study aimed at validating the Home Run Metrics Test, a dynamic assessment tool designed to measure baseball batting accuracy in real-game scenarios. Traditional methods often need to pay more attention to key factors such as cognitive decision-making, reaction time, and adaptability, leading to incomplete evaluations of a batter's skills. To address these limitations, the Home Run Metrics Test was designed to evaluate a range of abilities, including consistency, power, pitch recognition, and plate discipline. The study employed a psychometric research approach, comparing the test scores of varsity players and Physical Education students to establish known-group validity. Results showed a significant difference in batting accuracy between the groups, with varsity players outperforming PE students, confirming the test's validity (Cohen's d = 2.324). Reliability was assessed through Cronbach's alpha, initially calculated at 0.579 for five trials, and predicted to improve to 0.733 after extending the test to ten trials using the Spearman-Brown prophecy formula. This moderate internal consistency reflects the inherent variability in batting performance under real-game conditions. The Home Run Metrics Test offers practical applications for both teaching and research, providing educators with a comprehensive tool for assessing and developing student batting skills while offering researchers a validated instrument to explore the impact of various factors on batting accuracy. The findings underscore the importance of continued refinement of assessment tools to better capture the complexities of baseball batting in both educational and athletic contexts.

Keywords: Home Run Metrics Test, Baseball batting accuracy in real-game scenarios, Psychometric research, Known-group validity, Spearman-Brown Prophecy Formula,

INTRODUCTION

Baseball batting accuracy is a crucial skill that directly impacts a player's performance and the overall outcome of the game. However, accurately measuring this skill presents significant challenges, as current testing methods often fail to capture the complexities of real-game scenarios. Traditional assessments tend to overlook essential factors like swing mechanics, pitch variations, and decision-making processes, leading to an incomplete evaluation of a batter's abilities (Gumilar et al., 2021; Herring et al., 2024; Nasu et al., 2020). This study addresses these limitations by exploring advanced methods for assessing baseball batting accuracy, aiming to improve the reliability and applicability of testing tools (Nevins et al., 2019; Rohmah et al., 2019).

Understanding the biomechanics behind batting accuracy is key to optimizing performance and reducing injury risk. Torso dynamics during the follow-through phase are particularly important, as higher bat head speed after ball impact is linked to better torso rotation, which enhances both speed and accuracy (Horiuchi & Nakashima, 2022). Proper lower body mechanics also play a vital role, with lead foot ground reaction forces significantly correlating with bat speed at ball contact, making lower extremity kinematics crucial for maximizing accuracy (Orishimo et al., 2023).

Additionally, visual-motor coordination is a critical factor, with studies showing that ocular-tracking performance can account for a significant portion of the variance in batting accuracy, including home run ability (Chen et al., 2021). This highlights the importance of visual tracking in successful hitting. The coordination of eye and body movements is complex, influenced by both visual information and the timing of the swing, underscoring the intricate relationship between visual and motor systems in achieving both accuracy and power (Kishita et al., 2020).

Moreover, research into bat swing parameters reveals that bat-head speed and swing angle are crucial determinants of the distance a ball travels, directly influencing the likelihood of hitting home runs (Morishita et al., 2019). Superior cognitive-motor integration contributes to higher exit velocities and lower miss ratios, both essential for home run success, making home runs a key indicator of true batting accuracy (Nasu et al., 2020). To minimize injury risks while enhancing batting mechanics, optimizing kinematic chains, such as lead knee extension and pelvis rotation, is essential, as these principles are also crucial for effective training programs (Diffendaffer et al., 2023).

In real-game settings, batting accuracy is influenced by a mix of decision-making, cognitive factors, and environmental conditions. Research using a virtual reality (VR) system found that decision-making based on pitch type significantly impacts a batter's stability and accuracy. Most batters rely on cues from the pitcher's motion rather than the ball's trajectory, which can affect their performance during games (Tani et al., 2023). Superior cognitive-motor coordination, reflected in higher exit velocities and lower miss ratios, often leads to better batting averages, emphasizing the importance of these processes during games (Nasu et al., 2020). Environmental factors also play a role; for instance, higher temperatures can impair umpire decision-making accuracy, indirectly affecting batting outcomes (Fesselmeyer, 2021). Additionally, advanced knowledge of pitch types can reduce timing errors, potentially enhancing batting accuracy during games (Kidokoro et al., 2020). Biomechanically, precise timing and coordination between the trunk and hands are critical for successful batting, as highlighted by studies using hand-worn inertial measurement units (IMUs) in real-game conditions (Punchihewa et al., 2021).

Developing a real-game batting accuracy test for local schools in a third-world country like the Philippines requires a practical and economical approach. The test should replicate the dynamic nature of actual games while being cost-effective and accessible. Basic equipment, like a standard pitching machine or a coach pitching from a fixed distance, can simulate real-game scenarios. To capture decision-making and cognitive-motor coordination, the test should include variations in pitch types and speeds, requiring batters to react to visual cues, as seen in VR-based findings (Tani et al., 2023). Incorporating simple visual-tracking exercises before batting could further enhance accuracy, as ocular-tracking performance is a significant predictor of success (Chen et al., 2021). The test should also consider environmental factors by being conducted under different conditions to simulate real-game settings. Coaches can use smartphones to record and analyze bat-ball contact timing and coordination, ensuring that the trunk and hand movements align with successful hitting patterns (Punchihewa et al., 2021). This approach combines essential equipment, cognitive challenges, and accessible technology to create a comprehensive yet economical batting accuracy test suitable for local schools.

This study employs a psychometric research approach to evaluate the psychometric properties of a real-game setting baseball batting accuracy test. Participants included students from a state university in Lanao del Sur. The pilot study aims to gather validity and reliability metrics, ultimately enhancing softball training and performance by establishing standardized criteria and scoring systems for assessing students' overhand throwing accuracy skills.

MATERIALS AND METHODS

This study employs a psychometric research design with the goal of validating a baseball batting accuracy test for known-group validity and internal consistency. The pilot study compares the test scores between college

PE students and baseball varsity players to determine known-group validity (Howell et al., 2016). Comparing the test scores of these distinct groups allows the researchers to determine whether the instrument possesses known-group validity, meaning it can effectively distinguish between groups that are expected to differ in their batting accuracy (Cook, 2015; Howell et al., 2016; Jewsbury & Bowden, 2014). This validity component is essential for proving that the test can differentiate between various skill levels and developmental phases (Cook, 2015). Varsity players are expected to have the highest scores due to their advanced training and experience, followed by college students (Paradis et al., 2014).

The test was subjected to internal consistency analysis to ensure it reliably measures baseball batting accuracy. Initially, Cronbach's alpha was calculated across five trials using frequentist scale reliability statistics to evaluate the consistency of participants' performance. To further enhance reliability, an additional five trials were added, bringing the total to 10, and the Spearman-Brown prophecy formula was applied to estimate the expected improvement in reliability from the increased number of trials. This approach aligns with the importance of selecting appropriate reliability measures based on the characteristics of the data (Anselmi et al., 2019).

While Cronbach's alpha is widely used, its limitations—such as sensitivity to the number of items and assumptions of tau-equivalence—highlight the need for careful interpretation (Edwards et al., 2021). Despite these limitations, Cronbach's alpha remains a commonly used method for assessing internal consistency, especially in test construction, where evaluating changes in alpha with added trials is crucial for ensuring reliable measurement (English & Keeley, 2015).

Participants. The participants in the study comprised 30 individuals, including 15 varsity players (9 males and 6 females) and 15 PE students (8 males and 7 females). All participants were healthy and provided informed consent prior to their involvement in the study. The varsity group, consisting of athletes with advanced training and experience, included 9 male and 6 female players, while the PE student group, composed of individuals with varying levels of experience in physical education, included 8 male and 7 female participants. This diverse group allowed for a comprehensive analysis of baseball batting accuracy across different skill levels.

The pilot test was conducted at a state university in Lanao del Sur, Philippines. Located at an elevation of 2000 meters above sea level, this site provides a unique high-altitude setting that may influence physical performance. The university's state-of-the-art sports facilities made it an ideal location for pilot experiments, providing the essential infrastructure for conducting professional-level assessments of baseball batting accuracy in a controlled environment.

The Test. The *Home Run Metrics Test* (see Appendix A) is a dynamic softball batting accuracy assessment designed to simulate real-game scenarios and measure a batter's ability to make precise contact with a dynamically pitched ball. The test evaluates not only batting accuracy but also factors such as reaction time, consistency, power, pitch recognition, and plate discipline. Participants undergo a series of ten fastpitch pitches delivered by a skilled pitcher, with successful hits recorded and scored based on the quality and placement of each hit. The scoring system ranks outcomes from minimal contact to home runs, assigning points that reflect the batter's skill level. The highest possible score is 100, achieved by hitting ten home runs, while the lowest score is ten, resulting from ten called strikes. The test also emphasizes adaptability by requiring batters to respond to varying pitch conditions. This structured and transparent scoring system allows for a comprehensive evaluation of each batter's performance, categorizing them into levels from Novice to Expert based on their total score. The test setup includes essential safety measures, proper equipment, and a controlled environment to ensure the accuracy and reliability of the results, making it suitable for use in both educational and athletic settings.

The design of the Home Run Metrics Test aligns with findings that higher bat velocity and ball exit speed during preseason assessments correlate strongly with better in-game batting performance among collegiate varsity players (Carrol et al., 2023). This connection underscores the importance of assessing dynamic skills in conditions that closely mirror real gameplay, as done in this test. By incorporating ten fastpitch pitches delivered by a skilled pitcher, the test challenges participants to respond to varying pitch types and speeds, which is crucial for evaluating their adaptability and reaction time.

Furthermore, the test's emphasis on precision and power is in accordance with findings that advanced training methods, such as dynamic vision training, significantly enhance batting accuracy metrics like launch angle and hit distance (Liu et al., 2020). The scoring system in the Home Run Metrics Test, which ranges from minimal contact to home runs, reflects this focus on both the quality of contact and the ability to hit for power. This system is structured to distinguish between different levels of skill, providing a clear pathway for evaluating batters from Novice to Expert, similar to the skill differentiation seen in studies (Beldon et al., 2022; Capio et al., 2020).

The adaptability component of the test, requiring batters to adjust to various pitch conditions, is particularly important. As highlighted (Gumilar et al., 2021), even varsity-level athletes face ongoing challenges in achieving target batting accuracy, indicating the necessity of continual skill refinement. This test's requirement for batters to respond to diverse and unpredictable pitch scenarios mirrors the real-game challenges that athletes face, making it a valuable tool for both training and evaluation.

The test setup, including safety measures, proper equipment, and a controlled environment, ensures that the assessment is not only accurate but also reliable, minimizing external variables that could impact performance. This aligns with the recommended methodological rigor (Butler et al., 2024), which emphasizes the need for controlled conditions when evaluating motor skill proficiency.

Data Gathering Procedure. The educational institution overseeing the study approved the data-gathering procedure for the Home Run Metrics Test, ensuring compliance with ethical and procedural standards. In addition, participants initially received an orientation session in which they were informed about the safety protocols, the test procedure, and the specific skills being assessed. This session was crucial for preparing the participants for the testing environment and clarifying any doubts regarding the procedure. Following the orientation, participants sign consent forms confirming their voluntary participation in the study.

Before the actual testing started, the researchers conducted a 10-minute warm-up session designed to prepare the participants physically and mentally for batting. The warm-up included exercises specific to batting, ensuring that all participants were at optimum performance levels before they began the test. This was followed by a skill rehearsal, during which participants became accustomed to the batting setup and the types of pitches they would encounter.

Additionally, participants were tested individually following the Home Run Metrics Test protocol. However, each participant faced only a series of five legal pitches instead of 10, as stipulated in the protocol for mass testability and to reduce the time for individual testing. The duration of the test for each participant ranged from one to two minutes, ensuring a quick and efficient assessment while minimizing fatigue. The researcher recorded the scores of the participants in every batting trial. After completing the test, participants were debriefed about their performance. This feedback is essential for participants to understand their performance metrics and areas of improvement. Following the debriefing, participants engage in cool-down exercises.

Throughout the data-gathering process, the emphasis is on creating a controlled, safe, and supportive environment that allowed for the accurate assessment of batting skills. The structured approach not only helps in maintaining consistency across all tests but also ensures that the data collected is reliable and valid for further analysis. This methodical procedure was designed to optimize the assessment of each participant's skill and provide valuable insights into their batting accuracy and overall performance in softball.

RESULTS AND DISCUSSION

The results of the known-group validity and internal consistency analysis are presented in this section. In addition, discussions with supporting literature further enriched the implication of the findings.

Known-Group Validity. The assumption for a known-group validity investigation is that there is a measurable difference between two groups with varying athletic abilities, such as varsity players and PE students, in this context. Table 1 presents the statistical analysis comparing the baseball batting accuracy of 15 varsity players and 15 PE students.

Table 1. Result of ANCOVA and Post Hoc Test between the overhand throwing accuracy of varsity players and PE students

Groups	N	Mean	SD	F	p	Post hoc test			
						Mean difference	t	Cohen's d	p_{tukey}
Varsity players	15	27.267	5.861	40.491	<0.001	11.533	6.363	2.324	<0.001
PE students	15	15.733	3.863						

Table 1 presents the results of an ANCOVA comparing the baseball batting accuracy between varsity players and PE students. The analysis included 15 participants in each group, with the varsity players achieving a mean score of 27.267 (SD = 5.861) and the PE students having a mean score of 15.733 (SD = 3.863). The ANCOVA revealed a highly significant F value of 40.491 ($p < 0.001$), indicating a statistically significant difference in batting accuracy between the two groups.

Following the ANCOVA, a post hoc test was conducted to explore the differences between the groups further. The post hoc analysis showed a mean difference of 11.533 between the varsity players and PE students, with a t value of 6.363 and a Cohen's d of 2.324, indicating a large effect size. The p_{tukey} value of <0.001 further confirms that the difference in batting accuracy between the groups is both statistically meaningful. This strong effect size highlights the considerable gap in performance levels between varsity players and PE students.

The confirmation of known-group validity in this study is strongly supported by the large effect size indicated by Cohen's d of 2.324. This significant effect size demonstrates that varsity players, who achieved much higher baseball batting accuracy scores compared to PE students, possess substantially greater proficiency in this technical skill. Such a finding aligns with existing research on athletic skill development. For instance, a study revealed that more skilled individuals, such as varsity players, exhibit higher proficiency in sport-specific technical skills, which are crucial for differentiating levels of athletic ability (Koopmann et al., 2020). Similarly, even among highly active students, varsity-level athletes showed greater proficiency in fundamental movement skills due to their advanced development through specialized training and consistent practice (Butler et al., 2024). Moreover, Beldon and colleagues (2022) highlighted that varsity athletes often perceive their skill development as superior, owing to the more rigorous and structured training environments they experience compared to their peers in club sports.

This finding is consistent with a study (Carrol et al., 2023). Higher bat velocity and ball exit speed during preseason assessments were strongly correlated with better batting averages during games, highlighting the advanced training and skill levels of varsity players. This correlation suggests that varsity players, with their refined technical abilities, are better equipped to achieve higher batting accuracy, further supporting the known-group validity demonstrated in this study.

Additionally, research (Capio et al., 2020) comparing novice and intermediate players in softball batting showed that while analogy learning significantly improved batting accuracy for novice players, it had a different impact on intermediate players. This suggests that although less experienced players can improve with proper instruction, they may still fall short of the performance levels achieved by varsity players. This supports the expectation that varsity players, who have already surpassed the novice and intermediate stages, would demonstrate significantly higher batting accuracy, as seen in the results of this study.

Furthermore, Liu and colleagues (2020) explored the impact of dynamic vision training on batting practice performance among collegiate baseball players, finding that such training significantly enhanced metrics like launch angle and hit distance for varsity players. This indicates that advanced training methods, which are often accessible to varsity athletes, can further refine their batting accuracy, setting them apart from less experienced players who may not have access to such specialized training.

However, it is important to note that even among varsity players, there are ongoing challenges in skill development. For example, a study (Gumilar et al., 2021) on West Java female softball athletes found that despite their advanced level, varsity athletes still needed to fully achieve their target batting accuracy fully, emphasizing the need for continued refinement and development of skills at the vars This underscores the complexity of batting accuracy as a skill, even for more experienced players, and highlights the necessity for ongoing training and skill enhancement.

Reliability. Table 2 presents the baseball batting accuracy scores for each participant across these trials.

After obtaining the Cronbach's alpha for the five trials, 0.579, the Spearman-Brown prophecy formula was applied to estimate the effect of extending the test from 5 to 10 trials. The Spearman-Brown formula is particularly useful for predicting how reliability (Cronbach's alpha) will change when the length of a test is altered (Um, 2017). Now, this can calculate the expected reliability after doubling the number of trials. The Spearman-Brown prophecy formula is given by:

$$r_{k,k} = \frac{k(r_{1,1})}{1+(k-1)(r_{1,1})}$$

where k is the factor by which the test length is increased. In this case, k=2 because the number of trials is doubled from 5 to 10. The original reliability is Cronbach's alpha from the first five trials, which was 0.579.

Applying the formula,

$$r_{k,k} = \frac{k(r_{1,1})}{1+(k-1)(r_{1,1})} = \frac{2(0.579)}{1+(2-1)(0.579)} = \frac{1.158}{1.579} \approx 0.733$$

The calculation shows that extending the test to 10 trials is expected to increase the reliability to approximately 0.733. This improved reliability score indicates a stronger internal consistency, suggesting that the additional trials would make the test a more consistent measure of baseball batting accuracy. The increase in reliability highlights the importance of test length in achieving more stable and reliable assessments, supporting the notion that a longer test with more trials could better capture the true abilities of participants (English & Keeley, 2015; Sarwiningsih, 2017).

Table 2 Result of the participants' first five trial scores in the Home Run Metrics Test

Participant	Baseball Batting Accuracy Scores				
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1	3	8	5	7	10
2	10	3	8	3	9
3	7	9	6	10	3
4	7	4	3	3	3
5	2	3	9	8	10
6	2	8	10	3	3
7	4	3	3	9	8
8	3	8	6	4	8
9	2	4	6	6	5
10	1	3	8	7	8
11	3	7	6	7	7
12	2	4	4	2	6
13	3	4	4	9	3
14	6	5	2	2	3
15	7	4	8	7	9
16	2	2	8	2	2

17	2	2	7	2	4
18	2	7	2	3	2
19	5	4	2	6	3
20	7	8	2	4	2
21	4	2	2	3	2
22	1	3	4	3	3
23	2	2	7	2	2
24	2	4	4	2	6
25	1	2	2	3	2
26	1	5	1	3	5
27	2	4	2	5	2
28	6	5	2	2	7
29	2	2	2	2	2
30	2	2	2	2	4
Chronbach's α	0.579				

The internal consistency of 0.733 observed in the extended Home Run Metrics Test, after applying the Spearman-Brown prophecy formula, reflects the inherent complexities and variabilities associated with baseball batting in real-game situations. The variability in pitch speeds, trajectories, and spin forces batters to continuously adjust their timing and technique, leading to fluctuations in performance, even in controlled testing environments (Tani et al., 2023). Batting accuracy relies heavily on the synchronization of cognitive decision-making with motor execution, and this coordination can vary from pitch to pitch, especially under pressure or fatigue, further contributing to inconsistent scores (Nasu et al., 2020; Chen et al., 2021). External factors such as temperature, lighting, and psychological pressure also affect a batter's focus, causing variations in performance across trials (Fesselmeyer, 2021; Kidokoro et al., 2020).

Even varsity players, who generally have higher technical skills, experience performance fluctuations due to minor technical adjustments or lapses in focus (Koopmann et al., 2020; Liu et al., 2020). Additionally, adaptation and fatigue during multiple trials can either improve or degrade performance, respectively, impacting consistency (Gumilar et al., 2021). Therefore, the internal consistency of 0.733 observed in the study reflects a relatively reliable test, but it also acknowledges the inherent variability in baseball batting performance under real-game conditions. This moderate reliability underscores the complex interplay of technical skills, cognitive factors, and environmental influences that affect batting consistency across trials.

CONCLUSION

This study validated the *Home Run Metrics Test* as a comprehensive tool for assessing baseball batting accuracy, addressing the limitations of traditional methods by incorporating factors such as cognitive decision-making, reaction time, and adaptability to real-game conditions. The test demonstrated strong known-group validity, with varsity players significantly outperforming PE students, reflecting the advanced skills acquired through rigorous training. The internal consistency, enhanced by extending the test to 10 trials and yielding a reliability score of 0.733, highlights the inherent variability in batting performance. While the test proves effective in distinguishing skill levels, it also underscores the complexities of accurately measuring such a dynamic skill, pointing to the need for ongoing refinement to further improve its reliability and applicability.

Practical Implications

The validation of the Home Run Metrics Test has significant practical implications for both teaching and research in physical education and sports science. For educators, this test provides a reliable and comprehensive tool for assessing students' baseball batting accuracy in a way that closely mirrors real-game scenarios. The test allows teachers to more accurately evaluate batting accuracy, including reaction time, pitch recognition, and adaptability in their students. This, in turn, can lead to more targeted instruction and training programs that address specific areas of improvement, ultimately enhancing student performance and engagement in the sport.

For researchers, the Home Run Metrics Test offers a validated instrument that can be used to study various aspects of batting performance, including the impact of different training methods, the role of cognitive and motor coordination, and the influence of environmental factors on accuracy. The test's strong known-group validity and improved internal consistency after extending trials make it a valuable tool for longitudinal studies and experimental research. Moreover, the test's adaptability to different levels of skill allows researchers to explore performance across a wide range of participants, from novices to advanced athletes, providing deeper insights into the development of batting skills and the factors that contribute to success in baseball and softball.

REFERENCES

1. Anselmi, P., Colledani, D., & Robusto, E. (2019). A comparison of classical and modern measures of internal consistency. Frontiers in Psychology, 10, 2714. https://doi.org/10.3389/fpsyg.2019.02714
2. Beldon, Z., Walker, J. T., & Collins, J. (2022). Comparison of the development of character and skills between club and varsity athletes. Recreational Sports Journal, 46(1), 105–114. https://doi.org/10.1177/15588661221077696
3. Butler, L. S., Sugimoto, D., Erdman, A., Yoder, J., Greiner, K., Larroque, C., Latz, K., Loewen, A., Wyatt, C. W., DeVerna, A., PRiSM Injury Prevention Research Interest Group, & Ulman, S. (2024). Highly active middle school athletes demonstrate poor motor skill proficiency. Sports Health: A Multidisciplinary Approach, 16(4), 527–533. https://doi.org/10.1177/19417381231178822
4. Capio, C. M., Uiga, L., Lee, M. H., & Masters, R. S. W. (2020). Application of analogy learning in softball batting: Comparing novice and intermediate players. Sport, Exercise, and Performance Psychology, 9(3), 357–370. https://doi.org/10.1037/spy0000181
5. Carrol, A., Krupp, T., Tucker, K., Siekirk, N. J., & Kendall, B. J. (2023). The relationship between cognition, preseason hitting assessments, and in-game batting performance in collegiate baseball and softball players. International Journal of Exercise Science, 16 6, 23–30. https://api.semanticscholar.org/CorpusID:258376445
6. Chen, R., Stone, L. S., & Li, L. (2021). Visuomotor predictors of batting performance in baseball players. Journal of Vision, 21(3), 3. https://doi.org/10.1167/jov.21.3.3
7. Cook, D. A. (2015). Much ado about differences: Why expert-novice comparisons add little to the validity argument. Advances in Health Sciences Education, 20(3), 829–834. https://doi.org/10.1007/s10459-014-9551-3
8. Diffendaffer, A. Z., Bagwell, M. S., Fleisig, G. S., Yanagita, Y., Stewart, M., Cain, E. L., Dugas, J. R., & Wilk, K. E. (2023). The clinician's guide to baseball pitching biomechanics. Sports Health: A Multidisciplinary Approach, 15(2), 274–281. https://doi.org/10.1177/19417381221078537
9. Edwards, A. A., Joyner, K. J., & Schatschneider, C. (2021). A simulation study on the performance of different reliability estimation methods. Educational and Psychological Measurement, 81(6), 1089–1117. https://doi.org/10.1177/0013164421994184
10. English, T., & Keeley, J. W. (2015). Internal consistency approach to test construction. In R. L. Cautin & S. O. Lilienfeld (Eds.), The Encyclopedia of Clinical Psychology (1st ed., pp. 1–3). Wiley. https://doi.org/10.1002/9781118625392.wbecp156
11. Fesselmeyer, E. (2021). The impact of temperature on labor quality: Umpire accuracy in Major League Baseball. Southern Economic Journal, 88(2), 545–567. https://doi.org/10.1002/soej.12524
12. Gumilar, A., Darajat, J., Ma'mun, A., Nuryadi, N., Hambali, B., Mudjihartono, M., & Mulyana, D. (2021). Batting performance analisys of west java athletes. Jurnal Pendidikan Jasmani Dan Olahraga, 6(2). https://doi.org/10.17509/jpjo.v6i2.37215
13. Herring, C. H., Beyer, K. S., Redd, M. J., Stout, J. R., & Fukuda, D. H. (2024). Utility of novel rotational load-velocity profiling methods in collegiate softball players. Journal of Strength and Conditioning Research, 38(1), 136–145. https://doi.org/10.1519/JSC.0000000000004601

14. Horiuchi, G., & Nakashima, H. (2022). Torso dynamics during follow through in baseball batting. Sports Biomechanics, 1–11. https://doi.org/10.1080/14763141.2022.2071328
15. Howell, C. R., Gross, H. E., Reeve, B. B., DeWalt, D. A., & Huang, I.-C. (2016). Known-groups validity of the Patient-Reported Outcomes Measurement Information System (PROMIS®) in adolescents and young adults with special healthcare needs. Quality of Life Research, 25(7), 1815–1823. https://doi.org/10.1007/s11136-016-1237-2
16. Jewsbury, P. A., & Bowden, S. C. (2014). A description of mixed group validation. Assessment, 21(2), 170–180. https://doi.org/10.1177/1073191112473176
17. Kidokoro, S., Matsuzaki, Y., & Akagi, R. (2020). Does the combination of different pitches and the absence of pitch type information influence timing control during batting in baseball? PLOS ONE, 15(3), e0230385. https://doi.org/10.1371/journal.pone.0230385
18. Kishita, Y., Ueda, H., & Kashino, M. (2020). Temporally coupled coordination of eye and body movements in baseball batting for a wide range of ball speeds. Frontiers in Sports and Active Living, 2, 64. https://doi.org/10.3389/fspor.2020.00064
19. Koopmann, T., Faber, I., Baker, J., & Schorer, J. (2020). Assessing technical skills in talented youth athletes: A systematic review. Sports Medicine, 50(9), 1593–1611. https://doi.org/10.1007/s40279-020-01299-4
20. Liu, S., Ferris, L. M., Hilbig, S., Asamoa, E., LaRue, J. L., Lyon, D., Connolly, K., Port, N., & Appelbaum, L. G. (2020). Dynamic vision training transfers positively to batting practice performance among collegiate baseball batters. Psychology of Sport and Exercise, 51, 101759. https://doi.org/10.1016/j.psychsport.2020.101759
21. Morishita, Y., Katsumata, Y., & Jinji, T. (2019). The effect of changes in hitting location on bat-swing parameters in baseball batting. Taiikugaku Kenkyu (Japan Journal of Physical Education, Health and Sport Sciences), 64(2), 463–474. https://doi.org/10.5432/jjpehss.18058
22. Nasu, D., Yamaguchi, M., Kobayashi, A., Saijo, N., Kashino, M., & Kimura, T. (2020). Behavioral measures in a cognitive-motor batting task explain real game performance of top athletes. Frontiers in Sports and Active Living, 2, 55. https://doi.org/10.3389/fspor.2020.00055
23. Nevins, D., Smith, L., & Kensrud, J. (2019). Sensitivity of batted-ball speed to swing speed models. Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology, 233(3), 416–423. https://doi.org/10.1177/1754337119835682
24. Orishimo, K. F., Kremenic, I. J., Modica, E., Fukunaga, T., McHugh, M. P., & Bharam, S. (2023). Lower extremity kinematic and kinetic factors associated with bat speed at ball contact during the baseball swing. Sports Biomechanics, 1–12. https://doi.org/10.1080/14763141.2023.2269418
25. Paradis, K., Carron, A., & Martin, L. (2014). Development and validation of an inventory to assess conflict in sport teams: The group conflict questionnaire. Journal of Sports Sciences, 32(20), 1966–1978. https://doi.org/10.1080/02640414.2014.970220
26. Punchihewa, N. G., Arakawa, H., Chosa, E., & Yamako, G. (2021). A hand-worn inertial measurement unit for detection of bat–ball impact during baseball hitting. Sensors, 21(9), 3002. https://doi.org/10.3390/s21093002
27. Rohmah, O., Gumilar, A., Hambali, B., & Salman, S. (2019). Development of instruments batting in softball with live pitching implementation for students. Proceedings of the 3rd International Conference on Sport Science, Health, and Physical Education (ICSSHPE 2018). Proceedings of the 3rd International Conference on Sport Science, Health, and Physical Education (ICSSHPE 2018), Bandung, Indonesia. https://doi.org/10.2991/icsshpe-18.2019.22
28. Sarwiningsih, R. (2017). The comparison accuracy estimation of test reliability coefficients for national chemistry examination in Jambi Province on academic year 2014/2015. JKPK (Jurnal Kimia Dan Pendidikan Kimia), 2(1), 34–42. https://doi.org/10.20961/JKPK.V2I1.8740
29. Tani, Y., Kobayashi, A., Masai, K., Fukuda, T., Sugimoto, M., & Kimura, T. (2023). Assessing individual decision-making skill by manipulating predictive and unpredictive cues in a virtual baseball batting environment. 2023 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW), 775–776. https://doi.org/10.1109/VRW58643.2023.00230

APPENDIX

Appendix A

Home Run Metrics Test

A test on dynamic softball batting accuracy based on a real-game scenario

Developed by Oliver Napila Gomez[a] and Michelle Himulatan[b]

[a] Lourdes College, Inc, Cagayan de Oro City [b] Jasaan National High School, Jasaan, Misamis Oriental

email: oliver.gomez@lccdo.edu.ph

email: michelle.himulatan@deped.gov.ph

The Home Run Metrics Test is a dynamic softball batting accuracy test that measures a batter's ability to contact a dynamically pitched ball accurately, which involves tracking the number of successful hits out of total attempts and using a scoring system to evaluate the placement of each hit based on real game-based scenarios. Along with batting accuracy, the test also involves reaction time, consistency, power, pitch recognition, and plate discipline. Adaptation to the changes in the pitching condition is an aspect controlled in this test.

Materials and Resources

1. **Skilled Pitcher.** The pitcher must be someone with experience and the ability to deliver pitches with accuracy and control consistently, capable of adjusting the speed, trajectory, and type of pitch to match the requirements of the test.
2. **Softballs.** Regulation-sized softballs are appropriate for the age and skill level of the participants.
3. **Bats, Helmets, and Protective Gear.** Participants can use the equipment while batting to ensure their safety and comply with regulations.
4. **Batting Cage or Netting.** Set up a batting cage or install netting around the testing area to contain stray balls and ensure the safety of participants and observers.

Setup

1. **Location Selection.** Choose a suitable location for conducting the test, such as a softball field or indoor facility with enough space for batting practice. Ensure the area is free from obstacles and provides a safe environment for participants and observers.
2. **Field Preparation**. Set up the batter's box and home plate according to regulation dimensions. Mark the pitching rubber on the pitcher's mound at the appropriate distance from home plate (e.g., 43 feet for fastpitch softball). Install a batting cage or netting around the testing area to contain stray balls and ensure the safety of participants and observers.
3. **Pitching Area.** Position the skilled pitcher on the pitcher's mound, ready to deliver pitches to the batter. Ensure the pitcher has clear visibility of the batter's box and home plate.
4. **Participant Area.** Participants should be stationed in the batter's box, wearing helmets and any other necessary protective gear. Provide a selection of bats for participants to choose from based on their preferences and comfort.
5. **Observation Area.** Designate an observation area for coaches, evaluators, or researchers to monitor the test and collect data. This area should provide a clear view of the pitching area, batter's box, and home plate.
6. **Equipment Check**. Verify that all equipment, including softballs, bats, helmets, and protective gear, is in good condition and compliant with relevant regulations. Prepare a drying cloth to ensure that the ball is always dry.
7. **Safety Measures**. Emphasize safety protocols to all participants and observers, including the importance of wearing helmets and staying alert during batting practice. Ensure first aid supplies are readily available in case of any injuries or emergencies.

Testing Protocol

Introduction

1. Begin by welcoming participants and providing an overview of the test objectives and procedures.
2. Review safety protocols, emphasizing the importance of wearing helmets and staying alert during batting practice.
3. Explain the parameters being measured, including batting accuracy, reaction time, consistency, power, pitch recognition, plate discipline, and adaptability.

Warm-Up

4. Conduct a brief warm-up session to allow participants to loosen up their muscles and get comfortable in the batter's box.
5. Provide participants with an opportunity to practice swinging and contacting pitches of varying speeds and trajectories.

Pitching Practice

6. Allow participants to familiarize themselves with the pitcher's delivery and the movement of different pitch types.
7. Encourage participants to communicate with the pitcher to ensure pitches are delivered accurately and consistently.

Testing Phase

8. Each participant will receive a total of 10 fastpitch pitches delivered along the strike zone by the skilled pitcher.
9. Only successful hits on pitches within the strike zone will be counted, and pitches called balls will not be included in the count.
10. A designated runner (not the batting test participant) will run on behalf of the batter to measure how many bases are covered after every successful hit.

Data Collection

11. Assign observers to record data on participant performance during each round, specifically batting accuracy and the number of successful hits out of total attempts. Moreover, the observer will take note of the batting performance remarks:

☐ **Called Strike.** This occurs when a pitch passes through the strike zone without the batter attempting a swing, and the umpire calls it a strike. It indicates that the batter either misjudged the pitch or chose not to swing.

☐ **Swinging Strike.** A swinging strike happens when the batter swings at the pitch but fails to contact the ball. This indicates the batter's timing or judgment of the pitch was off.

☐ **Slight Hit without Trajectory Change**. The batter contacts the ball, but it is such a light touch that it does not alter the ball's trajectory. This could indicate an attempt to hit but poor timing or contact.

☐ **Slight Hit Causing Trajectory Change to Foul.** The batter makes contact, slightly altering the ball's trajectory enough to send it to foul territory. This indicates some control but not sufficient to direct the ball effectively in fair play.

☐ **Legally Batted Ball Caught (Fly Out).** A legally batted ball is hit into the air and caught by a fielder, which does not allow the batter to advance to first base. This outcome demonstrates the ability to make solid contact but needs to be improved in placement to evade fielders.

☐ **Infield Hit.** The batter makes strategic contact, resulting in a ball that remains in the infield but allows them to reach first base safely despite being fielded.

☐ **Hit but Could Only Advance to 1 Base (Single).** A single is a hit that allows the batter to safely reach first base without any errors involved by the opposing team. It generally indicates good contact and placement of the ball where it is not easily fielded.

☐ **Hit and Could Advance to 2 Bases (Double).** A double is a hit where the batter safely reaches second base. This typically means the ball was hit well enough to get past the infielders and into the outfield, providing enough time for the batter to reach second base.

☐ **Hit and Could Advance to 3 Bases (Triple).** A triple, which is less common than singles or doubles, occurs when the batter hits the ball deep into the outfield and reaches third base safely. It requires excellent placement and usually a significant amount of power.

☐ **Homerun Hit.** A home run is achieved when the batter hits the ball out of the playing field in fair territory, allowing them to circle all the bases and score without being put out. This outcome showcases both excellent power and precision in hitting.

Scoring Procedure

To create a structured and transparent scoring system for the dynamic softball batting accuracy test, the system assigns points based on the ranked outcomes specified. This point system will quantitatively evaluate each batter's performance, focusing on skill, accuracy, and effectiveness.

Observations	Point	Interpretation
Called Strike	1	The batter does not swing at a pitch that is called a strike by the umpire
Swinging Strike	2	The batter swings and misses the pitch completely
Slight Hit without Trajectory Change	3	The batter makes minimal contact that does not alter the ball's trajectory, resulting in an easy play for the defense
Slight Hit Causing Trajectory Change to Foul	4	The batter makes contact that slightly alters the ball's trajectory, sending it to foul territory
Legally Batted Ball Caught (Fly Out)	5	The batter hits the ball into the air, but it is caught by a fielder, resulting in an out
Infield Hit	6	The batter makes strategic contact, resulting in a ball that remains in the infield but allows them to reach first base safely despite being fielded
Hit but Could Only Advance to 1 Base (Single)	7	The batter successfully hits the ball and reaches first base safely, indicating good placement and timing
Hit and Could Advance to 2 Bases (Double)	8	The batter hits the ball well enough to safely reach second base, showing better placement and power
Hit and Could Advance to 3 Bases (Triple)	9	The batter hits the ball deep into the outfield, allowing them to reach third base, which indicates significant power and excellent placement
Homerun Hit	10	The highest scoring outcome, where the batter hits the ball out of the field in fair territory, allowing them to circle all bases, showcasing optimal power and precision

Note:

1. Each batter gets a set number of pitches (e.g., 10 pitches) to maximize their score.

2. Sum the points from each pitch to obtain a total score for each batter. Higher total scores indicate a more skilled and effective batting performance. For example, 10 homerun hits is 10x10 = 100 points, the highest score a batter can achieve. Meanwhile, for a batter who has 10 called strikes, the lowest score is 1x10 = 10.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume IX Issue IIIS February 2025 | Special Issue on Education

Score interpretation

Score Interpretation Based on Batting Accuracy Levels:

Range	Description	Interpretation
10-30	Novice	Limited ability to make effective contact with the ball, frequent misses or ineffective swings, and minimal control over the bat.
31-50	Basic	Improving timing and contact, but still struggling with power and placement, resulting in more fouls and fly outs
51-70	Competent	Good bat control, better placement of hits, starting to exploit gaps in the field, and occasionally showing power to reach second base
71-90	Proficient	Strong batting skills, consistent power, and accuracy, able to direct the ball and achieve multiple-base hits. They start to challenge outfielders with their hitting depth
91-100	Expert	Exceptional control, timing, and power. These batters have a deep understanding of pitching styles and can adapt their batting to maximize results. Nearly every hit contributes significantly to the game