International Journal of Research and Review
[Indexed, Peer-Reviewed Journal]
Volume 13; Issue: 4; April 2026
Website: www.ijrrjournal.com
E-ISSN: 2349-9788; P-ISSN: 2454-2237

Research Paper

Item Difficulty and Discriminatory Index of Objective Type Test Items Related to Introduction and Instrumentation in Sports Biomechanics for Master Degree in Physical Education

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DOI: https://doi.org/10.52403/ijrr.20260463

ABSTRACT

Background: Item analysis ensures valid and reliable test construction in educational measurement. In postgraduate physical education particularly in sports biomechanics it is important to maintain the right balance between how challenging an assessment is and how well it distinguishes between different levels of student understanding.

Objective: This study assessed item difficulty and discrimination indices of objective test items in sports biomechanics for M.P.Ed. students, validating their scientific soundness and educational relevance.

Methods: Thirty-three (N=33) M.P.Ed. students (Batch 2024–26) enrolled in the "Fundamentals of Sports Biomechanics" course at IGIPESS, University of Delhi, participated in the study. A 17-item knowledge test, comprising multiple choice, fill in the blank, and matching type questions, was administered under standardized conditions. Item difficulty (p-value) and discrimination index (D) were calculated, and reliability was assessed using the odd–even method with Pearson correlation.

Results: Analysis revealed that 47% of items were easy ($p \geq 0.70$), 41% moderate ($0.30 \leq p < 0.70$), and 12% difficult ($p < 0.30$). Discrimination indices showed that 29% of items were poor (<0.15), 29% acceptable (0.15–0.24), and 41% excellent (>0.34). Reliability testing demonstrated significant internal consistency ($r = 0.599$, $p < 0.01$), confirming the stability of the instrument.

Conclusion: The assessment demonstrated balanced item difficulty, strong discriminatory power, and acceptable reliability, establishing its validity as a tool for evaluating biomechanics knowledge at the postgraduate level. Systematic item analysis strengthens test construction and ensures alignment with curricular objectives, supporting evidence-based teaching in physical education.

Keywords: Item Difficulty, Discrimination Index, Reliability, Sports Biomechanics, Knowledge Evaluation, Test Construction.

INTRODUCTION

Sports biomechanics is one of the foundational disciplines of physical education that significantly contributes to the scientific exploration of human movement, making it highly relevant for postgraduate students in physical education (Baudha, 2023). For Master of Physical Education (M.P.Ed.) Programme, biomechanics serves as a critical link between theoretical instruction and practical implementation, equipping them with the skills to develop targeted training strategies and improve motor efficiency as well as physical efficiency and sports pedagogy (Cui & Wang, 2024). Integrating biomechanical concepts into the curriculum also helps develop critical thinking and informed decision-making skills, which are crucial for aspiring educators and sports professionals (Kamaraj College, 2023). Concentrate on key thematic areas, particularly the foundational concepts and instrumentation techniques in biomechanics, including motion principles, force dynamics, and tools for analyzing human movement (YMCA College of Physical Education, 2025).

The Difficulty Index (ID) and Discrimination Index (DI) are important tools used to assess the quality of test items. The Difficulty Index shows how many students answered a question correctly, helping to determine whether it is easy, difficult, or appropriately balanced. The Discrimination Index, on the other hand, indicates how effectively an item distinguishes between high- and low-performing students, with higher values reflecting better discrimination. Together, these indices enhance the validity and reliability of objective assessments in physical education and sports biomechanics (Natekar & De Souza, 2016; Mehrens & Lehmann, 1991).

This study is designed to Critically assess the scientific soundness of objective test formats, such as multiple-choice questions (MCQs), fill-in-the-blank items, and matching-type questions, used to evaluate theoretical knowledge in the field of sports biomechanics (Andrabi, Shaw, & Husain, 2025).

Using validated tools improves the accuracy of student assessment and also helps curriculum designers better align teaching objectives with real-world skills (Baena-Morales et al., 2024). In addition, the findings of this study can support the development of standardized evaluation models that capture the interdisciplinary nature of biomechanics, combining both theoretical knowledge and practical application. For M.P.Ed. students, such improvements foster a more rigorous educational environment and better prepare them for research-based and professional applications in sports science.

MATERIALS & METHODS

The research involved a group of thirty-three postgraduate students (N = 33) enrolled in the Master of Physical Education (M.P.Ed.) program at Indira Gandhi Institute of Physical Education and Sports Sciences, University of Delhi. All participants belonged to the 2024–26 batch and were studying the course “Fundamentals of Sports Biomechanics,” which was taught over a period of five weeks. During this time, students attended regular weekly sessions conducted by a subject expert. As part of the teaching process, they were initially familiarized with the basic concepts, including the meaning and definitions of kinesiology and biomechanics. The sessions emphasized their importance, scope, major areas of study within physical education, and Instrumentation (Clock & Timers, Stroboscopy, Cinematography, Videography, Force Transducers, Electrogoniometry, EMG, etc.) providing a conceptual foundation before the administration of objective test items. This ensured that learners had a clear theoretical background to support valid assessment of their knowledge.

After the teaching phase was completed, a structured knowledge test was designed to evaluate students’ understanding of sports biomechanics concepts. The initial set of multiple-choice questions (MCQs) was prepared by the course instructors, and these items were subsequently examined by a panel of experts to ensure they were relevant, clear, and properly aligned with the course objectives.

The test was administered under standardized conditions in Biomechanics Lab of IGIPESS (University of Delhi), and student responses were recorded systematically. The collected data were organized in a spreadsheet using Microsoft Excel for further analysis. To ensure the scientific credibility of the test items, an internal validation process was carried out through item analysis methods.

Each question was assessed for its level of difficulty using the Difficulty Index (P-value), which represents the proportion of students who answered the item correctly. Based on established norms (Natekar & De Souza, 2016), items were categorized into three groups:

- Too Difficult ($P < 0.30$)
- Acceptable ($P = 0.30–0.69$)
- Too Easy ($P \geq 0.70$)

To assess the discriminatory power of each item, the Discrimination Index (D) was computed using the formula:

$D = Ph - Pl$

where Ph represents the proportion of correct responses in the high-scoring group and Pl in the low-scoring group. Students were arranged in descending order according to their total test scores and then split into two groups: high achievers (n = 9) and low achievers (n = 9). This grouping made it possible to identify which items were effective in distinguishing between different levels of student performance.

To assess the consistency of the test, the odd–even reliability method was used. The items were divided into two comparable halves, and the correlation between the scores of both halves was calculated. This approach provided an estimate of the test's reliability, confirming that it consistently measured the intended constructs across the sample.

RESULTS

Table 1: Descriptive Statistics and Distribution of Scores Across High and Low Performance Groups in the Sports Biomechanics Knowledge Test

Items	Test Takers (n)	Score Mean ± S.D.	Median	High Score Group (n)	Low Score Group (n)
17	33	12 ± 2.29	12	9	9

Note: Rounded to two digits after the decimal; n=number

Table 1 presents the results of a 17-item assessment completed by 33 postgraduate students. The average score recorded was 12, with a standard deviation of 2.29, and the median was also 12. For conducting the item analysis, the 27% grouping method was used, which categorized nine students into the high-score group and nine into the low-score group.

Table 2: Norm table of Difficulty Index(p) Classification Based on Natekar & De Souza (2016)

Difficulty Index (p-value)	Interpretation
$p \geq 0.70$	Easy Item
$0.30 \leq p < 0.70$	Moderate Item
$p < 0.30$	Difficult Item

This table presents the norm categories for the Difficulty Index, showing how item p-values indicate whether a test question is easy, moderate, or difficult. Items falling between 0.30 and 0.70 are considered acceptable, while values above 0.70 indicate easy items and below 0.30 indicate difficult items.

TABLE 3: ITEM DIFFICULTY OF EACH ITEM

ITEM NO.	ITEM DIFFICULTY	INTERPRETATION
Q1	0.94	Too Easy
Q2	0.64	Moderate item
Q3	1.00	Too Easy
Q4	0.94	Too Easy
Q5	0.21	Too Difficult
Q6	0.24	Too Difficult

Q7	0.42	Moderate Item
Q8	1.00	Too Easy
Q9	0.85	Too Easy
Q10	0.70	Moderate Item
Q11	0.70	Moderate Item
Q12	0.94	Too Easy
Q13	0.67	Moderate Item
Q14	0.85	Too Easy
Q15	0.64	Moderate Item
Q16	0.36	Moderate Item
Q17	0.95	Too Easy

TABLE 4: Categorization of the test items In Regards to their Ratings of Difficulty Index (p)

S. No.	**Number of Items**			**Total Number of Items**
	Too Difficulty	**Acceptable**	**Too Easy**	
	(Less than 0.30)	**(0.30 to 0.70)**	**(More than 0.70)**	
Total Count	2	7	8	17
Item No.	Q5, Q6	Q2, Q7, Q10, Q11, Q13, Q15, Q16	Q1, Q3, Q4, Q8, Q9, Q12, Q14, Q17	

Table 3 and 4 presents a clear distribution of item difficulty, with Q5 and Q6 classified as difficult ($p < 0.30$), seven items Q2, Q7, Q10, Q11, Q13, Q15, and Q16 falling within the moderate range (0.30–0.70), and eight items Q1, Q3, Q4, Q8, Q9, Q12, Q14, and Q17 identified as easy ($p > 0.70$). Overall, the item difficulty analysis indicates a well-structured test, with most questions falling within the moderate or easy range. This distribution suggests that the assessment was generally accessible while still offering an appropriate level of challenge for learners.

TABLE 5: Categorization of ratings of Discriminatory Index.

Category	**DI RANGE**	**Item count**	**Item Numbers**
Poor	Less than 0.15	5	Q1, Q3, Q5, Q8, Q17
Acceptable	0.15 to 0.24	5	Q4, Q6, Q9, Q12, Q16
Good	0.25 to 0.34	0	
Excellent	Greater than 0.34	7	Q2, Q7, Q10, Q11, Q13, Q14, Q15

The discrimination analysis presented in Table 3 indicates that five test items specifically Q1, Q3, Q5, Q8, and Q17 exhibited weak discriminatory power, with index values falling below 0.15. Another five items (Q4, Q6, Q9, Q12, and Q16) demonstrated acceptable discrimination, ranging between 0.15 and 0.24. Interestingly, none of the items fell within the “good” discrimination range of 0.25 to 0.34. However, a substantial portion of the test seven items in total (Q2, Q7, Q10, Q11, Q13, Q14, and Q15) achieved excellent discrimination values exceeding 0.34. These items effectively differentiated between high-performing and low-performing students, underscoring their strength in evaluating conceptual understanding within the domain of sports biomechanics.

TABLE 7: DESCRIPTIVE STATISTICS FOR ODD-EVEN

Descriptive Statistics			
	N	Mean	Std. Deviation
ODD	33	0.7104	0.14943
EVEN	33	0.7083	0.15203
Valid N (listwise)	33		

Table 7 presents the reliability analysis conducted using the odd–even method, which yielded closely aligned results. In the odd–even method, the mean score for odd-numbered items was 0.7104 (SD = 0.14943), while even-numbered items recorded a mean of 0.7083 (SD = 0.15203). These findings indicate a high degree of internal consistency across different item groupings, reinforcing the structural stability and reliability of the test instrument.

TABLE 8: CORRELATIONS OF ODD EVEN RELIABILITY

Correlations			
		ODD	EVEN
ODD	Pearson Correlation	1	.599**
	Sig. (2-tailed)		0.000
EVEN	Pearson Correlation	.599**	1
	Sig. (2-tailed)	0.000	
	N	33	33
**. Correlation is significant at the 0.01 level (2-tailed).			

The odd–even reliability analysis (Table 7) showed a significant positive correlation (r = .599, p < .01, N = 33), confirming strong internal consistency between the two item groups and supporting the test's structural reliability.

DISCUSSION

The present study explored the properties of a 17-item biomechanics assessment developed for postgraduate students in physical education. Overall performance levels were moderate (M = 12, SD = 2.29), suggesting that the instrument was appropriately matched to the curriculum and provided a fair measure of student achievement (Nitko & Brookhart, 2014).

The analysis of item difficulty showed that most of the questions (about 88%) were either easy or moderately challenging, which is consistent with accepted principles of good test design (Haladyna, Downing, & Rodriguez, 2002). The discrimination analysis added further support to the quality of the test: 30% of items demonstrated acceptable discrimination (D = 0.15–0.24), while 41% reached excellent levels (D > 0.34), successfully distinguishing between higher- and lower-achieving students. Only a few items showed weaker performance, indicating areas where refinement is needed (Ebel & Frisbie, 1991).

The odd and even method produced a significant correlation (r = .599, p < .01), reinforcing the stability of the test scores (Gronlund & Waugh, 2009). Overall, these results indicate that the test is psychometrically robust, with an appropriate level of difficulty, effective ability to distinguish between learners, and satisfactory reliability.

Overall, the test provides a valid and reliable measure of biomechanics knowledge at the postgraduate level students and contributes to evidence-based teaching practices in physical education. Future studies should include a larger sample and introduce questions that assess higher-level thinking skills, which would broaden the scope and strengthen the validity of biomechanics assessments in advanced academic contexts.

CONCLUSION

Results showed balanced item difficulty, effective discrimination, and acceptable reliability. Most items were easy to moderately challenging, while several displayed excellent discriminations, clearly separating high- and low-achievers. Reliability measures, including the odd–even method, demonstrated good internal consistency, indicating that the instrument is stable.

Overall, the tool was found to be valid, reliable, and flexible, making it appropriate for use in similar educational settings. Systematic item analysis thus strengthens test construction and ensures alignment with curricular goals.

Declaration by Authors

Ethical Approval: Approved

Acknowledgement: None

Source of Funding: None

Conflict of Interest: No conflicts of interest declared.

APPENDIX

Q. No.	Question
1	Full form of FPS?
2	The term Kinesiology is derived from the Greek word 'Kinesis' and 'Logos' which means?
3	Biomechanics Deals with: (a) The study of force only (b) The study of nutrition in sports (c) The measurement of energy expenditure (d) The study of Mechanics & their effects on living system.
4	Write the Four Environments of goal oriented movements.
5	Write an example of Diagnostic Teaching?
6	Write an example of Diagnostic Coaching?
7	Which research is ideal for fundamental movement analysis?
8-14	Match the following: a) Clocks & Timers. i) Force Transducers b) Stroboscopy. ii) Lower FPS c) Cinematography. iii) KINOVEA d) Videography. iv) Pressure Transducers e) Computer Analysis Software v) Measure & Record Time f) Force Plate. vi) Multiple action on a single photo/frame g) Pressure Plate. vii) Higher FPS
15	Write the Name of any two biomechanical instruments used for measuring kinetic aspects.
16	Define Kinesiological Analysis?
17	Write any six Importance of Biomechanics in Physical Education?

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How to cite this article: Anil Kumar Baghel, Ajit Kumar, Dhananjoy Shaw. Item difficulty and discriminatory index of objective type test items related to introduction and instrumentation in sports biomechanics for master degree in physical education. *International Journal of Research and Review*. 2026; 13(4): 608-614. DOI: *https://doi.org/10.52403/ijrr.20260463*

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