Measurement of physical literacy of elementary school students in Indonesia: an analysis using the Rasch model

Medición de la alphabetización física de los alumnos de primaria en Indonesia: Un análisis mediante el modelo Rasch

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Abstract

Introduction: Physical literacy assessments should be conducted at the primary school level as early as possible to facilitate the development of further treatments.
Objective: This research aimed to analyze datasets to identify the physical literacy profile of primary school students, their strengths and weaknesses in specific aspects of physical literacy, and to assess the suitability and reliability of the physical literacy measurement instruments employed in the study.
Methodology: The research method utilized was a cross-sectional survey, gathering data from 60 primary school students across various locations throughout the same timeframe. Students between the ages of 8 and 12 filled out a physical literacy questionnaire. The data was then analyzed using Rasch modeling with the help of the WinStep 5.7.3 application for validation, data cleaning, calibrating item difficulty and individual abilities, and describing the relationship between item difficulty levels and individual abilities using the same unit scale (logit).
Results: Based on the mapping results, there is a classification of physical literacy for primary school students: the high category at 46.7%, the medium category at 33.3%, and the low category at 20%. The item difficulty levels are classified into three categories: difficult at 16.7%, medium at 73.3%, and easy at 10%.
Conclusions: This analysis offers insight into the variability of students' understanding of physical literacy and the potential direction of interventions to enhance their skills.

Keywords

Physical literacy; Rasch model; primary school; physical education.

Resumen

Introducción: Las evaluaciones de alfabetización física deben realizarse en el nivel de la escuela primaria lo antes posible para facilitar el desarrollo de tratamientos posteriores.
Objetivo: Esta investigación tuvo como objetivo analizar conjuntos de datos para identificar el perfil de alfabetización física de los estudiantes de la escuela primaria, sus fortalezas y debilidades en aspectos específicos de la alfabetización física, y evaluar la idoneidad y confiabilidad de los instrumentos de medición de la alfabetización física empleados en el estudio.
Metodología: El método de investigación utilizado fue una encuesta transversal, que recopiló datos de 60 estudiantes de la escuela primaria en varias ubicaciones durante el mismo período de tiempo. Los estudiantes entre las edades de 8 y 12 años completaron un cuestionario de alfabetización física. Luego, los datos se analizaron utilizando el modelo Rasch con la ayuda de la aplicación WinStep 5.7.3 para la validación, limpieza de datos, calibración de la dificultad de los ítems y las habilidades individuales, y descripción de la relación entre los niveles de dificultad de los ítems y las habilidades individuales utilizando la misma escala de unidades (logit).
Resultado: Con base en los resultados del mapeo, existe una clasificación de alfabetización física para estudiantes de escuela primaria: la categoría alta con un 46,7%, la categoría media con un 33,3% y la categoría baja con un 20%. Los niveles de dificultad de los ítems se clasifican en tres categorías: difícil con un 16,7%, medio con un 73,3% y fácil con un 10%.
Conclusiones: Este análisis ofrece una perspectiva de la variabilidad de la comprensión de la alfabetización física por parte de los estudiantes y la posible dirección de las intervenciones para mejorar sus habilidades.

Palabras clave

Alfabetización física; modelo de Rasch; escuela primaria; educación física.

Introduction

Physical literacy is a multifaceted concept that encompasses an individual's ability to confidently and competently engage in various physical activities, underpinned by motor skills, cognitive understanding, and a positive attitude towards physical activity (Whitehead, 2019; Permana et al., 2024). It is recognized as a crucial component of holistic development, particularly during the primary education years, as it supports not only physical growth but also cognitive and social development (Gu et al., 2019; Pavez-Adasme et al., 2024). Research has consistently highlighted the significance of fostering physical literacy during early education to establish a solid foundation for lifelong health and well-being, as well as to cultivate sustained engagement in physical activity throughout an individual's life (Bremer et al., 2020, Gomes Gonçalves et al., 2024). The early acquisition of physical literacy is instrumental in shaping children's ability to participate in physical activity confidently, adopt healthy habits, and develop essential life skills such as decision-making, cooperation, and problem-solving.

Despite its recognized importance, the systematic integration and evaluation of physical literacy within primary education curricula remain inadequate, particularly in developing countries such as Indonesia. Studies indicate that while physical education programs are implemented in schools, there is often a lack of structured assessment frameworks or tools to evaluate students' physical literacy levels effectively (Friskawati et al., 2023). This gap poses significant challenges for educators and policymakers in designing physical education programs that cater to the diverse needs of students and address their physical, cognitive, and social developmental requirements. Without a comprehensive understanding of students' physical literacy profiles, it becomes difficult to tailor educational interventions that foster their overall growth and long-term engagement in physical activity (Melby et al., 2022).

Existing research on physical literacy has predominantly focused on its theoretical underpinnings, exploring the benefits of physical literacy for child development and its potential to enhance overall health outcomes (Tremblay & Longmuir, 2017; Harvey & Pill, 2019). However, these studies often rely on descriptive or basic inferential analyses, which may provide limited insights into the complexities of physical literacy and the effectiveness of measurement tools. Moreover, the psychometric properties of physical literacy assessment instruments have not been extensively scrutinized, particularly in the context of primary education. This methodological limitation hampers the ability of researchers and educators to obtain reliable and valid data that can inform the development of evidence-based educational practices (Cairney et al., 2019).

In addressing these challenges, advanced statistical techniques such as Rasch Modeling offer a promising solution. Rasch Modeling is a robust analytical method that evaluates both the difficulty level of test items and the ability level of respondents, providing nuanced insights into the strengths and weaknesses of assessment instruments. This technique also accounts for individual differences in students' physical literacy levels, allowing researchers to identify specific areas where interventions are needed (Huang & Chen, 2020). By employing Rasch Modeling, researchers can enhance the reliability and validity of physical literacy assessments while uncovering patterns and trends that may be obscured in traditional analyses. This methodological innovation has significant implications for improving the quality of physical education programs and fostering a deeper understanding of physical literacy development among primary school students.

Despite its potential, the application of Rasch Modeling in physical literacy research remains limited, particularly in Indonesia. As a developing country, Indonesia faces unique challenges in promoting physical literacy, including resource constraints, limited teacher training, and the absence of standardized assessment frameworks. While global studies have emphasized the importance of evaluating physical literacy to inform policy and practice, there is a lack of localized research that addresses the specific needs and contexts of Indonesian primary schools. This gap highlights the need for innovative approaches that can provide comprehensive data on students' physical literacy levels and inform the design of culturally and contextually relevant interventions (Friskawati et al., 2023).

This study seeks to address this research gap by employing Rasch Modeling to analyze a physical literacy mapping dataset of primary school students in Indonesia. The application of this advanced statistical technique represents a significant methodological contribution to the field, as it allows for a detailed examination of the psychometric properties of physical literacy assessment tools and provides actionable insights into the developmental needs of students. By leveraging Rasch Modeling, this research aims

to bridge the gap between theoretical knowledge and practical application, offering evidence-based recommendations for improving physical education programs in Indonesia.

The novelty of this study lies in its use of Rasch Modeling to systematically analyze physical literacy data in a primary education context. While previous studies have emphasized the importance of physical literacy and its impact on child development, few have utilized advanced statistical techniques to evaluate the effectiveness of assessment instruments and identify individual differences among students. This research not only contributes to the growing body of knowledge on physical literacy but also addresses a critical methodological gap in the field. Furthermore, the findings of this study have the potential to inform the development of targeted interventions that enhance physical literacy and promote lifelong engagement in physical activity, ultimately contributing to improved health outcomes at both individual and societal levels (Valadi & Cairney, 2022). The objective of the present study was to employ the Rasch modeling technique to analyze the physical literacy mapping dataset of primary school students. It is expected that this analysis would provide a comprehensive understanding of the physical literacy levels of students, the reliability of the measurement instruments, and the existence of individual differences in physical abilities. The findings of this study would be crucial in developing curricula and interventions that are more effective in enhancing physical literacy at the primary school level.

Method

The research employed the cross-sectional survey method, which involves collecting data from a specific population at a single point in time (Ary et al., 2018). In order to record or describe the present state of students' physical literacy in primary schools, researchers simultaneously assessed the results of respondents' exposure. The sample consisted of 60 primary school students between 8 and 12. The physical literacy of students in primary schools was mapped using a questionnaire for data collection. This study had been granted ETHICAL APPROVAL with No. 6/UN40.K/PT.01.01/2024 by the International Conference on Harmonization—Good Clinical Practice (ICH-GCP), Universitas Pendidikan Indonesia. The PL-C Quest instrument grid (Barnett et al., 2021) utilized in this study is as follows in table 1:

Table 1. Exam Content Outline of the Physical Literacy Questionnaire Instrument for Primary School Students (Barnett et al., 2021).

No	Domain	Element	Item Number	Total Items
1	Physical: The skills and fitness a person acquirss and applies through movement.	Movement skills, Moving with equipment, Object manipulation, Coordination, Stability Balance, Flexibility, Agility, Strength, Muscular endurance, Cardiovascular endurance, Reaction time, Speed.	1,2,3,4,5, 6,7,8,9,10, 11,12	12
2	Psychological: The attitudes and emotions a person has towards movement and the impact they have on their confidence and motivation to move.	Engagement & enjoyment, Confidence, Motivation, Connection to place, Self-perception, Self-regulation (emotions), Self-regulation (physical).	13,14,15, 16,17,18, 19	7
3	Social: A person's interaction with others in relation to movement	Relationships, Collaboration, Ethics, Society & culture.	20,21,22, 23	4
4	Cognitive: A person's understanding of how, why and when they move.	Content knowledge, Safety & risk, Rules, Reasoning, Strategy & planning, Tactics, Perceptual awareness.	24,25,26, 27,28,29, 30	7

The instrument for the physical literacy questionnaire that was created had been field validated and analyzed using Rasch modeling and the item fit order procedure, as illustrated in Table 2.

Table 2. Validation Results of the Physical Literacy Questionnaire Instrument (Item Fit Order)

No. Item	MNSQ	ZSTD	Pt. MC	Description
1	1.00	0.05	0.47	Valid
2	0.90	-0.27	0.40	Valid
3	1.00	0.06	0.46	Valid
4	0.78	-1.30	0.65	Valid
5	0.75	-1.65	0.46	Valid
6	0.97	-0.12	0.54	Valid
7	0.68	-1.79	0.25	Valid
8	1.43	2.15	0.30	Valid
9	0.83	-0.86	0.59	Valid
10	1.63	2.75	0.38	Valid
11	1.15	0.78	0.37	Valid
12	0.71	-1.64	0.64	Valid

Table 2. Validation Results of the Physical Literacy Questionnaire Instrument (Item Fit Order)

No. Item	MNSQ	ZSTD	Pt. MC	Description
13	0.62	-2.57	0.67	Valid
14	1.39	2.03	0.22	Valid
15	0.62	-2.18	0.59	Valid
16	1.30	1.49	0.42	Valid
17	0.74	-1.38	0.56	Valid
18	0.93	-0.26	0.21	Valid
19	1.33	1.56	0.52	Valid
20	1.27	1.20	0.07	Valid
21	1.08	0.35	0.19	Valid
22	0.81	-0.97	0.22	Valid
23	0.98	-0.05	0.52	Valid
24	1.00	0.07	0.35	Valid
25	1.20	0.99|	0.36	Valid
26	1.31	1.50	0.30	Valid
27	0.83	-1.08	0.58	Valid
28	1.41	1.91	0.31	Valid
29	0.77	-1.24	0.67	Valid
30	1.62	2.75	0.27	Valid

The validation of each item of the physical literacy questionnaire instrument was determined by referring to the criteria used to measure item validity through Rasch modeling, which is as follows: 1) Logit 0.5 <MNSQ <1.5; Logit -2.0 <ZSTD <+2.0; and Logit 0.4 <Pt. MC. <0.85. Boone et al. (2014) declare items valid if they meet one of these criteria. The analysis in Table 2 concludes that all items on the physical literacy questionnaire instrument for primary school students are valid and suitable for data collection. Additionally, all data that had been collected were entered into a Microsoft Excel file and analyzed using the WINSTEPS version 5.7.3 application, measurement software through Rasch modeling for validation, data cleaning, calibrating item difficulty and individual ability, and describing the relationship between item difficulty and individual ability using the same unit scale of scaled logit (Linacre, 2011).

Results

Rasch modeling was employed to analyze the physical literacy mapping of primary school students in order to ascertain the degree to which an instrument can measure diversity. This determination was made to discern whether the instrument could accurately measure the intended variables (Higgins, 2007; Andrich, 2010). The data collection results were subsequently analyzed to clean up data using the respondents' entries.

Table 3. Summary of Person Measure Data (N = 60) (Pre- and Post-Data Cleaning)

	Total Score	Count	Measure	Model Error				
Mean	93.9	30	1.20	0.29				
Standar Deviation	8.3	0.0	0.75	0.04				
Max.	111	30	2.99	0.40				
Min.	76	30	-0.11	0.25				
Model RMSE	0.30	TRUE SD	0.68	Separation	3.31	Person	Reliability	0.84

CRONBACH ALPHA Person RAW SCORE "TEST" RELIABILITY = 0.92

Table 4. Summary of Item Measure Data (N=30) (Item Reliability)

	Total Score	Count	Measure	Model Error
Mean	187.9	60	0.00	0.04
Standar Deviation	28.7	0	1.08	0.00
Max.	228	60	3.44	0.05
Min.	84	60	-2.15	0.04
Model RMSE		Item Reliability		0.96

The results of respondent data cleaning (pre- and post-data cleaning) are presented in Tables 3 and 4. Of the 60 respondents collected, no respondents were eliminated (maximum or minimum extreme measure). Therefore, all respondents were eligible for further analysis at the subsequent stage to determine the interaction relationship between respondent characteristics and 30 items. Meanwhile, Table 4 displays the summary statistical data for the research instrument items, indicating that the items are reliable for assessing students' physical literacy. In addition, the item separation index illustrates the

distribution of these items in the classification of easy and difficult items (Trantham et al., 2021). Thus, the respondents' ability index is the determining factor in determining their consistency (Nguyen & Seong, 2014). The instrument is more effective at identifying broader groups of respondents (able-unable) and groups of items (difficult-easy) as the separability value increases (Parkitny et al., 2012; Sumintono & Widhiarso, 2015). In Table 3, the pre-post data cleaning results demonstrate that the instrument can identify three groups of items based on the separation person (3.31). The Cronbach Alpha Person value, which measures the reliability of the interaction between people and items as a whole, is 0.96. This value is above 0.5, indicating that the interaction between respondents and items is of a very high category, as per Fisher (2007). The mapping of the difficulty level of items on the instrument for mapping students' physical literacy in primary schools is illustrated in Table 5, and the level of physical literacy of students in primary schools is illustrated in Table 6 below.

Table 5. Classification of item difficulty levels based on Logit Value Item (LVI)

Indicator	No	Logit Item	Logit Value Item (LVI)		
			Difficult LVI > 1.06	Moderate 1.06 ≥ LVI ≥ -1.06	Easy LVI < -1.06
Physical	1	-0.14		√	
	2	3.44	√		
	3	-0.46		√	
	4	0.83		√	
	5	1.43	√		
	6	1.06	√		
	7	0.29		√	
	8	0.70		√	
	9	0.36		√	
	10	-0.86		√	
	11	-0.65		√	
	12	.29		√	
Psychological	13	1.09	√		
	14	0.89		√	
	15	-0.27		√	
	16	0.22		√	
	17	-0.86		√	
	18	-1.34			√
	19	-0.86		√	
Social	20	-1.34			√
	21	-2.15			√
	22	-0.55		√	
	23	-.18		√	
Cognitive	24	0.06		√	
	25	-0.97		√	
	26	-0.65		√	
	27	1.34	√		
	28	-0.06		√	
	29	-0.06		√	
	30	-0.60		√	
N			5	22	3

Table 5 contains data regarding the item difficulty of the physical literacy questionnaire for primary school students, which depicts the difficulty level related to each indicator. The logit item value (LVI), which explains item difficulty (specific competencies), indicates that students face significant challenges in physical literacy related to certain indicators. The item difficulty levels are classified into three categories, as shown in Table 5. These categories are as follows: difficult at 16.7%, moderate at 73.3%, and easy at 10%. Figure 1 shows the distribution map for item difficulty levels.

Figure 1. Number of visibility and gender fitness in PE Textbooks from Grade 1

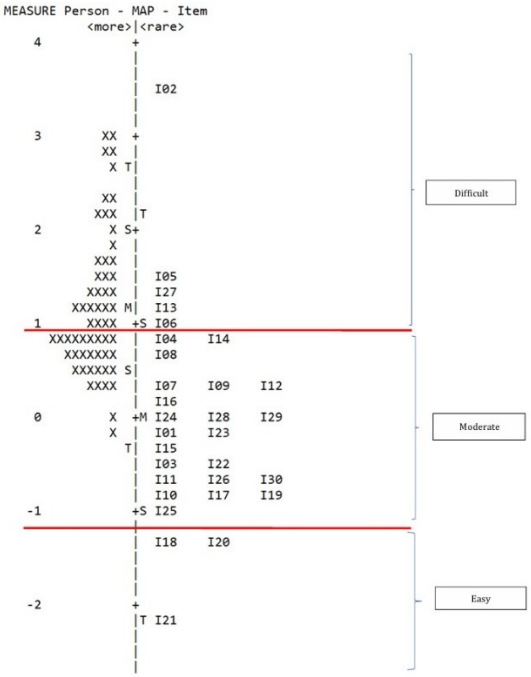
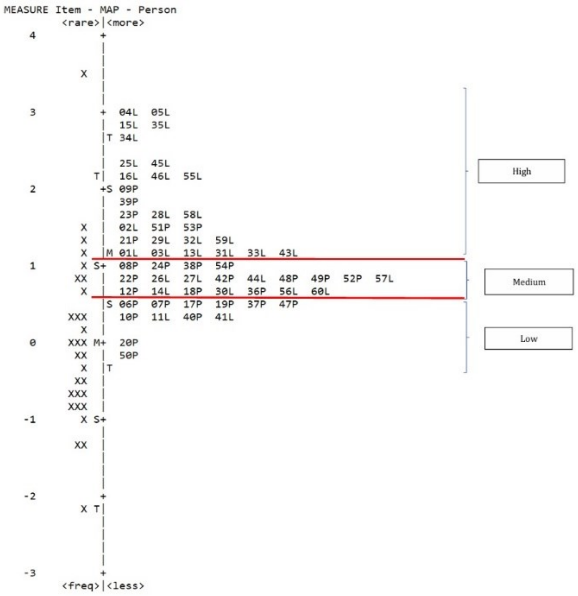


Table 6. Logit Value of Persons (LVP) Physical Literacy (N= 60)

Classification	High LVP ≥ 1.20	Medium 1.20 < LVP < 0.74	Low LVP ≤ 0 .74
Total (%)	28 (46.7%)	20 (33.3%)	12 (20%)

In Table 6, the physical literacy level of primary school students is categorized into three categories: high, medium, and low. The mean value and the standard deviation are combined to determine the category. According to the respondent separation index, the scale differentiates students "very well." The findings indicate that most students require enhancements to their physical literacy to improve their performance. Regarding the visualization of students' physical literacy mapping, Wright's map analysis will reveal the distribution of items and respondents (Bond & Fox, 2007).

Figure 2. Wright map to show the distribution map of respondents



Based on the results above, and to explain the results of the Rasch model analysis of physical literacy, the researchers provide a diagram showing the levels of student ability and the difficulty level of the items in Figure 3 below.

Figure 3. Diagram of student ability and item difficulty (physical literacy)

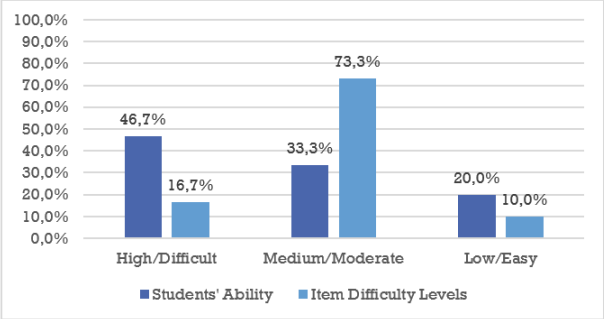


Figure 3 shows that students' physical literacy skills were 46.7% in the high category, but the majority were in the medium and low categories (53.3% in total). This result highlights the importance of intervening in kids' physical literacy in schools by developing innovative programs to increase physical literacy skills to their full potential. Figure 3 shows that physical literacy items are mostly in the medium difficulty category. The difficulty level of items at each level is described as follows:

1. The difficulty level of items in the difficult category includes moving with equipment, muscular endurance, coordination, and reasoning.
2. The difficulty level of items in the medium category includes movement skills, object manipulation, stability, balance, flexibility, agility, strength, cardiovascular endurance, reaction time, speed, engagement & enjoyment, confidence, motivation, connection to place, self-perception, self-regulation (emotions), self-regulation (physical), relationships, collaboration, ethics, society & culture, content knowledge, safety & risk, rules, strategy & planning, tactics, and perceptual awareness.
3. The difficulty level of items in the easy category includes enjoyment, ethics, and relationships.

Based on the findings above, it is clear that utilizing the Rasch model to conduct detailed analysis can aid in identifying the components of physical literacy that are still lacking and already good, allowing teachers to build more successful advanced intervention programs.

Discussion

Physical literacy includes the skills and knowledge necessary to maintain an active and healthy lifestyle, as well as the ability to participate effectively in physical activity and sports. The findings of this study offer an in-depth look at the obstacles that primary school students encounter in their pursuit of physical literacy, as evidenced by the data obtained through Rasch modeling. The items classified as "difficult" suggest that approximately one-third of the competencies assessed necessitate more complex knowledge or skills. This may result from various factors, including a lack of hands-on experience, skills that necessitate the integration of multiple physical abilities, or activities that have not been frequented by students to promote physical literacy through physical education (Durden-Myers et al., 2022). Furthermore, flaws in the current physical education curriculum, inadequate facilities, or inadequate training for educators in effective teaching methods may impede students' skill development (Belton et al., 2019). As a result, it is critical to evaluate and update curricula and teaching methods to ensure that they are more appropriate for students' needs and that they receive adequate exposure to a wide range of physical activities that promote the overall development of physical literacy competencies (Yldzer & Munusturlar, 2021). Interventions intended to rectify these deficiencies should incorporate adaptive

and evidence-based approaches, ensuring that each student receives a diverse and sufficient learning experience in their physical education (Inimfon Aniema Essiet et al., 2021; Komar, 2021).

Most items were classified as "moderate" in difficulty, suggesting that most of the competencies assessed were within the students' capabilities with reasonable effort. This aligns with the principle that students can acquire basic physical literacy skills through structured practice and gradual learning. Most skill development theories suggest optimal motor learning happens when the challenge aligns with the student's current ability, motivating them to keep improving (Schmidt et al., 2017). Items at the "easy" difficulty level indicate that a minority of students have achieved relatively easy mastery of the skills. This could apply to fundamental skills that students regularly incorporate into their daily routines or those they have already learned (Taplin, 2019). According to the motor learning theory, frequently practiced or familiar skills become easier to master and implement (Goodway, Jacqueline D., Jhon C. Ozmun, 2021).

The map of item difficulty distribution is a valuable tool for comprehending the distribution of difficulty. This map enables us to directly observe the areas in which students encounter greater challenges and those that are fairly easy. This can assist educators and policymakers in identifying areas that require additional attention and developing more effective teaching strategies. For instance, if the map indicates that items with a high level of difficulty are tailored to particular aspects of physical literacy, more precisely targeted interventions can be developed to enhance students' capabilities in that area.

The abovementioned results significantly impact the teaching and development of physical literacy in primary schools. For items classified as challenging, educators may implement deeper approaches, such as project-based learning or exercises that emphasize complex skills. For the medium category, teaching approaches that ensure basic skills are reinforced while providing additional challenges would be beneficial. Before moving on to more complex skills, educators can use easy items to build student confidence. By understanding this distribution of difficulty, educators can more effectively customize curriculum and interventions to meet students' specific needs and enhance their physical literacy development (Cairney et al., 2022).

This analysis offers important insights into the extent to which students' mastery of physical literacy varies and how interventions can be designed to improve their skills. This categorization was accomplished by combining the mean and standard deviation, a method frequently employed in statistical analysis to ascertain the extent to which data deviates from the mean and identify groups within the data (Louis Cohen & Morrison, 2018). Students in the high category exhibited a high level of physical literacy, displaying above-average abilities in various physical skills and related knowledge. Students with high levels of physical literacy typically have more access to physical activity opportunities and more advanced motor skills and can leverage their experiences more effectively, per skill development theory (Whitehead, 2010). This implies they may have acquired sufficient experience and effective practice in developing their physical literacy.

Students in the moderate category exhibited an intermediate level of physical literacy, indicating that they possessed basic skills but may not have mastered the more complex ones. According to motor learning theory, students in this category may have achieved a level of proficiency in fundamental skills but necessitate additional practice and guidance to advance to more advanced levels (Brian et al., 2017). Compared to their classmates, students in this category exhibited lower physical literacy levels. This may indicate a lack of motivation, an inability to develop fundamental skills well, or a lack of opportunity to practice (Telford et al., 2019). Students in the low category may necessitate more intensive and support-based interventions to enhance their skills, as motor skill development theory emphasizes the significance of early exposure and structured practice in the development of physical skills (Goodway, Jacqueline D., Jhon C. Ozmun, 2021). The respondent separation index shows that the scale used in this study can distinguish very well between students with different physical literacy levels. This implies that the measurement tool employed is accurate in detecting discrepancies between students with varying skill levels (Bond & Fox, 2007). The ability of the measuring instrument to differentiate between various levels of ability is crucial for the accuracy and usefulness of the data obtained for further analysis, as per the theory of measurement validity and reliability (Kline, 2015).

These findings indicate a substantial requirement to enhance the physical literacy of students, particularly those in the low or medium categories. It is crucial to design an intervention program that prioritizes the development of basic skills and offers additional opportunities for practical application and hands-on experience for students in the low category. The program should consider various pedagogical approaches that suit students' needs and tailor the learning materials to their skills (M Whitehead, 2019). A teaching approach that reinforces fundamental skills while introducing suitable challenges would be highly beneficial for students in the moderate category. This is consistent with the principle that student learning is most effective when they are in a challenge zone suitable for their skill level (Durden-Myers & Bartle, 2023).

Conclusions

This study highlights the effectiveness of Rasch modeling as a methodological tool for assessing the physical literacy levels of primary school students. The analysis revealed that most students were classified in the "medium" category of physical literacy, with the questionnaire items primarily distributed within a medium difficulty range. These findings underscore significant variability in students' physical literacy levels and the necessity for differentiated instructional strategies. Furthermore, the respondent separation index confirmed the ability of the measurement instrument to reliably distinguish between varying levels of student ability, while the Wright map analysis provided actionable insights for curriculum development and targeted educational interventions.

The study underscores the critical importance of adaptive, data-driven teaching approaches to address the diverse needs of students and enhance their physical literacy. By utilizing comprehensive mapping data, educators can better tailor their methods to foster equitable and effective learning experiences. This research serves as a foundation for future studies, encouraging the development and implementation of intervention programs aimed at improving physical literacy and their subsequent evaluation using Rasch modeling. The findings contribute to advancing evidence-based practices in physical education, promoting holistic student development, and supporting the broader goal of fostering lifelong physical literacy.

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