ORIGINAL ARTICLE

Developing a precise gross motor skills assessment instrument for elementary school students (ages 7-9)

Cahyo Wibowo[1ABCDE], Dennys Christovel Dese[2BCDE], Yahya Eko Nopiyanto[3BCDE]

[1,2] Physical Education Study Program, Satya Wacana Christian University, Indonesia
[3] Physical Education Study Program, Bengkulu University, Indonesia

Abstract

Background and Study Aim	The assessment instrument for gross motor skills in physical education is crucial in developing fundamental motor skills in elementary school students. This research aims to formulate an assessment tool for gross motor skills tailored to students aged 7-9, aligning with their specific characteristics.
Material and Methods	This study adopts a research and development approach utilizing the 4D development procedure (Define, Design, Develop, Disseminate). It involves the validation process by five experts in motor skills and physical education, comprising faculty members from five distinct universities. The trial subjects encompass 310 elementary school students aged 7-9, while the instrument's effectiveness is evaluated by 35 individuals, including physical education teachers and students. Statistical analyses encompass content validity, criterion validity, test-retest reliability using Cronbach's alpha, and descriptive percentage analysis.
Results	This research has produced a gross motor skills assessment instrument comprising 11 movement components: sit and stand up, rolling, one-leg stand, gallop, slide, jump, bouncing a ball, catching, throwing, kicking, and hitting. The content validity result is 1>0.763, criterion validity (rxy) > 0.304, Cronbach's alpha value for all items > 0.60, and the average perception assessment of instrument effectiveness > 93%, falling into the category of extremely high.
Conclusions	The assessment instrument demonstrates high validity and reliability, effectively addressing the challenges associated with the need for assessments tailored to the evaluated subject's characteristics, objectives, and relevance. An easily comprehensible instrument, coupled with language accessibility, yields positive outcomes for physical education teachers in the assessment process.
Keywords:	instruments, assessment, gross motor skills, physical education

Introduction

Physical education plays an immensely vital role in the development of elementary school children, particularly in learning fundamental motor skills. Fundamental motor skills encompass a child's ability to engage their muscles in various physical activities such as running, jumping, walking, throwing, and others [1]. Physical education is a platform for children to cultivate their motor skills through structured and measurable activities. Numerous studies underscore the significance of possessing motor skills in elementary school children, with one highlighting that a child with good motor skills tends to exhibit enhanced self-confidence, aiding in the increase of physical activities and reduction of sedentary behavior [2, 3]. The phenomenon of motor skill development in 7-9-year-old elementary school children represents a crucial period in their motor development process. Within the age range of 7-9 years, children undergo substantial development in gross and fine motor skills, concentration, coordination, environment, and exercise [4]. During this age, children commence applying basic movements in structured activities in their daily lives and through physical education learning in school. Therefore, by providing appropriate support from internal and external perspectives, children can more easily develop motor skills individually or in groups, supporting their potential to remain active in various activities [5].

The proficient development of motor skills in elementary school children positively impacts holistic child development [6]. Proficient motor skills aid children in cultivating physical abilities for daily life [3, 7]. They can execute various locomotor and manipulative movements without significant hindrance. Physical activities involving diverse motor skills help children maintain a high fitness level. Through active movement, they can sustain an ideal body weight, exercise muscles, and bones to retain strength and uphold the health of the cardiovascular system. This contributes to reducing the risk of cardiometabolic diseases such as obesity and heart-related issues in the future [8].

Each child's motor skills naturally vary; some exhibit proficiency while others lag behind. It is crucial, particularly for physical education teachers, to pay attention to the motor development of each learner [9]. Presently, a significant issue is the prevalence of low fitness levels among many elementary school children [10]. Numerous primary school children are grappling with obesity and diabetes resulting from physical inactivity [5]. Addressing this matter falls within the responsibility of educators, especially physical education teachers, to devise effective physical education programs for elementary school children. Assessment instruments are pivotal in this context, serving as tools to evaluate learners' abilities [11]. Motor assessment instruments gauge a child's motor development and identify motor delays or disorders [12]. In the context of physical education programs, these instruments aid physical education teachers in selecting or crafting learning programs that align with the motor skills proficiency of the learners. Therefore, accurate and validated instruments are essential [13]. Teachers are crucial in advancing the nation's civilization and preparing learners with competent and relevant skills [14]. Achieving these milestones necessitates skills that require teachers to stay updated with knowledge to anticipate various possibilities in the learning process [15]. Learners' attainment of optimal learning outcomes begins with the competencies teachers possess in executing their roles and functions [16].

Based on the preliminary study, many physical education teachers must implement a basic motor skills assessment system. Teachers often focus solely on sports and games, neglecting the fundamental aspects of movement itself. In this process, there needs to be more systematic monitoring of the measurable and planned development of motor skills. This is evidenced by teachers' need to understand basic motor skills assessment instruments better. The lack of understanding among physical education teachers regarding motor skills assessment instruments can be attributed to several factors:

– the complexity of fundamental motor skills instruments may be considered too challenging to comprehend and irrelevant to the school environment. Physical education teachers may struggle to apply these instruments, especially if they are developed using language or terminology that is not easy to understand.

– ineffective and inefficient instruments may result in the wastage of time and energy,

– resource limitations - physical education teachers face constraints in terms of facilities and assistants for assessment implementation,

– low urgency levels - physical education teachers may perceive little importance in assessing and monitoring the development of motor skills.

Based on the background and problem identification provided, the research problem formulation in this study is how to develop an assessment instrument for basic motor skills in children aged 7-9 years. In line with the research problem, the development objective is to create an assessment instrument for basic motor skills by student characteristics. The product specifications in this study include an assessment instrument for gross motor skills in elementary school students aged 7-9 years, intended to assist physical education teachers in implementing a systematic and planned monitoring and evaluation process for gross motor skills.

Materials and Methods

Participants

The trial subjects in this research comprised 310 elementary school students aged 7-9 years (grades 1-3) from three schools in the Salatiga region: Islamic Elementary School Kurma, Public Elementary School 2 Beringin, and Elementary School Marsudirini 77. The study further included five physical education teachers instructing at elementary schools in Salatiga and 30 students from the Physical Education program.

Research Design

This study adopts a Research & Development (R&D) approach, utilizing research findings to design new procedures and products systematically tested, evaluated, and refined in the field to meet specific criteria. The development procedure follows the Dick & Carey theory's four stages, as developed by various experts:

(a) Define instructional requirements,

(b) Design prototypical instructional model,

(c) Develop tested and reliable instructional model,

(d) Disseminate instructional model [17, 18, 19].

The application of these developmental steps is not rigid but adaptable to the characteristics of the research subjects and the study location, considering the field's developmental needs.

Stage 1: Define - This stage establishes and defines the necessary conditions for development, considering the learners' requirements. It includes learner analysis, concept analysis, task analysis, and objective formulation.

Stage 2: Design - In this stage, the steps include developing assessment standards, selecting media, choosing formats, and creating initial designs.

Stage 3: Develop - The goal of this developmental stage is to produce the final assessment instrument after revision based on expert feedback and trial data. It involves two steps: (a) Expert Assessment: This step aims to validate the product's suitability and is conducted by five experts in physical

education and sports. Based on expert input, the instrument is revised to enhance effectiveness and user-friendliness. (b) Development Testing: This stage comprises limited-scale testing, product revision, and large-scale testing.

Stage 4: Disseminate - The final stage involves disseminating the product for community utilization. Packaged as a motor skills assessment book, the product undergoes socialization with physical education students and teachers. This aims to gather responses and feedback on the developed instrument. Subsequently, mass printing and marketing are carried out for widespread use. Before field trials, the product undergoes expert content validity testing to ensure its validity [20].

Following this, reliability testing is conducted on elementary school students aged 7-9. The product design revolves around gross motor skills, categorizing movements into balance, locomotion, and manipulative [21]. Each movement category comprises several components. The data collection instruments include assessment rubric questionnaires, perception questionnaires, and cameras. Data collection involves direct performance assessment, with students executing motor skill movements and their performance evaluated through direct observation. Evaluators must be familiar with the assessment indicators. Perception questionnaires are distributed to physical education teachers and students to gather responses, opinions, and assessments of the developed instrument. The assessment rubric questionnaire has undergone expert validation by five lecturers from different universities specializing in physical education and motor skills.

Ethics Committee Approval Statement

Approval from the University, has been granted for conducting this research, confirming its ethical procedure. The research procedures adhere to the principles outlined in the Helsinki Declaration. All research participants willingly consented to become respondents, having previously completed informed consent forms. To ensure comprehensive understanding, the researcher provided a research information sheet detailing the research background, objectives, procedures, potential risks, and benefits to respondents and parents.

Statistical Analysis

Content Validity. Content validity indicates whether a test measures the intended substantive coverage. The Content Validity Ratio (CVR) formula [22]: is as follows:

$$CVR = (n_e - N/2)/N/2 - original \ [22]$$

in which n_e is the number of experts that rated the item as "Essential", and N is the panel size.

The instrument can be deemed valid based on decision-making if the minimum CVR value, with a significance level of 0.05, is 0.763 < the CVR obtained from the five experts.

Criterion Validity. Criterion validity is employed to assess the quality of the developed instrument based on its usage experience [23]. Pearson Product-Moment Correlation statistical test and IBM SPSS Statistics 25 are utilized to determine criterion validity. The instrument can be considered valid based on decision-making if the calculated r-value> the tabled r-value of 0.304.

Test-Retest Reliability. Reliability, interpreted as consistency or stability, is assessed in this study using the test-retest method with Cronbach's alpha analysis. The decision-making criterion for reliability is if Cronbach's alpha value > 0.60, the instrument is considered reliable.

Descriptive Percentage. The assessment instrument, having undergone various testing stages and revisions and deemed suitable for use, will be disseminated. Product evaluation employs descriptive percentages to observe the instrument's feasibility by direct users, namely physical education teachers and physical education program students. Percentage calculations are also applied in the large-scale trial. The percentage calculation for the large-scale trial employs the following categories: Excellent (x > 36), Good (30 < x ⩽ 36), Adequate (25 < x ⩽ 30), Insufficient (19 < x ⩽ 25), Very Insufficient (x ⩽ 19).

Results

The research findings elucidate that content validity testing was conducted by five experts in physical education and motor skills. Subsequently, a total of 310 elementary school students participated in both limited and extensive scale trials, which were evaluated through criterion validity and reliability testing, as elaborated in the table 1.

Table 1. Expert Validation Test Results

Skills assessed	minimum CVR value	CVR Value	Description
Sit and stand up	0.763	1	Valid
Rolling	0.763	1	Valid
Standing on one leg	0.763	1	Valid
Riding	0.763	1	Valid
Sliding	0.763	1	Valid
Jumping	0.763	1	Valid
Running	0.763	1	Valid
Bouncing a ball	0.763	1	Valid
Catching	0.763	1	Valid
Throwing	0.763	1	Valid
Kicking	0.763	1	Valid

CVR: Content Validity Ratio.

Based on Table 1, the minimum CVR value at a significance level of 0.05 with a total of five validators, experts in physical education and motor skills education, is 1, more significant than 0.763, the minimum CVR value for five validators. It can be concluded that each skill item is accepted or deemed appropriate and valid based on the expert assessment.

Further, in the expert validation process, several revisions and inputs were obtained, including the following:

1. For the balance movement, the "toe-heel" movement was added to assess the students' balance during this specific activity.
2. For the manipulative movement, the "hitting" motion was added to complement the existing set of movements.
3. The skill "riding" was renamed.
4. Adjustments were made to the size and type of the ball used in the bouncing skill to align with the characteristics of the students.

Subsequently, revisions were made considering the expert input. The name "riding" was changed to "galloping," and an additional criterion, "hitting," was added. The assessment criteria for hitting were carried out using a tennis ball and a hockey stick. Further validation was conducted based on field trials to reinforce the validity and ensure the instrument meets the needs and characteristics of elementary school students aged 7-9. The following are the results of the criteria validity.

Based on Table 2, it is known that the r-table value is 0.304. This means that if the relationship between each skill or item and the total score is 0.000 < 0.05, and the Pearson correlation is positive rxy > 0.304, it can be concluded that the measured skill or item is valid. These skills or items are tools for collecting accurate data.

On the other hand, skills or items deemed invalid or questionable will be excluded from the instrument and not used, resulting in a total of 11 skills or items (table 3).

The Cronbach's alpha value for all items is > 0.60. Therefore, as the basis for decision-making in the reliability test, the 11 motor skills items or all items for the gross motor skill variable are reliable or consistent and fall within the high-reliability category.

After undergoing the stages of validation and revision the results revealed that eight students (2.9%) were categorized as insufficient, 27 students (10%) fell into the adequate category, 159 students (59.3%) were categorized as good, and 74 students (27.6%) were classified as excellent, with a mean score of 34.46 (table 4). Therefore, it can be concluded that the majority of students possess gross motor skills falling within the good category.

The feedback results were gathered from physical education teachers and students in the physical education program through a questionnaire comprising six assessment indicators, each containing multiple questions. These six indicators include movement components, instrument suitability, ease of instrument use, facilities, assessment, and language (table 5).

The gross motor skills assessment instrument for elementary school students ages 7-9 proves effective and appropriate. The assessment results from teachers and students majoring in physical education describe that each indicator, including motion components, instrument suitability, ease of use, facilities and infrastructure, assessment, and language, obtained a score of > 93%, indicating a highly effective assessment category.

Table 2. Criteria Validation Test Results

Skills	rxy	r table	Explanation
Sit and stand up	0.689	0.304	Valid
Rolling	0.718	0.304	Valid
One-leg Stand	0.694	0.304	Valid
Gallop	0.520	0.304	Valid
Slide	0.554	0.304	Valid
Jump	0.402	0.304	Valid
Run	0.292	0.304	Invalid
Bouncing a ball	0.310	0.304	Valid
Catching	0.336	0.304	Valid
Throwing	0.368	0.304	Valid
Kicking	0.476	0.304	Valid
Hitting	0.375	0.304	Valid

rxy: calculated value of validation results.

Table 3. Reliability Test Results

Skills	Performance criteria	α
Sit and stand up	Proficient in maintaining a seated position with hands gripping both legs and heels closely aligned. Swinging backward until the shoulders and nape contact the mat, with hands consistently clasping around the shins. Repeat the forward motion while maintaining a grasp on the shins, returning to a balanced seated position. Executing a standing movement without the palms touching the mat, swinging the arms forward with the final motion of the arms facing upward.	0.743
Rolling	The initial position for supine lying entails facing upwards, with legs extended and arms straight overhead. Rolling in a consistent direction from end to end across the mattress. Rolling straight without extending beyond the boundaries of the mattress. Arms and legs remain elevated, not making contact with the floor.	0.636
One-leg Stand	The body is positioned upright and aligned. Arms are positioned beside the waist, with the gaze directed forward. The supporting feet remain stationary and do not shift. Avoiding any falls, ensuring that the feet make contact with the floor.	0.846
Gallop	The body and gaze are oriented forward. One foot is positioned in front, and the other is positioned behind. Progressing forward with the front and back feet remaining fixed without alternation. There is a brief moment of both feet touching the ground with a visible leap in momentum.	0.679
Slide	Moving sideways with an upright posture and a forward-facing gaze. Shifting with feet positioned shoulder-width apart (not excessively wide). Sideways movement followed by the other leg. There is a brief moment of both feet touching the ground with a visible leap in momentum.	0.684
Jump	Repetition of rhythm from alternating leg movements in a stride jump. There is a brief moment of both feet touching the ground with a noticeable leap in momentum. Arm movements are swung alternately to chest height in opposition to the leg jumping motion. Coordination involves lifting the knees to a height of 45° - 90°, followed by a straightening movement of the opposite leg.	0.711
Bouncing a ball	The body and gaze face forward. Legs slightly bent and spaced shoulder-width apart. Bouncing the basketball with fingers rather than palm and dribbling it. Bouncing the ball up to waist height.	0.722
Catching	The body maintains an upright position facing forward with legs spread shoulder-width apart. The ball is thrown and caught using only the same hand when throwing upwards. The ball is caught above the head with the palm facing upwards. The feet remain stationary without shifting positions.	0.717
Throwing	The body maintains an upright position facing forward with legs spread shoulder-width apart. The ball is thrown using only one hand. The ball is thrown from above the head with the palm facing upwards and with the opposite foot. Hip and shoulder rotation face towards the target.	0.710
Kicking	The body maintains an upright position facing forward. Executing a kick using the inner part of the foot. The supporting foot is positioned beside/near the ball. The body is slightly tilted sideways during the kick.	0.792
Hitting	The body maintains an upright position facing forward. Both hands grasp the bat positioned beside the head. The bat is swung towards the ball using both hands. The body's position rotates in alignment with the direction of the swing motion of the strike.	0.708

α : Cronbach's Alpha.

Table 4. Wide scale test results

Criteria	N	M	%
Excellent	74		27.6
Good	159	34.46	59.3
Adequate	27		10
Insufficient	8		2.9
Very insufficient	-		-

N: number of respondents, M : as average value / Mean, % : is percentage

Table 5. Assessment dissemination from physical education teachers and college students

Indicators	PE Teacher	College student
Motion components	93%	96%
Instrument suitability	95%	94%
Ease of use	95%	95%
Facilities and infrastructure	97%	95%
Assessment	96%	95%
Language	95%	96%

Discussion

The findings of this research have reached a significant advancement in the development of assessment instruments for evaluating gross motor skills among elementary school students aged 7-9 years. This study addresses deficiencies in the monitoring and assessment practices of physical education teachers concerning the gross motor skills of elementary school students, which often need more specificity and alignment with the characteristics of these students. The discussion within this research explores novel and critical aspects based on research results that reveal the prevalent lack of precision and measurability in assessing students' motor skills by most physical education teachers. The identified gaps in the current assessment methodologies, which predominantly focus on cognitive and scholastic aspects, underscore the neglect of attention and significance towards gross motor skills.

This study highlights a myriad of significant variables in the gross motor skills of elementary school students. Consistent with recent research findings that emphasize the diversity in students' motor skill development through physical education [24, 25]. In addition, this study also affirms that physical education teachers tend to concentrate on instructing specific sports disciplines without conducting a comprehensive assessment of gross motor skills in general. This practice may adversely affect students' motor development, as the research findings elucidate that disruptions in the motor development of elementary school students can lead to learning difficulties and a decline in academic grades and achievements [26]. Other studies also support the notion that if elementary school students exhibit poor gross motor skills, it will impact their cognitive abilities. This is due to the positive correlation between low gross motor skills and diminished cognitive capabilities in elementary school students [27]. Content validity testing involved collaboration with motor skills and physical education experts, followed by direct field testing of criterion validity. The research results elucidate the importance of engaging experts in the validity process to ensure the relevance and representativeness of content and the quality of the newly developed instrument [28]. Reliability was assessed through test-retest, calculating the Cronbach's alpha coefficient. The success of this instrument demonstrates its reliability and consistency in providing accurate data across measurements.

The novelty of the research findings lies in developing a user-friendly assessment instrument for physical education teachers. Several research outcomes indicate that the ease of use of this instrument can enhance efficiency in conducting assessments and monitoring the motor skill development of students [29, 30]. This becomes crucial in aiding students' motor skill development and assisting physical education teachers in tracking students' progress beyond the academic context. Appropriate and user-friendly instruments and technology are essential for enhancing the effectiveness of physical education learning for teachers and students [31, 32, 33]. This study significantly benefits elementary school students' physical education learning. The newly developed assessment instrument can transform teachers' assessment paradigms regarding students' gross motor skills, providing accurate and relevant information. From the students' perspective, this

instrument can increase satisfaction with learning and foster students' interest in participating in physical education classes. Research findings expound that using the right instrument can influence students' interest in participating in physical education learning, including developing their social skills [34, 35, 36].

In conclusion, this study provides a more comprehensive understanding of the gross motor skills of elementary school students aged 7-9 years through a specific, user-friendly, and reliable assessment instrument. This instrument has the potential to assist teachers in identifying students' developmental needs and offering timely interventions. Teachers and educational policymakers in elementary schools can apply the implications of this research. The developed assessment instrument can be implemented across various schools to broadly enhance understanding and monitoring of student's gross motor skills. Furthermore, further research can explore the implementation of this instrument in diverse educational contexts and school environments, creating opportunities for further innovation and the implementation of best practices in developing the gross motor skills of elementary school students. This research is the foundation for ongoing efforts to enhance child education by better understanding gross motor skills.

Despite the positive impact of this research on the physical education learning process, particularly in motor skill assessment, certain limitations warrant attention. The developed instrument in this study explicitly targets elementary school students aged 7-9 years, thus necessitating careful consideration and in-depth examination when generalizing results to the entire population of elementary school children. Variations in physical development, learning environments, and age can influence the validity of the assessment instrument. While the assessment instrument is designed to approach skills holistically, individual variations in gross motor skills that this instrument may not

capture should be continually addressed through ongoing development and calibration. Additionally, although research results indicate that physical education teachers find the assessment instrument user-friendly, further research is required to evaluate the readiness of physical education teachers to implement this instrument effectively across diverse school environments. Factors such as adequate training and administrative support need consideration to ensure the sustained use of this instrument over the long term. A deeper understanding of these limitations can pave the way for further research to enhance this assessment instrument's validity, reliability, and applicability in the holistic and comprehensive context of elementary school education.

Conclusions

The assessment instrument demonstrates high validity and reliability, effectively addressing the challenges associated with the need for assessments tailored to the evaluated subject's characteristics, objectives, and relevance. An easily comprehensible instrument, coupled with language accessibility, yields positive outcomes for physical education teachers in the assessment process. This research provides a concrete solution for enhancing the ability to assess and monitor the motor skills of elementary school students. The implications of this study extend to a paradigm shift, emphasizing the significance of understanding motor skill diversity and providing physical education teachers with precise and pertinent assessment tools.

Acknowledgement

References

1. Zeng N, Ayyub M, Sun H, Wen X, Xiang P, Gao Z. Effects of Physical Activity on Motor Skills and Cognitive Development in Early Childhood: A Systematic Review. *Biomed Res Int*. 2017;2017:1–13. https://doi.org/10.1155/2017/2760716

2. Sutapa P, Pratama KW, Rosly MM, Ali SKS, Karakauki M. Improving Motor Skills in Early Childhood through Goal-Oriented Play Activity. *Children*. 2021;8(11):994. https://doi.org/10.3390/children8110994

3. Greier K, Drenowatz C, Ruedl G, Kopp M, Burtscher M, Greier C. Effect of Daily Physical Education on Physical Fitness in Elementary School Children. *Advances in Physical Education*. 2020;10(02):97–105. https://doi.org/10.4236/ape.2020.102009

4. Lorås H. The Effects of Physical Education on Motor Competence in Children and Adolescents: A Systematic Review and Meta-Analysis. *Sports*. 2020;8(6):88. https://doi.org/10.3390/sports8060088

5. Hodder RK, O'Brien KM, Lorien S, Wolfenden L, Moore THM, Hall A, et al. Interventions to prevent obesity in school-aged children 6-18 years: An update of a Cochrane systematic review and meta-analysis including studies from 2015–2021. *EClinicalMedicine*. 2022;54:101635. https://doi.org/10.1016/j.eclinm.2022.101635

6. Cameron CE, Cottone EA, Murrah WM, Grissmer DW.

How Are Motor Skills Linked to Children's School Performance and Academic Achievement? *Child Dev Perspect*. 2016;10(2):93–8. https://doi.org/10.1111/cdep.12168

7. Monika Haga. Body and movement in early childhood; spaces for movement-based play. *Journal of Physical Education and Sport*. 2021;21(1).

8. Malm C, Jakobsson J, Isaksson A. Physical Activity and Sports—Real Health Benefits: A Review with Insight into the Public Health of Sweden. *Sports*. 2019;7(5):127. https://doi.org/10.3390/sports7050127

9. Clark JE. On the Problem of Motor Skill Development. *J Phys Educ Recreat Dance*. 2007;78(5):39–44. https://doi.org/10.1080/07303084.2007.10598023

10. Eveland-Sayers BM, Farley RS, Fuller DK, Morgan DW, Caputo JL. Physical Fitness and Academic Achievement in Elementary School Children. *Med Sci Sports Exerc*. 2007;39(5):S399. https://doi.org/10.1249/01.mss.0000274573.54238.aa

11. Chu SKW, Reynolds RB, Tavares NJ, Notari M, Lee CWY. Assessment Instruments for Twenty-First Century Skills. In: *21st Century Skills Development Through Inquiry-Based Learning*, Singapore: Springer Singapore; 2017. P. 163–192. https://doi.org/10.1007/978-981-10-2481-8_8

12. Gidion H. The Importance of Measuring Fine Motor Skill in Early Children's Education. In: *Proceedings of the 3rd International Conference on Vocational Higher Education (ICVHE 2018)*, Batam, Indonesia: Atlantis Press; 2020. https://doi.org/10.2991/assehr.k.200331.160

13. Bukvić Z, Ćirović D, Nikolić D. The importance of physical activity for the development of motor skills of younger school age children. *Medicinski Podmladak*. 2021;72(2):34–9. https://doi.org/10.5937/mp72-31878

14. Chiva-Bartoll O, Ruiz-Montero PJ, Olivencia JJL, Grönlund H. The effects of service-learning on physical education teacher education: A case study on the border between Africa and Europe. *Eur Phy Educ Rev*. 2021;27(4):1014–31. https://doi.org/10.1177/1356336X211007156

15. Xie J, Wang M, Hooshyar D. Student, parent, and teacher perceptions towards digital educational games: How they differ and influence each other. *Knowledge Management & E-Learning: An International Journal*, 2021; 142–160. https://doi.org/10.34105/j.kmel.2021.13.008

16. Carrasco CJG, Rodríguez-Medina J, Martínez PM, González VBA. Effects of a teacher training program on the motivation and satisfaction of history secondary students. *Revista de Psicodidáctica (English ed)*. 2021;26(1):45–52. https://doi.org/10.1016/j.psicoe.2020.08.001

17. Thiagarajan S. *Instructional Development for Training Teachers of Exceptional Children: A Sourcebook;* 1974.

18. Gorbi Irawan A, Nyoman Padmadewi N, Putu Artini L. Instructional materials development through 4D model. Abdullah AG, Foley J, Suryaputra IGNA, Hellman A (eds.) *SHS Web of Conferences*, 2018;42: 00086. https://doi.org/10.1051/shsconf/20184200086

19. Dick W. The dick and carey model: Will it survive the decade? *Educational Technology Research and Development*, 1996;44(3): 55–63. https://doi.org/10.1007/BF02300425

20. Almanasreh E, Moles R, Chen TF. Evaluation of methods used for estimating content validity. *Research in Social and Administrative Pharmacy*. 2019;15(2):214–21. https://doi.org/10.1016/j.sapharm.2018.03.066

21. David L. Gallahue JCOJG. *Understanding motor development : infants, children, adolescents, adults*. 7th ed. New York: McGraw-Hill; 2012.

22. Brinkman WP. *Design of a Questionnaire Instrument. Handbook of Mobile Technology Research Methods*; 2009.

23. Sullivan GM. A Primer on the Validity of Assessment Instruments. *J Grad Med Educ*. 2011;3(2):119–20. https://doi.org/10.4300/JGME-D-11-00075.1

24. Invernizzi P, Crotti M, Bosio A, Cavaggioni L, Alberti G, Scurati R. Multi-Teaching Styles Approach and Active Reflection: Effectiveness in Improving Fitness Level, Motor Competence, Enjoyment, Amount of Physical Activity, and Effects on the Perception of Physical Education Lessons in Primary School Children. *Sustainability*. 2019;11(2):405. https://doi.org/10.3390/su11020405

25. Wawrzyniak S, Korbecki M, Cichy I, Kruszwicka A, Przybyla T, Klichowski M, et al. Everyone Can Implement Eduball in Physical Education to Develop Cognitive and Motor Skills in Primary School Students. *Int J Environ Res Public Health*. 2022;19(3):1275. https://doi.org/10.3390/ijerph19031275

26. Rahmawati C, Suhardi S, Mustadi A. Is it important to overcome motor problems of elementary school-age students? *Fizicko Vaspitanje i Sport Kroz Vekove*. 2021;8(1):94–104. https://doi.org/10.5937/spes2101094R

27. Miklánková L. Cognitive competence of a child in primary school age in the context of gross motor skills. *IJAEDU- International E-Journal of Advances in Education*, 2019; 200–206. https://doi.org/10.18768/ijaedu.593487

28. Fahmina SS, Masykuri M, Ramadhani DG, Yamtinah S. Content validity uses Rasch model on computerized testlet instrument to measure chemical literacy capabilities. In 2019. p. 020023.

29. Chairilsyah D. Web-Based Application to Measure Motoric Development of Early Childhood. *JPUD - Jurnal Pendidikan Usia Dini*. 2019;13(1):1–14. https://doi.org/10.21009/10.21009/JPUD.131.01

30. Lander N, Nahavandi D, Mohamed S, Essiet I, Barnett LM. Bringing objectivity to motor skill assessment in children. *J Sports Sci*. 2020;38(13):1539–49. https://doi.org/10.1080/02640414.2020.1747743

31. Gong X. Research on the Application of Modern Information Technology in Physical Education. In: *2021 4th International Conference on Information Systems and Computer Aided Education*, Dalian

China: ACM; 2021. P. 1463–1466. https://doi.org/10.1145/3482632.3483174

32. Baena-Morales S, Urrea-Solano M, Gavilán-Martin D, Ferriz-Valero A. Development and validation of an instrument to assess the level of sustainable competencies in future physical education teachers. PESD-FT questionnaire. *Journal of Applied Research in Higher Education*. 2023;15(1):1–19. https://doi.org/10.1108/JARHE-09-2021-0330

33. Cocca A, Veulliet N, Drenowatz C, Wirnitzer K, Greier K, Ruedl G. Assessment of a Novel Instrument Measuring Perceived Physical Education Teachers' In-Class Skills. *Behavioral Sciences*. 2023;13(1):42. https://doi.org/10.3390/bs13010042

34. Syafruddin, Hasanah U. Review on the Implementation of Physical Education Learning. In: *Proceedings of the 1st International Conference of Physical Education (ICPE 2019)*, Padang, Indonesia: Atlantis Press; 2020. https://doi.org/10.2991/assehr.k.200805.075

35. Mudjihartono M, Mudjianto S, Martini T. Character Establishment Through Physical Education. *Kinestetik : Jurnal Ilmiah Pendidikan Jasmani*. 2022;6(1):134–45. https://doi.org/10.33369/jk.v6i1.21026

36. Xie M. Design of a physical education training system based on an intelligent vision. *Computer Applications in Engineering Education*. 2021;29(3):590–602. https://doi.org/10.1002/cae.22259

Information about the authors:

Cahyo Wibowo; (Corresponding Author); https://orcid.org/0009-0002-5249-1238; cahyo.wibowo@uksw.edu; Physical Education Study Program, Faculty of Medicine and Health Sciences, Satya Wacana Christian University; Salatiga, Indonesia.

Dennys Christovel Dese; https://orcid.org/0000-0002-0168-3486; dennys.christovel@uksw.edu; Physical Education Study Program, Faculty of Medicine and Health Sciences, Satya Wacana Christian University; Salatiga, Indonesia.

Yahya Eko Nopiyanto; https://orcid.org/0000-0003-2920-0594; yahyaekonopiyanto@unib.ac.id; Physical Education Study Program, Faculty of Teacher Training and Education, Bengkulu University; Bengkulu, Indonesia.