



## Effectiveness of Movement Learning in Children: The Role of Developmental Maturity

Dudi Komaludin\*, Agus Mahendra, Nurlan Kusmaidi, Amung Ma'mun, Deo Farid Anggara

Department of Sports Education, Graduate School, Indonesia University of Education, West Java, Indonesia

\*Correspondence: E-mail: [dudikomaludin@upi.edu](mailto:dudikomaludin@upi.edu)

### ABSTRACT

This study investigated whether structured movement programs work differently for children at varying developmental levels using a 2x2 factorial quasi-experimental design with pretest-posttest measurements. Forty-eight children aged 5-6 years from an Islamic preschool in Kuningan Regency were assigned to groups using an intact classroom placement (no individual randomization). Developmental maturity was operationalized through age-based classification, including low maturity (5.0-5.5 years) and high maturity (5.6-6.0 years). The four-week intervention (eight 45-minute sessions) compared structured versus conventional activities across maturity levels. Motor skills were assessed using the Test of Gross Motor Development Third Edition (TGMD-3), while motivation, confidence, and understanding of physical activity were measured using an adapted early-childhood physical literacy questionnaire ( $\alpha = .81$ ). Results showed that while structured programs benefited everyone, their impact on motor skills varied significantly by maturity level ( $F=15.89$ ,  $p<.001$ ), with more mature children gaining greater advantages. Interestingly, benefits for motivation and confidence were similar across maturity levels. Within the limitations of this single-site study, the findings suggest that educators should implement structured movement programs while recognizing that motor skill benefits may vary according to developmental maturity, whereas affective outcomes, such as motivation and confidence, develop similarly across maturity levels.

### ARTICLE INFO

#### Article History:

Submitted/Received January 2026

First Revised January 2026

Accepted February 2026

Publication Date April 2026

#### Keyword:

developmental maturity, early childhood, fundamental movement skills, physical literacy

## INTRODUCTION

Early childhood represents a critical developmental period for establishing fundamental movement competencies (Robinson et al., 2015). Early motor competence significantly predicts long-term physical activity participation and health outcomes (Stodden et al., 2008). Meanwhile, fundamental movement skills significantly influence later physical activity and fitness levels (Barnett et al., 2016). Research tracking children from preschool through adolescence shows that early motor competence predicts physical activity participation years later, largely through its influence on confidence and perceived ability (Hulteen et al., 2018). Yet many educators assume these skills develop naturally through simple plays, without recognizing that most children actually need explicit teaching to learn proper movement patterns.

Recent research challenges the old notion that motor development happens automatically as children mature. Studies across multiple countries now show that movement instruction quality matters tremendously perhaps as much as biological maturation itself (Brian et al., 2020). Children do not simply discover efficient movement patterns through trial and error during free play. They typically need someone to show them proper forms, provide structured practice opportunities, and offer specific feedback about what they are doing right and what needs adjustment (Logan et al., 2012). Meta-analyses of intervention studies consistently demonstrate that structured fundamental movement skill programs produce substantially larger developmental gains than unstructured activities, with effect sizes often reaching medium to large magnitudes (Morgan et al., 2013). Without this guidance, many children reach school age with surprisingly limited movement competence.

This recognition carries important implications for early childhood programs. Indonesian *Raudhatul Athfal* institutions, which blend Islamic education with academic preparation, often allocate minimal time for structured physical activity, to ensure that students can focus on their religious and academic studies (Hidayati et al., 2018). These schools face competing demands teaching religious concepts, developing literacy and numeracy, managing limited resources. Physical education frequently receives whatever time remains after addressing these priorities. Many of them rely on brief free play periods where children choose their own activities with minimal adult involvement. While free play certainly has values for social development and creativity (Timmons et al., 2012), research suggests it is insufficient for enhancing optimal motor development in most children without complementary structured instructions.

Recent research emphasizes physical literacy dimension which encompasses movement ability, motivation, confidence, and understanding to engage in lifelong physical activity, highlighting its significance in promoting overall health and well-being (Robert et al., 2018). This holistic approach underlines the necessity of fostering physical literacy to enhance fitness levels and encourage active lifestyles among individuals of all ages (Purnomo et al., 2025). Research confirms that affective dimensions may prove as influential as motor competence for long-term activity engagement (Cairney et al., 2019).

However, in any preschool classroom, the same-age children vary dramatically in their developmental readiness. Some five-year-olds can focus intently during demonstrations, remember multi-step instructions, and make precise adjustments based on feedback. Others struggle with sustained attention, forget instructions quickly, or lack the motor control to

execute suggested modifications (Lopes et al., 2012). These differences reflect complex interactions between genetic inheritance, prenatal conditions, early experiences, and individual temperament (Cruickshank et al., 2024). Neuroscience research reveals that child motor control systems mature at varying rates, with substantial individual differences in myelination patterns, synaptic density, and cortical thickness affecting movement learning capacity (Yasmita et al., 2022), suggesting that chronological age provides only rough indication of a child actual readiness to benefit from particular types of instruction.

This variability raises crucial questions for program designs. Recent theoretical models suggest that motor learning depends critically on matching task difficulty to learner capability, with optimal development occurring when challenges slightly exceed the current competence of the zone of proximal development for movement skills (Chow et al., 2018). If effectiveness varies by maturity, educators should differentiate instructions offering simpler activities and more support for less ready children. They have direct implications for how teachers allocate limited resources and whether they can reasonably apply uniform expectations across developmentally diverse groups.

Despite growing evidence for structured movement programs, critical gaps remain in understanding how developmental maturity moderates the intervention effectiveness. Most intervention studies compare treatment and control groups without examining whether benefits distribute uniformly across maturity levels (Webster & Ulrich, 2017). This gap is particularly acute in Indonesian Islamic preschools, where limited research examines how structured movement interventions interact with developmental readiness to influence both motor skills and physical literacy. Understanding these interaction effects has direct implications for program differentiation, instructional individualization, and appropriate developmental expectations (Valentini et al., 2016).

Therefore, this study investigated whether structured movement program effectiveness varies by developmental maturity level in Islamic preschool children. Specifically, this study examined the main effects of structured versus conventional programs on motor skills and physical literacy, the moderating role of developmental maturity on these outcomes, and the difference of intervention effects between motor competence and physical literacy dimensions. Understanding these relationships can inform evidence-based decisions about program implementation, instructional differentiation, and developmentally appropriate expectations in early childhood movement education.

## **METHODS**

The study employed a 2×2 factorial quasi-experimental design, which enables the simultaneous examination of two independent variables and the assessment of both their main effects and their interaction effects. This type of factorial structure is particularly appropriate in educational and behavioral research contexts where full randomization is impractical, yet robust causal inferences are still required through systematic comparison of treatment conditions (Creswell & Creswell, 2023). The first factor was activity type, the structured movement instruction versus conventional practice. Our second factor was developmental maturity, operationalized through chronological age classifications including low maturity group (children aged 5.0-5.5 years) and high maturity group (children aged 5.6-6.0 years). This age-based classification reflected existing classroom groupings and aligned with developmental differences observable in preschool settings. This created four groups of twelve children each, allowing us to compare not just intervention versus control, but also

whether the intervention effects varied by maturity level. We could not randomly assign individual children to groups without disrupting existing classrooms, so intact classes was used as a practical compromise that enhanced ecological validity while acknowledging some internal validity limitations (Friskawati, 2023).

### **Participants**

The study was conducted at an Islamic preschool in Cipari Village, Cigugur District, Kuningan Regency. The school enrolled forty-eight children across two age-based classrooms. The study included everyone for three practical reasons, including the small enrollment that made sampling unnecessary, the statistical reason since adequate numbers in each experimental cell was needed, and the total population sampling to eliminate the selection bias. The institution had never implemented any systematic movement program beyond informal free play, making it ideal for examining intervention effects from a true baseline. Children ranged from five to six years old, with younger children in one class and older children in another class so the natural maturity division are leveraged for the factorial design.

### **Sampling Procedures**

The study employed a total population sampling strategy. All children enrolled at the participated preschool during the 2021 academic year were invited to participate, resulting in full participation of the accessible population (100%). The final sample comprised 48 children (25 boys, 23 girls) with mean age of 5.38 years ( $SD = 0.31$ ). Inclusion criteria involved children aged between 5.0-6.0 years, fulfilling regular attendance at the institution, and giving parental consent. Exclusion criteria included having diagnosed with developmental delays or physical disabilities that would preclude participation in movement activities, having chronic health conditions limiting physical activity, and having the enrolment midway through the intervention period. No children were excluded based on these criteria. This approach was chosen due to the small population size and to avoid selection bias.

Participants were naturally grouped into two intact classrooms based on the existing school placement, which reflected differences in developmental maturity aligned with age-related school grouping practices. One class represented the lower maturity group (younger children aged 5.0 – 5.5 years) and the others represented the higher maturity group (older children aged 5.6 – 6.0 years). Each class was then assigned to either the structured movement intervention or the conventional activity condition, forming four experimental cells with twelve children each.

Data collection took place at the school multipurpose indoor and outdoor activity areas during regular school hours. No financial incentives were provided to participants or their families. Parental consent and institutional approval were obtained prior to data collections and all procedures complied with ethical standards for research involving young children. Given the factorial design and sample size ( $N = 48$ ), statistical power was considered adequate to detect medium-to-large effects for the main and interaction effects in factorial ANOVA, consistent with Cohen's (2013) and Lakens (2022) recommendations for behavioural research.

### **Materials and Apparatus**

Gross motor skills were assessed using the Test of Gross Motor Development Third Edition (TGMD-3) (Ulrich, 2017). The TGMD-3 is a widely used and standardized instrument designed to evaluate fundamental locomotor and object control skills in children aged 3–10 years. The test demonstrates strong psychometric properties, with reported internal consistency

coefficients above .90 and inter-rater reliability exceeding .85. The assessment includes performance criteria scored through direct observation of movement execution.

Physical literacy was assessed using an adapted early-childhood physical literacy questionnaire. The instrument was developed through a systematic adaptation process. The initial item pool was derived from conceptual frameworks proposed by Whitehead (2010) and Cairney et al. (2019). The adaptation process involved expert panel reviews by three early childhood education specialists and one measurement expert to ensure age-appropriateness and cultural relevance for Indonesian Islamic preschool context, language simplifications and visual support development, pilot testing with 15 children from a similar institution to assess comprehension and response patterns, and refinement based on pilot data and expert feedback. The instrument focused on three affective and cognitive domains. While comprehensive physical literacy frameworks include physical competence as the core domain, this study excluded direct physical competence assessment from this questionnaire because motor skills were measured separately and more precisely using the TGMD-3 standardized assessment to avoid redundancy and the affective-cognitive focus allowed clearer examination of whether structured programs influenced the child psychological readiness for physical activity independent of their actual motor performance. This modified approach aligned with recent conceptualizations emphasizing the multidimensional nature of physical literacy while acknowledging that components could be measured through different complementary instruments. The three assessed domains were the motivation to engage in physical activity, confidence in movement ability, and basic understanding of the importance of physical activity. Items were administered in an interview-assisted format using age-appropriate language and visual prompts to support comprehension. Responses were rated on a simplified Likert-type scale. Pilot testing demonstrated acceptable internal consistency (Cronbach's  $\alpha = .81$ ).

## Procedures

Experimental groups received structured movement sessions twice a week for four weeks, eight sessions in total, each lasting 45 minutes with consistent time allocation (warm-up for 10 minutes, core instruction for 25 minutes, and cool-down/reflection for 10 minutes). The intervention followed a systematic skill progression across four weeks. Week 1 focused on locomotor skills (running, hopping, galloping). Week 2 addressed object control fundamentals (throwing, catching with large balls). Week 3 integrated advanced object control (kicking, striking). Week 4 combined skills through simple movement sequences and games. Within each session, skills progressed from isolated practice to combined movements, with complexity adjusted based on observable performance. The session design followed evidence-based principles from motor learning research emphasizing explicit skill instructions, deliberate practice, and specific feedback to enhance participant ability to perform motor tasks effectively and efficiently (Hendry et al., 2015). Sessions followed a consistent three-phase structure. The instruction began with warm-up activities that prepared children physically while reviewing previously learned skills and establishing positive energy. The core instructional phase targeted specific movement patterns through demonstration-practice-feedback cycles informed by Newell's constraints-led approach (Chow et al., 2018) where instructors showed proper form while highlighting two or three critical components, children practiced with encouragement and task modifications matching their capabilities, while instructors provided specific constructive feedback delivered positively. Each session was closed with gradually declining activity, brief reflection helping children recognize their progress, and positive closure reinforcing intrinsic motivation.

Control groups continued their regular schedule with brief free play period aligning with the characteristic of typical Islamic preschool practice.

### Design or Data Analysis

The analysis began with descriptive statistics means, standard deviations, and gain scores computed both overall and for each factorial cell. We examined statistical assumptions through Shapiro-Wilk tests supplemented by visual inspection of Q-Q plots for normality and Levene's test for homogeneity of variance. Following assumption verification, the researcher conducted factorial ANOVA on gain scores rather than ANCOVA with pretest scores as covariates. This decision was based on three considerations: (1) random assignment to activity type was not possible due to intact classroom structure, making baseline equivalence uncertain and potentially violating ANCOVA assumption of covariate independence from treatment; (2) the examination of pretest scores revealed no significant between-group differences ( $p > .05$  for all comparisons), suggesting baseline equivalence despite non-random assignment; and (3) gain score analysis provided more intuitive interpretation of intervention effects while maintaining statistical validity when groups were initially equivalent. Analyses were conducted separately for each outcome using SPSS Version 25. The ANOVA examined three effects, namely the activity type main effect (experimental versus control averaged across maturity levels), maturity main effect (high versus low maturity averaged across activity types), and their interactions whether activity type effectiveness varied by maturity. The practical significance used partial eta-squared effect sizes alongside conventional significance testing, with benchmarks of .01, .06, and .14 representing small, medium, and large effects respectively (Cohen, 2013).

### RESULTS

All groups showed positive development over the four weeks, even the control groups improved through the natural maturation and regular school experiences. However, improvement magnitudes varied dramatically. Table 1 shows that the motor skill gains of children in experimental group approached three times of those in control groups. The low maturity experimental group improved 28.3%, while the control group gained 9.7%. The high maturity experimental group gained 28.5%, while the control group gained 10.2%. The percentages look similar across maturity levels within the experimental group, but the more mature children improved 20.34 points while the less mature children gained 16.52 points, a difference of nearly four points suggesting maturity matters even when percentage improvements appear comparable.

Physical literacy patterns revealed something different. Experimental gains (1.83-1.84 points) doubled control improvements (1.00-1.23 points), clearly demonstrating intervention effectiveness. However, a careful attention should be given at the experimental gains (1.83 points for low maturity and 1.84 points for high maturity children) which were identical within measurement error. This uniformity contrasts sharply with the motor skill pattern where absolute gains varied noticeably by maturity, hinting at fundamentally different developmental mechanisms underlying technical skills versus psychological engagement dimensions.

**Table 1.** Descriptive Statistics for Motor Skills and Physical Literacy

Group	Pretest M (SD)	Posttest M (SD)	Gain (Points)	Gain (%)	n
<b>Gross Motor Skills</b>					
Control - Low Maturity	63.75 (5.2)	69.92 (4.8)	6.17	9.7	12
Experimental - Low Maturity	58.42 (6.1)	74.94 (5.3)	16.52	28.3	12
Control - High Maturity	70.33 (4.9)	77.50 (4.5)	7.17	10.2	12
Experimental - High Maturity	71.33 (5.3)	91.67 (4.2)	20.34	28.5	12
<b>Physical Literacy</b>					
Control - Low Maturity	4.48 (0.8)	5.48 (0.7)	1.00	22.3	12
Experimental - Low Maturity	5.34 (0.9)	7.17 (0.6)	1.83	34.3	12
Control - High Maturity	5.10 (0.7)	6.33 (0.7)	1.23	24.1	12
Experimental - High Maturity	5.30 (0.8)	7.14 (0.6)	1.84	34.7	12

Statistical testing confirmed these patterns. Table 2 presents complete factorial ANOVA results. For motor skills, both activity types ( $F=89.45$ ,  $p<.001$ ,  $\eta^2=.670$ ) and maturity levels ( $F=67.32$ ,  $p<.001$ ,  $\eta^2=.605$ ) showed very large main effects. More importantly, a significant interaction emerged ( $F=15.89$ ,  $p<.001$ ,  $\eta^2=.265$ ), confirming that intervention effectiveness varied meaningfully by maturity. Among high maturity children, experimental groups outperformed control groups by 14.17 points. Among low maturity children, this advantage shrank to just 5.02 points. Both groups benefited substantially from structured instructions, but more mature children extracted considerably greater advantage from identical teaching experiences.

Physical literacy results revealed a different story. Significant main effects appeared for both activity types ( $F=45.23$ ,  $p<.001$ ,  $\eta^2=.507$ ) and maturity levels ( $F=12.67$ ,  $p=.001$ ,  $\eta^2=.223$ ). The maturity effect was much smaller, suggesting psychological dimensions develop independently of neuromuscular maturation. Most of the results revealed no interaction ( $F=0.22$ ,  $p=.641$ ,  $\eta^2=.005$ ). The negligible effect size approaching zero indicates structured programs enhance motivation, confidence, and understanding uniformly across maturity levels, completely different from the motor skill pattern showing clear differential effectiveness.

**Table 2.** Factorial ANOVA Results for Motor Skills and Physical Literacy

Source	df	MS	F	p	$\eta^2$
<b>Gross Motor Skills</b>					
Activity Type (A)	1	2847.35	89.45	<.001	.670
Maturity Level (B)	1	2143.22	67.32	<.001	.605
A × B Interaction	1	505.84	15.89	<.001	.265
Error	44	31.83	—	—	—
<b>Physical Literacy</b>					
Activity Type (A)	1	24.58	45.23	<.001	.507
Maturity Level (B)	1	6.88	12.67	.001	.223
A × B Interaction	1	0.12	0.22	.641	.005
Error	44	0.54	—	—	—

## DISCUSSION

Divergent patterns make theoretical sense when developmental readiness is considered. Children at higher maturity levels typically demonstrate better attentional control, more refined movement coordination, and greater capacity to process and apply instructional feedback on observable skills that directly support motor learning. When presented with explicit instructions highlighting movement components, developmentally advanced children can fully exploit neurological and developmental advantages. Consequently, they focus effectively during demonstrations despite distractions, generate precise motor commands matching what they saw, execute adjustments suggested through feedback, and consolidate new patterns into long-term memory relatively quickly (Lenroot & Giedd, 2006; Andrieux & Proteau, 2014).

Less mature children benefit substantially too. Their gains far exceeded what control groups achieved through conventional activities. However, they are working within tighter neurological constraints. Their motor control systems could not yet execute the precise adjustments that more mature children could manage. Their attentional capacities limit how much instruction they can process (Kushner et al., 2015). Their cerebellar circuits need more repetitions to consolidate new patterns. This does not mean structured instructions failed for them since their impressive improvements were apparent. It means that we might need different pedagogical approaches, such as providing more demonstration, less verbal explanation, simpler tasks before complex variations, modified practice structures providing more support, and adjusted expectations recognizing their current capabilities while still pushing meaningful progress.

Physical literacy benefits suggest fundamentally different developmental mechanisms. Motivation to be active, confidence in one ability, and understanding why movement matters appear less constrained by neuromuscular maturation than motor execution itself (Giblin et al., 2014). These psychological dimensions develop through mechanisms responsive to supportive instructional climates regardless of current motor capability. The emphasis of structured programs on positive reinforcement, psychological safety, explicit discussion of

movement purpose, and celebration of individual progress apparently succeeded in nurturing these dimensions uniformly. A child with limited motor control can still develop confidence through experiencing improvement, motivation through enjoying the process, and understanding through learning why physical activity matters even if their technical skill development proceeds more slowly.

This dissociation carries profound implications. It suggests that even children whose motor development proceeds slowly due to maturational constraints can develop psychological foundations supporting continued engagement foundations that may prove more critical than technical proficiency for lifelong physical activity participation (Stodden et al., 2008). Research increasingly shows that childhood motor competence predicts adolescent activity levels primarily through its influence on confidence and perceived competence rather than through technical skills. If we can nurture motivation, confidence, and understanding uniformly while recognizing that technical skill development may vary, we position all children for sustained engagement regardless of their developmental trajectory.

From practical perspectives, findings argue strongly for implementing structured movement programs while recognizing the need for differentiated approaches. The substantial main effects justify program implementation across diverse populations where structured instructions clearly work better than conventional unstructured activities for developing both motor skills and physical literacy. The motor skill interaction highlights the necessity of individualized goals, appropriately challenging activities matching current capabilities, and progress evaluation emphasizing individual improvement rather than age-based standards that disadvantage late-maturing children (Valentini et al., 2016). For Indonesian Islamic preschool contexts, results support allocating greater curricular time to systematic movement education, training teachers in effective instructional techniques, and integrating physical development with existing religious and academic objectives.

Several limitations warrant acknowledgment. The quasi-experimental design using intact classrooms means that the researchers could not completely rule out pre-existing group differences, though balanced factorial structure and large effect sizes suggest intervention effects rather than selection artifacts (Branca & Branca, 2025). Our four-week timeframe showed meaningful changes but could not address whether the benefits persist long-term longitudinal follow-up would strengthen confidence in sustained impacts. Maturity operationalizations through classroom assignment provided practical convenience but lacked sophistication of detailed developmental assessment. However, a more nuanced approach is necessary to capture the complexities of a child development effectively (Ozkan & Worrall, 2017). Replication across diverse institutional contexts would establish generalizability boundaries. Despite these limitations, convergent findings from descriptive trajectories, statistical tests, and theoretical predictions provide reasonable confidence in core conclusions.

## CONCLUSION

This study investigated how developmental maturity moderates the effectiveness of structured movement programs in Islamic preschool children. The results have addressed the three research objectives. First, the structured movement instruction had shown to produce significantly greater improvements in motor skills and physical literacy compared to conventional practice, demonstrating clear main effects of activity type. Secondly, higher maturity children showed superior motor skill development but similar physical literacy gains compared to lower maturity peers, indicating differential main effects of maturity across

outcomes. The last, significant interaction effects emerged for motor skills, with higher maturity children gaining greater benefits from structured instruction, while physical literacy improvements were uniform across maturity levels. These findings suggest that while structured programs benefit all children, educators should consider developmental readiness when setting motor skill expectations, though affective outcomes develop similarly regardless of maturity level.

Within study limitations with a single-site investigation with 48 children over four weeks, findings have practical implications for Islamic preschool educators. It is suggested that structured movement programs should be implemented universally, but differentiating motor skill goals based on developmental readiness while maintaining uniform emphasis on building motivation and confidence across all maturity levels is required.

#### ACKNOWLEDGMENT

The author gratefully acknowledges RA Binaul Ummah for supporting this research and the participating children and families for their generous involvement.

#### AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

#### REFERENCES

- Andrieux, M., & Proteau, L. (2014). Mixed observation favors motor learning through better estimation of the model's performance. *Experimental Brain Research*, *232*(10), 3121–3132.
- Barnett, L. M., Van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2009). Childhood motor skill proficiency as a predictor of adolescent physical activity. *Journal of adolescent health*, *44*(3), 252-259.
- Branca, G., & Branca, G. (2025). Discussions, Implications, and Limitations of the Research. *International Series in Advanced Management Studies*, 105–115.
- Brian, A., Getchell, N., True, L., De Meester, A., & Stodden, D. F. (2020). Reconceptualizing and operationalizing Seefeldt's proficiency barrier: Applications and future directions. *Sports Medicine*, *50*(11), 1889-1900.
- Cairney, J., Dudley, D., Kwan, M., Bulten, R., & Kriellaars, D. (2019). Physical literacy, physical activity and health: Toward an evidence-informed conceptual model. *Sports medicine*, *49*(3), 371-383.
- Chow, J. Y., Meerhoff, L. A., Choo, C. Z. Y., Button, C., & Tan, B. S. J. (2023). The effect of nonlinear pedagogy on the acquisition of game skills in a territorial game. *Frontiers in psychology*, *14*, 1-10.
- Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. routledge.
- Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approach*. Sage publications.
- Cruickshank, V., Pill, S., Williams, J., Mainsbridge, C., & Nash, R. (2024). Primary school Physical Education (PE) specialist teachers' experiences of teaching Health Education and Physical Education. *Curriculum Perspectives*, *44*(1), 3-13.
- Friskawati, G. F., Ma'mun, A., & Mahendra, A. (2023). Early childhood educators' beliefs on increasing fundamental motor skills by playing games in a physical education context:

- The contradictory belief. *Edu Sportivo: Indonesian Journal of Physical Education*, 4(3), 243-255.
- Giblin, S., Collins, D., & Button, C. (2014). Physical Literacy: Importance, Assessment and Future Directions. *Sports Medicine*, 44(9), 1177–1184.
- Hendry, D. T., Ford, P. R., Williams, A. M., & Hodges, N. J. (2015). *Five Evidence-Based Principles of Effective Practice and Instruction*. 414–429.
- Hidayati, H., Hatthakit, U., & Isaramalai, S. A. (2018). Physical Activity among Muslim Adolescents in Indonesia. *Idea Nursing Journal*, 9(2), 43-49.
- Hulsteen, R. M., Morgan, P. J., Barnett, L. M., Stodden, D. F., & Lubans, D. R. (2018). Development of foundational movement skills: A conceptual model for physical activity across the lifespan. *Sports medicine*, 48(7), 1533-1540.
- Kushner, A. M., Kiefer, A. W., Lesnick, S., Faigenbaum, A. D., Kashikar-Zuck, S., & Myer, G. D. (2015). Training the developing brain part II: cognitive considerations for youth instruction and feedback. *Current Sports Medicine Reports*, 14(3), 235–243.
- Lakens, D. (2022). Sample size justification. *Collabra: psychology*, 8(1), 1-29.
- Lenroot, R. K., & Giedd, J. N. (2006). Brain development in children and adolescents: insights from anatomical magnetic resonance imaging. *Neuroscience & biobehavioral reviews*, 30(6), 718-729.
- Logan, S. W., Robinson, L. E., Wilson, A. E., & Lucas, W. A. (2012). Getting the fundamentals of movement: a meta-analysis of the effectiveness of motor skill interventions in children. *Child: care, health and development*, 38(3), 305-315.
- Lopes, V. P., Rodrigues, L. P., Maia, J. A., & Malina, R. M. (2011). Motor coordination as predictor of physical activity in childhood. *Scandinavian journal of medicine & science in sports*, 21(5), 663-669.
- Morgan, P. J., Barnett, L. M., Cliff, D. P., Okely, A. D., Scott, H. A., Cohen, K. E., & Lubans, D. R. (2013). Fundamental movement skill interventions in youth: A systematic review and meta-analysis. *Pediatrics*, 132(5), 1361-1383.
- Ozkan, T., & Worrall, J. L. (2017). A Psychosocial Test of the Maturity Gap Thesis. *Criminal Justice and Behavior*, 44(6), 815–842.
- Purnomo, A., Hidayat, Kusmaedi, N., Ma'mun, A., Nuryadi, & Paramitha, S. T. (2025). The Role of Physical Literacy in Supporting Physical Fitness Levels: A Holistic Approach to Student Development in Physical Education. *ACTIVE: Journal of Physical Education, Sport, Health and Recreation*, 14(3), 872–878.
- Robinson, L. E., Stodden, D. F., Barnett, L. M., Lopes, V. P., Logan, S. W., Rodrigues, L. P., & D'Hondt, E. (2015). Motor competence and its effect on positive developmental trajectories of health. *Sports medicine*, 45(9), 1273-1284.
- Stodden, D. F., Goodway, J. D., Langendorfer, S. J., Robertson, M. A., Rudisill, M. E., Garcia, C., & Garcia, L. E. (2008). A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. *Quest*, 60(2), 290-306.
- Timmons, B. W., LeBlanc, A. G., Carson, V., Connor Gorber, S., Dillman, C., Janssen, I., ... & Tremblay, M. S. (2012). Systematic review of physical activity and health in the early years (aged 0–4 years). *Applied physiology, nutrition, and metabolism*, 37(4), 773-792.
- Ulrich, D. A. (2017). Introduction to the special section: Evaluation of the psychometric properties of the TGMD-3. *Journal of Motor Learning and Development*, 5(1), 1-4.
- Valentini, N. C., Logan, S. W., Spessato, B. C., de Souza, M. S., Pereira, K. G., & Rudisill, M. E. (2016). Fundamental motor skills across childhood: Age, sex, and competence outcomes of Brazilian children. *Journal of Motor Learning and Development*, 4(1), 16-36.

- Webster, E. K., & Ulrich, D. A. (2017). Evaluation of the psychometric properties of the test of gross motor development—third edition. *Journal of Motor Learning and Development*, 5(1), 45-58.
- Whitehead, M. (Ed.). (2010). *Physical literacy: Throughout the lifecourse*. Routledge.
- Yasmita, I., Mahdum, M., & Kartikowati, R. S. (2022). Manajemen penyelenggaraan pendidikan inklusi untuk siswa berkebutuhan khusus di SDS Cendana Duri. *Jurnal JUMPED (Jurnal Manajemen Pendidikan)*, 10(1), 62-76.