Game-based motor coordination (GBMC): an innovative approach to early childhood development

Coordinación motora basada en el juego (GBMC): un enfoque innovador para el desarrollo de la primera infancia

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Abstract

Introduction: this research is a pilot study and will evaluate the impact of a new approach to early childhood development, Game-Based Motor Coordination (GBMC), on children's cognitive, affective, physical activity habits and motor coordination.
Objective: a GBMC approach was used to evaluate the efficacy of an eight-week intervention.
Methodology: A total of 112 students (aged 7 to 8 years) from two public schools participated. One school served as the intervention group (53 students: 27 boys and 26 girls) and one school served as the control group (59 students, 29 boys and 30 girls). Motor coordination was assessed using standardized tests (KTK3+) before and after the intervention.
Results: further analysis of the group-by-gender interaction on hand-eye coordination skills ($p = 0.01$) revealed a significant improvement among boys in the GBMC intervention group compared to boys in the control group who received regular learning. Children in the intervention group showed more significant improvements in motor coordination compared to the control group in balance beam ($\eta p^2 = 0.16$), jumping sideways ($\eta p^2 = 0.19$), moving sideways ($\eta p^2 = 0.14$), and eye-hand coordination ($\eta p^2 = 0.16$).
Discussion: Given the importance of well-developed motor coordination, early childhood education and physical education teachers in schools should be taught how to implement a GBMC model into their classes.
Conclusions: The GBMC model effectively enhances motor coordination and is positively received by teachers involved in this study as an innovative method for supporting meaningful and structured physical education for low-grade students in Indonesia (ages 7–9).

Keywords

Early childhood, intervention, motor coordination, learning model, pedagogy.

Resumen

Introducción: esta investigación es un estudio piloto y evaluará el impacto de un nuevo enfoque del desarrollo en la primera infancia, la coordinación motora basada en el juego (GBMC, por sus siglas en inglés), en los hábitos cognitivos, afectivos y de actividad física y en la coordinación motora de los niños.
Objetivo: Se utilizó un enfoque GBMC para evaluar la eficacia de una intervención de ocho semanas.
Metodología: Participaron un total de 112 alumnos (de entre 7 y 8 años) de dos escuelas públicas. Una escuela sirvió como grupo de intervención (53 alumnos: 27 niños y 26 niñas) y otra como grupo de control (59 alumnos, 29 niños y 30 niñas). La coordinación motora se evaluó mediante pruebas estandarizadas (KTK3+) antes y después de la intervención.
Resultados: un análisis más detallado de la interacción entre los grupos por sexo en las habilidades de coordinación mano-ojo ($p = 0,01$) reveló una mejora significativa entre los niños del grupo de intervención GBMC en comparación con los niños del grupo de control que recibieron un aprendizaje regular. Los niños del grupo de intervención mostraron mejoras más significativas en la coordinación motora en comparación con el grupo de control en la barra de equilibrio ($\eta p^2 = 0,16$), los saltos laterales ($\eta p^2 = 0,19$), los movimientos laterales ($\eta p^2 = 0,14$) y la coordinación ojo-mano ($\eta p^2 = 0,16$).
Discusión: Dada la importancia de una coordinación motora bien desarrollada, los profesores de educación infantil y educación física en las escuelas deberían recibir formación sobre cómo implementar un modelo GBMC en sus clases.
Conclusiones: El modelo GBMC mejora eficazmente la coordinación motora y ha sido acogido positivamente por los profesores que participaron en este estudio como un método innovador para apoyar una educación física significativa y estructurada para los alumnos de primaria de Indonesia (de 7 a 9 años).

Palabras clave

Primera infancia, intervención, coordinación motora, modelo de aprendizaje, pedagogía

Introduction

There is limited understanding of the learning methods in early childhood that relate to improving the performance of motor coordination (MC). This should be a primary focus during early childhood to develop MC skills, which are essential prerequisites for motor development and sport-specific skills (Platvoet et al., 2016; Stodden et al., 2008). Developing MC during early childhood is important because it is the optimal time to learn. It is also important to find an environment that is suitable for the child. A suitable environment to stimulate MC skills is at school. Teachers must think creatively and improve pedagogical skills to develop good learning models to make students comfortable and happy because programs and exercises are the driving force behind improving MC performance (Biru et al., 2025; Clark, 2007; Gallahue et al., 2012).

Early childhood (especially between the ages of 6 and 8) is an appropriate time for rapid maturation of the cortex and better brain organization, thus providing an opportunity for MC improvement (Mardiansyah et al., 2023; Platvoet et al., 2016). In a current research review, Giuriato et al (2021) found several studies that showed significant improvements, even within a short period of four weeks, due to receiving a learning experience that is developmentally appropriate, such as structured learning models provided by PE teachers. However, further research in child development is needed to assess the optimal environment for implementing the learning model (Canli et al., 2024; Morgan et al., 2013). It is hypothesized that a game or play-based model can improve the quality of physical education (PE) by providing an enjoyable learning experience.

Several studies have explored learning models to improve MC in children as part of talent development (TD) research, with goal-directed learning as one of the approaches (Toering et al., 2012). Effective instruction can play a crucial role in enhancing goal-directed learning (Platvoet et al., 2016). However, there is limited evidence on the role of goal-directed learning in enhancing MC among children under the age of 9, and this topic remains underexplored in the existing literature. Appropriate instruction provided by teachers plays a positive role in the output of goal-directed learning (Platvoet et al., 2016). It is believed that such instruction can facilitate children's learning experiences and development of MC, particularly when the interval between instruction, practice, improvement, and assessment is relatively short (Mardiansyah et al., 2024). In addition, the effectiveness of TD in specific sports is increasingly supported by assessment and monitoring through Global Positioning Systems (GPS) (Ravé et al., 2020). In sports like football, GPS has become the most widely used tool for tracking workloads during training and competition (Akenhead & Nassis, 2016). Similarly, in educational settings, the use of GPS represents an innovation for effective monitoring in the development of children's movement skills.

In addition to the recommended goal-directed learning model, model-based practice (MbP) is a suitable approach for early childhood development (Hordvik et al., 2024). MbP is a teaching approach utilized in PE. Programs are designed around various pedagogical models to provide diverse, student-centered experiences. This approach promotes meaningful learning across multiple domains (physical, lifestyle, emotional, social, and cognitive development) (Astuti et al., 2023; Baker, 2016). In Indonesia, primary school begins at the age of 7. Therefore, this research primarily focuses on children aged 7 and 8, who are still considered part of the early childhood category. Furthermore, MbP can support teachers in creating a more meaningful learning experience by fostering better integration between the curriculum, teaching strategies, learning activities, and assessment methods (Hordvik et al., 2024). Engaging children in meaningful learning experiences during PE can be one approach to encourage their active participation in physical activity outside the school setting (Borges et al., 2022; Smith et al., 2023).

In PE, meaningfulness is concerned with the purpose and goals behind the movements learned by each child, the assessment of each child's experience emphasized the emotional significance of the encounter and the perception of how PE relates to other life experiences (Smith et al., 2023). However, joy plays a central role in how an experience is perceived and valued, particularly for children (Biru et al., 2025). Creating meaningful experiences requires thoughtful effort, as teachers must carefully design engaging and interactive learning processes that capture children's interest. In Indonesia, meaningful learning still needs to be socialized for effective implementation. Many teachers continue to use traditional PE methods, which results in a poor learning experience for children. The government needs to address these issues to ensure PE becomes more meaningful and increases children's participation in physical activities.

To optimize learning in early childhood, teachers need to think creatively when designing engaging and impactful lessons and utilize a variety of teaching models and approaches. However, the majority of pre-service teachers' experience in teaching and learning utilizes more single-model approaches (e.g., Sports Education, Cooperative Learning) than multi-model approaches (Mardiansyah et al., 2024). Hordvik et al. (2024) reviewed five articles detailing PE teachers' experiences learning to teach using the MbP approach, which incorporates various models. Overall, these articles emphasized that pre-service teachers appreciated the philosophy and key features of MbP, acknowledging its numerous benefits compared to traditional teacher-centered PE (Baker, 2016). Teachers can use many strategies to improve the quality of learning in early childhood. Early childhood education is a challenge for every teacher, as this stage is primarily a period of play. Without engaging activities, children can become uncontrollable. On the one hand, PE provides an opportunity for children to play and have fun with their peers, as they enjoy engaging in an interesting and diverse environment (Sando & Sandseter, 2022). In addition, Pan et al. (2023) integrated the Teaching Games for Understanding (TGFU) model with Sport Education (SE) in PE classes, with a focus on basketball teaching. The TGfU-SE model demonstrated a more positive impact on students' learning motivation, enjoyment of the sport, responsibility, and game performance. The TGfU-SE model has a stronger positive influence on the learning effects of students in PE. Therefore, PE teachers need to apply effective and enjoyable learning models in supporting the achievement of learning objectives. Developing new models that are needed to address child development issues is urgently needed as a learning innovation.

Therefore, this research proposes a learning approach focusing on a multi-model strategy by engaging children in play-based activities. The Game-Based Motor Coordination (GBMC) model emphasizes student-centered learning to enhance children's coordination skills from an early age. It also promotes deep learning across multiple domains (cognitive, affective, social, and psychomotor development). Additionally, the principle of GBMC learning is based on competition. Every game introduced by the teacher is designed to be competitive to enhance enthusiasm, challenge, and enjoyment in the learning process.

In this study, our primary objective was to examine the experiences of 7- and 8-year-old children learning through GBMC in PE lessons in Indonesia. The secondary objective was to assess the effectiveness of GBMC in improving young children's MC skills during the eight-week intervention. With GBMC, we aim to expand the limited research exploring experiences in teaching and learning through GBMC as an innovative approach in early childhood.

Methods

Design

In this study, we examined a sample unfamiliar with GBMC learning. In the intervention group schools, GBMC was implemented twice a week for 45 minutes. In contrast, the control group schools followed standardized instruction without implementing GBMC.

Intervention

The model implemented in schools with intervention conditions was developed based on several previous studies on game-based learning approaches to improve MC and motor skills in primary school children (Mardiansyah et al., 2023; Platvoet et al., 2016; Sutapa et al., 2021). GBMC was developed to enhance an essential factor, the foundation of sports skills, which has not received much attention in PE. The program enhances the enjoyment of PE by promoting social connectedness, facilitating fun learning, improving cognitive abilities, and increasing perceived competence in PE. To achieve this goal, we developed a model curriculum by adopting the Teaching Game for Understanding (TGfU).

Our model focuses on improving MC skills in low-grade students in primary school through games that emphasize communication, social skills, cognitive development, joint strategy building, planning, and trust. All games can be played using readily available and low-cost equipment. Teachers can independently implement the games without external support, with each session lasting less than thirty minutes. The intervention was integrated into regular PE classes, specifically within a 45-minute session, and the games were systematically conducted twice per week.

Procedure

Children in the intervention program (i.e., GBMC) was included in the mandatory elementary school PE class. Teachers were recruited through email and direct phone calls. Six PE teachers were contacted, and four agreed to participate in the study. Each teacher received an informational letter detailing the research project, with the aim of ensuring that all teachers conducted at least two classes (one intervention and one control) at the same grade level to minimize potential influences of the learning model. However, due to limited permission from the school, this study could only implement two teachers teaching in the GBMC program and one teacher in the no GBMC program.

The study intervention used the Körperkoordinationstest Für Kinder (KTK3+) test to measure motor coordination performance at the pretest and posttest. The KTK3+ test battery, a revised version of the KTK3 that includes an eye-hand coordination task, is used to assess children's motor coordination (T. Canli et al., 2023; Coppens et al., 2021; M. de Niet et al., 2021). The KTK3+ evaluates overall motor coordination abilities (Kiphard & Schilling, 1974, 2007). The test consists of four subtests: backward balance (BB), sideways movement (MS), sideways jumping (JS), and the eye-hand coordination task (EHC). The KTK3+ items have demonstrated good test-retest reliability, with values of 0.80 for BB, 0.84 for MS, 0.95 for JS, and 0.87 for EHC (Platvoet et al., 2018).

The children were briefed on the test procedure before each subtest. Following the instructions, participants completed each task barefoot. The administration, scoring, and calculation of the KTK3+ test for children were carried out in accordance with the official manual.

For the quantitative data, the teacher and the primary researcher conducted pretests and posttests using the KTK3+ on the school field for all research participants. Meanwhile, for the qualitative data, research assistants conducted interviews with PE teachers who implemented the GBMC model to assess the effectiveness of the developed learning model. In addition, six randomly selected students (3 boys and 3 girls) were interviewed to evaluate the quality of the GBMC model for early childhood education. Within the student group, there are three sets of questions to gather the required qualitative data (students' level of enjoyment during PE lessons using the GBMC model, students' perceptions of the knowledge acquired through the GBMC, and the transferability of learning from GBMC-integrated PE sessions to general PE classrooms).

Participants

Children aged 7-8 years participated in this study from a rural area in West Sumatra, Indonesia. Two primary schools participated in the study after obtaining ethical approval from Universitas Negeri Padang (874/UN35.9/LT/2023) and local authorities (421.2/38/07/SDN.24-2023). One school served as the GBMC intervention group and the other as the control group. The schools were selected based on similar student numbers, facilities, and proximity to each other. Parents and students consented to participate and could opt out of the study. This study involved 112 primary school students. In the intervention group, a total of 53 students participated, with 25 students aged 7 years (12 boys and 13 girls) and 28 students aged 8 years (15 boys and 13 girls). Meanwhile, in the control group, 59 students participated, with 27 students aged 7 years (11 boys and 16 girls) and 32 students aged 8 years (18 boys and 14 girls).

Data Analyses

In this study, an analysis of the mean and standard deviation in the groups (GBMC intervention and control) and gender was conducted to examine the pretest and posttest scores, across the four categories of KTK3+ for children between the ages of 7 and 8. The statistical analysis employed was analysis of variance (ANOVA), a method designed to test for variations across different age groups and changes over time in KTK3+ scores.

A comparison of statistical techniques will demonstrate differences in subgroups over time. The group effect in the between-participants analysis indicates the difference in mean scores between the intervention and control groups on the pretest and posttest. In addition, the measurement effect in the analysis shows the difference in scores between the two study groups. A significance level of 0.05 was used for all KTK3+ subtest.

Results

The study examined a total of 59 students in the control group (29 boys, 30 girls) and 53 students in the intervention group (27 boys, 26 girls). Participants in both groups provided complete data for both the pretest and posttest conditions.

Significant main effects were revealed in the intervention group by ANCOVA for BB ($F(1, 103) = 40.23$; $p < 0.05$; partial $\eta p^2 = 0.281$), JS ($F(1, 103) = 49.38$; $p < 0.05$; partial $\eta p^2 = 0.324$), MS ($F(1, 103) = 30.31$; $p < 0.05$; partial $\eta p^2 = 0.227$), and EHC ($F(1, 103) = 58.76$; $p < 0.05$; partial $\eta p^2 = 0.363$).

Table 1. Mean and standard deviation of pretest and posttest for the intervention group and control group on KTK3+ subtest.

Outcome Measures	Pretest (Mean ± SD)		Posttest (Mean ± SD)	
	Intervention	Control	Intervention	Control
Balance Beam	62.76 ± 9.74	58.17 ± 8.85	68.00 ± 6.72	57.66 ± 8.64
Jumping Sideways	42.75 ± 9.90	41.14 ± 9.45	50.15 ± 10.41	41.24 ± 9.59
Moving Sideways	31.17 ± 5.85	38.12 ± 11.16	37.21 ± 5.16	35.15 ± 6.89
Eye-Hand Coordination	4.38 ± 6.95	5.36 ± 7.33	11.00 ± 9.34	5.86 ± 6.48

There was a significant interaction between group-by-gender ($F(1, 100) = 6.89$; $p < 0.05$; partial $\eta p^2 = 0.063$) and age-by-gender ($F(1, 100) = 6.58$; $p < 0.05$; partial $\eta p^2 = 0.062$) on the Eye-Hand Coordination subtests. Boys in the intervention group exhibited better mean scores than those in the control group across both age categories. Furthermore, a significant age-by-gender interaction was also found for the Moving Sideways score ($F(1, 100) = 9.61$; $p < 0.05$; partial $\eta p^2 = 0.088$), showing that boys in the intervention condition outperformed girls in the control condition and increased with increasing age in both groups. Furthermore, Table 2 presents the results of the KTK3+ subtests, including the means, standard deviations, and p-values for both conditions, categorized by gender.

Table 2. Mean and standard deviation of pretest and posttest for boys and girls in the intervention and control groups.

Outcome Measures	Pre-Test (Mean ± SD)		Post-Test (Mean ± SD)	
	Intervention	Control	Intervention	Control
Balance Beam				
Boys	61.89 ± 10.9	58.31 ± 10.4	67.30 ± 7.5	57.41 ± 10.1
Girls	63.65 ± 8.5	58.03 ± 7.3	68.73 ± 5.8	57.90 ± 71
Jumping Sideways				
Boys	45.19 ± 10.6	41.59 ± 11.9	53.15 ± 10.2	41.28 ± 11.0
Girls	40.23 ± 8.6	40.70 ± 6.4	47.03 ± 9.9	41.20 ± 8.2
Moving Sideways				
Boys	33.70 ± 4.2	38.38 ± 13.6	39.78 ± 4.8	37.66 ± 7.6
Girls	28.54 ± 6.2	37.87 ± 8.3	34.54 ± 4.1	32.73 ± 5.2
Eye-Hand Coordination				
Boys	7.00 ± 8.8	7.06 ± 7.9	14.81 ± 11.6	7.28 ± 7.1
Girls	1.65 ± 2.1	3.70 ± 6.4	7.04 ± 3.3	4.50 ± 5.6

All interaction effects and main effects for BB, JS, MS, and EHC are reported in Table 3. Regarding the effect of GBMC on the KTK3+ subtests, a significant effect on the group was found. All KTK3+ subtests improved more in the intervention group than in the control group. This suggests that the intervention specifically improved students' perceived motor coordination skills in PE. Regarding balance beam, jumping sideways, and moving sideways, we found no effect on the interaction between groups and genders on the experience of these three KTK3+ substest. However, this had a significant effect on the improvement of motor coordination. These results suggest that GBMC has less impact on gender differences in these three subtests in PE.

Furthermore, we found a large significant effect of the children's age difference ($F(1) = 53.47$, $p < .001$, $\eta p^2 = .161$) on eye-hand coordination. On average, the older children scored significantly higher than their younger peers on all four test items. Furthermore, an interaction effect between age and gender was found (MS: $F(1, 100) = 9.61$; $p < 0.003$; partial $\eta p^2 = 0.088$, EHC: $F(1, 100) = 6.58$; $p < 0.012$; partial $\eta p^2 = 0.062$). For MS and EHC, 8-year-olds, on average, develop more than 7-year-olds. All other comparisons between age for the four test items were not significant.

Table 3. Effects of main and interaction testing KTK3+ for gender, age and groups effects

Dependent Variable	Effects	df	F	p	ηp^2
Balance Beam	Group x Gender	1	0.05	.826	.000
	Group x Age	1	0.19	.660	.002
	Age x Gender	1	0.144	.705	.001
	Group	1	18.59	.000	.157
	Gender	1	0.22	.641	.002
Jumping Sideways	Group x Gender	1	2.82	.096	.027
	Group x Age	1	0.07	.786	.001
	Age x Gender	1	1.05	.309	.010
	Group	1	24.14	.000	.194
	Gender	1	1.17	.282	.012
Moving Sideways	Group x Gender	1	0.240	.626	.002
	Group x Age	1	0.58	.450	.006
	Age x Gender	1	9.61	.003	.088
	Group	1	15.86	.000	.137
	Gender	1	20.46	.000	.0170
Eye-Hand Coordination	Group x Gender	1	6.89	.010	.064
	Group x Age	1	0.87	.354	.009
	Age x Gender	1	6.58	.012	.062
	Group	1	18.45	.000	.156
	Gender	1	5.08	.026	0.48

Note. Group = intervention group vs. control group; Gender = boys vs. girls; Age = 7 years vs. 8 years

Discussion

The primary aim of this study was to evaluate the effects of a GBMC intervention program implemented in lower-grade PE classes. We investigated the impact of the GBMC learning model on the KTK3+ and examined whether individual development was affected by age and gender. The primary outcomes of this study indicated a pivotal positive influence of GBMC on perceived MC.

The findings from this intervention are in line with other intervention studies. Karabourniotis et al. (2002) showed that children in the intervention group who received a 12-week motor skills curriculum scored higher than those who received regular PE lessons. Developing a skill-oriented learning program for children in grade one can effectively improve their motor skills, similar to the results of this study. In addition, Costello and Warne (2020) and Biru et al. (2025) explained the results of a 4-week and 8-week program they developed that improved children's skills, as explained by higher post-test scores. Our study changed the assessment method with KTK3+, and we did not use TGMD to assess intervention and control classes (Mardiansyah et al., 2023).

We found evidence that the GBMC learning model increased students' competence. In this study, the MC posttest results showed that children participating in GBMC achieved higher scores compared to those in the control group. These findings suggest that GBMC may have a positive impact on children who demonstrate a lack of physical skills, motivation, and confidence in engaging in physical activities. These findings are in line with the study of Engels & Freund (2020) in Germany, which showed that game-based learning was associated with enjoyment, improved motor skills, and physical activity in PE learning. Thus, the GBMC learning model may help increase the PE class's fun and excitement, but the game does not help students feel more rested or relaxed. This suggests that GBMC learning might be an essential tool in PE for integrating students who are usually "left behind" and "get lost" in competitive games.

Our findings showed that most of the children developed their MC. However, most children did not develop it, especially in the control class. The mean developmental level of MC was found to be significantly higher in children who were 8 years of age compared to those aged 1 year. In accordance with the findings of Niet et al. (2022), the underlying reason may be that children aged 8 years have reached a point of optimal physical and cognitive development to enhance their MC to a greater extent than their younger counterparts. The other reason was the possibility that 8-year-olds benefited more from the GBMC learning model because they were better able to understand the teacher's instructions and excelled at reflecting on their performance (Platvoet et al., 2016). In this way, 8-year-olds are assumed to engage in more deliberate practice, which might explain the difference in proficiency. However, in contrast to the findings of Vandorpe et al. (2011), a significant number of 8-year-old children have poor MC skills compared to previous decades. This also suggests a need for a critical examination of the current PE curriculum. Therefore, PE teachers need to be able to use learning models that are effectively used to

improve students' skills in PE learning. One of the suitable models is the model we are currently developing (GBMC learning model), which can improve motor skills and fun situations in PE learning in primary schools.

The findings of this study indicated a significant increase in scores on the BB, JS, MS, and EHC measures for students who participated in the GBMC learning model intervention group. A significant group interaction by gender further indicated that boys and girls in the intervention group scored better than boys and girls in the control group on all KTK3+ measures. For instance, Neira-Navarrete et al. (2024) used modified Invasion Games in two groups (intervention and regular PE classes) for 60 minutes per session for 12 weeks, which showed a positive increase in motor competence at the end of the study period for the intervention class.

We found evidence that the GBMC learning model contributed to increased feelings of social relatedness in PE classes. Social relatedness describes how strongly each student feels integrated and involved in PE learning (e.g., "I feel the cohesiveness of playing with friends during PE learning). The results of the student interviews and the significant interaction between group and gender suggests a specific effect of the GBMC learning model on how strongly boys and girls feel related to each other in PE. These findings are consistent with previous research on other game-based learning approaches, such as improving teamwork skills (Engels & Freund, 2020) and social skills (Hsiao & Chen, 2016).

The GBMC learning model also contributed to an increase in perceived competence among students. Consequently, students who engaged in the GBMC learning model reported higher levels of perceived competence compared to those who did not participate. These findings indicate that GBMC positively influenced less skilled students and helped them feel more successful in motor skills. Therefore, the GBMC model is a valuable framework for PE teachers when designing lessons that support the inclusion of students who typically struggle in competitive games.

Our study was conducted on a sample group within the early childhood stage. The limited number of studies focusing on this period underscores the need to broaden the scope of the existing literature. However, a key strength of this study lies in the structured implementation of GBMC, which is designed based on MC elements derived from a thorough review of early childhood education and PE curricula while also considering children's developmental needs. Additionally, the focus of our research serves as another strength of this study, offering a more comprehensive assessment of the impact of games on MC, a crucial factor in children's development. The main limitation of this study is that the GBMC intervention was conducted only twice a week, and children's PA levels were not tracked on other days. In addition, factors that may influence early childhood development, such as socioeconomic status, nutrition, family lifestyle, and parental education level, were not considered. These factors could affect the study's outcomes. Hence, future research should consider these factors and expand the implementation of GBMC to a larger and more diverse sample.

Conclusions

The GBMC intervention resulted in a significant increase in MC among children aged 7-8 years. These findings suggest that structured game-based learning focused on motor skills can effectively enhance MC. In particular, the group with the intervention condition showed significant increases in all subtests of KTK3+ compared to the control group in various aspects of MC. The findings emphasize the importance of integrating general learning approaches with coordination-based learning and motor skill development in early childhood and PE. In addition, the GBMC approach effectively promotes MC and encourages student engagement and active participation, contributing to the overall development of the child. Given the importance of well-developed MC, PE teachers must be trained in implementing the GBMC model and assessing each student's MC to optimize learning outcomes holistically. For future research, we recommend conducting longitudinal studies to explore the long-term effects of GBMC on children's MC, physical activity, fundamental motor skills, broader physical fitness, and the influence of various social backgrounds. The implementation of this model will support the enhancement of motor development for all children.

Author Contributions

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Competing Interests

Rembulan Catra Banyu Biru, Vevi Sunarti, and Arischo Mardiansyah declare no competing of interest regarding the content of this research.

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