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The Development of Modified Ball Games in Stimulating the Sensorimotor Development of Children Aged 4-6 Years

*Siti Rahmawati[1], Ajat[2]
[1,2]Universitas Panca Sakti Bekasi

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Abstrak

Penelitian ini bertujuan untuk mengembangkan permainan bola modifikasi dalam menstimulasi perkembangan sensorimotor anak usia 4-6 tahun di Taman Bermain Sahabat Sekar Mekar, Kabupaten Bogor. Penelitian ini menggunakan pendekatan Research and Development (R&D) dengan model Borg and Gall yang dimodifikasi menjadi lima tahapan, yaitu penelitian dan pengumpulan informasi, perencanaan, pengembangan produk awal, uji coba lapangan awal, serta revisi produk. Metode ini melibatkan analisis data kualitatif dan kuantitatif melalui observasi, wawancara, dan kuesioner yang dilakukan kepada guru serta para ahli dalam bidang materi dan media. Hasil penelitian menunjukkan bahwa permainan bola modifikasi yang dirancang berhasil meningkatkan perkembangan sensorimotor anak secara signifikan. Validasi yang dilakukan oleh para ahli menyimpulkan bahwa permainan ini efektif dalam menstimulasi berbagai aspek sensorimotor, seperti keseimbangan, koordinasi mata-tangan, gerakan motorik kasar dan halus, serta keterampilan ritmis. Permainan bola modifikasi juga dirancang untuk dapat disesuaikan dengan keterbatasan ruang dan kebutuhan anak, sehingga dapat diterapkan secara optimal dalam lingkungan pendidikan anak usia dini. Keterbatasan ruang di Taman Bermain Sahabat Sekar Mekar yang awalnya menjadi kendala dalam aktivitas fisik anak berhasil diatasi dengan modifikasi permainan ini. Uji coba menunjukkan bahwa permainan bola modifikasi mampu meningkatkan minat dan partisipasi anak dalam kegiatan fisik secara lebih aktif dan terarah. Pengembangan ini memberikan alternatif solusi bagi pendidik dalam merancang aktivitas yang mendukung perkembangan sensorimotor anak usia 4-6 tahun.

Abstract

This study aims to develop a modified ball game to stimulate the sensorimotor development of children aged 4-6 years at Taman Bermain Sahabat Sekar Mekar, Bogor Regency. This study us Research and Development (R&D) approach with the Borg and Gall model modified into five stages, namely research and information gathering, planning, initial product development, initial field trials, and product revision. This method involves qualitative and quantitative data analysis through observations, interviews, and questionnaires conducted to teachers and experts in the fields of material and media. The results showed that the

designed modified ball game successfully improved children's sensorimotor development significantly. Validation conducted by experts concluded that the game is effective in stimulating various sensorimotor aspects, such as balance, eye-hand coordination, gross and fine motor movements, and rhythmic skills. The modified ball game is also designed to be adapted to the limited space and needs of children, so that it can be applied optimally in an early childhood education environment. The limited space at Taman Bermain Sahabat Sekar Mekar, which was initially an obstacle to children's physical activity, was successfully overcome with this game modification. The trial showed that the modified ball game was able to increase children's interest and participation in physical activities as a whole.

✉ Corresponding author:
E-mail: sitifisiopediatri@gmail.com

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INTRODUCTION

Early childhood education plays a very substantial role in improving the quality of life for children in the future. Thus, Early Childhood Education (PAUD) can support the optimal growth and development of young children through learning programs that can optimize their development, one of which is through motor/movement learning with a sensorimotor approach.

Development is a series of progressive changes resulting from the process of maturation and experience. Development is not merely an increase in height or an individual's abilities; it is an integration process of many complex structures and functions (Hurlock, E.B., 2017). It is the result of the interaction of the maturation of the central nervous system with the organs it influences, such as the development of the neuromuscular system, speech abilities, emotions, and socialization. These overall functions play an important role in the holistic life of a human being (Rizky & Mahardika, 2023).

The sensory system consists of vision, hearing, touch, taste, smell, plus two internal sensory systems, namely proprioception (sensations originating from the joints and muscles that contribute to body awareness and unconscious body movements) and vestibular (sensations originating from the inner ear, contributing to balance and sensing the position of the head in relation to the environment and body)

(Ilviyantari, 2017). Each sensory system is supported by receptors located in one or more organs of the body that function as receptors (stimulus receivers). The stimuli/information received by the body is transmitted to the brain, then interpreted into a child's sensory perception (Cherry Kendra, 2019).

Meanwhile, motor skills, which include the motor system, are inseparable from the performance of movement skills and praxis. Praxis is the ability of a child to move, encompassing several concepts such as ideation, planning, postural tone, sensory processing, sequential organization, spatial organization, and temporal organization. Ideation is the child's ability to create concepts and steps/sequences to achieve the desired goal. Planning involves cognitive processes in coordinating body movements in correlation to spatial and temporal movement aspects. Postural tone is the readiness of muscles to respond or perform activities. Sensory processing (the ability to process sensory input) is the process underlying a child's movement and praxis abilities, where the child can detect, regulate/sort, and interpret the stimuli received by the body (sensory modulation and discrimination). Spatial organization includes the organization in determining the distance between oneself and external objects (internal map). Temporal organization is the timing arrangement of certain movement patterns in a series of actions (Yunitasari et al., 2023).

The importance of motor stimulation lies in the fact that motor activities during preschool age will support sports learning and the acquisition of both fundamental and complex movement skills (Brookhart & McMillan, 2019). Schmidt, R.A., and Lee, T.D. (2011) in (Musyafa'ah & Salim, 2024) state that the ability to move is a crucial aspect of life and human development and has a significant role in cognitive and socio-emotional domains. Supported by research concluding that gross motor skills (large movement motor skills) have a relationship with cognitive development in early childhood. Physical activity will affect academic skills and self-regulation in early childhood. Even for children aged 3-5 years, who are developing self-regulation and numeracy skills (Ica Anggi Cahaya Asari et al., 2023). Where self-regulation will become the foundation of psychosocial health and academic achievement in the future (McGowan et al., 2023).

Motor development will influence the overall growth of the child, related to neuromotor (movement) skills, cognitive, social, and emotional skills. Motor

development is an essential component in preschool and elementary school age (McGray, 2011). Motor/movement activities are any body movements produced by skeletal muscles, which ultimately result in energy expenditure (Palmer & Apovian, 2017). Competence in children's basic motor skills will facilitate participation in physical activities and is crucial for holistic child development. Children's motor competence includes basic movement patterns such as running, jumping, and catching a ball (Stiggins, 2017). It is currently known that there is a clear relationship between brain areas involved in motor skills (especially the cerebellum) and brain areas involved in cognitive skills (especially the pre-frontal cortex) (Oberle et al., 2021). Therefore, it is important to stimulate motor skills.

Sensorimotor development refers to the ability acquired by children to interact with their environment through a combination of senses and motor skills. Thus, this developmental process is a two-way interaction between sensory perception and motor activities (ranging from simple to complex movements). A child's sensorimotor development also includes body awareness (how certain body parts function), spatial awareness (which parts of space the body occupies), awareness of movement direction and the position of objects in that space, time orientation for movement, and the time required for movement (rhythmic movement skills) (Waite, S., Bølling, M., & Bentsen, 2020).

Based on the above explanation, it can be concluded that the importance of sensorimotor development in early childhood stages cannot be overstated. Not only does it encompass motor skills, but it also impacts physical health and prepares children for pre-academic/academic abilities in the future (ASTIKA et al., 2023).

The term "play" originates from the word "playing," which involves pretend activities done with or without tools for the sake of enjoyment, allowing children to project their hopes and personal conflicts. The goal of these activities is for children to release all negative emotions, such as unpleasant experiences and unfulfilled hopes, through play, which brings about feelings of happiness and relief (Ardini & Lestariningrum, 2018).

Several ball playing techniques that can be performed by young children include catching and throwing (bounce and chest pass), dribbling, and shooting the ball. Modified ball games are an innovation in educational learning related to motor skills

that can be adjusted to the characteristics of children's development. Research results indicate that playing basketball affects the improvement of gross motor skills in children aged 5-6 years (Reswari, 2021).

Modified ball games are activities that use a ball in a joyful and fun atmosphere, involving manipulative movements such as catching and throwing, dribbling, and shooting the ball. These ball-playing techniques can be utilized to stimulate children's development, one of which is sensorimotor development (Imani et al., 2020).

RESEARCH METHODOLOGY

The method used by researchers is the research and development (R&D) method. This is a scientific approach to investigate, design, produce, and validate the products that have been created or to validate and develop products. In this study, the procedure used is development with the Borg and Gall model approach, with adjustments to the research steps. The R&D method with the Borg and Gall model used includes the processes of information gathering and research, planning, developing the initial product, initial field testing, and then revising the main product to meet the needs of the children at Taman Bermain Sahabat Sekar Mekar.

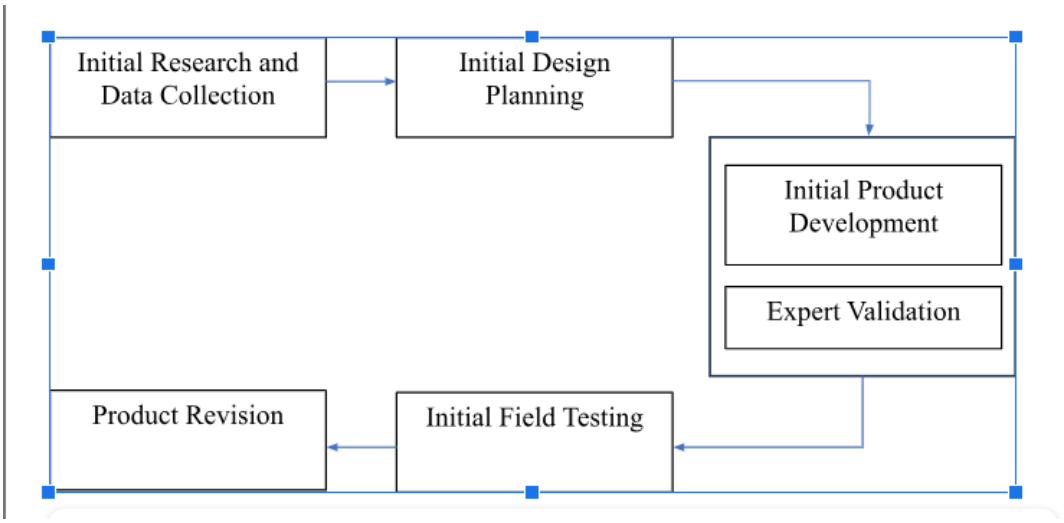

Figure 1. Modified Borg and Gall Development Research

RESEARCH RESULTS AND DISCUSSION

The results of the research on the development of modified ball games to stimulate sensorimotor development in children aged 4-6 years at Taman Bermain Sahabat Sekar Mekar include initial data analysis covering initial observations and interviews with teachers at Taman Bermain Sahabat Sekar Mekar. The development research procedure is based on the Borg and Gall research design adapted to the needs and includes 5 stages: 1) Research and information gathering, 2) Planning, 3) Developing the initial product, 4) Initial field testing, 5) Product revision. The researcher limits the development research steps to five stages according to the needs of the learning model development. The final product of this research is a modified ball game that will stimulate sensorimotor development.

1. Research and Information Gathering Stage

To obtain information and an overall picture of the activities carried out, as well as the conditions and challenges faced by teachers or students, especially in the development of modified ball games, initial data collection was carried out in this research and media development. During observations and interviews with classroom teachers, several issues were encountered during the learning process, particularly in the sensorimotor development of children aged 4-6 years at Taman Bermain Sahabat Sekar Mekar in Bogor Regency. Therefore, researchers developed modified ball games, intended as a solution to help sensorimotor development in a fun and enjoyable way for children.

The researcher conducted direct observations in the classroom during the learning process. The subjects of this research interview were classroom teachers at Taman Bermain Sahabat Sekar Mekar in Bogor Regency, covering the learning process, teaching and learning obstacles, game media, and student characteristics in the learning process.

It can be concluded that educators/teachers at Taman Bermain Sahabat Sekar Mekar face several challenges in optimizing the development of sensorimotor areas in children aged 4-6 years. The main challenge is the limited space for movement, which hinders children from engaging in free physical

activities, thus affecting the maximal development of sensorimotor skills. Additionally, the current ball games are considered less suitable for the abilities of children in this age range, due to their sometimes overly high complexity. This results in varying levels of interest in ball games among children, with some showing enthusiasm, while others are less interested.

Overall, there is a need to develop games that are more tailored to the needs and abilities of children, as well as efforts to overcome the existing space limitations to optimize children's sensorimotor stimulation. Therefore, modified ball games can be a solution for students at Taman Bermain Sahabat Sekar Mekar in developing sensorimotor skills.

2. Planning Stage

After conducting preliminary research and identifying problems, the planning and development stages are carried out. Some of the problems found during the learning process of children at Taman Bermain Sahabat Sekar Mekar include the suboptimal sensorimotor development of the children. Therefore, researchers developed a modified ball game product, which is an educational game designed to address the existing problems.

3. Initial Product Development Stage

The modified ball game is designed to meet the needs of sensorimotor development in children aged 4-6 years. The goal is to enhance children's sensorimotor skills through challenging and enjoyable activities that are appropriate for their abilities. This addresses the limitations of movement space, as the game will be designed to maximize the use of available space, ensuring that children can still move and explore the play environment.

The initial product will take into account the opinions and input from teachers, as well as subject matter and media experts. This will ensure that the modified game is engaging and suitable for the interests and abilities of the children. The game will be adapted to meet the developmental needs of children aged 4-6 years, considering their basic abilities. The initial product will address the main challenges identified by teachers and validators in

designing motor activities in the form of ball games for children at Taman Bermain Sahabat Sekar Mekar, enabling more effective game design.

The initial product will consider the use of appropriately sized balls, visual aids such as colored tape and pictures to enhance children's understanding and engagement in the game. The initial product will propose how the modified ball game can be integrated into the learning process or routine activities at the playground to ensure consistent and effective implementation.

By combining information from interviews and needs analysis, the initial modified ball game product will be designed to meet the goal of sensorimotor development in children aged 4-6 years, considering the needs at Taman Bermain Sahabat Sekar Mekar. The initial modified ball game designed will then be assessed and validated by experts. The average criteria fall into the "Very High" category with a percentage of 88%, indicating that this modified ball game is effective in stimulating auditory, visual, tactile, proprioceptive, and vestibular sensory areas, as well as improving gross and fine motor skills.

The level of agreement (reliability) among validators was tested by calculating the intraclass correlation coefficient (ICC). From Table 4.5, the analysis results show an average inter-rater agreement of 0.791, while the rater consistency is 0.762, indicating high stability (Streiner & Norman, 2008; Yudha, 2020).

Tabel 1. Instrument Reliability Test Results

	Intraclass Correlation[b]	***95% Confidence Interval***		***F Test with True Value 0***			
		Lower Bound	*Upper Bound*	*Value*	*df1*	*df2*	*Sig*
Single Measures	.791[a]	-.071	.687	2.222	4	3	.002
Average Measures	.762[c]	-.248	.868	2.222	4	3	.002

Intraclass Correlation Coefficient

Two-way mixed effects model where people effects are random and measures effects are fixed.

a. The estimator is the same, whether the interaction effect is present or not.

b. Type C intraclass correlation coefficients using a consistency definition. The between-measure variance is excluded from the denominator variance.

c. *This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.*

4. Initial Field Testing Stage

To determine the effectiveness of the trial of modified ball games on stimulating sensorimotor development in children aged 4-6 years at Taman Bermain Sahabat Sekar Mekar, an experiment with modified ball games was conducted. The initial step taken by researchers was to conduct a pre-test to determine the initial abilities of children related to sensorimotor development. The initial observations of 13 students revealed that there were still children who had not yet developed optimally. The achievement levels were categorized as follows: Not yet developed (BB) for 1 child or 7.69%, Starting to develop (MB) for 2 children or 15.38%, Developing as expected (BSH) for 6 children or 46.15%, Developing very well (BSB) for 4 children or 30.76%. Based on the calculation of the average pre-test score, which was 68.31, it was determined that children were still not optimal in gross motor skills, fine motor skills, coordination, and body balance, as well as speed and body movements according to the instrument sheet.

Table 2. Pre-test Experiment Results

Categories	Class Interval	f	%
BSB	> 71	4	30,76
BSH	66 – 70	6	46,15
MB	61 – 65	2	15,38
BB	< 60	1	7,69
Total		**13**	**100**

The treatment given to the research subjects, namely children aged 4-6 years, is in the form of modified ball game activities. This treatment is carried out by the teacher accompanied by the researcher during the learning process, by first preparing the modified ball game as a supporting activity that will be implemented, and providing materials to the children with the help of visuals such as pictures and movement examples (demos). The implementation of the modified ball game is conducted during the "large group time" session where the children are usually given one group activity. Thus, the researcher can routinely carry out the modified ball game activities, conducted three times a week for a month. After doing the opening activities, such as greeting, singing,

and questioning about the activities before going to school, light warm-up exercises like breathing exercises, simple hand and limb movements are conducted. After that, the children are ready to perform the series of activities, by first providing examples (demos) or pictures and brief explanations about the playing activities. In turns, the children are given the opportunity to try the movements that have been demonstrated until completion. The closing activity involves the children, such as asking about their feelings, what movements have been done, and providing a brief and easily understandable explanation of the activities that have been conducted.

The next stage, after being given treatment in the form of modified ball game activities, is the post-test to determine the children's sensorimotor development. This final stage measurement is carried out once after the treatment has been given three times a week for one month.

Table 3. Post-test Experiment Results

Categories	Class Interval	F	%
BSB	> 85	8	61,54
BSH	81 - 85	2	15,38
MB	76 - 80	2	15,38
BB	< 75	1	7,69
Jumlah		**13**	**100**

The results of observations after being given modified ball game activities to 13 students show an increase in the class interval compared to the pre-test. The achievement level in the "not yet developed" (BB) category shows progress with a score increase of <75 for this category. For the "beginning to develop" (MB) category, there are 2 children or 15.38%. For the "developing as expected" (BSH) category, there is an increase where the initial score range was 66-70, which increased to the score range of 81-85 with 2 children or 15.38%. For the "developing very well" (BSB) category, there is also an increase to 8 children or 61.54% with a score of >85 from the previous pre-test score of >71. Supported by the calculation of the average post-test score becoming 84.8, this shows an increase in the interval values and post-test average scores.

The Wilcoxon Signed Rank Test is a non-parametric test to measure the significance of the difference between 2 paired ordinal or interval scale data groups that are not normally distributed (Octavia & Utara, 2024). The differences in pre-test and post-test results are analyzed using the Wilcoxon signed-rank test to determine the differences in sensorimotor development of children aged 4-6 years before and after being given the treatment of modified ball game activities that have been developed.

Tabel 4. Analisis *Wilcoxon Signed Ranks* Kelompok Eksperimen *Pre-test* dan *Post-test*

	Posttest - Pretest
Z	-3.185[b]
Asymp. Sig. (2-tailed)	.001

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Based on the results in Table 4.9, the Asymp. Sig. (2-tailed) probability is 0.001, which indicates that this probability is below the alpha value of 0.005. This shows that there is a significant difference and increase in the experimental class before and after being given modified ball game activities. Therefore, it can be concluded that there is an effect of modified ball games on the sensorimotor development of children aged 4-6 years at Sekar Mekar Playgroup in Bogor Regency.

To determine the quality and practicality of the product, both user teachers were given a product practicality assessment questionnaire covering the aspects of objectivity, systematicity, flexibility, efficiency, and practicality. In general, the two teachers assessed that the product has good objectivity, systematicity, flexibility, efficiency, and practicality.

Table 5. Product Practicality Assessment Table

No	Assessment Indicators	Teacher Responses		Total	%	Categories
		1	2			
1	Objectivity	13	14	27	90	Very Practical
2	Systematicity	15	15	30	100	Very Practical
3	Flexibility	14	15	29	97	Very Practical
4	Efficiency	14	13	27	90	Very Practical
5	Practicality	13	14	27	90	Very Practical

Overall, the test results show that ball game activities fall into the 'Very Practical' category. This indicates that modified ball game activities are objective, systematic, flexible, efficient, and practical in their classroom application. This is very important to ensure that the learning process in stimulating children's sensorimotor abilities using modified ball games runs well and effectively

5. Product Revision Stage

Based on the initial field test results, it can be concluded that modified ball games are suitable for use by children aged 4-6 years to stimulate sensorimotor development. During the trials, the children had no difficulty playing the modified ball games and were enthusiastic about engaging in the activities. These modified ball games underwent improvements and revisions after expert validation tests and initial field tests.

The research on the development of modified ball games has shown significant results in stimulating the sensorimotor abilities of children aged 4-6 years at the Sahabat Sekar Mekar Playground. Based on observations, interviews, and field tests, several obstacles were found that affect the sensorimotor development of children, such as limited play space and the complexity of games not suitable for the child's age. Therefore, modified ball games were developed to overcome these obstacles. These modified ball games are designed with the sensorimotor needs of children in mind. The activities involve simple yet challenging movements, such as throwing, catching, dribbling, rolling, and bouncing the ball, with visual aids like colored tape, pictures, and movement demonstrations. These activities will help children develop sensorimotor skills,

including hand-eye coordination, balance, and both gross and fine motor skills, which will support the learning process in the future.

The development stage of the game involves several steps, starting from observation to field testing. In the testing stage, children are given pre-tests and post-tests to evaluate the improvement of their sensorimotor abilities after being given treatment in the form of modified ball games. The post-test results show significant improvement in the children's development category, with the majority of children experiencing improvement in the 'very well-developed' category and an increase in the average score in the post-test assessment.

In the development of modified ball games, it is important to consider the limitations of movement space in the playground and the children's interest in current ball game activities. The game should be designed considering the age and motor skills of the children, and it should be attractive and aligned with their interests. This is important to ensure that the provided game is not only enjoyable but also supports the appropriate sensorimotor development in children

Overall, these modified ball games are considered very promising for integration into the learning process or routine activities at the Sahabat Sekar Mekar Playground. With various movements that are easy for children aged 4-6 years to understand, these games are not only enjoyable but also effective in developing children's sensorimotor abilities.

CONCLUSION

The development of modified ball games using the Borg and Gall research and development model was adapted to the researchers' needs. The development process was carried out through several stages, including research and information gathering through observation and interviews, initial product planning, initial product development by conducting expert validation and reliability tests, which were rated 'very good,' initial field testing involving 13 students at the Sekar Mekar Playground in Bogor Regency, and finally, the product revision stage.

The initial field test results conducted on 13 students at the Sekar Mekar Playground in Bogor Regency showed that the developed modified ball games

could be effectively used to stimulate the sensorimotor development of children aged 4-6 years. The post-test categorization results showed good improvement in sensorimotor development. Additionally, the practicality test conducted with users also indicated that the modified ball game product was generally considered practical by the teachers in stimulating the sensorimotor development of children at the Sekar Mekar Playground in Bogor Regency."

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