ASPI | Afarand Scholarly Publishing Institute; Turkey
ISSN: 2345-2897; Health Education and Health Promotion. 2023;11(1):125-131. 10.58209/hehp.11.1.125

Effect of the Project-based Learning Model, Age, and Motor Educability on Fundamental Motor Skills in Early Children

ARTICLE INFO

Article Type
Original Research

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How to cite this article
Aliriad H, Soegiyanto S, Hari Setijono H, Sulaiman S. Effect of the Project-based Learning Model, Age, and Motor Educability on Fundamental Motor Skills in Early Children. Health Education and Health Promotion. 2023;11(1):125-131.

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Article History
Received: December 14, 2022
Accepted: March 4, 2023
ePublished: March 19, 2023

ABSTRACT

Aims This study aimed to investigate the effect of the project-based learning model, age, and motor educability on the enhancement of fundamental motor skills in young children.

Materials & Methods This experimental study with pre-test and post-test design was carried out on students between the ages of 8 and 9, during February and June of 2022, in Semarang, Central Java, Indonesia. Students participated in a 30-week Fundamental Movement Skills program that included one session (about 60 minutes) per week and was presented in community settings by a certified local instructor. The motor skills of students were tested before and after the intervention, and collected data were analyzed using Generalized Linear Model hypothesis testing.

Findings There were significant differences between the effects of the Project-based Learning Model for games with tools and games without tools (p=0.0001), as well as for high motor educability and low motor educability levels (p=0.031), on the enhancement of fundamental motor skills in post-test. Additionally, there was an interaction between the Project-based Learning Model and the motor educability level on the rise of fundamental motor skills in the post-test, which means that the two factors had an impact on each other's effects on the fundamental motor skills.

Conclusion Fundamental motor skills are more influenced by games using the Project-based Learning Model paradigm than by games without tools, especially if children have high motor educability.

Keywords Physical Education; Learning; Education; Motor Skills; School

CITATION LINKS

[1] Fundamental motor ... [2] The influences of learning ... [3] The relationship between ... [4] Age and gender ... [5] Boys and girls ... [6] The relationship ... [7] Supporting student ... [8] Effects of intelligence ... [9] Effect of a fundamental ... [10] Health-related fitness ... [11] Association between ... [12] An analytical study ... [13] Relationship of fundamental ... [14] Association of impulsive ... [15] Desain dan Analisis ... [16] Football skills ... [17] Motor educability ... [18] Penerapan model pembelajaran ... [19] Merancang pembelajaran ... [20] Pengembangan model ... [21] Project based-learning ... [22] Interventions to improve ... [23] Compare intelligence ... [24] The correlation between ... [25] Analysis of sports ...

Introduction

Children first learn to manage their general bodily motions before moving on to more specialized talents. There are two main types of basic motor skills: Large motor skills and fine motor skills [1]. The capacities required to properly control bodily motions are known as basic motor skills. This includes the capacity to control the head, arms, and legs as well as more subtle actions like writing, opening a bottle's cap, and grasping. While fine motor abilities are more subtle actions like gripping, writing, and opening bottle lids, gross motor skills are larger movements like walking, running, and jumping [2]. For children to learn, communicate, and interact with their surroundings, they need to be able to understand and control their basic motor movements. This is why basic motor skills are crucial for a child's development [3].

Basic motor abilities are advantageous for both boys and girls, however, depending on the skill area targeted, there may be variances in the pattern of improvement displayed by the sexes [4]. It might be a result of individual variances in particular motor skill strengths and weaknesses [5]. The two key components of physical education that are motor education and motor skills are interrelated and have an impact on students' motor skills [6].

A teaching strategy known as Project-Based Learning (PBL) gives pupils the chance to learn through projects that are connected to actual societal issues [7]. PBL can be packaged as a game to examine the relationship between cognitive, affective, and motor intelligence [8]. Students can develop skills, information, and attitudes that are pertinent to demands in the real world by implementing PBL (Figure 1).

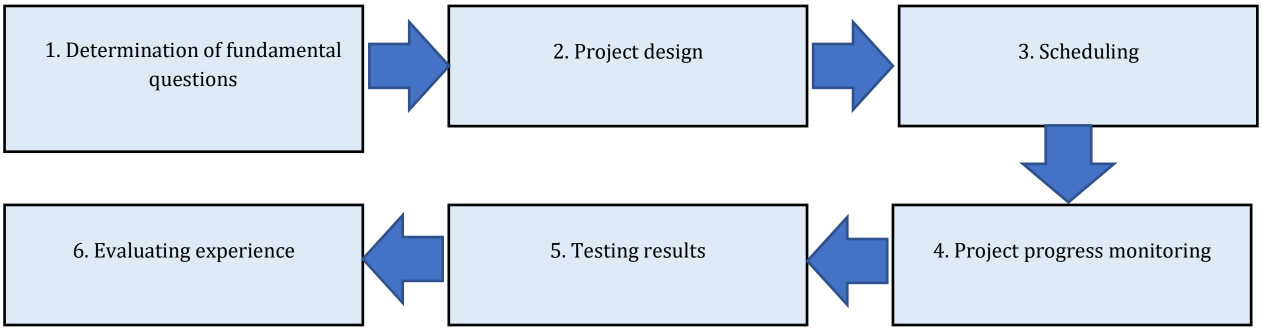

Figure 1) Project-based learning model

Both boys and girls can benefit from a play fun game training program that helps them become more physically competent. Children's motor abilities, coordination, and strength can all be improved via regular, organized exercise, which also helps with fitness and physical condition. To retain the improvement that has been made, it is crucial to maintain chances for practice. Making sure kids have access to suitable exercise facilities and continuing to try to incorporate Fundamental Movement Skills (FMS) or other workouts into their daily routines are two ways to do this [9]. Health-Related Fitness (HRF) knowledge tests can be administered before and after the PBL intervention to gauge how well the PBL model has increased students' HRF knowledge. In addition, you can gather information about students' knowledge of health-related fitness after participating in PBL interventions using other techniques, including observation, interviews, or open-ended questions [10].

Children who engage in regular physical activity can improve their strength, coordination, and balance, all of which are necessary for mastering simple movements [11]. In a long-term study, it was discovered that physical activity helps young children develop their FMS. Perceived motor skills did not modulate the association between FMS and physical activity, according to other investigations. This indicates that, in the absence of any other mediators, physical exercise directly influences the early development of FMS. There are several levels of each person's or athlete's motor educability [12].

FMS and physical activity are related. However, a causal link between the two cannot be demonstrated with certainty [13]. The causal link between FMS and physical activity needs to be determined in more detail to assure the viability of practical implementation. To ascertain if physical activity directly influences the development of FMS in young children or whether other factors mediate the association, research utilizing an appropriate design, such as an experimental design, can be helpful [14]. This study aimed to investigate the effect of the project-based learning model, age, and motor educability on the enhancement of fundamental motor skills in young children.

Materials and Method

This study's methodology employs an experimental pre-test and post-test design. This study utilized a 2 × 2 × 2 factorial design [15] (Table 1). The educational program employs a range of techniques, like games, to assist pupils develop their basic motor abilities [16]. The study was carried out between February and June of 2022 in Semarang, Central Java, Indonesia. For the school project, 35 student settings totaling 50 locations were purposefully chosen based on the setting type (sports club, local council, and school) and geographic distribution (5 provinces). In the beginning, 112

[DOI: 10.58209/hehp.11.1.125]

students between the ages of 8 and 9 participated in the intervention. Before and after the intervention, the students in this group who had an attendance rate of less than 70% (i.e., 21 classes) were evaluated on the FMS (n=32; mean age = 8.6±1.2 years; from 39 out of 50 locations). The intervention group had 32 boys and girls.

Table 1) Research design framework

Variable	Project based learning model							
	A1				A2			
Age	B1		B2		B1		B2	
ME	C1	C2	C1	C2	C1	C2	C1	C2
Group	A1B1 C1	A1B1 C2	A1B2 C1	A1B2 C2	A2B1 C1	A2B1 C2	A2B2 C1	A2B2 C2
Total	8	8	8	8	8	8	8	8

A1: PBL model game, without tools
A2: PBL model game, with tools
B1: Age, 8 years
B2: Age, 9 years
C1: Motor educability, high
C2: Motor educability, low

The samples for the experiment were chosen at random from the groups of kids who had good and poor motor educability; there were 32 samples total from each group, making 8 students in each group. In one semester, this research was carried out eight times with a weekly frequency. The motor skills of class III elementary school pupils were tested before and after the study, which yielded the necessary data. The Metheny-Johnson Motor Educability Test was utilized in this study to gather data and conduct analysis to identify differences between treatment groups [17].

Written informed consent was provided by the participants, and all procedures were handled according to the Declaration of Helsinki. The study obtained approval from the ethics committee of Universitas Negeri Semarang.

Instrument

Students in the intervention group participated in a 30-week theoretically supported FMS program that included one session (about 60 minutes) per week, was presented in community settings, and was delivered by a certified local instructor (e.g., sport and recreation leaders, school teachers, or caregivers). In addition, to support during the program, all instructors received a one-day training course. Ten basic motor skill themes were used to categorize motor educability into high and low levels. These items included: 1) One foot-touch head, 2) Side learning rest, 3) Grapevine, 4) One-knee balance, 5) Stroke stand, 6) Double heel kick, 7) Cross-leg squat, 8) Full left turn, 9) One knee - head to the floor, and 10) Hop.

The second edition of the Test of Gross Motor Development (TGMD-2) measures students' basic motor abilities. This test was used to measure students' FMS both before and after the 30-week intervention. The test was done within a building and took about 20 minutes to finish for each youngster. The TGMD-2 measures the level of performance in six locomotor skills (run, gallop, hop, leap, horizontal jump, and slide) and six object control skills (strike a stationary ball, stationary dribble, catch, kick, overhand throw, and underhand roll).

For each ability, each kid was assessed twice using 3-5 components, which were either present (=1) or absent (=0). A raw subtest score was created by adding the raw values for object control and locomotor skills. The post-intervention score was then subtracted from the baseline value to determine the gain scores. With great test-retest reliability, inter-rater reliability, and good internal consistency (Cronbach's alpha values for locomotor and object control subtests are 0.85 and 0.88, respectively), the TGMD-2's psychometric quality is well established. For students aged 3 to 10 years, construct, content, and concurrent validity have been established. A team of qualified examiners collected the data in line with the test handbook. The TGMD-2 manual was comprehensive, each examiner had a half-day assessment training, and they all had a background in physical education.

Statistical analysis

Data were analyzed using the Kolmogorov-Smirnov test for normality, Levene's test for homogeneity, and Generalized Linear Model (GLM) for testing hypotheses. The data analysis was done by SPSS 23.0 software.

Findings

The mean score of FMS in the PBL model without tools increased from the pre-test (6.66) to the post-test (6.97). Similar to this, the mean score of FMS in the PBL model of games with tools showed a rise from the pre-test (7.12) to the post-test (8.11). The FMS post-test on the PBL model of games with tools had a minimum value of 4, which is regarded as low, while the FMS post-test on both the PBL model of games with tools and without tools had a maximum value of 9, which is regarded as very high. The game practice without media was inferior to the game learning program with media, receiving an average score of 6.97, while the latter had an average score of 8.11 (Table 2).

The FMS at age 8 is nearly identical to the average between the FMS pre-test and post-test, which was 6.84 and 7.73, respectively. On the other hand, it was discovered that FMS had an average rise from FMS pre-test to FMS post-test of 7.34 at the age of 8 years. The minimum value for the FMS post-test at age 8 was 4, which is regarded as low, and the maximum score for the FMS post-test at age 9 was 9, which is regarded as extremely high. The average difference between the pre-test and post-test scores for students aged 8 and 9 years on the FMS test was 7 (Table 2).

FMS at low motor educability increased from 6.66 at pre-test to 6.97 at post-test. The FMS at high motor educability, however, was about the same on average between the pre-test and post-test, which were both 7.12. With a minimum score of 4, the FMS post-test on high motor educability is regarded as low. With scores for high educability motors of 8 and low educability motors of 7, the test results for motor educability

[DOI: 10.58209/hehp.11.1.125]

demonstrated that the high educability motor group was superior to the low educability motor group (Table 2).

Table 2) Mean scores of FMS based on the PBL model, age, and motor educability in pre-test (n=32) and post-test (n=32)

Variable	Min-Max	Mean±SD
PBL model		
• Without tools		
FMS pre-test	6-8	6.66±0.57
FMS post-test	4-8	6.97±0.81
• With tools		
FMS pre-test	6.5-8	7.12±0.44
FMS post-test	7-9	8.11±0.62
Age		
• 8 years		
FMS pre-test	6-8	6.84±0.54
FMS post-test	7-9	7.73±0.67
• 9 years		
FMS pre-test	6-8	6.934±0.58
FMS post-test	4-9	7.34±1.09
Motor educability		
• Low		
FMS pre-test	6-8	6.66±0.57
FMS post-test	4-8	6.97±0.81
• High		
FMS pre-test	6.5-8	7.12±0.44
FMS post-test	7-9	8.11±0.62

The FMS at low motor educability and 8 years old was about the same on average between the FMS pre-test and post-test of 6.81 and 7.78, respectively. However, the average rise from the FMS pre-test (6.87) to the FMS post-test (7.69) was higher in the FMS at low motor educability and 9 years old. Other outcomes generated by FMS at high motor educability and 8 years old were nearly same on average from the FMS pre-test (6.94) to the FMS post-test (7.31). On the other hand, the average FMS score at high motor educability and 9 years old increased from the FMS pre-test (6.94) to the FMS post-test (7.37). The minimum value for the FMS post-test at high motor educability and age 8 was 4, which is considered low, while the maximum value for the FMS post-test at low/high motor educability and age 9 was 9, which is regarded as extremely high (Table 3).

It was shown an average change in the FMS from the pre-test (6.59) to the post-test (7.31) for the low motor educability and PBL model of games without tools. Similar to this, there was an average increase in the FMS from the pre-test (7.09) to the post-test (7.43) for low motor educability and the PBL model of games with tools. Without virtually the same average from the pre-test (6.72) to the post-test (6.62), the FMS delivered the same findings on the high motor educability and PBL models. The FMS acquired using nearly identical tools on the high motor educability and PBL models of the game ranged from a pre-test average of 7.16 to a post-test average of 8.06. The FMS post-test for the high motor educability and PBL models when using tools had a minimum value of 4, which is regarded as low, while the FMS post-test for the low/high motor educability and the PBL model when using both tools and without tools had a maximum value of 9, which is regarded as very high (Table 3).

Table 3 compares the PBL game model with the FMS at the age of 8 years, with approximately identical means from the FMS pre-test of 6.59 through the FMS post-test of 6.97. A similar comparison was made between the FMS achieved at the age of 8 years and the PBL model of games without tools, with the FMS pre-test of 6.72 and the FMS post-test of 6.97. When students aged 9 were tested using the FMS, different results were obtained, and the PBL model of tool-based games saw an average increase from the FMS pre-test of 7.156 to the FMS post-test of 8.125. The average rise from the pre-test (7.09) to the post-test (8.09) was seen in the FMS obtained at the age of 9 years, as well as the PBL model without tools. The FMS post-test at age 8 and the PBL Model of games with tools had a minimum value of 4, which is regarded as low, while the FMS post-test at age 9 and the PBL model of games with tools and without tools had a maximum value of 9, which is regarded as extremely high (Table 3).

Table 3) Mean scores of FMS based on motor educability and age interaction, motor educability interaction and PBL models, age interaction and the PBL model in pre-test (n=16) and post-test (n=16)

Interactions			Min-Max	Mean±SD
Motor educability & Age				
• Low	• 8 years	FMS pre-test	6-8	6.81±0.57
		FMS post-test	7-9	7.78±0.60
	• 9 years	FMS pre-test	6-7.5	6.87±0.53
		FMS post-test	7-9	7.69±0.75
• High	• 8 years	FMS pre-test	6-8	6.94±0.60
		FMS post-test	4-9	7.31±1.29
	• 9 years	FMS pre-test	6-8	6.94±0.57
		FMS post-test	6-9	7.37±0.88
Motor educability & PBL model				
• Low	• Without tools	FMS pre-test	6-8	6.59±0.55
		FMS post-test	7-8	7.31±0.44
	• With tools	FMS pre-test	6.5-8	7.09±0.42
		FMS post-test	7-9	7.43±0.60
• High	• Without tools	FMS pre-test	6-8	6.72±0.60
		FMS post-test	4-8	6.62±0.96
	• With tools	FMS pre-test	6.5-8	7.16±0.47
		FMS post-test	7-9	8.06±0.65
Age & PBL model				
• 8 years	• Without tools	FMS pre-test	6-8	6.59±0.52
		FMS post-test	4-8	6.97±1.07
	• With tools	FMS pre-test	6-8	6.72±0.63
		FMS post-test	6-8	6.97±0.46
• 9 years	• Without tools	FMS pre-test	6.5-8	7.16±0.51
		FMS post-test	7-9	8.12±0.53
	• With tools	FMS pre-test	6.5-7.5	7.09±0.37
		FMS post-test	7-9	8.09±0.71

Discussion

The purpose of this study was to examine the effectiveness of the project-based learning model, age, and motor educability on 8-9-year-old students.

The attitudes, knowledge, and abilities that students have learned through project-based learning must be thoroughly assessed. A project appraisal is an activity that evaluates a task that has a deadline or must be finished in a specific amount of time. The PBL model is divided into two categories in this study, namely games with media and without media, which can boost student creativity in learning the PBL model, where the pre-test

[DOI: 10.58209/hehp.11.1.125]

and post-test scores rise. According to the Buck Institute for Education (BIE) [18], learning that engages students in learning activities that entail problem-solving as well as opportunities for them to further express their creativity would improve their learning outcomes and creativity. This game's PBL learning paradigm is excellent for facilitating student-focused learning.

Between the ages of 8 and 9, the average score on the Fundamental Motor Skill Test (FMS), which was based on the findings of the pre-test and post-test, was 7. According to various research, ball speed created by parents who are adults, is similar to ball speeds produced by students aged 8 to 9 years [19]. The average speed of men is 54.4 feet per second (16.6 meters per second), while that of women is 39.1 feet per second (11.9 meters per second). It can be said that students between the ages of 8 and 9 have the same movement capacities in terms of their physical development, meaning that there is no age difference between the two groups in terms of learning how to move.

The ability to pick up new movements quickly is referred to as motor educability. The ability to comprehend and master new movements can be assessed using motor educability, which can help with the motion learning process. This skill may have an impact on a person's capacity to learn new motions and adjust to unfamiliar surroundings. Because it might make learning new movements easier for some people, motor educability is a crucial feature that must be taken into account during the motion learning process [20].

According to the study's findings, there are differences between the effects of the PBL model for games with tools and games without tools, as well as for high motor educability and low motor educability levels, on the growth of the FMS post-test. Additionally, there is an interaction between the PBL model and the motor educability level on the rise in the FMS post-test, which means that the two factors have an impact on each other's effects on the FMS rise after students enroll in the learning program. The P-value for the PBL model variables was 0.0001, for the motor educability model variables was 0.031, and for the PBL model and motor educability interactions was 0.001. The PBL model and the students' motor educability level have an impact on the growth of FMS once students enroll in the learning program [21]. This research supports their findings. The use of FMS with preschoolers can help them develop their basic motor skills and lower their risk of injury [22]. In addition to physical exercise, other factors like heredity, nutrition, and training all have an impact on a person's motor abilities [23].

Students can achieve their potential by concentrating on developing their motor abilities and motor education without sacrificing crucial fundamental movement skills [24]. Sports management can assist students in project-based learning in understanding how sports can be managed efficiently and developing important skills in sports management, including planning, organizing, coordinating, and supervising sporting events [25]. In this study, students worked on project-based activities where the project was differentiated from games using tools and without tools, and they were indirectly managed so that they could progress systematically and take turns.

Moreover, this study revealed gender-specific patterns in how students interacted with one another when learning FMS, with girls participating cooperatively and lovingly and boys interacting in a competitive and personalized way. Future research should focus on examining the instructional and social components of motor skill programs and developing pedagogical techniques that would lessen variations in FMS performance between boys and girls in light of the sex differences found in the current study.

This study's translational value, which involved the large-scale implementation of a learning model of project-based learning, age, and motor educability intervention, is one of its strongest points. In particular, if pupils have high motor educability, it is recommended to use game learning programs with media to strengthen their core motor abilities. This program has proven to be more effective than traditional instruction. It is particularly remarkable that, with the help of available resources, this curriculum might be successfully implemented in a wide range of community contexts (such as sports clubs, schools, and student care facilities) throughout a sizable geographic area.

The study was limited by the absence of a true experimental design because the intervention was provided to kids by local governments and sports organizations, while the control group was drawn from schools. Notwithstanding this constraint, the control group of kids represented the population as the schools were chosen fairly, and the baseline test results between the intervention and control groups were comparable. The lack of fidelity metrics for the program implementation was another study's shortcoming. It was not possible to evaluate how the various instructors used the material. The program provided teachers with training and a teacher manual filled with a variety of activities for each skill theme, but they were free to choose the topics for each lesson. Notwithstanding these drawbacks, the curriculum appears to be quite strong, as evidenced to have had a favorable effect on students' development of their core motor abilities, establishing the ecological validity of this program.

According to the finding of this study, it is advised to use media-rich game-learning programs for primary school pupils, especially for those with high motor educability, to help them develop their fundamental motor skills. This program is more successful than traditional classroom instruction. To provide appropriate learning programs, sports teachers must consider the age group and level of motor educability of their pupils. To examine suitable model strategies that would address disparities in FMS between boys and girls and to assess the long-term impact of community-based therapies, more study is required.

Conclusion

The PBL model of games with tools has a stronger impact on elementary school kids' Fundamental Motor

[DOI: 10.58209/hehp.11.1.125]

Skills than games without tools, but there is no age difference in the effect. The fundamental motor skills of primary school pupils are more influenced by low motor educable than by high motor educable, but there is no interaction between low and high motor educable at the ages of 8 and 9. However, the PBL model of games with tools and games without tools with low and high motor educability interacts with the fundamental motor skills of primary school pupils.

Acknowledgements: We gratefully thank all respondent.

Ethical Permission: The Research Ethics Committee approved this study. All respondents were informed about participating in the survey and gave written informed consent for the study.

Conflict of Interests: The authors declare that they have no competition.

Authors' Contribution: Aliriad H (First Author), Introduction Writer/Main Researcher/Discussion Writer (25%); Soegiyanto S (Second Author), Introduction Writer/Discussion Writer (25%); Hari Setijono H (Third Author), Introduction Writer /Methodologist (25%); Sulaiman S (Fourth Author), Introduction Writer/Discussion Writer (25%)

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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[DOI: 10.58209/hehp.11.1.125]