

Development of gross motor skills and nutrition literacy among inclusive junior high school students

Ngatman^{1ACE}, Sugiyanto^{2ABE}, Nevitaningrum^{3ACD}, Dalu Danangjaya^{1ABC},
Muhamad Nanang Solikhin^{4BDE}

¹ Department of Physical Education, Faculty of Sports Science and Health, Yogyakarta State University, Indonesia

² Department of Sport Science, Faculty of Sports, Sebelas Maret University, Indonesia

³ Department of Physical Education, Faculty of Teacher Training and Education, Siliwangi University, Indonesia

⁴ Department of Traditional Indonesian Medicine, Faculty of Sports Science and Health, Yogyakarta State University, Indonesia

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Abstract

Background and Study Aim Slow learners in inclusive junior high schools often face difficulties in developing gross motor skills and possess limited nutritional literacy. Both aspects are essential for fostering independence in daily functioning and promoting a healthy lifestyle. This study aimed to evaluate the effectiveness of active physical education-based nutrition learning in improving gross motor skills and nutritional literacy among slow learners.

Material and Methods This quasi-experimental study involved 40 slow learners from an inclusive junior high school. Participants were assigned to two balanced groups. The experimental group (n = 20; 10 females, 10 males) received active physical education-based nutrition learning. The control group (n = 20; 10 females, 10 males) received conventional instruction without treatment. Instruments included the Test of Gross Motor Development-2 (TGMD-2) to assess gross motor skills and a multiple-choice test to measure nutritional literacy. The prerequisite analyses included the Shapiro-Wilk test (normality), Levene's test (homogeneity of variance), and Box's M test (homogeneity of covariance). The hypotheses were tested using MANCOVA.

Results The MANCOVA results showed a significant treatment effect on both gross motor skills and nutritional literacy, with substantial effect sizes (partial $\eta^2 = 0.956$ for TGMD-2 and 0.903 for nutritional literacy). The pre-test covariate for TGMD-2 significantly influenced motor skills ($F = 59.23$; $p < 0.001$), while the pre-test for nutritional literacy was not significant.

Conclusions Active physical education-based nutrition learning effectively improves both gross motor skills and nutritional literacy among slow learners in junior high school. This approach is recommended as an integrative strategy in inclusive education to support physical and cognitive development.

Keywords: gross motor skills, nutrition literacy, active physical education, slow learners, inclusive education.

Introduction

Inclusive education aims to ensure that every student, regardless of cognitive or physical ability, receives equal opportunities to learn, develop, and participate in physical and academic activities. Among students with learning difficulties, slow learners often encounter complex challenges that affect both their motor and cognitive development. Limited gross motor skills may hinder their ability to engage in physical education effectively, while low nutritional literacy can negatively influence their daily habits and overall health. These interrelated difficulties highlight the need for educational approaches that address physical competence and nutrition knowledge simultaneously within inclusive school environments.

Individuals with slower learning capabilities have distinct needs in the educational process, especially regarding cognitive and motor skills. They face challenges in understanding and remembering information and require additional time to master concepts compared to their peers [1]. In addition, motor skills also present difficulties, as delays in motor development affect their participation in physical activities and physical education [2]. If opportunities for motor development are not maximized, the consequences extend beyond physical delays, influencing emotional, social, and cognitive growth, which are crucial for pupils' overall development [3]. Therefore, educators play a key role in recognizing and addressing the needs of slow learners. By implementing an Individualized Education Plan (IEP), teachers can adapt instructional strategies to better meet the specific requirements of individual pupils [4].

Physical education in inclusive schools plays

a central role in cultivating healthy and active lifestyles. Integrating nutritional education with physical activities helps children improve their motor abilities and adopt healthier habits that promote both physical and cognitive growth. A comprehensive review and meta-analysis conducted in the United States indicated that collaboration between nutritionists and sports professionals is essential for encouraging healthy and active lifestyles among students [5]. Similarly, another study showed that interdisciplinary educational interventions significantly improved students' understanding of diet, nutrition, and physical activity, thereby confirming the effectiveness of integrating nutrition and health education in fostering student development, including within inclusive settings [6].

The 2018 Riskesdas report revealed alarming trends in adolescent dietary habits in Indonesia: 62.2% did not have breakfast, 95.5% consumed insufficient amounts of fruits and vegetables, and 75.7% frequently ate spicy foods. Moreover, 40.7% reported regular intake of fried, cholesterol-rich, and fatty foods, 26.2% consumed excessive salty foods, and 53.1% consumed excessive sugary foods, while 93.6% consumed inadequate fruits and vegetables [7]. These findings align with global data showing that approximately 390 million children and adolescents aged 5–19 years are overweight, while 160 million are classified as obese worldwide. Childhood obesity poses serious concerns for physical health and overall quality of life, as it is associated with increased morbidity and mortality [5]. Such statistics emphasize adolescents' low nutritional literacy and poor awareness of healthy dietary habits. This situation is further aggravated by low levels of physical activity. A systematic review found that children, regardless of gender, preferred sedentary activities such as video games and television over outdoor physical activities during leisure time, indicating a global shift toward sedentary lifestyles [8]. This trend is also evident among slow learners, who face the combined challenges of limited nutritional literacy and weak gross motor skills, placing them at greater risk of unhealthy lifestyle patterns that further impede motor and cognitive development.

In response, research suggests that slow learners are more engaged when learning activities incorporate games, as these foster motivation and active participation [9]. Game-based activities help develop fundamental motor skills such as running, jumping, and kicking a ball [10]. Consequently, physical education offers an effective approach, as game-based learning enables slow learners to experience concepts directly while simultaneously supporting both motor and cognitive development [11,12].

Other studies reinforce the importance of

integrating nutrition and physical activity. Mafugu's research showed that students with slow learning conditions tend to have low nutritional literacy, which contributes to poor gross motor and overall physical development [13]. Without sufficient knowledge, students are less able to make healthy food choices, leading to unhealthy eating patterns [13]. Healthy lifestyle habits are therefore fundamental to supporting students' physical and cognitive growth [14,15]. Conversely, insufficient physical activity contributes to poor gross motor development, as limited exposure to movement hinders the acquisition of essential motor skills [16].

In practice, nutrition is often taught separately from physical education, preventing students from connecting theoretical knowledge with practical application. However, integrating nutrition into physical education through structured play has the potential to enhance understanding while simultaneously developing gross motor skills. Implementation challenges remain, as many teachers lack adequate training, knowledge of activity design, and access to sports equipment and facilities [5]. This issue aligns with a study showing that students understand and apply knowledge more effectively when engaged in interactive and practical learning experiences. Therefore, it is essential to use diverse, engaging, and experiential teaching methods that integrate nutrition education with physical activities to increase student interest and participation [17].

Analysis of research findings has shown that the integration of nutrition education with physical activity contributes to better motor development, healthier lifestyle choices, and improved cognitive outcomes among students. Researchers emphasize that combining theoretical and practical learning within inclusive educational environments helps slow learners overcome limitations in both motor and nutritional domains. However, challenges related to limited teacher preparation, insufficient adaptation of learning materials, and inadequate facilities continue to hinder the full implementation of such integrative approaches. This context underscores the importance of exploring effective models of active, nutrition-based physical education that can address the complex developmental needs of slow learners in inclusive settings.

Despite this evidence, challenges persist in inclusive schools. Slow learners often have a limited understanding of the importance of healthy eating and display weak gross motor skills. These limitations are compounded by a lack of variety in teaching methods. Nutrition is frequently taught through abstract student worksheets (*Lembar Kerja Siswa*, or student activity sheets) without real-world application, which reduces nutritional literacy. Many students also show little interest in theoretical classroom learning, preferring hands-on activities.

Unhealthy lifestyle habits, such as frequent fast-food consumption and low levels of physical activity, further worsen motor skill deficiencies, leading to negative effects on both physical and cognitive development.

Based on the preceding analysis, it is essential to develop an innovative learning approach that integrates nutrition education and physical activity within a unified framework. Such an approach would enable slow learners to not only understand nutritional concepts theoretically but also apply them through meaningful physical activities. The active physical education-based nutrition learning model is considered highly relevant, as it promotes experiential learning that simultaneously stimulates both cognitive and motor development. Although previous studies have examined nutrition education and physical activity, most have addressed these areas separately. Comprehensive approaches that combine both aspects, particularly in the context of inclusive schools in Indonesia, remain scarce.

Therefore, this study introduces a contextual and interactive active physical education-based nutrition learning intervention designed to address the limitations identified in prior research. This approach integrates nutrition education and physical education within a single experiential learning framework aimed at enhancing gross motor skills and nutritional literacy among slow learners in inclusive junior high schools.

Materials and Methods

Participants

The participants were 8th-grade students from an inclusive junior high school in Yogyakarta, Indonesia, aged 13–15 years. A purposive sampling technique was applied with the following inclusion criteria: (1) students identified as slow learners based on psychological assessment or diagnosis, (2) aged 13–15 years, (3) non-athletes, (4) physically healthy and able to participate in light-to-moderate physical activities (verified by a doctor’s certificate), and (5) obtained parental or guardian consent. Exclusion criteria included: (1) students with severe physical disabilities, (2) students with chronic illnesses, and (3) students who participated in less than 80% of the program.

A total of 50 students were screened, and 40 met the eligibility criteria. The eligible participants were proportionally assigned to two groups: the experimental group (n = 20; 10 females, 10 males), which received the Active Physical Education–Based Nutrition Learning intervention, and the control group (n = 20; 10 females, 10 males), which received conventional instruction without the intervention.

Ethical clearance and an official university approval letter were obtained (No. B/679/UN34.16/PT.06.01/2025). Written parental or guardian consent was also secured before participation.

Research Design

This study employed a quasi-experimental design with a pretest–posttest control group, as illustrated in Figure 1. The experimental group received the Active Physical Education–Based Nutrition Learning intervention for 16 weeks, while

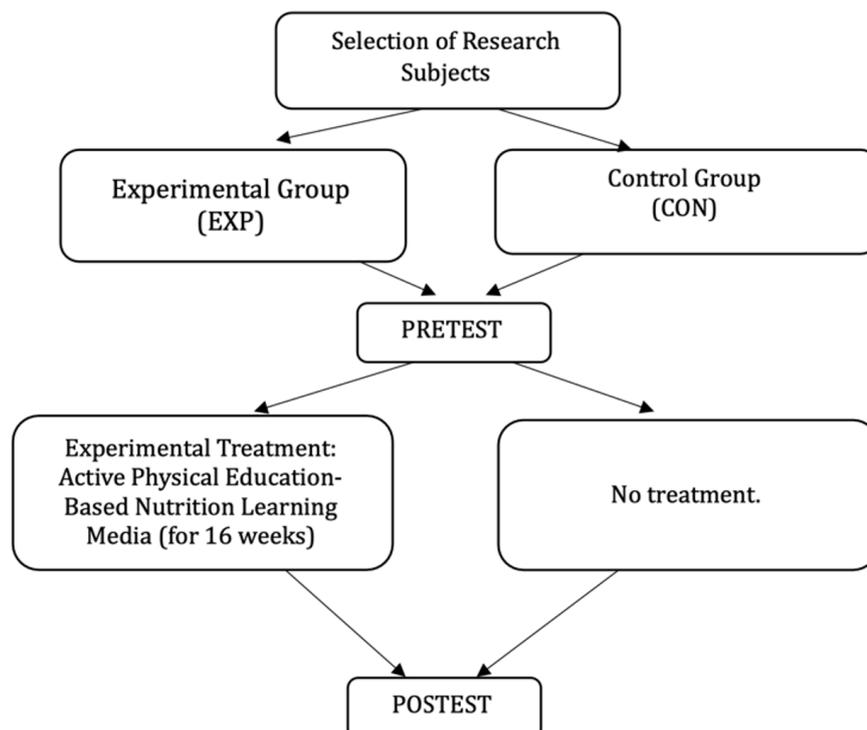


Figure 1. Research flow.

the control group received no treatment.

Procedure

Experimental Group (EXP)

The experimental group participated in the Active Physical Education–Based Nutrition Learning program, which consisted of 12 sessions. Each session lasted 3 × 40 minutes (120 minutes), following the inclusive school physical education schedule, and included three main phases: warm-up (10–15 minutes), main activity (80–90 minutes), and cool-down (10–15 minutes). The exercise intensity was maintained at a moderate level according to the Borg Rating of Perceived Exertion (RPE) scale (11–13), indicating that students perceived the activities as “somewhat hard” but still manageable. This intensity was chosen to ensure safe, inclusive, and meaningful participation, particularly for slow learners. The Borg RPE scale has been widely used in studies involving children’s physical activity, including research on participants aged 11–14 years, which confirmed that they could reliably regulate their physical effort corresponding to RPE levels 9, 13, and 17 [18]. Each session consisted of 3–5 repetitions of movements, interspersed with 2-minute rest intervals between sets. Instructions were delivered briefly and clearly, supported by visual media such as food images, color symbols, and nutrition-category cards to facilitate students’ understanding.

The intervention consisted of structured physical activities that integrated nutrition education through weekly games and movement-based sessions, as outlined below:

1. Week 1 (Orientation): Introduction to program objectives, procedures, and benefits, followed by pretests (TGMD-2 and nutritional literacy).
2. Weeks 2–3 (Understanding nutrients and their types): Nutrition Relay — a relay race in which students categorized food cards into nutrient groups (carbohydrates, protein, fat, vitamins, minerals, water).
3. Weeks 4–5 (Nutritional functions): Nutritional Ball Throw — students threw food-labeled balls into baskets representing nutritional functions (energy source, body-building, and protective materials).
4. Weeks 6–7 (Grouping foods by nutrients): Food Basket Game — an obstacle course combined with the categorization of food-labeled balls. Students ran through zigzag obstacles, crawled, jumped, and then threw plastic balls with food pictures into baskets according to their nutritional content.
5. Weeks 8–9 (Linking food to energy needs): Energy Race — students performed movements on two track lines (high energy = 20 m sprint; low energy = leisurely walk or light jumps). After completing the exercise, they attached food

pictures corresponding to the energy lines.

6. Weeks 10–11 (Connecting food with health benefits): Nutrition Strike Ball — students hit or kicked food-labeled balls into health-related categories (e.g., milk → healthy bones; fish → strong muscles; fruit → body resistance; sweet potato → energy).
7. Week 12 (Evaluation): Post-tests (TGMD-2 and nutritional literacy). The experimental group then conducted a program evaluation, discussed challenges and solutions, and received reinforcement on maintaining a balanced diet and regular physical activity.

Learning Program Intervention

The Active Physical Education–Based Nutrition Learning program was developed and validated through an expert evaluation process involving seven specialists. The expert panel included three specialists in teaching materials, three experts in special needs education (slow learners), and one expert in learning media. Each expert independently assessed the program’s content accuracy, instructional clarity, and suitability for slow learners. Their evaluations were used to refine the structure, activities, and visual components of the learning materials.

To enhance the transparency and reproducibility of this study, sample learning materials were developed, including:

- (1) student worksheets containing task instructions and reflection prompts;
- (2) game rules and activity guidelines describing session flow, duration, and objectives;
- (3) visual aids used throughout the intervention sessions.

All these elements were compiled into the Teaching Module “Active Physical Education–Based Nutrition Learning, «which provides a complete description of the instructional design, learning objectives, teaching media, and step-by-step session implementation.

The reliability of the Active Physical Education–Based Nutrition Learning program was assessed using Cronbach’s Alpha coefficients, all of which exceeded the minimum acceptable value of 0.60, confirming the program’s internal consistency and dependability [19,20].

Teaching Module “Active Physical Education–Based Nutrition Learning”

Learning Achievements: Students are able to demonstrate their ability to perform sports movements and develop healthy lifestyle behavior patterns through fun and meaningful physical activities.

Learning Objectives:

1. To understand the concept of nutrition and the function of nutrients through active physical activities.

2. To categorize foods based on their nutritional content.
 3. To relate different types of food to energy needs and health benefits.
 4. To demonstrate improvement in gross motor skills through physical activity-based games and nutrition education.
- Subject: Physical Education.
Curriculum: Independent Curriculum.
Class: Phase D – Junior High School (Grade VII).
Time Allocation: 12 meetings × 120 minutes (3 × 40 minutes).

A. Material Description

The learning materials integrate physical education and nutrition education through activity-based games designed to strengthen understanding of nutrition concepts (nutrient types, functions, energy, and health benefits) and to develop basic motor skills (locomotor, non-locomotor, and manipulative).

B. Teaching Media

- Food picture cards (carbohydrates, proteins, fats, vitamins, minerals, water)
- Food-labeled plastic balls
- Baskets or basketball rings labeled with nutritional functions
- Energy images (high and low)
- Whistles, ropes, cones, a scoreboard, and reflection papers

C. Learning Steps

1.Meeting 1: Program Orientation and Pretest

Objective: To introduce the program, explain the objectives and benefits of the activities, and conduct pretests on motor skills (TGMD-2) and nutritional literacy.

Time: 120 minutes

Main Activity (80–90 minutes): Explanation of objectives and procedures, completion of the nutritional literacy instrument, and implementation of the TGMD-2 test (locomotor and object control).

Cool-down (10–15 minutes): Light muscle relaxation and brief reflection on the importance of maintaining an active and nutritionally balanced lifestyle.

2.Sessions 2–3: “Nutrition Relay” Game
Objective: To identify groups of nutrients (carbohydrates, proteins, fats, vitamins, minerals, water).

Equipment: Food picture cards, colored nutrient category boards, and track cones.

Teaching Media: The visual teaching media used in this activity are shown in Figure 2.

Rules (Summary):

- Each team lines up at the starting line.
- The teacher announces a nutrient category (e.g., carbohydrates).
- One student runs to pick the corresponding food card and attaches it to the correct category board.
- The fastest and most accurate team earns points.
- Warm-up (10–15 minutes): Light jogging around the field and dynamic stretching.
- Main Activity (80–90 minutes): Implementation of the “Nutrition Relay” game according to the rules, repeated for 3 sets × 5 minutes with a 2-minute rest between sets, varying the nutrient categories in each round.
- Cool-down (10–15 minutes): Easy walking and static stretching while reviewing examples of nutritious foods.

3. Sessions 4–5: “Nutritional Ball Throw” Game

Objective: To relate food types to their nutritional functions (energy, building, and protection).

Equipment: Food picture balls and baskets labeled with nutritional functions.

Media: The visual teaching media used in this activity are shown in Figure 3.

Rules (Summary):

- Students throw food picture balls into baskets corresponding to the correct nutritional function.
- Each correct throw earns one point.
- The team with the highest score wins.
- Warm-up (10–15 minutes): Throw-and-catch pairing and arm stretching exercises.
- Main Activity (80–90 minutes): Implementation of the “Nutritional Ball Throw” game in group

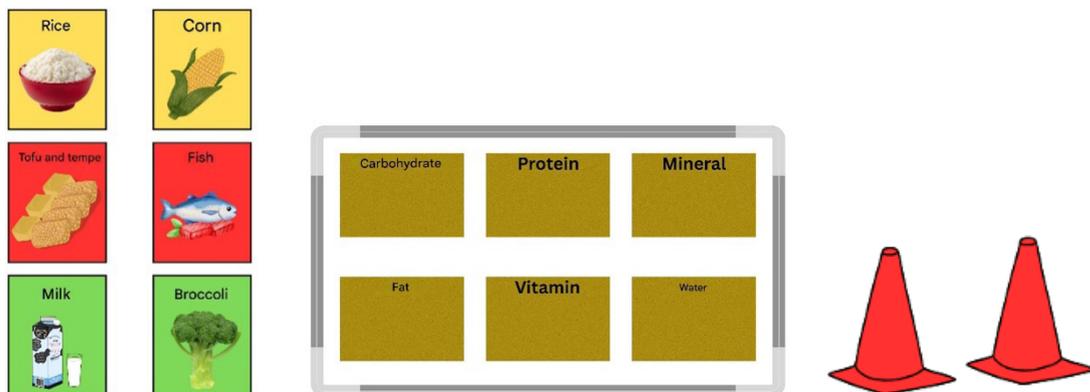


Figure 2. Visual teaching media used in the “Nutrition Relay” game.

format, with variations in distance and ball size. The game is repeated for 3 sets × 5 minutes, with a 2-minute rest between sets.

- Cool-down (10–15 minutes): Breathing exercises and discussion about the functions of food in the body.

4. Sessions 6–7: “Food Basket Game”

Purpose: To develop basic movement skills and reinforce understanding of nutrient groupings.

Equipment: Food balls, nutrition baskets, and obstacles (cones, ropes, low bars).

Media: The visual teaching media used in this activity are shown in Figure 4.

Rules (Summary):

- Students complete the obstacle track (running, jumping, crawling).
- They collect food balls and place them in baskets according to the correct nutrient group.
- Scores are based on speed and accuracy.
- Warm-up (10–15 minutes): Zigzag running, jumping on the spot, and dynamic stretching.
- Main Activity (80–90 minutes): Implementation of the “Food Basket Game” with obstacle variations. The game is repeated for 3 sets × 5 minutes with a

2-minute rest between sets.

- Cool-down (10–15 minutes): Slow walking and full-body stretching.

5. Sessions 8–9: “Energy Race” Game

Objective: To understand the concept of food energy and its relationship to physical activity.

Equipment: Food images with energy values, and two marked paths — one for “high energy” and one for “low energy.”

Media: The visual teaching media used in this activity are shown in Figure 5.

Rules (Summary):

- Students select a food picture.
- If the food represents high energy → they perform a 20 m sprint; if it represents low energy → they walk leisurely.
- After completing the movement, students attach the food image to the corresponding energy path.
- Warm-up (10–15 minutes): Light jogging and dynamic stretching.
- Main Activity (80–90 minutes): Implementation of the “Energy Race” game with rotation of student roles. The game is repeated for 3 sets × 5 minutes, with a 2-minute rest between sets.



Figure 3. Visual teaching media used in the “Nutritional Ball Throw” game.



Figure 4. Visual teaching media used in the “Food Basket Game.”

- Cool-down (10–15 minutes): Leisurly walking, relaxation, and discussion about balanced energy in daily nutrition.

6. Sessions 10–11: “Nutrition Strike Ball” Game

Objective: To link food items with their corresponding health benefits.

Equipment: Food picture balls and a target board with health benefit categories.

Media: The visual teaching media used in this activity are shown in Figure 6.

Rules (Summary):

- Students kick or hit food picture balls toward target areas that correspond to the appropriate health benefit (e.g., milk → healthy bones).
- Scores are based on accuracy in direction and benefit classification.
- Warm-up (10–15 minutes): Light kicking and punching movements, followed by dynamic stretching.
- Main Activity (80–90 minutes): Implementation of the “Nutrition Strike Ball” game in groups. The game is repeated for 3 sets × 5 minutes with a 2-minute rest break between sets.
- Cool-down (10–15 minutes): Stretching of leg and arm muscles and reflection on the health benefits of food.

7. Meeting 12: Posttest and Reflection

Objective: To assess improvements in motor skills (TGMD-2) and nutritional literacy, and to reinforce students’ commitment to a healthy lifestyle.

- Warm-up (10–15 minutes): Light exercise and joint stretching performed together.
- Main Activity (80–90 minutes):
 - Administration of posttests on gross motor skills (TGMD-2) and nutritional literacy.
 - Discussion of learning outcomes and evaluation of students’ experiences during the program.
- Cool-down (10–15 minutes): Relaxation and breathing exercises, followed by affirmation of commitment to maintaining an active and nutritionally balanced lifestyle.

D. Evaluation

The evaluation covered two main aspects:

1. Cognitive: Nutritional literacy test (20 multiple-choice questions).
2. Psychomotor: Assessment of gross motor skills using the Test of Gross Motor Development–2 (TGMD-2).

E. Attachment

1. Student Worksheets (LKPD)
2. Active Physical Education–Based Nutrition Learning
3. Phase: D (Grade VII)
4. Time Allocation: 12 meetings (3 × 40 minutes per meeting)

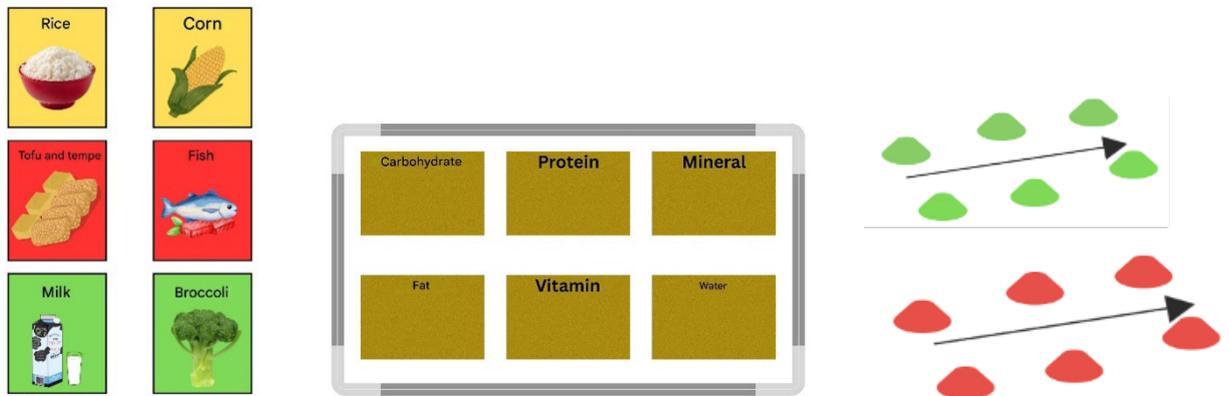


Figure 5. Visual teaching media used in the “Energy Race” game.

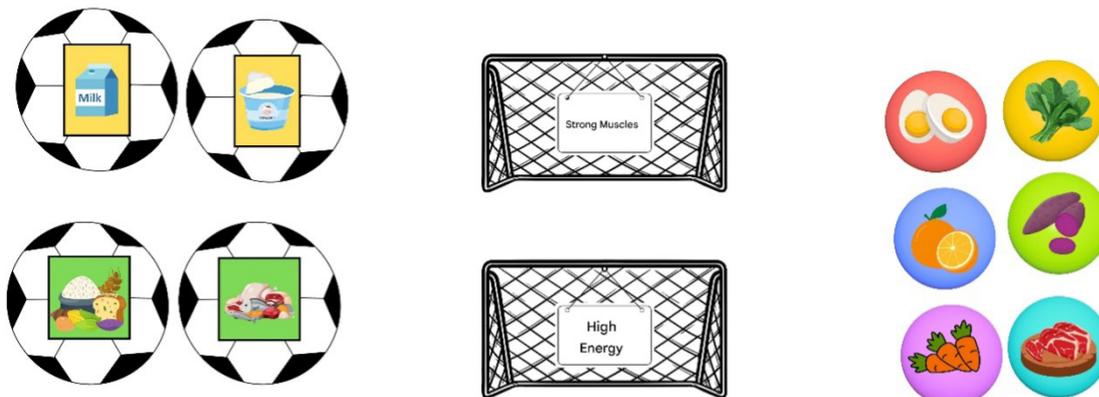


Figure 6. Visual teaching media used in the “Nutrition Strike Ball” game.

General Instructions

Part A: Game Activities and Self-Observation

The student worksheet for recording movements, recognized foods, and perceived benefits during each game activity is presented in Table 1.

Part B: Self-Reflection

Students reflected on their understanding of nutrition concepts and their participation in activities by answering the following questions:

- Give two examples of foods that belong to the carbohydrate group.
- What are the benefits of protein for your body?
- When does your body need high energy?
- Name two healthy eating habits you want to maintain after participating in this activity.
- Rate your level of activity during this session by ticking (✓).

The categories used for student self-assessment are presented in Table 2.

Facilitators, Training, and Fidelity Monitoring

All activities in the experimental group were facilitated by Physical Education (PE) teachers who held at least a bachelor's degree in Physical Education and were either certified civil servants (ASN) or had a minimum of two years of teaching experience in inclusive schools. These criteria ensured that facilitators possessed sufficient pedagogical competence and experience working with students with special educational needs.

Before the intervention, all PE teachers participated in a two-week intensive training program to ensure instructional consistency and adaptive teaching competence when working with slow learners. The training included workshops, microteaching sessions, and guided simulations

focusing on three core competencies:

- (1) delivering adaptive verbal and visual instructions;
- (2) using visual learning media such as food cards, color symbols, and nutrition-category boards;
- (3) applying a structured fidelity checklist to monitor adherence to the intervention protocol.

During the intervention, weekly fidelity monitoring was conducted by the research team using a standardized observation sheet that assessed session duration, clarity of instruction, activity flow, and student engagement. This systematic monitoring ensured consistent implementation of all sessions according to the intended design of the intervention.

Control Group (CON)

The control group (CON) participated in traditional nutrition learning sessions integrated within conventional physical education classes. The program was conducted over 12 sessions of 120 minutes each (3 × 40 minutes), consistent with the schedule of the experimental group. Each session included a brief lecture and a question-answer segment delivered by the PE teacher, focusing on the same nutrition topics as those taught in the experimental group (e.g., types of nutrients, their functions, and healthy food choices). No physical activity-based learning methods or interactive games were applied.

The instructional format emphasized teacher explanation, note-taking, and verbal recall exercises, representing a passive learning condition. The exercise intensity during the physical activity components was maintained at a moderate level (Borg scale 11–13) to ensure comparable physical engagement across groups. During the first and final

Table 1. Student worksheet for game activities and self-observation

No.	Game Name	Type of Movement Performed	Examples of Foods Recognized	Benefits of Activities for the Body
1	Nutrition Relay	Sprinting, grabbing, sticking	Rice, bread, tempeh	Improves speed and nutritional knowledge
2	Nutritional Ball Throw	.....	.....	.....
3	Food Basket Game	.....	.....	.....
4	Energy Race	.....	.....	.....
5	Nutrition Strike Ball	.....	.....	.....

Table 2. Student self-assessment of activity participation level

Category	Description	Choice
Active	Participated fully, showed enthusiasm, and cooperated well with friends	<input type="checkbox"/>
Moderately Active	Participated but occasionally lacked focus	<input type="checkbox"/>
Needs Guidance	Often passive and required teacher encouragement	<input type="checkbox"/>

weeks, participants completed pretest and posttest assessments (TGMD-2 and nutritional literacy tests) to allow for equitable comparison. After the intervention, the control group was offered the opportunity to participate in the Active Physical Education–Based Nutrition Learning program as a delayed intervention, ensuring ethical equity in participation.

Instruments

Nutrition Literacy Test

Nutritional literacy was assessed using a 20-item multiple-choice test covering five key indicators.

The indicators and corresponding item numbers were as follows:

1. Understanding nutrition concepts – items 1–4.
2. Identifying nutrient functions – items 5–8.
3. Grouping foods based on nutrient content – items 9–12.
4. Linking food to energy needs – items 13–16.
5. Linking food to health benefits – items 17–20.

After developing the multiple-choice instrument, content validation and reliability testing were carried out. The validation was performed by seven experts using the Aiken’s V method, and the reliability was tested using Cronbach’s Alpha. The results showed satisfactory validity ($V = 0.78$) and high internal consistency ($\alpha = 0.833$ for 12 items), confirming that the instrument was appropriate for assessing nutritional literacy among inclusive junior high school students.

Gross Motor Skills Test

Gross motor skills were assessed using the Test of Gross Motor Development, Second Edition (TGMD-2). This standardized instrument is designed to measure fundamental movement skills in children aged 3 to 10 years [21].

The justification for using this test in the present study is based on recommendations found in previous research [22, 23], which indicate that the TGMD-2 is appropriate for individuals with special needs or developmental delays who may be older than 10 years. The gross motor profiles of students with learning difficulties are often comparable to those of younger children, particularly in locomotor skills (running, leaping, hopping) and object control skills (throwing, catching, kicking) [21, 22, 23]. The TGMD-2 demonstrates strong psychometric properties and has been widely applied in studies involving children with various motor or developmental challenges [22].

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics for Windows, version 30 (IBM Corp., Armonk, NY, USA). The Shapiro–Wilk test was applied to assess data normality, as the sample size was fewer than 20 participants [23]. The Levene’s test was used to examine the homogeneity

of variance, while Box’s M test was employed to verify the homogeneity of covariance matrices. Normalized gain (N-gain) scores were calculated and classified according to Hake’s criteria to determine the improvement in gross motor skills and nutritional literacy. Multivariate Analysis of Covariance (MANCOVA) was used to test the study hypotheses, with pretest scores included as covariates. This analytical approach was chosen because the study involved two related dependent variables and required controlling for baseline differences between groups. MANCOVA was considered appropriate as it allows for simultaneous testing of treatment effects, increases statistical power, and provides more reliable results than univariate analyses [24].

Results

The program’s validity and reliability were analyzed using the Content Validity Index (CVI) and Cronbach’s Alpha. The combined results of the media and material expert assessments are presented in Table 3.

Based on the validation results summarized in Table 3, all evaluated aspects met the very feasible criteria. For the media expert assessment, the aspects of visual clarity and movement representation, media safety and suitability, and ease of use were all rated very feasible. Likewise, the material expert evaluation showed that integration of nutrition content with physical activity, quality of learning materials, and usefulness were each categorized as very feasible. Therefore, the Active Physical Education–Based Nutrition Learning program was determined to be highly feasible for implementation in inclusive school settings.

The reliability of the Active Physical Education–Based Nutrition Learning program was evaluated using Cronbach’s Alpha to determine the internal consistency of each assessment aspect. The summary of the reliability test results is presented in Table 4.

As shown in Table 4, all Cronbach’s Alpha coefficients exceeded the minimum threshold of 0.60, indicating high internal consistency and stability of the learning program. According to previous research, coefficients above 0.60 are considered acceptable for reliability [19,20]. Therefore, the Active Physical Education–Based Nutrition Learning program was confirmed to be both valid and reliable for implementation.

The content validation of the nutrition literacy instrument was conducted by seven expert raters using the Aiken’s V coefficient. The evaluation covered twelve rated aspects, focusing on content relevance, clarity, sequencing, and language suitability for inclusive junior high school students. The detailed results of the validation process are presented in Table 5.

Table 3. Expert Validation Results for the Active Physical Education–Based Nutrition Learning Program

No.	Aspects of Assessment	Total Score	Average Score	Percentage (%)	Category
Media Expert Evaluation					
1	Visual Clarity & Movement Representation	161	3.83	95.83	Very Feasible
2	Media Safety and Suitability	196	3.50	87.50	Very Feasible
3	Media Ease of Use	175	3.57	89.29	Very Feasible
Subtotal (Media Experts)			3.63	90.87	Very Feasible
Material Expert Evaluation					
1	Integration of Nutrition Materials with Physical Activity	84	3.50	87.50	Very Feasible
2	Quality of Learning Materials	89	3.59	89.77	Very Feasible
3	Usefulness	82	3.49	86.54	Very Feasible
Subtotal (Material Experts)			3.53	87.94	Very Feasible

Table 4. Reliability Test Results of the Active Physical Education–Based Nutrition Learning Program

No.	Eligibility Aspects	Cronbach’s Alpha	Status
1	Visual Clarity & Movement Representation	0.856	Reliable
2	Media Safety and Suitability	0.808	Reliable
3	Media Ease of Use	0.821	Reliable
4	Integration of Nutrition Materials with Physical Activity	0.838	Reliable
5	Quality of Learning Materials	0.884	Reliable
6	Usefulness	0.871	Reliable

As shown in Table 5, all twelve rated aspects achieved Aiken’s V values exceeding the minimum threshold of 0.74, with an average coefficient of 0.78.

This study generated data that were systematically analyzed using several statistical procedures, including descriptive analysis, assumption testing (normality, homogeneity of variance, and homogeneity of covariance), calculation of normalized gain (N-gain), and the main analysis employing MANCOVA on the variables of gross motor skills and nutritional literacy among slow learners in inclusive junior high schools.

The presentation of results was organized sequentially, beginning with descriptive statistics, followed by assumption testing, effectiveness estimation using N-gain, and concluding with hypothesis testing.

The descriptive findings for both the TGMD-2 (gross motor skills) and Nutrition Literacy tests are presented in Table 6.

According to Table 6, the descriptive findings of the TGMD-2 test indicate that the experimental group achieved a pre-test mean score of 88.80 (range 79–98), showing that their initial gross motor abilities were within this range. After the intervention, the mean score increased markedly to 117.15 (range 111–126), indicating a substantial improvement in fundamental motor skills.

The control group exhibited a pre-test mean score of 88.90 (range 80–95) and a post-test mean of 93.20 (range 84–98), reflecting only a slight improvement. These results suggest that the intervention was effective in enhancing gross motor abilities compared with the untreated group.

Similarly, the descriptive statistics for the Nutrition Literacy test show that the experimental group’s mean score rose from 40.00 (range 30–55) at pre-test to 79.00 (range 70–90) at post-test, indicating a significant improvement in nutrition knowledge. The control group’s mean score increased only slightly, from 43.25 (range 30–55) to

Table 5. Validation of the Nutrition Literacy Question Instrument

No.	Rated Aspect	Σs	V	Description
1	The questions presented cover the concept of nutrition.	21	0.75	Accepted
2	The questions aim to improve the nutritional literacy of inclusive junior high school students.	21	0.75	Accepted
3	The questions are presented sequentially, from easy to difficult.	22	0.79	Accepted
4	The questions cover the concept of nutrition.	24	0.86	Accepted
5	The questions cover the functions of nutrients.	21	0.75	Accepted
6	The questions cover nutritious food groups.	21	0.75	Accepted
7	The questions cover nutritional needs.	22	0.79	Accepted
8	The questions cover the benefits of nutritious foods.	21	0.75	Accepted
9	The questions are neither too easy nor too difficult.	22	0.79	Accepted
10	The questions comply with the curriculum standards for inclusive junior high school students.	16	0.80	Accepted
11	The vocabulary used is appropriate for the students' comprehension level.	22	0.79	Accepted
12	The language used follows PUEBI (The Indonesian Spelling System General Manual).	22	0.79	Accepted
Average		21	0.78	Accepted

Note. V for rater = 7; at a 5% error rate, a minimum value of 0.74 is considered acceptable.

Table 6. Descriptive Results of TGMD-2 and Nutrition Literacy Tests

Test Type	Group	N	Mean	SD	Min	Max
TGMD-2 (Gross Motor Skills)	Pre-Test Experimental	20	88.80	5.207	79	98
	Post-Test Experimental	20	117.15	4.568	111	126
	Pre-Test Control	20	88.90	3.582	80	95
	Post-Test Control	20	93.20	3.708	84	98
Nutrition Literacy	Pre-Test Experimental	20	40.00	6.882	30	55
	Post-Test Experimental	20	79.00	5.282	70	90
	Pre-Test Control	20	43.25	6.742	30	55
	Post-Test Control	20	45.00	6.489	35	55

45.00 (range 35–55), demonstrating that meaningful gains in nutritional literacy occurred primarily in the experimental group following the intervention.

Normality Test Results

The assumption of normality was tested using the Shapiro–Wilk test for both dependent variables – TGMD-2 (gross motor skills) and Nutrition Literacy.

The results demonstrated that all significance values for both the experimental and control groups, in pre-test and post-test conditions, were greater than 0.05, confirming that the data were normally distributed.

The detailed outcomes of the normality test for both variables are presented in Table 7.

As shown in Table 7, all significance values for both TGMD-2 and Nutrition Literacy exceeded 0.05, indicating that the data met the assumption of normality across all groups and testing phases.

Homogeneity of Variance Test Results

The homogeneity of variance assumption was examined using Levene's Test for both dependent

variables – TGMD-2 (gross motor skills) and Nutrition Literacy.

The results confirmed that all significance values exceeded 0.05, indicating that the variance across groups was homogeneous.

The detailed findings of Levene's Test for both variables are presented in Table 8.

As shown in Table 8, both TGMD-2 and Nutrition Literacy variables produced significance values greater than 0.05 (0.166 and 0.480, respectively), confirming that the homogeneity of variance assumption was satisfied for both datasets.

Homogeneity of Covariance Test Results

The homogeneity of covariance was examined using Box's M Test.

The analysis produced a Box's M value of 12.583 with a significance level of 0.082 ($p > 0.05$), indicating that the covariance matrices across groups were homogeneous.

Therefore, the assumption of homogeneity of covariance was satisfied.

N-Gain Results

Table 7. Normality Test Results of TGMD-2 and Nutrition Literacy

Test Type	Group	Sig. (Shapiro-Wilk)	Interpretation
TGMD-2 (Gross Motor Skills)	Pre-Test Experimental	0.948	Normal
	Post-Test Experimental	0.074	Normal
	Pre-Test Control	0.358	Normal
	Post-Test Control	0.102	Normal
Nutrition Literacy	Pre-Test Experimental	0.157	Normal
	Post-Test Experimental	0.128	Normal
	Pre-Test Control	0.380	Normal
	Post-Test Control	0.101	Normal

Table 8. Results of Homogeneity of Variance Test for TGMD-2 and Nutrition Literacy

Test Type	F	df1	df2	Sig.	Interpretation
TGMD-2 (Gross Motor Skills)	1.992	1	38	0.166	Homogeneous variance ($p > 0.05$)
Nutrition Literacy	0.510	1	38	0.480	Homogeneous variance ($p > 0.05$)

Table 9. N-Gain Results for TGMD-2 and Nutrition Literacy

Test Type	Group	Pre	Post	N-Gain	Percentage (%)	Category
TGMD-2 (Gross Motor Skills)	Experimental	88.80	117.15	28.35	72.32	Moderately effective
	Control	88.90	93.20	4.30	10.99	Not effective
Nutrition Literacy	Experimental	40.00	79.00	39.00	65.00	Moderately effective
	Control	43.25	45.00	1.75	3.08	Not effective

The normalized gain (N-Gain) analysis was conducted to measure the relative improvement in both gross motor skills (TGMD-2) and nutrition literacy between the pre-test and post-test phases.

The results showed that the experimental group experienced substantial increases across both variables, while the control group demonstrated minimal changes.

The detailed N-Gain results for both tests are presented in Table 9.

As shown in Table 9, the experimental group achieved markedly higher N-Gain percentages in both TGMD-2 (72.32%) and nutrition literacy (65.00%), indicating a moderate level of effectiveness for the intervention.

In contrast, the control group demonstrated only marginal gains of 10.99% and 3.08%, respectively, classified as not effective.

These findings confirm that the Active Physical Education-Based Nutrition Learning program substantially improved both gross motor skills and nutrition literacy among slow learners compared with conventional instruction.

MANCOVA Hypothesis Testing Results

The MANCOVA analysis was conducted to examine the overall effect of the Active Physical Education-Based Nutrition Learning intervention on the combined dependent variables [gross motor skills (TGMD-2) and nutrition literacy] while controlling for pre-test scores. The multivariate test

results using Pillai's Trace are presented in Table 10.

As shown in Table 10, the MANCOVA results revealed a statistically significant multivariate effect of group on the combined dependent variables ($p < 0.001$), indicating that the intervention had a substantial influence on both outcomes even after controlling for pre-test scores. The analysis also confirmed that only the TGMD covariate was significant, while the nutrition literacy covariate was not. These findings demonstrate that the applied learning intervention effectively improved both gross motor skills and nutrition literacy among slow learners.

The univariate results were analyzed to identify the specific effects of the intervention on each dependent variable [gross motor skills (Post-TGMD) and nutrition literacy (Post-Literacy)] after controlling for the pre-test covariates. The results of the univariate MANCOVA tests are presented in Table 11.

As shown in Table 11, both dependent variables — gross motor skills and nutrition literacy — demonstrated statistically significant improvements following the intervention ($p < 0.05$). The large effect sizes indicate that the applied program had a powerful influence on students' development across both domains. The covariate Pre-TGMD was significant only for the motor skill outcome, confirming that initial motor ability partially influenced post-intervention performance, while

Table 10. Multivariate MANCOVA Results (Pillai’s Trace)

Effect	Statistics	Value	F	Sig.	Partial η^2	Category	Interpretation
Group	Pillai’s Trace	0.973	628.0	0.000	0.973	Large	Significant effect of group on combined DVs
Pre-TGMD	Pillai’s Trace	0.644	31.64	0.000	0.644	Large	Significant effect of TGMD covariate
Pre-Literacy	Pillai’s Trace	0.048	0.884	0.422	0.048	Small	Nutrition literacy covariate not significant

Note. According to Cohen, effect sizes are interpreted as small ($\eta^2 = 0.01$), medium ($\eta^2 = 0.06$), and large ($\eta^2 = 0.14$).

Table 11. Univariate MANCOVA Results on Dependent Variables

Source	DV	F	Sig.	Partial η^2	Category	Interpretation
Group	Post-TGMD	791.11	0.000	0.956	Large	Significant difference, large effect
Group	Post-Literacy	333.89	0.000	0.903	Large	Significant difference, large effect
Pre-TGMD	Post-TGMD	59.23	0.000	0.622	Large	Significant covariate
Pre-TGMD	Post-Literacy	1.77	0.191	0.047	Small	Not significant
Pre-Literacy	Post-TGMD	0.00	0.996	0.000	None	Not significant
Pre-Literacy	Post-Literacy	1.79	0.190	0.047	Small	Not significant

Note. According to Cohen, effect sizes are interpreted as small ($\eta^2 = 0.01$), medium ($\eta^2 = 0.06$), and large ($\eta^2 = 0.14$).

Pre-Literacy did not significantly affect the results.

Overall, the findings confirm that the Active Physical Education–Based Nutrition Learning program effectively enhanced both motor and cognitive aspects of student development within the inclusive school setting.

Taken together, these findings provide robust evidence that the culturally adapted and physically active nutrition education model was highly effective for slow learners in inclusive junior high school settings. The magnitude of the effects demonstrates the program’s potential for replication and its practical relevance in improving students’ holistic health literacy and physical competence.

Discussion

This study aimed to evaluate the effectiveness of active physical education–based nutrition learning in improving gross motor skills and nutritional literacy among slow learners. The findings showed that incorporating nutrition instruction into active physical education lessons in inclusive junior high schools significantly enhanced both gross motor abilities and nutritional literacy among students with learning difficulties. The MANCOVA results confirmed this effectiveness, revealing a substantial impact on both dependent variables, as reflected by the high partial η^2 values (0.956 for TGMD-2 and 0.903 for nutritional literacy). These outcomes demonstrate that the intervention successfully improved both motor and cognitive domains.

This study aligns with prior studies. One study indicated that organized physical exercise significantly influences pupils’ gross motor

development, especially for those with special needs [25]. Another study revealed that children participating in both unstructured and organized play have enhanced motor coordination. However, this requires intentional teaching tactics to maximize advantages [10]. Moreover, WHO recommendations emphasize that physical exercise is crucial for physical and mental health as well as for motor development [26]. These studies collectively demonstrate that systematic physical exercise treatments enhance motor abilities, physical fitness, and academic and cognitive areas.

Beyond motor development, this study also reinforces the importance of innovative strategies to improve nutritional literacy. Balanced nutrition podcasts enhance student engagement and understanding [27]. Nutrition education programs significantly improved adolescents’ nutritional knowledge and practices [28]. Another study found that animated media effectively increased knowledge and promoted healthier eating behaviors [29]. These studies emphasize that diverse and interactive learning strategies foster active participation and meaningful learning outcomes.

Taken together, these findings suggest that integrating nutrition education with active physical education creates a dual impact. It enhances gross motor skills while simultaneously improving nutrition literacy. These domains are crucial for inclusive students, as motor development supports independence in daily activities, builds self-confidence, and encourages active engagement in physical environments [30]. Nutrition literacy equips students with the knowledge and habits

necessary to maintain a healthy lifestyle. It enables them to make informed dietary choices that promote long-term well-being [31, 32, 33, 34]. Strengthening these two aspects simultaneously is particularly important for inclusive education, as it fosters both physical independence and consistent health-promoting behaviors.

Covariate analysis revealed that initial TGMD-2 scores (Pre-TGMD) significantly predicted post-intervention gross motor outcomes ($F = 59.23$; $p < 0.001$; partial $\eta^2 = 0.622$). This indicates that baseline motor competence plays a crucial role in subsequent development. It aligns with several studies that confirmed the lasting influence of early motor competence on later achievement [35, 36, 37]. Conversely, initial nutritional literacy scores did not significantly influence post-test outcomes ($p > 0.05$; partial $\eta^2 < 0.05$). This suggests that the intervention itself primarily drove improvements. This finding is consistent with previous studies emphasizing that comprehensive and practical nutrition education programs can improve dietary practices regardless of students' prior knowledge [38, 39].

These findings are theoretically substantiated by Piaget's theory of learning through play, Bandura's social learning theory, and Vygotsky's constructivist framework. These theories emphasize the significance of direct experience, social interaction, and cooperation in the learning process. Numerous studies indicate that interactive and collaborative learning environments enhance both motivation and the application of information [40, 41, 42].

This study contributes to inclusive physical education by presenting a pedagogical model that combines gross motor learning and nutrition literacy within an active learning framework. The model connects physical and cognitive development, enabling students to acquire nutrition concepts through movement-based experiences. It also overcomes the limitations of traditional methods that separate nutrition and physical education into distinct domains.

The findings show that integrating physical activity with nutrition literacy is both feasible and effective for slow learners in inclusive schools when teachers act as adaptive facilitators. Physical education teachers are responsible for modifying tasks, adjusting activity intensity, and providing clear visual instructions suited to students' abilities. Through this adaptive approach, students not only learn nutrition concepts but also develop healthy habits through direct physical engagement.

This integrated model can help reduce learning gaps in both areas and may be applicable beyond Indonesia. This integrated model may also contribute to the development of inclusive education practices consistent with constructivist and experiential learning approaches. It provides a practical framework for improving both nutrition

literacy and motor competence among inclusive learners.

Limitations of the Study

Several limitations should be noted. The relatively small sample size limits the generalizability of the results. The short duration of the intervention prevents conclusions about long-term effects. Gender differences were not analyzed, so it remains unclear whether outcomes varied between male and female students. In addition, the study was conducted in a specific cultural and educational context, an Indonesian inclusive junior high school, which may restrict the applicability of the findings to other educational systems.

Future research should involve larger samples, use longitudinal designs, include gender-based comparisons, and test the intervention at different educational levels. Further studies could also examine how teachers implement this model across various schools and teaching contexts, focusing on fidelity, student engagement, and program sustainability. In addition, it may be useful to explore the use of digital or game-based tools to support participation and adaptive learning for slow learners.

Conclusions

The study confirmed that integrating nutrition learning into physical education lessons can effectively support the comprehensive development of students with learning difficulties in inclusive settings. The approach promotes both physical competence and awareness of healthy lifestyle habits. Such integration provides a meaningful learning framework where movement and knowledge complement each other, supporting the goals of inclusive education and fostering active participation of all students.

Acknowledgment

The authors extend sincere gratitude to Universitas Negeri Yogyakarta, the school principals, physical education teachers, and all inclusive junior high school students in Yogyakarta, Indonesia, for their invaluable contributions to this study.

Conflict of Interest

The authors declare no conflict of interest regarding the authorship or the findings of this study.

AI Tools Usage

In preparing this manuscript, the authors used ChatGPT (OpenAI, San Francisco, CA) to refine sentence structure and improve language clarity. The entire content was thoroughly reviewed, edited, and validated by the authors and a language expert. The authors assume full responsibility for the accuracy, originality, and integrity of the manuscript.

References

- Hafidah H, Rukli R. Treatment Slow Learner Learning Repetitive Addition with Realistic Mathematics Learning Approach. *Mimbar Sekolah Dasar*, 2022;9(3): 396–412. <https://doi.org/10.53400/mimbar-sd.v9i3.48586>
- Bin Zulkifli Z, Binti Anal A. The importance of physical education and health subjects for students with special educational needs in Malaysia. *International Journal of Social Science Humanity & Management Research*, 2023;2(09). <https://doi.org/10.58806/ijsshmr.2023.v2i9n12>
- Wibowo C, Dese DC. A multimodal physical activity training program to improve motor competence in college students: evidence from a controlled 12-week trial. *Pedagogy of Physical Culture and Sports*, 2025;29(4): 288–296. <https://doi.org/10.15561/26649837.2025.0406>
- Md Isa FW, Toran H. Exploring The Role of Special Education Teachers in The Process of Preparing and Implementing Individual Education Plans in The Special Education Integration Program. *International Journal of Academic Research in Business and Social Sciences*, 2024;14(5):168-185. <https://doi.org/10.6007/IJARBS/v14-i5/21196>
- Phetla MC, Skaal L. Efficacy of a Brief Intervention to Improve the Levels of Nutrition and Physical Exercise Knowledge Among Primary School Learners in Tshwane, South Africa: A Quasi-Experimental Study. *International Journal of Environmental Research and Public Health*, 2024;21(12): 1592. <https://doi.org/10.3390/ijerph21121592>
- Oliveira MLD, Castagnoli JDL, Machado KMC, Soares JM, Teixeira F, Schiessel DL, et al. Interdisciplinary Educational Interventions Improve Knowledge of Eating, Nutrition, and Physical Activity of Elementary Students. *Nutrients*, 2022;14(14): 2827. <https://doi.org/10.3390/nu14142827>
- Syafei A, Badriyah L. Literasi gizi (nutrition literacy) dan hubungannya dengan asupan makan dan status gizi remaja. *Jurnal Ilmu Kesehatan Masyarakat*, 2019;8(04):182–90. <https://doi.org/10.33221/jikm.v8i04.402>
- Hu D, Zhou S, Crowley-McHattan ZJ, Liu Z. Factors That Influence Participation in Physical Activity in School-Aged Children and Adolescents: A Systematic Review from the Social Ecological Model Perspective. *International Journal of Environmental Research and Public Health*, 2021;18(6): 3147. <https://doi.org/10.3390/ijerph18063147>
- Ardianti SD, Wanabuliandari S, Wijayanti E. Need Analysis Of “Si Eco” Ethno-Confidence Game for Slow Learner Students. *Jurnal Ilmiah Sekolah Dasar*, 2021;5(3): 461. <https://doi.org/10.23887/jisd.v5i3.39534>
- Masrun, Okilanda A, Khairuddin, Utama J, Putra AR. Learning of gross motor skills based on fun games: a study of coordination development in 5–6-year-old children. *Pedagogy of Physical Culture and Sports*, 2025;29(4): 233–242. <https://doi.org/10.15561/26649837.2025.0401>
- Ul Hassan J, Malik Muhammad Saad Missen, Amnah Firdous, Arfa Maham, Amna Ikram. An Adaptive M-Learning Usability Model for Facilitating M-Learning for Slow Learners. *International Journal of Interactive Mobile Technologies (ijIM)*, 2023;17(19): 48–69. <https://doi.org/10.3991/ijim.v17i19.42153>
- Widodo JP, Subandowo M, Musyarofah L, Slamet J. Interactive gamification-flip-book for developing students’ outcomes. *Advances in Mobile Learning Educational Research*, 2023;3(2): 754–762. <https://doi.org/10.25082/AMLER.2023.02.002>
- Mafugu T. Assessment of high school learners’ familiarity with nutrition education principles. *European Journal of Clinical Nutrition*, 2021;75(2):392–399. <https://doi.org/10.1038/s41430-020-00712-5>
- Wafiqoh R, Maulana SA, Pramuditya SA. Mathematics learning difficulties of slow learner students in terms of reflektif abstraction measurement. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 2022;11(2): 1052. <https://doi.org/10.24127/ajpm.v11i2.4770>
- Alsamiri Y. How learning disabilities teachers in the kingdom of Saudi Arabia define students with giftedness and learning disabilities. *Jurnal Cakrawala Pendidikan*, 2018; <https://doi.org/10.21831/cp.v38i3.21566>
- Winson NL, Fourie JV. Recognising developmental coordination disorder in Foundation Phase classrooms. *South African Journal of Childhood Education*, 2020;10(1). <https://doi.org/10.4102/sajce.v10i1.838>
- Alhamuddin Alhamuddin, Abdul Rohman, Ahmad Fanani. Developing a Project-Based Learning Model for Slow Learners in Higher Education. *Jurnal Pendidikan Islam Indonesia*, 2022;6(2): 86–96. <https://doi.org/10.35316/jpii.v6i2.404>
- Williams JG, Eston RG, Stretch C. Use of the Rating of Perceived Exertion to Control Exercise Intensity in Children. *Pediatric Exercise Science*, 1991;3(1): 21–27. <https://doi.org/10.1123/pes.3.1.21>
- Johnson NE, Maas MB, Coleman M, Józefowicz RF, Engstrom JW. Education research: Neurology training reassessed: The 2011 American Academy of neurology resident survey results. *Neurology*, 2012;79(17):1831–4. <https://doi.org/10.1212/WNL.0b013e3182703fa3>
- Ngatman N, Sumaryanto S, Gani I, Solikhin MN. Improving the basic groundstroke forehand and backhand techniques of male beginners aged 8-12 through the Acentos method-based training model. *International Journal of Human Movement and Sports Sciences*. 2024;12(2):267–76. <https://doi.org/10.13189/saj.2024.120201>
- J S, S S. Comprehensive Evaluation of Fundamental Motor Skills: Insights From the Test of Gross Motor Development-3. *Cureus*, 2023; <https://doi.org/10.7759/cureus.46381>
- Griffiths A, Toovey R, Morgan PE, Spittle AJ. Psychometric properties of gross motor assessment tools for children: a systematic review. *BMJ Open*, 2018;8(10): e021734. <https://doi.org/10.1136/bmjopen-2018-021734>
- Avram C, Mărușteri M. Normality assessment, few paradigms and use cases. *Revista Romana de Medicina de Laborator*, 2022;30(3): 251–

260. <https://doi.org/10.2478/rrlm-2022-0030>
24. Huang CY, Zane NW, Hunter L, Vang L, Apesoa-Varano EC, Joseph J. Promoting mental and physical health of Vietnamese immigrants through a cultural movement intervention. *Cultural Diversity & Ethnic Minority Psychology*, 2025;31(1): 46–57. <https://doi.org/10.1037/cdp0000591>
 25. Pradnyani TIAR, Pramita I, Tianing NW. The effect of physical activity for the development of motor skill in children aged 3–12 years old: a narrative review. *Kinesiology and Physiotherapy Comprehensive*, 2024;3(1): 23–28. <https://doi.org/10.62004/kpc.v3i1.30>
 26. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *British Journal of Sports Medicine*, 2020;54(24): 1451–1462. <https://doi.org/10.1136/bjsports-2020-102955>
 27. Taningrum N, Kriswanto ES, Pambudi AF. From headphone to health: utilizing podcast to improve the nutrition literacy of high school students. *Retos*, 2024;59: 267–273. <https://doi.org/10.47197/retos.v59.108421>
 28. Munir Z, Adirawan AS, Faruq U, Mu'adam M, Ramadana MF. Efektivitas Program Edukasi Gizi Seimbang Dalam Meningkatkan Pengetahuan Dan Praktik Gizi Seimbang Pada Remaja [Efektivitas Program Edukasi Gizi Seimbang Dalam Meningkatkan Pengetahuan Dan Praktik Gizi Seimbang Pada Remaja]. *Jurnal Keperawatan Profesional*, 2024;12(2): 109–119. (In Indonesian). <https://doi.org/10.33650/jkp.v12i2.9458>
 29. Azhari MA, Fayasari A. Pengaruh edukasi gizi dengan media ceramah dan video animasi terhadap pengetahuan sikap dan perilaku sarapan serta konsumsi sayur buah [Pengaruh edukasi gizi dengan media ceramah dan video animasi terhadap pengetahuan sikap dan perilaku sarapan serta konsumsi sayur buah]. *Action: Aceh Nutrition Journal*, 2020;5(1): 55. (In Indonesian). <https://doi.org/10.30867/action.v5i1.203>
 30. Suwandi R, Hariyanto FA, Kurnianto H. Level Aktivitas Fisik dan Pola Hidup Sehat Siswa di Masa Pandemi Covid-19 [Level Aktivitas Fisik dan Pola Hidup Sehat Siswa di Masa Pandemi Covid-19]. *Discourse of Physical Education*, 2022;1(2): 125–135. (In Indonesian). <https://doi.org/10.36312/dpe.v1i2.883>
 31. Rintala P, Linjala J. Scores on Test of Gross Motor Development of Children with Dysphasia: A Pilot Study. *Perceptual and Motor Skills*, 2003;97(3): 755–762. <https://doi.org/10.2466/pms.2003.97.3.755>
 32. Tiara UI. Hubungan Obesitas Dengan Kejadian Hipertensi [Hubungan Obesitas Dengan Kejadian Hipertensi]. *Journal of Health Science and Physiotherapy*, 2020;2(2): 167–171. (In Indonesian). <https://doi.org/10.35893/jhsp.v2i2.51>
 33. Djaja N, Ratimanjari NG, Wiraharja ARS. Pengenalan Perilaku Hidup Bersih dan Sehat, Penyakit Tidak Menular, dan Gizi Seimbang pada Warga Desa Wates Jaya [Introduction to Clean and Healthy Living Behavior, Non-Communicable Diseases, and Balanced Nutrition to Wates Jaya Village Residents]. *Mitramas: Jurnal Pengabdian dan Pemberdayaan Masyarakat*, 2024;2(2): 123–132. (In Indonesian). <https://doi.org/10.25170/mitramas.v2i2.5475>
 34. Sumanik NB, Priyudahari BAP, Meilvidiri W. Edukasi Perilaku Hidup Bersih Dan Sehat (PHBS) Pada Anak Sekolah Dasar Di Distrik Nggolar [Clean and Healthy Living Behavior (PHBS) Education for Elementary School Children in Nggolar District]. *Dedication: Jurnal Pengabdian Masyarakat*, 2023;7(2): 227–238. (In Indonesian). <https://doi.org/10.31537/dedication.v7i2.1399>
 35. Robinson LE, Stodden DF, Barnett LM, Lopes VP, Logan SW, Rodrigues LP, et al. Motor Competence and its Effect on Positive Developmental Trajectories of Health. *Sports Medicine*, 2015;45(9): 1273–1284. <https://doi.org/10.1007/s40279-015-0351-6>
 36. Zeng N, Ayyub M, Sun H, Wen X, Xiang P, Gao Z. Effects of Physical Activity on Motor Skills and Cognitive Development in Early Childhood: A Systematic Review. *BioMed Research International*, 2017;2017: 1–13. <https://doi.org/10.1155/2017/2760716>
 37. Malika LD, Hariadi I, Fadhli NR, Roesdiyanto R. Keterampilan Motorik Kasar Anak Usia Prasekolah di TK Muslimat NU Dewi Masithoh 01 Kalipare Kabupaten Malang [Keterampilan Motorik Kasar Anak Usia Prasekolah di TK Muslimat NU Dewi Masithoh 01 Kalipare Kabupaten Malang]. *Sport Science and Health*, 2022;4(11): 964–979. (In Indonesian). <https://doi.org/10.17977/um062v4i112022p964-979>
 38. Taylor MK, Sullivan DK, Ellerbeck EF, Gajewski BJ, Gibbs HD. Nutrition literacy predicts adherence to healthy/unhealthy diet patterns in adults with a nutrition-related chronic condition. *Public Health Nutrition*, 2019;22(12): 2157–2169. <https://doi.org/10.1017/S1368980019001289>
 39. Karadağ G, Bilgiç D, Öztürk N, Özdemir T. Relationship Between Nutritional Literacy and Healthy Life Skills of University Students. *European Journal of Education*, 2025;60(1): e70019. <https://doi.org/10.1111/ejed.70019>
 40. Witasari R. Belajar dan Pembelajaran dari perspektif Teori kognitif, behaviorisme Konstruktivisme dan sosiokultural [Belajar dan Pembelajaran dari perspektif Teori kognitif, behaviorisme Konstruktivisme dan sosiokultural]. *BASICA*, 2024;3(2): 257–268. (In Indonesian). <https://doi.org/10.37680/basicav3i2.5764>
 41. Muflich RMR, Nursikin Mukh. Pandangan John Dewey dan Jean Piaget terhadap kurikulum pendidikan: perspektif teori pembelajaran aktif dan konstruktivisme [Pandangan John Dewey dan Jean Piaget terhadap kurikulum pendidikan: perspektif teori pembelajaran aktif dan konstruktivisme]. *Afeksi: Jurnal Penelitian dan Evaluasi Pendidikan*, 2023;4(6): 614–621. (In Indonesian). <https://doi.org/10.35672/afeksi.v4i6.173>
 42. Lestari S, Manurung AA, Sumarni S. Teori Belajar Konstruktivisme dan Implikasi dalam Pembelajaran IPA SD [Teori Belajar Konstruktivisme dan Implikasi dalam Pembelajaran IPA SD]. *JiIP - Jurnal Ilmiah Ilmu Pendidikan*, 2024;7(9): 10622–10628. (In Indonesian). <https://doi.org/10.54371/jiip.v7i9.5476>

Information about the authors:

Ngatman Ngatman; (Corresponding author); <https://orcid.org/0000-0002-3303-8529>; ngatman@uny.ac.id; Department of Physical Education, Faculty of Sports Science and Health, Yogyakarta State University; Special Region of Yogyakarta, Indonesia.

Sugiyanto Sugiyanto; <https://orcid.org/0000-0002-9991-5264>; sugiyantoprobo@gmail.com; Department of Sport Science, Faculty of Sports, Sebelas Maret University; Surakarta (Solo), Central Java, Indonesia.

Nevitaningrum Nevitaningrum; <https://orcid.org/0009-0004-5953-3714>; nevitaningrum@unsil.ac.id; Department of Physical Education, Faculty of Teacher Training and Education, Siliwangi University; Tasikmalaya, West Java, Indonesia.

Dalu Danangjaya; <https://orcid.org/0009-0000-0309-4944>; daludanang@gmail.com; Department of Physical Education, Faculty of Sports Science and Health, Yogyakarta State University; Special Region of Yogyakarta, Indonesia.

Muhamad Nanang Solikhin; <https://orcid.org/0000-0002-2505-0253>; nanangsolikhin@uny.ac.id; Department of Traditional Indonesian Medicine, Faculty of Sports Science and Health, Yogyakarta State University; Special Region of Yogyakarta, Indonesia.

Cite this article as:

Ngatman N, Sugiyanto S, Nevitaningrum N, Danangjaya D, Solikhin MN. Development of gross motor skills and nutrition literacy among inclusive junior high school students. *Pedagogy of Physical Culture and Sports*, 2025;29(5):482–498.

<https://doi.org/10.15561/26649837.2025.0510>

This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited (<http://creativecommons.org/licenses/by/4.0/deed.en>).

Received: 18.09.2025

Accepted: 26.10.2025; Published: 30.10.2025