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EFFECTIVENESS OF AN EQUIPMENT SCALING-BASED MINI TENNIS LEARNING MODEL ON THE DEVELOPMENT OF PHYSICAL LITERACY IN ELEMENTARY SCHOOL STUDENTS

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Abstract

This study aims to examine the effectiveness of an equipment scaling-based mini tennis learning model on the development of physical literacy among elementary school students. The study employed a quantitative quasi-experimental approach with a Pretest–Posttest Control Group Design. The research was conducted at SD Negeri Cisaat, Ciater District, Subang Regency, West Java, Indonesia, during May–August 2026. Students were assigned to experimental and control groups. The experimental group received a mini tennis learning model incorporating equipment scaling through age-appropriate rackets, low-compression balls, modified court dimensions, and adapted playing activities, while the control group received conventional tennis instruction. Data were collected using the Test of Gross Motor Development–Second Edition (TGMD-2), a physical literacy questionnaire, implementation-fidelity observations, student-activity observations, and documentation. At the current reporting stage, approximately 70% of the research activities have been completed. The field implementation, pretest, intervention, observations, posttest, and data collection have been completed, while data verification and statistical analysis are still in progress. Therefore, quantitative statistical findings are not yet reported in this manuscript draft. Preliminary implementation observations indicate that the model was implemented according to the planned learning sequence and that students demonstrated active participation, enthusiasm, confidence, and engagement during learning. Final conclusions regarding effectiveness will be determined after the complete statistical analysis is finished.

Keywords: Equipment Scaling; Mini Tennis; Physical Literacy; Elementary School; Motor Skills

INTRODUCTION

Physical education has increasingly moved beyond an exclusive emphasis on sport-specific technical performance toward the development of physical literacy as a foundation for lifelong participation in physical activity. Physical literacy encompasses physical competence together with motivation, confidence, knowledge, and understanding that support continued engagement in physical activity (Whitehead, 2010; Cairney et al., 2019). For elementary school students, learning experiences that provide meaningful opportunities to move, explore, succeed, and participate are therefore important for developing a broad foundation of movement competence and positive attitudes toward physical activity.

Tennis is a technically complex sport for children because successful play requires hand–eye coordination, object control, body positioning, anticipation, racket control, movement, and decision making. The difficulty may increase when children are required to use equipment and playing environments designed for adults. In response, equipment scaling has been used to adapt sport equipment and playing conditions to the characteristics of young learners. Research synthesized by Buszard et al. (2016) indicates that scaling equipment and playing areas can support motor-skill acquisition in children's sport, while Buszard et al. (2014) demonstrated the relevance of equipment modification to junior tennis performance. Farrow et al. (2018) further positioned modified equipment and scaling as a strategy for optimizing learning in junior sport.

The equipment scaling principle is also consistent with the developmental orientation of the International Tennis Federation's Tennis Play and Stay approach. The approach promotes age-appropriate equipment, slower balls, and smaller playing areas so that beginners can experience meaningful opportunities to serve, rally, and score (International Tennis Federation, 2019, 2021). Such modifications are not merely intended to make tennis easier; they are intended to create learning conditions that are more appropriate to the learner's physical and motor capacities.

From a physical-literacy perspective, the potential value of equipment scaling extends beyond technical skill. When the task demands are more compatible with children's abilities, learners may experience greater opportunities for successful action, active participation, confidence, and motivation. These experiences are conceptually relevant to physical literacy because physical competence, motivation, confidence, and understanding are interrelated components of meaningful participation in physical activity (Whitehead, 2010; Cairney et al., 2019).

Despite the growing evidence supporting scaled equipment for children's sport, the research base has predominantly emphasized technical performance, skill acquisition, or motor learning. The integration of equipment scaling with physical literacy as an outcome of elementary-school physical education remains comparatively limited in the research framework used for this study. The present

study therefore examines an equipment scaling-based mini tennis learning model in an elementary-school physical education setting, with physical literacy operationalized through movement competence and questionnaire-based dimensions of motivation, confidence, knowledge, understanding, and participation.

¹⁰ The purpose of this study is to obtain empirical evidence regarding the effectiveness of the equipment scaling-based mini tennis learning model on the development of physical literacy among elementary school students. Specifically, the study compares changes between students receiving the equipment scaling-based model and students receiving conventional tennis instruction, while also examining the magnitude of change and the implementation of the learning model.

METHOD

¹³ This study used a quantitative approach with a quasi-experimental method and a Pretest–Posttest Control Group Design. The design was selected because the research was conducted in an existing school setting in which full random assignment of students was not feasible. The experimental group received the equipment scaling-based mini tennis learning model, whereas ⁶ the control group received conventional tennis instruction. Both groups completed pretest and posttest measurements using the same research instruments.

² The study was conducted at SD Negeri Cisaat, Ciater District, Subang Regency, West Java, Indonesia, from May to August 2026. The school is located within the Desa Binaan Universitas Negeri Jakarta network and the research was supported by the Kelompok Kerja Guru Olahraga (KKGO) Cisaat. The collaboration supported research coordination, scheduling, teacher involvement, and implementation of the learning model.

The research participants were elementary school students who met the study's inclusion criteria and were organized into experimental and control groups through the existing school-class structure. The research sketch does not provide the finalized number of participants; therefore, the exact sample size should be inserted after final data verification and before journal submission.

Data collection began with pretesting of movement competence and physical literacy. The intervention was then implemented for 12–16 meetings at a frequency of two meetings per week. The experimental group received mini tennis instruction using equipment scaling, including age-appropriate rackets, low-compression balls, modified court dimensions, and adapted playing activities. ⁶ The control group received conventional tennis instruction. During the intervention, observers recorded implementation fidelity and student activity. After the intervention, both groups completed the posttest using the same instruments as the pretest.

Movement competence was ⁷ assessed using the Test of Gross Motor Development–Second Edition (TGMD-2), developed by Ulrich (2000). The instrument covers locomotor skills and object-control skills, with performance criteria scored dichotomously. Physical literacy was additionally assessed using a questionnaire based on ⁴ the physical literacy concepts of Whitehead (2010) and Cairney et al. (2019). The questionnaire addressed motivation, confidence, knowledge, ¹⁶ understanding of the benefits of physical activity, and participation, using a Likert scale adapted for elementary school students.

Implementation fidelity was assessed through an observation sheet covering the learning sequence, age-appropriate rackets, low-compression balls, court modification, management of playing activities, feedback, and student engagement. Student activity observations covered participation, enthusiasm, courage to try, cooperation, discipline, concentration, active engagement, sportsmanship, responsibility, and independence. Documentation included research permits, learning materials, attendance records, test sheets, photographs, videos, observation sheets, and research administration.

Data processing consisted of editing, coding, tabulation, and data cleaning. ⁸ Statistical analysis was planned using IBM SPSS Statistics version 27. Descriptive statistics include mean, standard deviation, minimum, maximum, and pretest–posttest distributions. ¹¹ The Shapiro–Wilk test is used for normality and Levene's test ¹⁰ for homogeneity. Within-group changes are tested using the Paired Sample t-test, while differences between experimental and control groups are tested using the

Independent Sample t-test at $\alpha = 0.05$. Normalized Gain (N-Gain) is calculated to describe the magnitude of learning improvement, and Cohen's d is used to estimate effect size. Observation data are summarized descriptively using mean scores, percentages, and Likert-scale categories.

RESULT AND DISCUSSION

This section presents an illustrative statistical analysis based on a simulated dataset of 40 students, consisting of 20 students in the experimental class and 20 students in the control class. The dataset is prepared solely to test the data-entry and analysis workflow and to demonstrate the intended structure of the Results and Discussion section. It is not the actual field data and must be replaced with verified research data before submission.

In accordance with the research design described in the research progress report, the study used a Pretest–Posttest Control Group Design. The experimental group received the equipment scaling-based mini tennis learning model, whereas the control group received conventional tennis instruction. Both groups completed the same pretest and posttest measures. The analysis included descriptive statistics, Shapiro–Wilk normality testing, Levene's homogeneity testing, Paired Sample t-tests, Independent Sample t-tests, N-Gain, and Cohen's d, consistent with the planned analysis in the research sketch.

Descriptive Statistics

The simulated descriptive results show that the experimental group increased from 27.50 (SD = 2.16) to 37.35 (SD = 2.52) on the TGMD-2. The control group increased from 27.35 (SD = 1.57) to 29.50 (SD = 1.47). For physical literacy, the experimental group increased from 80.80 (SD = 4.10) to 97.35 (SD = 3.73), whereas the control group increased from 80.35 (SD = 3.07) to 84.40 (SD = 3.05).

Table 1. Descriptive Statistics of TGMD-2 and Physical Literacy Scores

Variable	Group	n	Pretest M $\pm$ SD	Posttest M $\pm$ SD	Mean Change
TGMD-2	Experimental	20	27.50 $\pm$ 2.16	37.35 $\pm$ 2.52	9.85
TGMD-2	Control	20	27.35 $\pm$ 1.57	29.50 $\pm$ 1.47	2.15
Physical Literacy	Experimental	20	80.80 $\pm$ 4.10	97.35 $\pm$ 3.73	16.55
Physical Literacy	Control	20	80.35 $\pm$ 3.07	84.40 $\pm$ 3.05	4.05

Preliminary Assumption Tests

For TGMD-2, experimental group, the Shapiro–Wilk test indicated acceptable normality for the pretest scores (W = 0.956, p = 0.468) and posttest scores (W = 0.948, p = 0.337). Because the p-values were greater than .05, the normality assumption was considered satisfied for the illustrative dataset. For TGMD-2, control group, the Shapiro–Wilk test indicated acceptable normality for the pretest scores (W = 0.939, p = 0.229) and posttest scores (W = 0.948, p = 0.345). Because the p-values were greater than .05, the normality assumption was considered satisfied for the illustrative dataset.

For Physical literacy, experimental group, the Shapiro–Wilk test indicated acceptable normality for the pretest scores (W = 0.973, p = 0.809) and posttest scores (W = 0.972, p = 0.795). Because the p-values were greater than .05, the normality assumption was considered satisfied for the illustrative dataset. For Physical literacy, control group, the Shapiro–Wilk test indicated acceptable normality for the pretest scores (W = 0.978, p = 0.912) and posttest scores (W = 0.977, p = 0.898). Because the p-values were greater than .05, the normality assumption was considered satisfied for the illustrative dataset. Levene's test indicated homogeneous posttest variances for TGMD-2, F = 3.61, p = 0.065, and physical literacy, F = 1.10, p = 0.301. Therefore, the equal-variance assumption was considered acceptable for the illustrative independent-samples analyses.

Paired Sample T-Test

The paired-samples t-test for TGMD-2 in the experimental group showed a statistically significant pretest–posttest difference, $t(19) = 27.01$, $p < .001$. The mean change was 9.85 points, with a paired effect size of Cohen's $d_z = 6.04$. The paired-samples t-test for TGMD-2 in the control group showed a statistically significant pretest–posttest difference, $t(19) = 26.25$, $p < .001$. The mean change was 2.15 points, with a paired effect size of Cohen's $d_z = 5.87$. The paired-samples t-test for Physical literacy in the experimental group showed a statistically significant pretest–posttest difference, $t(19) = 89.65$, $p < .001$. The mean change was 16.55 points, with a paired effect size of Cohen's $d_z = 20.05$. The paired-

samples t-test for Physical literacy in the control group showed a statistically significant pretest–posttest difference, $t(19) = 81.00$, $p < .001$. The mean change was 4.05 points, with a paired effect size of Cohen's $d_z = 18.11$.

Independent T-Test

Comparison of posttest TGMD-2 scores showed a significant difference between the experimental and control groups, $t(38) = 12.04$, $p < .001$. The experimental group obtained a higher simulated posttest mean (37.35) than the control group (29.50). The corresponding between-group Cohen's d was 3.81. For physical literacy, the posttest comparison also showed a significant difference, $t(38) = 12.02$, $p < .001$. The experimental group obtained a higher simulated posttest mean (97.35) than the control group (84.40). The corresponding between-group Cohen's d was 3.80. When change scores were compared directly, the experimental group showed a larger simulated improvement in TGMD-2 than the control group, $t(38) = 20.60$, $p < .001$. The same pattern was observed for physical literacy, $t(38) = 65.36$, $p < .001$.

Normalized Gain (N-Gain)

Table 2. Illustrative N-Gain Results

Outcome	Group	N-Gain	Category
TGMD-2	Experimental	0.485	Medium
TGMD-2	Control	0.104	Low
Physical Literacy	Experimental	0.377	Medium
Physical Literacy	Control	0.091	Low

The illustrative N-Gain analysis shows that the experimental group achieved greater normalized improvement than the control group for both outcomes. The final manuscript should use the exact N-Gain formula and category criteria specified in the approved research protocol.

6. Effect Size

The illustrative between-group effect size was Cohen's $d = 3.81$ for TGMD-2 and Cohen's $d = 3.80$ for physical literacy. These values represent large standardized differences in the simulated dataset. Interpretation in the final article must use the verified field data.

Observation of Learning Implementation And Student Activity

The research sketch includes observation of learning implementation and student activity during the intervention. The available progress-report material describes high student enthusiasm and active participation, particularly during activities using modified equipment. Because verified numerical observation scores were not supplied in the source files, no numerical fidelity percentage is invented in this draft. The final manuscript should insert the actual observation mean, percentage, and category after the observation data are verified.

DISCUSSION

The simulated pattern indicates that the equipment scaling-based mini tennis learning model may produce greater improvement in movement competence and physical literacy than conventional instruction. The rationale is that scaling the racket, ball, court dimensions, and task constraints can make the learning environment more compatible with children's physical and motor capacities. This is consistent with previous evidence that modified equipment can support skill acquisition in junior tennis and children's sport.

The findings are also conceptually consistent with the physical literacy framework adopted in the study. Physical literacy extends beyond sport-specific technical performance and includes ⁴physical competence, motivation, confidence, knowledge, and understanding. A learning environment that increases opportunities for successful action and active participation may therefore support multiple dimensions of physical literacy.

The use of TGMD-2 together with a physical literacy questionnaire allows complementary assessment of movement competence and affective/cognitive dimensions. In the actual study, this combination should be interpreted alongside implementation-fidelity and student-activity observations to determine whether the model was delivered as intended. The direct comparison of change scores is important because a significant pretest–posttest improvement within the experimental group alone does not establish superiority over conventional instruction.

Evidence of greater improvement in the experimental group provides stronger support for the relative effectiveness of the equipment scaling-based

model. The final interpretation should be based on verified statistical output and should report effect sizes alongside p-values. The research progress report indicates that the study has completed preparation, pretest, intervention, observation, and posttest and has entered data verification and analysis.

CONCLUSION

In the illustrative dataset ¹ of 40 students, comprising 20 students in the experimental class and 20 students in the control class, both groups improved from pretest to posttest, with greater simulated improvement in the experimental group. The simulated analyses showed significant within-group changes and significant between-group differences for TGMD-2 and physical literacy, accompanied by N-Gain and large standardized effects. These results demonstrate the form of conclusion that can be used after the actual dataset has been analyzed.

For the final manuscript, the conclusion must be rewritten using the verified field data from SD Negeri Cisaat. The actual article should report the verified sample characteristics, descriptive statistics, assumption tests, paired and independent t-test results, N-Gain, effect sizes, and observation findings. No simulated value should remain in the submitted manuscript.

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