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The impact of nonlinear pedagogy on communication and skill acquisition

Wpływ pedagogiki nieliniowej na komunikację i nabywanie umiejętności

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Abstract

Study Purpose. The current investigation assessed the impact of hybrid nonlinear pedagogical models on skill acquisition and communication in physical education.

Methods. The intervention group was instructed in physical education applying hybrid pedagogical models for a duration of 12 weeks. Conversely, the control groups adhered to the physical education curricula of their respective schools. Scales for skill acquisition and communication, which had been previously developed for use with students, were implemented both prior to and subsequent to the program. Comparing the two groups required the application of paired sample t-tests, two-way and one-way analyses of variance, and a Pearson correlation analysis.

Results. In comparison to the control group, the intervention group demonstrated a substantial increase in communication and skill acquisition, according to the research findings. Enhancement of communication proficiency is observed in individuals who receive instruction through invasion game learning utilizing nonlinear pedagogy. The aforementioned conclusions are supported by the outcomes of paired sample t-tests, two-way Analysis of Variance (ANOVA), and one-way ANOVA: $F < 0.05$ ($F = 0.000 < 0.05$) and $p < 0.05$ ($p = 0.000 < 0.05$) respectively. Additionally, the Skill Acquisition ability exhibited an improvement subsequent to receiving the intervention based on nonlinear pedagogy and invasion game learning. The significance of this is supported by the outcomes of the paired sample t-tests, two-way ANOVA, and one-way ANOVA: $F < 0.05$ ($F = 0.000 < 0.05$) and $p < 0.05$ ($p = 0.000 < 0.05$), respectively.

Conclusions. The integration of hybrid nonlinear pedagogical models into physical education instruction through invasion games may facilitate students' communication development and skill acquisition. The results of this study provide motivation for physical education instructors to implement instructional techniques. Additionally, research is conducted into the effects of nonlinear pedagogy

Keywords

communication, skill acquisition, primary school students, nonlinear pedagogy

Streszczenie

Cel badań. Celem niniejszego badania była ocena wpływu hybrydowych modeli pedagogiki nieliniowej na proces nabywania umiejętności i komunikację w ramach wychowania fizycznego.

Metodyka. W badaniu uczestniczyła grupa interwencyjna, która przez 12 tygodni korzystała z hybrydowych modeli pedagogicznych. W odróżnieniu od niej, grupy kontrolne realizowały standardowe programy nauczania wychowania fizycznego obowiązujące w ich placówkach edukacyjnych. Do oceny zdolności nabywania umiejętności oraz komunikacji, zarówno przed, jak i po zakończeniu programu, wykorzystano specjalnie opracowane dla uczniów skale.

Wyniki. Badanie wykazało, że w porównaniu do grupy kontrolnej, uczestnicy z grupy interwencyjnej osiągnęli znaczące postępy w zakresie komunikacji i nabywania umiejętności. Poprawę zdolności komunikacyjnych stwierdzono u osób uczących się przez gry inwazyjne oparte na pedagogice nieliniowej. Potwierdzeniem tych obserwacji są wyniki sparowanego testu t oraz analizy wariancji dwuczynnikowej (ANOVA) i jednoczynnikowej, gdzie w obu przypadkach $F < 0.05$ ($F = 0.000$) i $p < 0.05$ ($p = 0.000$).

Również zdolności zdobywania umiejętności uległy poprawie po zastosowaniu interwencji opartej na pedagogice nieliniowej i nauce przez gry inwazyjne, co również potwierdzają wyniki testów statystycznych: $F < 0.05$ ($F = 0.000$) i $p < 0.05$ ($p = 0.000$).

Wnioski. Zastosowanie hybrydowych modeli pedagogiki nieliniowej w nauczaniu wychowania fizycznego przez gry inwazyjne może znacząco przyczynić się do rozwoju umiejętności komunikacyjnych i nabywania nowych umiejętności przez uczniów.

Odkrycia te zachęcają nauczycieli wychowania fizycznego do wprowadzania innowacyjnych metod dydaktycznych. Ponadto, zachęcają do dalszych badań nad efektywnością pedagogiki nieliniowej.

Słowa kluczowe

komunikacja, nabywanie umiejętności, uczniowie szkoły podstawowej, pedagogika nieliniowa

Introduction

Divergent approaches could present a challenge within the discipline of physical education [1]. In substitution of conventional physical education instruction, a student-centered approach has been implemented. Educators prioritize lessons that concentrate on required technical competencies, neglecting the surrounding context and the individual preferences of the pupils. In the student-centered approach, the instructor assumes the role of a facilitator, and pupils are motivated to engage in independent research to develop critical thinking skills in relation to problems [2, 3]. Various approaches may pose a challenge to the implementation of physical education [4]. The transition from traditional teacher-centered physical education instruction to a student-centered model has occurred. The implementation of a student-centered methodology allows students to develop their independence throughout the learning process. The teacher assumes the roles of facilitator, conceptualizer, and forum for the students' interchange of critical viewpoints, both individually and in groups [5].

Although a significant proportion of pupils (usually 80% or higher) expressed satisfaction with conventional or instructor-led physical education courses, an alternative methodology was required [6]. Due to its emphasis on physical activity across a variety of sports (both individual and group), physical education is regarded as a distinct discipline from the majority of academic disciplines. Conversely, a subset of students exhibits aversion towards physical education within the school setting, thereby impeding the effective implementation of physical education curriculum. Furthermore, there is empirical support indicating that a growing proportion of pupils perceive physical education as lacking in significance, appeal, and enjoyment [7]. The non-linear pedagogical approach, which is a component of student-centered learning, advocates for the notion of creating an educational setting that emphasizes collaborative efforts in both directions [8]. This approach aims to enhance a range of student competencies, ultimately inspiring students to develop a greater sense of intrinsic motivation while engaging in an enjoyable learning process [9].

Physical education programs must prioritize the development of psychomotor, cognitive, perceptual, and affective components of each student in order to maximize learning effectiveness [10]. Physical education has been included in the 2013 Curriculum as an instructional component designed to foster a student-centered learning environment in Indonesia. Physical education is an essential element of the national education system, as it enhances a multitude of indicators of complex learning outcomes including but not limited to reasoning intelligence, healthy lifestyles, movement skills, emotional intelligence, and attitude values; social skills; and critical thinking abilities. Physical Education values the development of organized educational opportunities that foster holistic development, including physical, mental, and emotional aspects [11].

As is generally accepted, sports practitioners, including physical education instructors and coaches, who consistently set the groundwork for research into how people move and interact, are preoccupied with the outcomes of skills. Devising effective methodologies to enhance skill acquisition and promote Physical Literacy is crucial. It helps individuals attain function-

nal mobility and extends beyond the realms of academic institutions and athletics [12]. Physical literacy incorporates a variety of daily activities and focuses on cognitive processes, perception, fitness, effectiveness, and social interaction throughout learning activities [13].

Communication, which is part of social skills, is part of the affective aspect. The purpose of communication in social skills is so that children can interact with peers, the community and the environment around which students live [14]. These skills can be learned, and students can do them from the simplest to the most complex, including: Waving, smiling, giving help, asking for help, making friends, expressing feelings, expressing opinions, defending their rights, these skills are very important for children's success in the classroom and in social environments [15].

Nonlinear Pedagogy is one of the student-centered or student-oriented learning approaches that, according to research in curricular studies, differs significantly when implemented in physical education [16]. This work's pedagogically oriented approach increases the value of all components and functions as a foundation for curriculum development [17]. It has been noted that one of the most prominent value orientations in the field of physical education is subject or disciplinary mastery, with practitioners pursuing verbal explanations, demonstrations, practice exercises, and game simulations to teach perceptual motor abilities [18]. Additional noteworthy value orientations within the realm of educational and curriculum studies encompass the learning process approach, which places critical emphasis on the manner in which learning transpires, as well as the ecological integration of learners within specific learning contexts [19]. Obtaining optimal learning outcomes, such as game skills, is primarily the responsibility of the students. Teachers assist students throughout the learning process by instituting representative performance that demonstrates a value orientation.

A variety of nonlinear learning models are currently gaining popularity in physical education, such as a) one such model is Teaching Games for Understanding, which advocates for a student-centered approach and emphasises exploratory learning within "game-like" scenarios [20], b) The implementation of the Constraints-Led approach learning paradigm holds promise in furnishing physical education with a structured framework that enables students to gain an understanding of how to perform environmental-based task exploration. The objective is to foster individuals who demonstrate greater ingenuity in resolving challenges presented by the instructor. Furthermore, for the Constraints-Led Approach to facilitate skill acquisition, an understanding of the fundamental neurobiological processes is necessary. By utilising games to enhance students' consciousness of their exploration of movement, instructors can acknowledge that, in accordance with motor learning theory, education is a dynamic science-based art form [21], c) In Physical Training, the principal aim of Sports Education is to foster students' competence and self-assurance in engaging in enjoyable activities throughout the academic year. This encourages them to continue their development and increases their likelihood of participating in these activities during their leisure time. However, it seems improbable to achieve this goal with the traditional structure of brief physical education units, where

parents organize competitive activities such as 6v6 volleyball and 5v5 basketball [22].

In this study, the experimental group implemented a nonlinear pedagogy learning model to improve students' communication abilities and skill development. The main objective of this program is to enhance students' skill acquisition and communication while fostering enjoyment in physical education. The development procedure for the program includes activities like analyzing the curriculum, creating syllabi, and formulating lesson outlines that cover a range of tasks. Through curriculum analysis, fundamental and foundational competencies are identified. Pupils are required to develop competence in various skills throughout the educational process. We developed a curriculum that integrates the identified fundamental competencies—cognitive, affective, and psychomotor—with corresponding materials, lesson times, and suitable activities. The lesson plan also contains a comprehensive outline of the curriculum, encompassing the meeting date and time, subject matter, educational tasks (including introduction, body, and conclusion), and designated study periods. In accordance with a nonlinear pedagogy, pupils participated in 12 weeks of phy-

sical activity on a daily basis. As a consequence, this investigation aims to explore these educational impacts. The present study investigated the impact of hybrid nonlinear pedagogical models on skill acquisition and communication in physical education.

Methods

A quasi-experimental research paradigm applying a control group pre-post test design is described in this article. In the Indonesian city of Yogyakarta's elementary schools, this inquiry was carried out.

Participants

The participants were 82 students from a single elementary school within the scope of this inquiry. The selection of participants was conducted via random sampling. Elementary school students in this study were aged between ten and twelve years old. The inquiry was carried out within the province of Yogyakarta, Indonesia. This province is located in the western part of Indonesia. The distribution of the samples is displayed in Table 1.

Table 1. Study design

Item	Frequency	%
Gender		
Male	41	50
Female	41	50
Age		
11	26	35
12	56	65
Class		
5	26	35
6	56	65
School		
Elementary School 1	27	32
Elementary School 2	29	37
Elementary School 2	26	31

Study organization

Documentation and observation are utilized as methods of data acquisition. Observation involving evaluation and documentation tools was employed in the data collection process for this research activity. Observation was the method by

which researchers obtained data regarding the pre-test and post-test for this inquiry. Twelve meetings of documentation in the form of lesson plans utilized by the instructor, as well as documentation during the pre-post test and when administering treatment.

Table 2. Design of studies and intervention

Levels	I	II	III	IV
Pre-test				
Intervention		Instrument Observation		
Post-test		12 weeks		
Participants		Instrument Observation		
		VI C 27 Pupils Nonlinear pedagogy learning		
		VI D 29 Pupils Linear pedagogy learning		
		V C 26 Pupils Control		

Procedure

In the beginning of the research, we developed an innovative physical education program utilizing nonlinear pedagogy and invasion activities for the children in the first intervention group. Additionally, we formulated a scale to assess the communication and skill acquisition of the children in this group. For the second

intervention group, we implemented a linear pedagogy approach and incorporated invasion games. A control group comprised physical education and sports programs. Each program lasts one semester, which is 12 weeks. Prior to and following all physical education and sports programs, we furnish every student with communication and skill acquisition scales.

Table 3 Interventions for nonlinear learning in experimental tests

Session	I	II	III	IV
1	Pre Test			
2	Nonlinear-linear-control	Invasion Game		Soccer
3	Nonlinear-linear-control	Invasion Game		Basketball
4	Nonlinear-linear-control	Invasion Game		Handball
5	Nonlinear-linear-control	Invasion Game		Futsal
6	Nonlinear-linear-control	Invasion Game		Basketball
7	Nonlinear-linear-control	Invasion Game		Handball
8	Nonlinear-linear-control	Invasion Game		Soccer
9	Nonlinear-linear-control	Invasion Game		Futsal
10	Nonlinear-linear-control	Invasion Game		Handball
11	Nonlinear-linear-control	Invasion Game		Soccer
12	Posttest			

Statistical analysis

Information was analyzed using SPSS Version 27.0 for Windows. An analysis of variance (ANOVA) with repeated measures was employed to compare the intervention 1 and 2 groups, in addition to the control group, prior to and following the implementation of the physical education and sports programs. The researchers then compared the disparities in communication and skill acquisition between groups prior to and

following the implementation of the physical education and sports program using one-way ANOVA. Preferably, paired sample t-tests were employed to evaluate disparities between groups.

Result

Before using parametric techniques of statistical analysis, it is essential to conduct a normality test on the data:

Table 4 The result of normality test communication and skill acquisition (Kolmogorov-Smirnov)

	Class	Communication		Skill Acquisition	
		df	Sig	df	Sig
Pre-test	Control	26	0.122	26	0.083
	Nonlinear	27	0.200	27	0.052
	Linear	29	0.129	29	0.056
Post-test	Control	26	0.052	26	0.088
	Nonlinear	27	0.087	27	0.051
	Linear	29	0.151	29	0.131

As shown in Figure 1, the interaction between the mean ratings of the intervention and control groups was statistically significant ($F(2.386) = 129.435; p = 0.000$). This suggests that the groups exhibited a distinct variation in the rate at which their communication skills evolved from before to after the intervention. Additionally, significant disparities in group communication are revealed by a one-way ANOVA. In the intervention nonlinear group, there are significant incremental changes in decision making from before ($M = 2.38$) to after

testing ($M = 3.66$). In the linear intervention group, there are significant reductions in communication from before ($M = 2.55$) to after ($M = 2.33$) the testing. Additionally, a decrease was observed in the pre-test and post-test scores of the first control group ($M = 2.28$) and the second ($M = 2.19$), but it was not statistically significant. The fact that the paired sample t-test identified a statistically significant difference provides additional support for this.

Variations in communication were observed within the nonli-

near intervention group ($t(27)$; $p = 0.000$). The paired sample t-test revealed significant disparities in communication within the intervention linear group ($t(29)$; $p = 0.001$). On the con-

trary, the control group exhibited no noteworthy discrepancies in communication ($t(26)$; $p = 0.266$).

TWO-WAY ANOVA COMMUNICATION

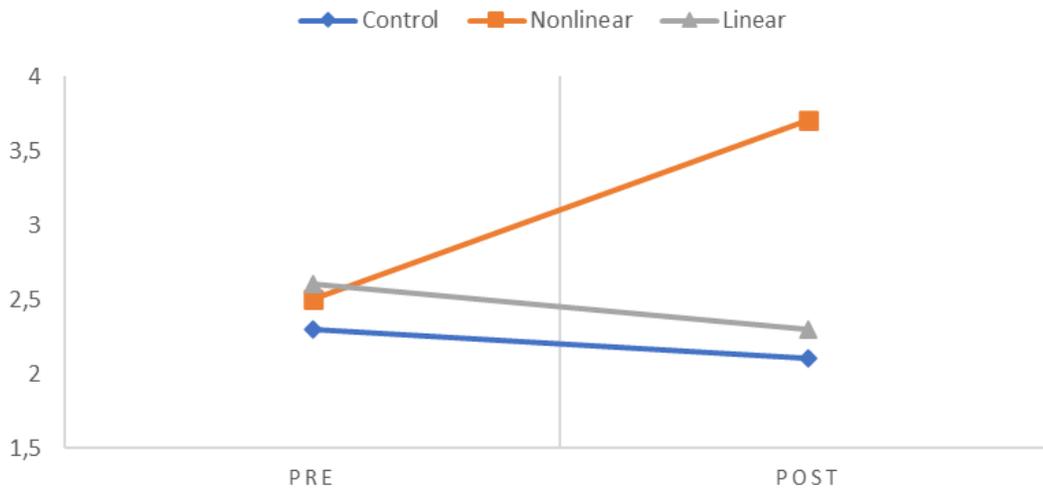


Figure 1. Interaction of average communication scores between and within groups

A notable interaction was observed between the mean scores of the intervention and control groups, as illustrated in Figure 2. There were statistically significant differences between the groups regarding the rate of change in skill acquisition from pre-intervention to post-intervention ($F(2.333) = 12.402$, $p = 0.000$). Additionally, a one-way ANOVA demonstrates noteworthy variations in skill acquisition among groups. The intervention nonlinear group exhibits significant incremental changes in skill acquisition from before ($M = 2.33$) to after testing ($M = 3.16$). In the intervention linear group, there was also an increase in skill acquisition from before to after the assessment ($M = 2.41$) ($M = 2.69$). Furthermore, while a noticeable change does occur,

the extent of this change decreases from the pre-test to the post-test. Specifically, the initial control group achieved an average score of $M = 2.25$, while the average score for the second control group dropped to $M = 2.17$. This is further supported by the results of the paired sample t-test, which indicated that the nonlinear intervention group experienced a statistically significant deviation in skill acquisition ($t(27)$; $p = 0.0001$). Significant differences in skill acquisition were also observed in the intervention linear group, as determined by the paired sample t-test ($t(29)$; $p = 0.012$). In the control group, no significant differences were observed in terms of skill acquisition ($t(26)$; $p = 0.570$).

TWO-WAY ANOVA COMMUNICATION

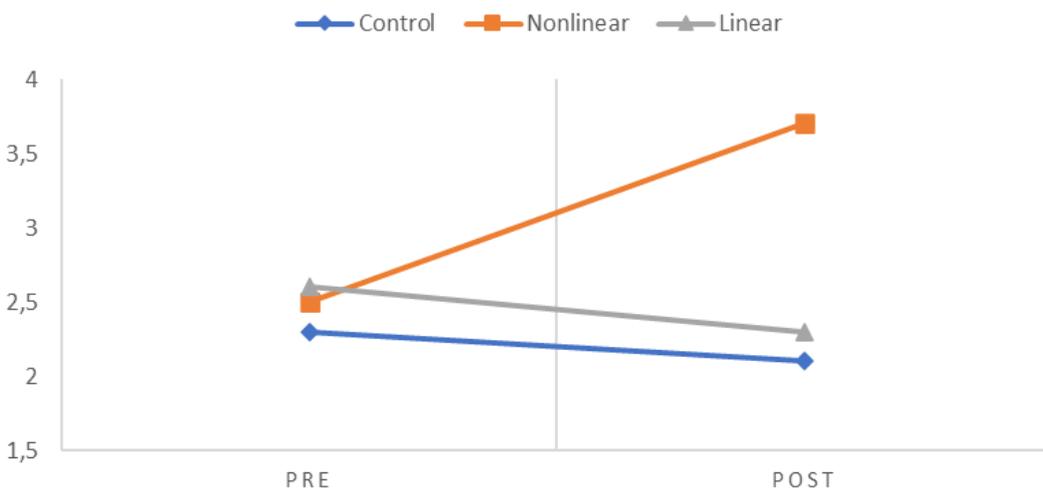


Figure 1. Interaction of average communication scores between and within groups

Discussion

Improved communication has been shown to enhance the effectiveness of the nonlinear pedagogy learning model [23]. Students do not learn movement skills in isolation from the context of their learning environment. For example, when students in the NP group were asked to describe several things related to communication with friends and teachers that they liked about this lesson, a child stated "I really like this because I can express my opinion. I really like this because I can express my opinion, and my friends, who usually don't listen, now pay attention to what I say," explained the child [24]. One of the important things presented in the nonlinear approach is the affective aspect here with the hybrid model it can increase students' abilities in communication, because students can play roles such as coach, manager, player, audience, etc., in playing these roles children are trained to be able to communicate well not only with friends but with teammates, opponents, coaches, etc [25].

Previous research revealed that social interactions with communication were identified as contributing to gaining meaningful experiences. The role of communication has been studied with various people involved in educational contexts, for example with: friends, teachers, coaches, and even family [26,27]. This highlights the important role of all relationships in the learning context, not just the role of friends, teachers and coaches but also with every aspect of communicating. A study involving 129 students aged 9-12 years from Australia, France, and Germany found that 75 to 90% of respondents in each country identified school communication as a key factor for their continued active participation in learning [28].

This nonlinear learning design perspective is also framed by students playing several roles in sports so as to enable communication between students. Expressing students' thoughts creatively is the most effective way of integration for communication, where students' thinking develops, vocabulary increases, and word use is appropriate [29,30]. In nonlinear learning, students who play roles are freed to think more creatively in expressing their opinions and ideas in learning and are challenged to be the best in a team or group.

The effectiveness of skill acquisition increased in both linear and nonlinear pedagogical learning models [31]. The development of pupils' relationships with the functional environment constitutes skills acquisition. Students do not solely acquire knowledge through autonomous learning in practical contexts. The progression of students' motor control and learning can be characterized by the definition of learning, which posits that it entails comparatively enduring modifications in an individual's internal state in response to the outcomes of movement

[32]. Additionally, the efficacy of the linear learning model is enhanced in this variable due to the fact that individual skill acquisition abilities are improved through the use of drill practice, which is typically employed to automate skill acquisition movements.

The students in the nonlinear pedagogy intervention group showed notable progress in communication and skill acquisition after participating in physical education. This finding illustrates that children's communication and skill acquisition development are notably enhanced through sports learning in the nonlinear pedagogy intervention group [32]. Students' skills and creativity are consequently enhanced, along with their abilities to acquire knowledge and communicate effectively, through sports education [33]. Student autonomy in problem-solving is enhanced through specialized sports instruction. By means of invasion activities, this program facilitates group learning. In a variety of contexts pertaining to game-related issues, pupils acquire the capacity to apply their communication skills [34]. Students can actively engage in physical education courses while simultaneously enhancing their communication abilities and skill development through the use of cooperative learning, sports education, and hybrid games incorporating understanding-based teaching. Elementary school students' learning and communication skills are enhanced through physical education. By incorporating real-world examples, athletic competitions teach students communication skills and skill acquisition, instilling a sense of accountability in the process of learning [35].

Conclusion

There was an increase in communication skills in class nonlinear pedagogy-based invasion game learning treatment. This is shown by the results of the two way ANOVA, one way ANOVA, and paired sample t-test which have values of $F < 0.05$ ($F = 0.000 < 0.05$) and $p < 0.05$ ($p = 0.000 < 0.05$), a significant difference exists between the two groups.

In addition to other benefits, nonlinear pedagogy-based invasion game learning led to an enhancement in skill acquisition abilities. According to the results of the two-way ANOVA, one-way ANOVA, and the paired sample t-test, which show F values less than 0.05 ($F = 0.000 < 0.05$) and p values less than 0.05 ($p = 0.000 < 0.05$), a significant difference exists.

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