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The Implication of Non-Linear Pedagogy on Volleyball Technical and Tactical Skills

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Abstract

In-Traditional sports and physical education practices have long been viewed as linear processes aided by analytical and decontextualization exercises. However, a learning process needs to encourage a holistic approach and non-linear pedagogy to enable students to understand the complexity of the learning and teaching processes where learners and teachers engage with each other and find solutions to overcome motor skill acquisition barriers. The research aimed to explore applying non-linear pedagogical principles in volleyball learning and their implications for sports teaching. It used The mix method with the sequential exploratory design. Participants of this study were 39 students, 19 males and 20 females aged 14-16 years, from 3 junior high schools in Malang City, East Java. The sampling technique used was the purposive sampling technique. Instruments used observation and questionnaires. Data analysis techniques used Ms. Excels and Spearman correlation. The study found a significant relationship between the game knowledge and competencies experienced in in-game skills, such as serving, passing, receiving, attacking, and blocking. In applying non-linear pedagogy in the study, students demonstrated interaction in multi-faceted games with each other for optimal responses to pre-established constructions.

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INTRODUCTION

Volleyball is a sport requiring a variety of technical-tactical features that players must master to face the challenges of the match (Wnorowski, 2007). To master the game, players must be able to strengthen the basic skills of the game, such as serving, receiving, blocking, attacking, positioning, and spiking, as well as tactical and mental abilities, such as focus, anticipation, and adaptive skills (Valiyev dan Rixsiyev, 2020). In addition, game intelligence and physiological factors are important to achieve a high-performance level. Traditional volleyball teaching and training methods, on the other hand, seem to be limited in developing the player skills (Pereira et al., 2010; Can, 2017).

Traditional sport pedagogy has long become an emphasis in the sports coaching process as learning is viewed as a linear process aided by the application of analytical and decontextualizing exercises, such as training activities designed to stimulate the 'ideal' movement patterns determined by the coach to complete a given task, neglecting real-world game scenario (Launder dan Piltz, 2013). However, due to the dynamics and non-linear character of learning, instructional and non-linear techniques have recently developed in the sports context (Chow et al., 2007). Players and teams are viewed as a complex systems with neurobiological abilities that can sense the flow of critical information in-game scenarios, regulate themselves when constrained, and adapt to stable and unstable situations (Pol et al., 2020).

Advances in motor control and learning in the human movement have offered more convincing evidence to support pedagogical approaches explaining the dynamics and complexities of movement ability acquisition (Atencio et al., 2014). According to the growing evidence, individual variations among learners should be considered when practitioners develop educational interventions in any learning situation (Schmeck, 1988; Nandagopal dan Ericsson, 2012). The emphasis is on the person; hence instructional techniques should consider the occurring dynamic and complex interactions (Griffiths dan Soruç, 2021) between learners, tasks, and environmental boundaries (Chow et al., 2011).

Non-linear pedagogy is an educational framework that requires learning to consider real-world situations (Körner dan Staller, 2018). Learning occurs when the learner is in the learning environment context, and information is obtained from learner interactions with the environment. The environment is essential for supplying knowledge sources, such as material substance, patterns, and invariant features that enable learners to build meaningful relationships (Davids et al., 2005). The importance of placing athletes in realistic learning situations is to allow them to align information to make intelligent and informed decisions based on their own, teammates, and opponents' abilities (Moy et al., 2016).

Knowledge is traditionally considered to exist outside the student body, while learning is an internal representational process. Ritella and Loperfido (2021) note that the teaching-learning process focuses on the self-organization of a group of interacting factors, including students, classroom environments, and teachers. Consequently, behaviorism assumes that students are satisfied with educational techniques. For example, students may be given specific parameters and asked to repeat the movement alone, in pairs, in a circle, etc. According to Yilmaz (2011), behaviorism was the dominant educational method during the twentieth century. However, it was especially overtaken by constructivism, which continues to have a significant effect on modern Physical Education. However, behaviorism has a dualistic perspective of Physical Education expressed in the separation of body and mind, or thought and action, and therefore underestimates the development of practical Physical Education knowledge. It also encourages the student to concentrate on the physical aspects rather than the academic aspects. The Physical Education method requires learning as a linear, quantitative, and explicit process of absorbing information.

However, in the last decades of the twentieth century, there was a surge in interest in constructivist learning theory in Physical Education (Daniel, 1996, Chambers, 2013). This method puts a more holistic approach to learning, rejecting the dualism of behavioral theory. Unlike behaviorism, constructivists believe that there is no predetermined external reality but a closely connected world that we can only understand when we experience it.

According to Kuhn (2007), constructivism is the theory that comes closest to the complexity and non-linear suggestion because it offers students a more protagonist and autonomous position and values them as the responsible and constructive people for their learning. For example, in guided discovery, students might

explore many options for producing a particular move and choosing the optimal method. According to Webb and Pearson (2008), Bunker & Thorpe, in 1982, developed Teaching Games for Understanding (TGfU) associated with the constructivist point of view in Physical Education. The purpose of TGfU, according to Forrest et al. (2006), is to build a learning experience for students to gain the key game tactical skills through games adapted to their physical, intellectual, and social capacities. TGfU emphasizes tactical knowledge of technical capabilities. According to Thorpe (1990), the underlying foundation of TGfU is the theory stating that technically constrained games encourage players to be more competitive. The modified version of the game helps improve understanding and awareness of the main game. Modified games require changes in the information, gameplay areas, or rules to assist students in solving tactical challenges. TGfU and non-linear pedagogy, according to Stolz dan Pill (2014), have similar characteristics, such as holistic perception of students, the role of the teacher, and the design of learning activities.

This is reminiscent of complexity theory which is perceived as a tangle of events, actions, interactions, feedback, and decisions that construct our phenomenal reality. According to Renshaw et al. (2009), the complexity theory is rooted in the dynamic system and ecological psychology theories in motor skills. Dynamic system theory argues that behavior stems from interactions with the environment. Certain conditioning variables can influence behavior. Non-linear pedagogy is based on students' perception, the classroom environment, teachers, and the learning process as a non-linear and complex system. Mason (2008) argues that non-linear perspectives and complexities imply a more holistic education beyond acquiring physical abilities to educate children with more excellent knowledge of learning, growth, and identity.

According to the complexity theory, student behavior is influenced by factors that affect each moment. At the same time, constraints are conditions that pressure the system to create reactions in a certain way (Doolittle, 2014). According to Chow and Atencio (2014), constraints are restrictions or qualities to stabilize student behavior and self-organization grouped into three categories, the students, their environment, and their work. Individual attributes, such as weight, height, and physical composition, are examples of student restrictions. Climate, atmosphere, topographical features, oxygen levels, and social elements, such as peer groups, societal rules, or cultural expectations, are examples of environmental restrictions. According to Orth et al. (2019), this kind of limitation is difficult to change when creating sessions using non-linear characteristics to achieve the desired goal. Instead, it is the teacher's responsibility to change the assignment-related boundaries. Task constraints that can be manipulated include changing the rules of the game while maintaining its internal rationale, changing the dimensions of the playing area, changing player roles, varying the number of participants in each task, and changing the time to complete the task.

Non-linear pedagogy, according to Davids et al. (2005), is implemented by modifying boundaries to elicit desired behaviors, stimulating diversity in tasks, and enabling exploratory learning. Students are open to a wide range of mobility possibilities in a non-linear environment for sports learning. Students discover personalized problem-solving abilities for task goals through changing constraints. It is essential to emphasize the relevance of scientific literacy, which will strengthen the relationship between the official curriculum and regular learning. According to Lee et al. (2017), teachers are a guide and facilitators of learning, while students are responsible for changing task boundaries to facilitate learning. Since opposition-collaborative sports display uncertainty about the game's characteristics, decision-making becomes a critical issue (Qudrat-Ullah, 2014). They define uncertainty as the result of interactions between teammates and opponents, claiming that players will never know 100%, with certainty, what their opponents will do. Since the tasks are varied, they will be able to deal with the uncertainties of unique game situations.

As a result, they recommend that teachers continue to manipulate task constraints. The traditional approach, which tends to practice skills without resistance and imitates or isolates technical movements from the environment where the skills occur, lacks flexibility in activities to stimulate decision-making. The limitations occurred in non-linear education differ significantly from the existing classical models. Constraints are the circumstances and channels where the desired behavior will emerge. On the other hand, rules are instructions

given for the desired behavior to occur. According to Rudd et al. (2020), shifts in coordination patterns in childhood are due to changes in restrictions imposed in actions, not due to given rules.

The application of non-linear pedagogy could improve the performance of the student gameplay outcomes in tactical decision-making, recovery movements to the base, drop shot, and smash skills in badminton games. This is because the application of non-linear pedagogy allows teachers to adapt tactics, skill assignments, and the existing learning environment to players' abilities (Nathan et al., 2017). Non-linear pedagogy in football results in a more accurate attacking game behavior and decision making, but not for technical abilities. A study has provided evidence that non-linear application in youth professional football is feasible and will support player development (Roberts et al., 2020). The application of non-linear pedagogy in futsal games could significantly contribute to improving tactical-technical abilities in futsal. The coach must consider the design of the task and the tactical principles of play to develop the tactical behavior of young futsal players (Roberts et al., 2020).

Several research results showed that the application of non-linear pedagogical skills effectively developed tactical skills in badminton, soccer, and futsal games. This study explored the application of non-linear pedagogical principles in volleyball learning and their implications for sports teaching.

A non-linear pedagogy has been developed and built based on a dynamic ecological approach. The emphasis of the pedagogical framework is exploratory learning, encouraging individual movement solutions (Chow & Atencio, 2014). Based on this perspective, giving children the freedom to explore a carefully designed learning environment will lead to the constraint-led synergy formation resulting in the performance of functional movement solutions. (Rudd, Crotti, et al., 2020). Consequently, non-linear pedagogy involves a child-centered approach to Physical Education where teachers channel children's learning by modifying task boundaries to assist the skill synergy formation that will be functional for the task at hand. The key aspect of this is not to limit synergy formation; thus, equipment manipulation or game rules providing the child with direct instructions will be preferable (Chow & Atencio, 2014).

For teachers who provide a non-linear pedagogical approach, movement skills must be practiced in a representative environment where perception and action are uninterrupted. It means that learning activities must be placed in a performance context capturing the dynamics where the skills to be learned can be performed, developed, and acquired (Rudd, Pesce, et al., 2020). In a non-linear pedagogical approach, the teacher modifies individual, task, and environmental constraints to support the exploration. According to the non-linearity in learning, variability is inherently present in how movement is controlled and produced. Therefore, variability in movement control can be functional and should be encouraged.

Furthermore, in non-linear pedagogy, the teacher must encourage an external attention focus to support self-organization (Moy et al., 2016). Several authors have proposed that non-linear pedagogy can support a child's basic psychological need for autonomy, relatedness, and competence from the self-determination theory perspective. Therefore, it may lead to higher levels of motivation toward physical activity engagement, which might positively affect the physical activity level in children compared to traditional teaching approaches (Lee et al., 2017).

METHODS

This research used a mix-method employing sequential exploratory design. The design combines qualitative and quantitative research sequentially using qualitative methods followed by quantitative methods (Creswell, 2013).

Participants

Participants of this study were 39 students, involving 19 male students and 20 female students aged 14-16 years, from 3 junior high schools in Malang City, East Java. The sampling technique used was purposive sampling. The technique was chosen because not all samples had criteria that matched the phenomenon under study (Sugiyono, 2016).

Instrument and Procedure

The instruments used were observation and questionnaires. Observations were conducted during learning activities, while questionnaires were used to strengthen data gained from observations. Activities were observed and recorded using notebooks and video/

audio recordings. Rule data were collected at the end of the twentieth session, which gave participants plenty of practice to self-assess their basic technical/tactical competence in volleyball. A summative compilation of teacher regular journal entries about activities and teaching during the study period, including reflection, observation, and interpretation of events during the sessions, was administered—students filled in a questionnaire to examine the relationship between knowledge or variable acquisition. The questionnaire contained a technical/tactical self-evaluation and perception of volleyball. Student responses to the questionnaire stored in a Likert scale ranging from 1-4 (1 = fair, 2 = good, 3 = very good, 4 = excellent).

Data Analysis

Notebook data and video/audio recordings were analyzed using MS Excel for descriptive variables. Spearman correlation was used to test the relationship between knowledge or variable acquisition gained from questionnaire data. The relationship category between variables included 0.1-0.3 as a weak category, 0.4-0.6 as a moderate category, 0.7-0.9 as a strong category, and 1 as a perfect category (Dancey & Reidy, 2007). The relationship in the Spearman correlation is said to be significant if the significance level obtained is more than 0.05.

RESULT

Teaching activities were carried out for six weeks, including four 2-hour sessions conducted every week. The teaching method was interactive, bringing up problem-solving and guided discovery aspects. In addition, the instructor acted as a facilitator to organize participants into heterogeneous groups without considering the participant's motor skills, competencies, and gender.

The basis for developing activities referred to previous research (Machado et al., 2019; Byrne, 2014; Gómez-Criado dan Valverde-Esteve, 2021) in various sports. There were changes to the game rules, the number of game participants, and the size of the playing area. Besides changes and innovative actions applied to the activity, it is also essential to modify the task boundaries in the activity (Práxedes et al., 2019).

New rules were introduced to increase the player's attention during the game, such as making three or more passes within the team before hitting the ball to the opposing team side. In addition, the participant ball-playing opportunities were increased by adding the dimensions and size of the playing area. Moreover, the materials were also modified, and players were given some leeway to allow them to adapt to their motor skill changes and modifications. Finally, the questioning technique was used during the game to ensure their perspective on the optimal strategy for a particular game situation, which is in line with the suggestions of the study conducted by Harvey dan Light (2015), Chow et al. (2007); Atencio et al. (2014).

Table 1. Guidelines for Volleyball Game Technical/ Tactical Self-Evaluation and Perceptions

Tactical Skills	Fair	Good	Very Good	Excellent
Serve	Inability to serve properly in the opponent's area	Can do good services	Able to see vacancies in the opponent's area and serve in the right space	Able to serve hard and difficult for the opponent to accept
Passing	Inability to pass to teammates	Able to perform the pass, sometimes not accurate	Able to perform passes in various ways, sometimes not accurate	Able to adapt the way of passing the ball and provide accurate passes
Defense/ Attack	Unable to block	Sometimes can do the work but do it inaccurately	Can help block many times	Can attack and do blocking in the right way
Receive	Unable to receive the ball properly	Sometimes receiving properly	Can receive well while playing	Can receive the ball well and make it easier for teammates to attack
Position	Improper positioning	Sometimes can move in the air in the right position	Sometimes can take the right position and move in position	Always able to occupy the right and logical position
Knowledge of the Rule	Inability to enforce rules	Often shows ignorance of the rules	On many occasions, can find fault	Always apply the rules and know the modified equipment

The importance of participant self-competence made all participants voluntarily evaluate themselves

about the basics and essence of the volleyball game's dynamics, techniques, and tactics using the rule guidelines (Maehana et al., 2021; Shaw, 2014) specially prepared for this purpose (see table 1). This tool was not directed at the volleyball technique mastery but rather at the player's self-recognition of their abilities in the game and their capacity to achieve standard parameters in practice required by the sports education curriculum.

Previous research (Machado et al., 2019; Byrne, 2014; Gómez-Criado dan Valverde-Esteve, 2021) in various sports were used to develop the activity. We changed the rules, the number of participants, the size of the field, and the materials used in the activity innovation according to the technique pioneered by Newell in 1986 (Renshaw et al., 2019). In addition, we set some additional rules, such as making at least three passes before moving the ball to the other half of the court to attract more pupils and focus on the action. By expanding the field's dimensions, changing the material, and allowing children to adapt the rules to their motor skills, we increased the number of possibilities for playing.

A commendable social bond developed among the participants, who showed respect and appreciation for one another. Also, the prevalence of enthusiasm for completing task objectives was noted. Since a 'flexible' teacher was aimed to provide a space for students to adapt to the new rules for the game, the changed size of the field, and their level of motor skills, the students showed gratitude to the teacher. Students also showed their desire to explore more deeply the activity by optimally engaging in any given constraints on the task. Furthermore, the students applied the best technical/tactical choices in their decision-making based on their circumstances during the game.

Figure 1 shows a substantial relationship between knowledge of game rules and the six parameters measured; passing, serving, attacking/blocking, position on the field, receiving and knowing the rules of the game. The relationship between parameters was analyzed statistically using Spearman correlation with the help of the SPSS program. The relationship in the Spearman correlation is said to be significant if the significance level obtained is more than 0.05. The results of the correlation analysis between parameters with the Spearman correlation analysis are presented in Table 2.

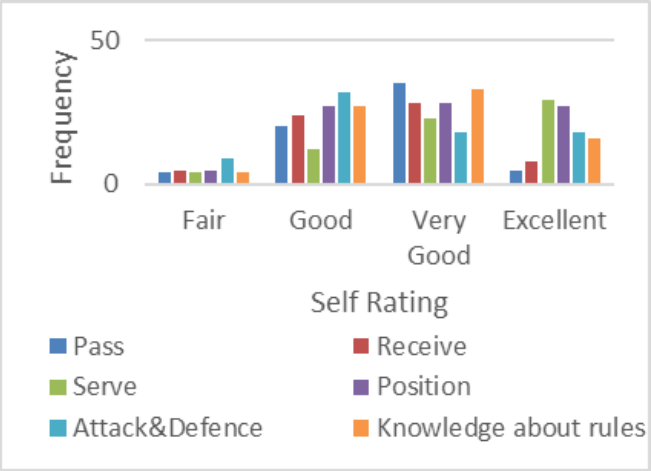

Figure 1. Guidelines for Volleyball Game Technical/ Tactical Self-Evaluation and Perceptions

Table 2. Correlation between Parameters

Parameters					
Pass	.46***	.565***	.359**	.454***	.365**
Serve	-	-	-	TS	.375**
Defense/attack	-	-	.57***	-	.269*
Receive	-	.268*	.291*	.49***	.265*
Position	-	-	-	.355**	.412***
Knowledge about the Rules	-	-	-	-	-

TS: not significant; *:p=0.05; **:p=0.010; ***:p=0.001

DISCUSSION

This study explored the application of non-linear pedagogy in high school volleyball didactics over six weeks. There were observations of the students' acclimatization to the game rules for their learning achievement process, motor skill competence, and the interconnections and relationships they built from a heterogeneous group. Arajo et al. (2004) argue that movement patterns emerge due to the imposed constraint imposition on action rather than as a result of given rules.

The student game understanding was found to be quite good based on the rubric results. There was a significant relationship between the game knowledge and service (r=0,265, p=0,043), passing (r=0,356, p=0,004), position on the field (r=0,412, p=0,001), receiving (r= 0,356, p =0.004), and attack/block (r=0.266, p=0.037), which is in line with the study of Machado et al. (2020) who noted that the activities undertaken were based on

a tactical depiction of the game. Students explored various movement patterns in several cases to find the technique providing the best solution for the game scenario. Modifications would allow greater flexibility in task design, encouraging explorations (Light, 2013). Development of important transverse aspects, such as autonomy or creativity emphasized in the educational curriculum, is related to optimizing possible movement options resulting from the task.

As previously stated, it is essential to enable students to identify the optimal solution to the available mobility options, implying that they can make appropriate decisions based on the circumstances. Due to the ambiguity in in-game situations created by the players' activities, decision-making becomes a critical component that must be considered in both cooperative and controversial sports (Araujo et al., 2006; Salusu, 2015). The diversity stems from boundaries differing from conventional approaches in how they were previously often practiced or through separate technical movements in the environment.

Instructors are responsible for group formation, where participants of various qualities coexist in diverse groups. Despite having varying degrees of motor ability and self-perceived motor competence, all participants were asked to agree on the rules and size of the play area. The results obtained in this activity are by Physical Education curriculum standards emphasizing the contribution to improving the cooperation, communication, and teamwork attitude for achieving the common goals in games, sports, and society.

The recognition and perception of non-linear learning have become more widely accepted as research and practice understand that coaching and teaching methods in sports education should consider the non-linearities. However, acceptance is only a part of the story because the actual delivery of education based on the non-linearity or complexity concept seems without challenges. Often, due to the anticipation of the instructor in teaching to realize predictable learning outcomes, this linear point of view is widely accepted as a way of teaching or coaching (Puchegger dan Bruce, 2020). As a result, practitioners find it challenging to give up “control” and receive good learning from the non-linear pedagogy. Some scholars and practitioners may also argue that there is no added benefit to 'knowing' non-linear learning if students are still learning and can continue to be responsible to their organizations, in their opinion.

Furthermore, some practitioners may argue that some features of non-linear pedagogy, such as increasing variety and changing tools, are already part of the existing teaching repertoire. It can easily be questioned whether it is a new understanding and helps non-linear learning or whether it is simply an existing concept stated differently. When given the option of teaching in a non-linear style, coaches and teachers face serious acceptance challenges. It is normal for practitioners to hold on to old habits that have served them well. Some may be interested in their understanding of how those habits work. Although some aspects of non-linear pedagogy are already used in educational applications today, further understanding of non-linear learning can help educational practitioners with better approaches to design and deliver instructions, feedback, and practices (namely pedagogical pathways).

Outside the classroom context, motor learning research supports the rationale for constructing representational learning designs (Mascolo, 2009). The concept of pedagogical representation ensures that the organized game or information movement is relevant and reflects the actual game. Simplifying tasks, rather than division of tasks, can help improve the representation (Correia et al., 2019). According to practitioners, modifying the game will help learners access the important perceptual information accessible in the performance setting and pair it with the appropriate behavior. According to (Moy, 2016) is to enable students to have the opportunity to acquire tactical awareness, make appropriate judgments, and practice skills in a proper practice context, which is an example of a good representational instructional design encouraging contextual learning. Therefore, teachers need to establish a learning environment that naturally stimulates students. Perera dan Patel (2019) shows that a non-linear educational approach can create a learning environment that encourages students to learn. Experts suggest that the important aspect of curriculum goals for children's physical and sports education is to ensure that the activities and pedagogies chosen to meet the learner's ongoing search for their psychological needs, such as feeling a sense of autono-

my and ability (Gill, Williams dan Reifsteck, 2017). An important challenge is how to build an intrinsically stimulating learning environment within a non-linear pedagogical framework.

CONCLUSION

Our findings conclude that using non-linear pedagogy in high school Physical Education sessions could help students identify and carry out optimal responses to game situations caused by the limitations. The student's self-evaluation of their skill acquisition awareness was excellent. The adoption and understanding of non-linear approaches to education and coaching were growing. However, further studies are needed to advise practitioners on applying the approach practically in coaching and Physical Education settings. It is essential to understand that non-linear pedagogy does not advocate any predetermined 'progress' on how teaching and learning should take place.

In practical situations, a fundamental paradigm shift is unlikely to occur immediately. However, ineffective teaching today, teachers can recognize components of a non-linear pedagogical approach (such as exploration through variety, emphasis on creativity, limited adaptability, and focus on the person). The advancement of non-linear pedagogy, such as TGFU and other Physical Education pedagogies, is based on its admission to the school. Therefore, the path forward is not simple. However, we have embarked on this effort to explore the potential non-linearity that can be provided to help young people acquire motor skills more effectively and meaningfully. The responsibility of the Physical Education practitioners is to recognize the relevance of non-linear pedagogy in achieving a comprehensive approach to the student skill development and enhancing certain features, such as decision making and autonomy. Future studies might focus on developing more practical examples of utilizing this point of view in various activities and sports.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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