Article

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Posted Date: 26 September 2023

doi: 10.20944/preprints202309.1595.v1

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Examine the Effects of a Reproduction and Production Teaching Styles Interventions in Primary Schoolchildren. What implications for Physical Education Teachers?

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Abstract: In recent years the study of the teacher-student relationship in the teaching-learning processes in physical education has had great emphasis. Previous studies have shown that the use of the Spectrum of teaching Styles can enhance intrinsic motivation, enjoyment, adherence to physical activity and physical activity levels in children and adolescents. The present study aims to assess if a physical education (PE) intervention based on the variations in teaching styles, with reference to production ones, can also have positive effects on physical fitness. The sample involved 4 primary school classes (n = 124 children, mean age = 8-10 years) recruited from the SBAM (Health, Wellness, Food Education and Movement at School) Project in Apulia, Southern Italy. Classes were randomly assigned to Experimental Group (EG) and Control Group (CG). EG followed a 5months experimental intervention based on the variation of teaching styles, while CG performed regular PE lessons. Physical fitness test was assessed with Standing Long Jump (SLJ), Medicine Ball Throw 1kg (MBT), and 20m sprint (20m), while two validated questionnaires were used to evaluate physical self-perception (PSP) and enjoyment. A 2x2 (intervention group x time) ANOVA was carried out to assess significant difference and interaction effect pre (t_0) and post (t_1) intervention protocol. Data analysis showed a significant improvement of physical fitness in both EG and CG, while PSP and enjoyment increased only in EG. Moreover, significant interaction ($p<.05$) effects were found for 20m sprint, PSP and Enjoyment with low effect size ($\eta^2 \sim .20$). The results of the present study highlight the effectiveness of a PE intervention based on the variation of teaching styles in improving physical fitness, self-perception, and enjoyment. Moreover, the use of production teaching styles significantly impacts self-perception and enjoyment, that are important mediating factors for guarantee better adherence to physical activity.

Keywords: teaching styles; model-based practice in physical education; physical fitness

1. Introduction

The fundamental role of Physical Education (PE) for children's educational process is well recognized by international literature [1–3]. In recent years, the Mode-Based Practice in Physical Education (has been conceptualized as an umbrella term for describing teaching and learning in PE through different pedagogical approaches and models (e.g., Direct Instruction, Personalized System for Instruction, Cooperative Learning, Sport Education, Physical Literacy, Inquiry Teaching, etc.) [4,5]. According to Pill, SueSee & Davies [6] the Spectrum of Teaching Styles [7] represents "*an approach centered around decision-making between the teacher and the learner about the 'how', 'when' and 'why' of their*

pedagogical decisions" (p.2), and it can be considered a Pedagogical Models in PE. In fact, the didactic-educational process in physical education is based not only on the motor tasks', equipment's, and spaces' analysis, but, above all, on the study of teacher-student(s) and student(s)-environment relations [8,9]. The choice of the modalities and strategies with which PE teacher propose motor tasks allow to activate (or inhibit) the mediation functions needed to enhance children's motor learning and promote healthy lifestyles [10–12]. Moreover, the bodily motor experience through different and differentiated motor tasks and organizational methods defines significant links and connections for disciplinary, interdisciplinary, and transversal learning. In this sense, the Spectrum of Teaching Styles can be considered a Pedagogical Model due to possibility to promote different way of learning and personalize the didactic action [7,13,14]. Moreover, in each lesson the proposal of a certain motor tasks (or the organization of an activity) through the intentional variation of educational communication and teaching styles led to the development of the physical, social, emotional, and cognitive channel [6,7,13].

The intentional and programmed proposal of executive variants related to motor tasks is modulated and adapted through the interaction of teaching styles [7] which have different effects on children's learning processes. The interaction of teaching styles and strategies, in fact, allows to promote different ways of access to skills and knowledge (e.g., different ways of learning, for reception and for discovery/ problem solving), foster the connections between skills, knowledge, attitudes, functional to motor skills, promote the relationships between cognitive-motor and social functions, necessary for interdisciplinary learning, and customize the didactic action [15].The proposal of motor tasks containing expected executive variants prompts, on the part of the child, predefined and linear motor responses (that is, require closely related-dependent previous acquisitions that are requirements for subsequent learning).

On the contrary, the solicitation of motor responses and executive variants unusual, creative and the reworking of variants and skills already learned, even if in different contexts and situations, allows the child to proceed in the learning path in a reticular and autonomous way, not fully predefined or linear-sequential, allowing autonomous management of space-time-quantitative-qualitative constraints [16,17].

In recent years, research on teaching styles in physical education has been mainly oriented to the study of teachers perceived used of teaching styles [18–21] and to the effects on children's motor skills learning [22–25], and goal orientation, motivation, and participation in PE [26–29].

Moreover, the development of cognitive psychology has opened new research fields aiming at studying which functions can provide a better adherence to physical activity during lifetime [30,31]. The knowledge and the identification of variables for promoting physical activity are necessary for ensuring the achievement of the strategic development aims of the Global Action Plan on Physical Activity 2018-2030 [32].

In fact, according to international literature self-perception and enjoyment of bodily-movement experiences are important mediating factors that can promote and ensure better adherence to physical activity and healthy lifestyles from infancy to adulthood [33–37].

The physical self-perception comes from the individual's experience with the environment and the way such experiences are lived: positive motor experiences in which children successfully experience a wide repertoire of activities and executive variants of motor tasks, enrich the individual body experience, that is, the experiences concretely carried out through the body and movement [10,38–48]. An essential condition for the educational process is the proposal of activities through teaching styles of production in which each student can independently experience different ways of performing a motor task and find the better solution to teacher's questions [7]. Findings revealed that basic psychological needs' satisfaction plays a key role in predicting adherence to physical activity and maintain higher motivation to be physically active [41]. This is true in different contexts and applications of physical activity, involving school physical education, leisure time (i.e., running, walking, fitness activity, sport (i.e., basketball, volleyball, soccer, martial arts, and adapted physical activity [42–46]. The study of Sum et al. (2022) has demonstrated that PE teachers' behavior and different teacher-student(s) communication can positive influence students perceived physical

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literacy, motivation and enjoyment when practicing physical activity [47]. Moreover, in educational setting, school-based lunchtime games intervention can increase mental well-being and perceived self-efficacy [48], while higher levels of academic stress are associate with increased amotivation that negatively affects the participation in physical education [27,49]. Form the PE teacher's perspective the use of production teaching styles can have positive effects on students' affective-emotional perception and foster time spent in physical activity [42,50].

Although much of the scientific research has been oriented to assessing how the use of different teaching styles (especially production ones) can encourage the onset of motivation, the self-perception and enjoyment during practice, the relationship between teaching styles and the promotion of physical fitness plays a priority role during developmental age.

Invernizzi et al. (2019) highlight increased physical fitness, motor competence, enjoyment and time spent in physical activity applying a 12-week multi-teaching styles interventions in primary schoolchildren [51]. Similarly, Komatni (2022) reported significant interaction effect between learning approach and motor skills development in enhancing children's physical fitness [52]. In fact, physical education lessons based on a task-based approach with higher levels of motor skills are positively associated with better physical fitness (body composition, hand muscle strength, endurance, flexibility, and cardiopulmonary endurance) compared to a command-based approach. Moreover, alternative, and non-traditional teaching approaches in physical education, such as Teaching Games for Understanding (TGfU), Project-Based Learning (PBL), and Collaborative Learning (CL) have proved to be effective in promoting not only academic achievement and enjoyment, but also physical fitness [53].

In the light of these evidence, this study aims to demonstrate the effectiveness of an PE intervention based on production teaching styles in promoting physical fitness, self-perception, and enjoyment in primary school children.

2. Materials and Methods

2.1. Sample

The study involved four primary school classes for a total of 124 children aged 8-10 years (M= 62, F= 62; main age= 9,21±0,19). The sample was recruited by one school that joined the SBAM - *Health, Wellness, Food Education and Movement at School* - Project [54] in Apulia (Southern Italy), coordinated by the University of Foggia. As required by University of Foggia procedure, informed consent was obtained from all participants to collect data. **Table 1** reported the sample's descriptive profile.

Table 1. Sample's Anthropometric Characteristics.

		Sample								
		Female			Male			Total Sample		
		N	Mea n	SD	N	Mean	SD	N	Mea n	SD
Control	*Age*	31	9,23	,42	31	9,23	,66	62	9,23	,55
	Weigh t	31	38,1 0	8,58	31	40,00	13,2 5	62	39,0 5	11,1 1
	Height	31	1,37 90	,074	31	1,38	,073	62	1,38	,073
	BMI	31	19,8 7	3,59	31	20,45	5,03	62	20,1 6	4,34
Experime ntal	*Age*	31	9,39	,61	31	9,03	1,85	62	9,21	1,38

 doi:10.20944/preprints202309.1595.v1

Weigh t	31	37,74	11,15	31	37,81	11,16	62	37,77	11,06
Height	31	1,370	,084	31	1,37	,080	62	1,37	,081
BMI	31	19,78	4,17	31	19,78	4,80	62	19,78	4,46

2.2. Procedure

A simple randomization procedure was applied to recruit the sample and to assign two classes in the Experimental Group (EG) and two in the Control Group (CG). Physical education lessons based on the variation of teaching styles (both reproduction and production) were proposed to the EG by Experts Graduated in Preventive and Adapted Motor Activities (n= 5) together with the generalist teacher, while CG performed PE lessons with the generalist teachers regularly.

The graduates in motor science (EG) were properly trained on the themes of teaching styles, on the proposal of motor tasks through different styles of teaching before the study started (5 meetings x 4h). Moreover, before the intervention, the learning units, the organizational modalities, and the motor tasks were shared with the Experts involved in the EG. Both Experts (EG) and Generalist Teachers (CG) were informed of the topics to be covered during PE lessons from January to May 2022 (2 hours x 16 weeks, for a total of 32 actual hours of intervention), as follows (**Table 2**):

a) Motor skills and small tools: the space-time executive variants (8 PE lessons);
b) Group games and space-time orientation (8 PE lessons);
c) Expressiveness and dramatization (8 PE lessons);
d) Motor coordination (8 PE lessons).

Table 2. Description of learning units.

Topics	Aims	Contents and Organizational Modalities	Teaching Styles
Motor skills and small tools: the space-time executive variants	➢ Perform basic motor skills and executive variants with the use of small tools; ➢ Discover and distinguish the specific use of tools in PE; ➢ Distinguish the rules of the proposed activities;	Individual and in pairs motor tasks with small tools (circle and ball,) considering the dynamic/stationary relation between them;	• Guided-discovery style; • Practice style;
Group games and space-time orientation	➢ Anticipate the course and outcome of an action; ➢ Perform and vary motor skills in minimum time; ➢ Organize a group game; ➢ Compare and apply different rules;	Ball games preparatory to team game;	• Practice style; • Guided-disvoery style; • Divergent discovery style;

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Expressiveness and dramatization	➢ Express emotions through body and movement; ➢ Produce unusual and creative gesture; ➢ Discover the rules of mimic-gestural communication; ➢ Represent and graphically rework the body-motor experience lived;	Symbolic interpretation of emotions through gestures and postures; Games of imitation, representation and body expression.	• Guided-disvovery style; • Divergent discovery style;
Motor coordination	➢ Combine motor skills according to spatial and temporal constraints; ➢ Perform motor skills according to strength and speed parameters; ➢ Analyze, self-assess and verbalize the motor experience;	Tasks in pairs of motor combination and spatial-temporal differentiation also with the use of small tools; Paths with specific interactions of basic motor skills and executive variants;	• Practice style; • Inlcusion style; • Guided-discovery style; • Divergent doscovery style;

The EG performed each lesson using guided discovery, convergent and divergent production styles (for about 60% of each PE lesson), predominantly; moreover, reproduction styles (practice and inclusion) were also integrated and modulated in each lesson. The CG performed PE lessons with the practice and command style, mainly.

The choice of teaching styles also reflects the diversity of organizational ways in which the motor tasks were proposed. In the EG individual, pairs, small groups and with small tools motor tasks were proposed varying the spaces, the tools, and the execution modes, and soliciting individual children's motor answers. On the contrary, group games, motor tasks organized in paths and circuits were used in CG. However, a list of descriptors of teacher's behavior for the teaching styles used in this study has been carried out through to implement educational communication and propose motor tasks (**Tables 3 and 4**).

Table 3. Descriptors of teacher's behavior for Reproduction Teaching Styles.

Reproduction Teaching Styles	Teachers' Behaviour	Students' Behaviour
Practice Style	The teacher… a) presents the motor task and communicates the learning objective; b) prepares the organizational modalities and the operating spaces (individual tasks, in	The students… a) perform the task independently; b) memorize motor sequences; c) acquire and repeat executive variants; gain awareness of the learning process and feedback.

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	pairs, paths, relay, circuits, in which the use of small tools is also provided; group and team games; etc.); the executive variants are predefined and few numerous; c) prepares the organization of sub-groups; d) indicates the execution methods, the serial number, repetitions, the intensity of the task and the executive difficulty on which to exercise; e) communicates the criteria for success of the task; f) corrects the error directly and indirectly.	
Inclusion Style	The teacher… a) presents the motor task and sets out the learning objective; b) presents the executive and organizational modalities, according to different levels of difficulty/intensity, increasing or reducing the number of executive variants and the use of tools; c) adapt the motor task through the executive variants, according to the needs of the students; d) communicates the relationships between motor skills performed/requests and related motor skills; e) corrects the error directly and indirectly.	The students… a) Design a range of options to allow the start of activities for all students / one and the same task; b) respect individual differences; choose the level of difficulty to practice; c) perform motor tasks according to different levels of difficulty; d) encourage continuous participation and increase uptime; e) foster and develop the self-assessment process

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Table 4. Descriptors of teacher's behavior for Production Teaching Styles.

Production Teaching Styles	Teachers' Behaviour	Students' Behavior
Guided Discovery	The teacher… a) Enunciates the objective, presents the motor task and recalls motor skills already acquired (in formal and non-formal contexts); b) It proposes a motor task and asks questions about the possible spatial-temporal-qualitative-qualitative executive variants /ways of using a tool/management of spaces and environments; c) It proposes a motor task and urges the discovery of analogies and differences with other tasks/tools/activities through questions and stimulus situations (in how many ways? How can you?); d) Requires the repetition of the motor task without repeating the same task but independently discovering the executive variants; e) Communicate interrogative/descriptive feedback to the student. Eg., in how many ways can we.... throw forward? (standing, sitting, walking, running, one hand, two hands from above, long-short, far-near, inside-out a circle, a target; after receiving the ball from... How many ways can we... jump through the circles in succession? (equal feet	The students… a) discover the executive variants of a task, a tool, a space (multilaterality); b) identify the relationships between the executive variants of a task and similar executive modes of different tasks; c) develop different motor responses, original, creative, transferable to other learning.

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	joined, forward-backward; one foot, even feet joined-apart, etc.).	
Divergent Disovery	The teacher… a) Communicates the objective, presents the motor task and recalls the motor skills already acquired; b) Proposes the execution of a motor task and solicits open, divergent motor responses (Who can...? In how many other ways is it possible... launch if I am in this position? ....) c) Asks questions and solicits open motor answers, in which each student is autonomous in the use of any skills /position choice, etc.); d) Asks questions and solicits motor answers through combinations of executive variants; e) Proposes motor tasks within space-time constraints; f) Communicate interrogative/descriptive feedback to the student. Eg., who can... move between circles... without walking or jumping? [quadrupedia]; In pairs, how to move forward in a defined space... without using legs?... [wheelbarrow game]; how to represent a story using only postures and gestures?	The students… a) Discover motor solutions consistent with the problem posed by the teacher; b) It identifies unusual, creative motor responses; it reworks previous modes of execution, through new executive variants and new relationships between variants;

2.3. Assessment

In addition to sample's anthropometric data collection (age, weight, height, and BMI), Cole's Scale was used to classify children as normal weight, overweight or obese [55].

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Physical fitness was assessed with the following motor tests: standing long jump (SLG), Medicine Ball Throw 1Kg (MBT), and 20m Speed (20m) [56–58]. Self-perception and enjoyment were evaluated with two validated questionnaires, Physical Self Efficacy Scale for Children [59] and Physical Activity Enjoyment Scale [60]. Physical fitness (lower limb strength, endurance, and speed) was evaluated during curricular physical education lessons two weeks before (t_0) and after (t1) the 5-month teaching intervention by Experts in Preventive and Adapted Physical Activity, while questionnaires were proposed both by generalist and Experts in the classroom.

2.4. Statistical Analysis

Descriptive statistics was carried out for all variables pre- and post-intervention. Independent t-test was uses to assess pre-intervention differences between EG and CG. A mixed methods repeated measures ANOVA (analysis of variance) was performed to evaluate differences in all physical fitness test, self-perception, and enjoyment after 20 weeks of intervention with a Group (EG - CG) x Time (t_0 – t_1) mixed model. Effect size was estimated with partial eta squared, as follows: η^2 ~. 20 = low, η^2 ~. 50 = medium and η^2~. 80 = high [61]. Significant index was set at p value less than 0.05. All statistical analysis were performed using SPSS vers. 26 (Chicago, IL, USA).

3. Results

Since almost the entire sample is normal weight, no differences in BMI were reported. No significant difference in physical fitness test, self-perception and enjoyment were found between EG and CG pre-intervention (t_0) (**Table 5**).

Table 5. Difference between EG and CG pre-intervention. PSP = physical self-perception, PACES = Enjoyment. .

Independent T-Test (t_0)														
						Levene's Test		t-Test for Equality of Means					95% CI	
	Group	N	Mean	SD	Mean SE	F	Sig.	t	gl	Sig.	Mean Dif.	SE Dif	Lower	Upper
SLJ	CG	62	1,17	,25	,032	,003	,953	1,196	122	,234	,05	,045	-,03	,14
	EG	62	1,12	,25	,031									
MBT	CG	62	3,9	,94	,12	,017	,897	-1,320	122	,189	-,23	,175	-,57	,11
	EG	62	4,23	,99	,12									
20m	CG	62	5,31	,63	,08	,016	,899	2,416	122	,117	,27	,11	,048	,49
	EG	62	5,04	,61	,07									
PSP	CG	62	16,65	3,40	,43	,341	,560	,923	122	,358	,53	,57	-,60	1,67
	EG	62	16,11	2,98	,38									
PACES	CG	62	35,24	5,10	,64	1,173	,281	-2,520	122	,113	-2,42	,96	-4,33	-,52
	EG	62	37,67	5,61	,71									

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The results of the 2x2 ANOVA (intervention group x time) show a statistically significant improvement in both the EG and the CG for physical fitness tests (**Table 6**). After the 16-week intervention protocol, better performances were recorded in both groups in the SLJ, MBT and 20m sprint (p<. 05). Moreover, post-intervention EG performed better in MBT and 20m than CG, while CG showed higher performance in SLJ.

Table 6. Pre- and post-intervention assessment. * = significant difference between t_0-t_1.

Differences pre-post intervention and interaction effects										
Measures	**Experimental Group (n=62)**				**Control Group (n=62)**				**Intervention x time p-value**	**η^2**
	t_0		**t_1**		**t_0**		**t_1**			
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*		
SLJ	1,12	,25	1,19*	,23	1,17	,25	1,22*	,23	,325	,016
MBT	4,23	,99	4,34*	1,01	3,99	,94	4,21*	,99	,143	,035
20m	5,04	,61	4,82*	,67	5,31	,63	4,85*	,61	,005	,124
PSP	16,11	2,99	17,68*	2,69	16,65	3,40	16,21	2,93	,000	,225
Enjoyment	37,67	5,61	39,73*	4,50	35,24	5,10	35,85	5,08	,040	,057

However, there was a non-significant interaction effect between intervention group and time for lower (SLJ) and upper (MBT) limbs strength (p= .325; p= .143). The 20m sprint analysis showed a significant intervention x time effect (p= .005) with low effect size (η^2 = .125).

Physical self-perception and enjoyment significantly increased in EG (p< .05), but not in CG. Also, significant interaction effect was found for both variables (p= .000), with an effect size of η^2 = .225 for physical self-perception, and η^2 = .057 for enjoyment.

4. Discussion

The results of the study revealed differences in motor performance and self-report scores for physical fitness, physical self-perception, and enjoyment after an experimental intervention based on the variation of teaching styles. Although the results showed a significant improvement of the components of physical fitness in the EG and CG, the factors related to the practice of physical activity (self-perception and enjoyment) improved only in the EG. This is important in the didactic field of physical education, from which a series of considerations may derive.

In fact, in EG children received more opportunities to choose and experiment with executive variants and motor responses, and this could lead not only to the development of physical fitness components (strength and speed), but also to the enhancement of motor coordination and to a greater perception of competence and enjoyment during practice than CG.

The development of self-perception and enjoyment are interdependent, and they arise from the results of successful motor tasks performed and the corresponding determined traces in the individual motor repertoire [7,62,63]. The ways in which teaching styles vary and are interconnected are crucial for assessing the effects on motor learning and related psychological factors. They are not opposite but complementary: the continuum between the styles of reproduction and production is based on the relationship between the decision-making processes of the teacher and those of the student [16,64,65]

Production styles promote the development of motor coordination and related psychological factors, essential components of motor skills and the study carried out highlighted. Previous studies in primary school have demonstrated the effects of variation in teaching styles (e.g., inclusion and practice) in a test/re-test intervention related to self-perception [66].

Morgan et al. (2005) highlighted that production styles (e.g., the guided discovery style) promote cognitive and affective responses compared to the use of reproduction styles (e.g., practice style) [62].

 doi:10.20944/preprints202309.1595.v1

Recently, Rivera-Pérez et al. (2020) has shown how the proposal of motor tasks with the teaching strategy of cooperative learning, both with reproduction (reciprocal and self-check styles) and production teaching styles (divergent discovery style) - promotes the development of emotional skills (emotional recognition, control and regulation of emotions, empathy) in children and adolescents [67]. The development of lateral thinking, empathic and socio-relational skills of the child, as well as the construction of positive and constructive interactions within the group-class should be solicited more in primary school, for the acquisition of the values related to the motor experience in the different organizational modalities [67]. In fact, the choice of teaching style has a strong impact on the way children learn (imitation; conditioning; tests and errors; intuition; understanding) and perform a motor task [6]. In this sense, the variation of teaching styles in physical education and, more generally, in the field of motor activities, should be encouraged to solicit multiple and different cognitive abilities and ways of thinking of children [68].

Furthermore, there are differences between generalist and specialist teachers in the mastery of teaching styles and in the variation of content and this affects the children's learning processes and the quality of the motor experience. A recent study has highlighted different methodological approach between the teachers themselves according to the type of degree in physical education and sports sciences: sports science teachers' degree mainly used the command style, while those with physical education degree (or both PE and sports sciences degree) applied different and differentiated teaching styles and strategies [69]. In addition, the study of da Silva et al. (2020) highlights how production styles foster the learning of sports-oriented skills of team sports, being closely related to several factors, such as the ability to make decisions, select appropriate motor responses, and be active and participate in different game situations [70]. Another study assessed the effects of two learning units, based on the command style and guided-discovery style, respectively, on the acquisition of gymnastic technical skills in primary school children [71]. Although learning outcomes are similar in both groups, the guided-discovery style allows for greater learning retention in the medium to long term than that of command style [71].

5. Conclusions

The present study highlights the effectiveness of the variation of teaching styles in PE to improve not only physical fitness, but also self-perception and enjoyment, that are correlates for guarantee better adherence to physical activity during lifetime. It has been showed that different teaching styles have different (but complementary) effects, both physical and motivational, on children. However, the following limitations can be underlined: (a) sample's age (8-10 years) has not been considered as covariate, (b) the effect of BMI (normal weight, overweight, obese) has not been analyzed, (c) small sample, and (d) no evaluation of retention effect. Moreover, it might be important to analyze the mastery and knowledge of the teaching styles of specialist PE teachers before starting the experimental activities.

The study stressed the importance of adequate PE teachers training on the use of teaching styles in the didactic of motor activities. Physical education teacher training, in fact, should provide a significant importance in the university curriculum on the topics of the methodology of motor activities and the introduction to sport in the developmental age to highlight the effects on the formation of the person not only determined by the variety of content and organizational arrangements but, above all, determined by changes in the modalities of educational communication (methodology). Future research are needed to analyze the effects related to the use of teaching styles in different educational settings.

Supplementary Materials: The following supporting information can be downloaded at the website of this paper posted on Preprints.org. Figure S1: title; Table S1: title; Video S1: title.

Author Contributions: Conceptualization, D.M. and D.C.; methodology, S.A.; software, D.M; formal analysis, D.M.; investigation, S.A.; data curation, D.M. and S.A.; writing—original draft preparation, D.M and S.A.; writing—review and editing, D.C.; visualization, P.L.; supervision, P.L.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Conflicts of Interest: The authors declare no conflict of interest.

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