Original Article

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Non-linear didactic technology-based intervention to enhance basic motor competencies with MOBAK-5: a pilot study in primary school

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Authors' Contribution: A – Study Design, B – Data Collection, C – Statistical Analysis, D – Manuscript Preparation, E – Funds Collection

Abstract

Introduction: Technologies in physical education, as Exergames (EXGs) or Active Videogames (AVGs), represent a useful tool to increase levels of physical activity and reduce sedentary behavior, but their effectiveness on motor competence development is still unclear. The aim of the study is to gain new knowledge about the development of motor competences, assessed under two different experimental conditions: (a) technology-based intervention protocol without teacher mediation, and (b) technology-based intervention with teacher mediation, based on the variation of teaching styles in a non-linear didactic approach. *Material and methods:* The sample consisted of 120 primary school children, ranged from 10 to 11 years, divided in Normal weight (Nw) and Overweight-Obese (Ow-Ob), according to BMI, and assigned to Experimental Group (EG) and Control Group (CG). EG followed a non-linear didactic approach, based on the use of different teaching styles, proposing different variants of motor tasks, and soliciting various learning methods, while in CG teachers explained and demonstrated only one variant of the proposed task, with children practicing and performing sequentially what was proposed. Motor competencies development was assessed with MOBAK-5, pre- and after one week at the end of intervention. *Results:* Evidenced positive effects on both Nw and Ow-Ob groups in EG, and on total sample, improving scores in all MOBAK subtest and total motor qualifications, while less positive effects can be observed in Control group for Normal-weight sample. *Discussion:* The integration of technology into physical education lessons, combined with non-linear didactics approaches represents an innovative and effective way to develop motor competencies in primary school. However, further studies are needed to confirm the results of this study.

Keywords: non-linear didactic; teaching styles; obesity; technology; physical education.

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INTRODUCTION

The integration of technology in the field of education is gradually changing teaching methodologies [1], representing a useful tool for student's learning enhancement and engagement [2,3]. Studies reveals that technology based didactic can be effective in reinforce curricular learnings, such as math and geography [4] or foreign languages [5], creating motivating and enjoyable learning experiences [6-8]. Technologies reached great attention and importance even in the field of physical education and physical activity [9] with the development of Exergames (EXGs) and Active Videogames (AVGs), as digital games to reduce time spent in sedentary activity [10,11], and assessment tools (pedometers, heart rate monitors and accelerometers) to monitor physical activity levels and energy expenditure [12].

The introduction of technologies in physical education contributes to define a hybrid learning environment, in which traditional equipment is integrated and combined with innovative tools expanding the didactic setting. Technology-based intervention on physical fitness and health-related status have been documented by international literature, especially in improving time spent in moderate to vigorous physical activity [13], promoting greater aerobic capacity and cardiovascular health [14], balance and proprioception [15].

Effects of EXGs and AVGs showed also significative positive effects on motivation in learning, socio-relational competencies and cognitive engagement during and post practice [16,17]. Although studies highlighted positive relationship between EXG practice and energy expenditure, together with the development of motivational factors, effects on motor competencies development remains unclear [15]. In school setting interventions aimed at enhancing quality of physical education and motor competencies development required an accurate analysis strategies, activities and methodological-didactical approaches used.

The non-linear didactic approach can characterize the activities that the child spontaneously carries out in school and outdoor contexts but can be intentionally mediated by the teacher to guide the student's learning process, for discovery, problem solving and to promote self-perception. and enjoyment, generating both motor executions functional to the personal repertoire of motor competencies and the prerequisites and interconnections for subsequent learning [18]

The effects of non-linear approach involve (a) personalization of the motor task (different learning times; duration, difficulty-intensity), (b) autonomy in the choice of executive variants and motor responses: originality and motor creativity, (c) interconnections between learning, and (d) inclusion and didactic obliquity. The learning process, from this perspective, is understood as a more complex process, linked to the variations of the constraints emerging from the environment and is the consequence of the interactions between motor task, child and environment [18]

International literature showed that (a) motor competencies are inversely correlated with BMI [19], (b) positive association between motor competence, time spent in moderate to vigorous physical activity and total physical activity [20], and (c) moderate association with physical self-perception [21].

MOBAK - Basic Motor Competencies in Europe - Assessment and Promotion (Application 2018/2019) is the European project in which the University of Foggia participates, aimed at studying the motor development of the child. The project is promoted as part of Erasmus + Sport and aims to study the motor development of the child and the related psycho-pedagogical and methodological factors, to develop a training process for teachers and Experts Graduates in Motor and Sports Sciences, on teaching methodologies and motor assessment protocols, to promote education to corporeality and daily motor activities, to acquire and maintain healthy lifestyles [22]. The MOBAK test instruments aim to assess the status and the development of basic motor competencies in children, helping teachers and educators to improve teaching-learning process. Actually, four MOBAK test instrument are been developed: the MOBAK-1-2, designed for 6- to 7-year-old children, MOBAK-3-4 for 8- to 9-year-old children and the MOBAK-5-6 for 10- to 11-year-old children, while MOBAK-KG (kindergartener) is still being developed [23].

The aim of the study is to gain new knowledge about the development of motor competences, assessed under two different experimental conditions: (a) technology-based intervention protocol without teacher mediation, and (b) technology-based intervention with teacher mediation, based on the variation of teaching styles in a non-linear didactic approach.

MATERIAL AND METHODS

Participants

The sample consisted of 120 primary school children (F: 54; M: 66), ranged from 10 to 11 years, divided in Experimental Group (EG) and Control Group (CG). The sample has been recruited in an experimental pilot project promoted by the Didactic Laboratory of Motor Activities of the University of Foggia, Apulia Region, in the South of Italy. Four classes were randomly selected from school: two took part in EG, and two in CG. The summary of anthropometrics characteristics of the sample is contained in Table 1. The program was structured to implement technology into curricular physical education lessons to assess (a) motor competences development according to Nw (Normal Weight) and Ow-Ob (Overweight-Obese) BMI; (b) the effect of technology-based intervention and teaching styles on motor competences development according to BMI; (c) verify the feasibility and acceptability of physical education programs integrated with technology.

Procedure

The project was introduced and proposed to the school in October 2019, after having agreed the organizational and implementation methods with the school manager. The project was carried out in November 2019 for eight weeks. The intervention protocol provided the proposal of different variants of motor tasks based on MOBAK-5 [24-25] basic motor competences, combined with fitness exercises, sport-specific competencies, but also elements related to food education, health education and other curricular learning. Both experimental and control groups provided for the use of video-projector in the gym, through videos structured on the basis of two areas of basic motor qualifications: object movement and self-movement. For each video have been structured 3 levels of increasing difficulty and intensity. In EG teachers used different teaching styles (guided discovery, convergent and divergent discovery), according to Mosston & Ashworth [26], proposing different variants of motor tasks, and soliciting various learning methods; in CG teachers explained and demonstrated only one variant of the proposed task, with children practicing and performing sequentially what was proposed.

Motor tasks were proposed both to the EG and CG through the support of videos that expanded the gym setting quantitatively and qualitatively. In EG the teacher urged the individual discovery of executive variants (expected variants) of the projected tasks, orienting, according to a non-linear approach [27] the links between the variants to favor the development of motor competencies (eg: forward-fast; loud-softly; inside-out). In addition, the teacher urged the students to solve motor problems through open and unusual, creative motor executions (responses), based on the individual repertoire, in which the systematic variation of the response was required for the same task or for different tasks (Figure 1A). Non-linear didactic approach led students to develop different learning methods and creative motor responses [28]. The CG was offered motor tasks and organizational methods through reproduction styles (practice style), with a reduced number of predefined and linear-sequential executive variants (Figure 1B). The video-intervention provided the following lesson structure:

- initial warm-up phase at lower intensity (individual or pairs activities);
- central phase of the lesson, during which children were divided into two groups: (a) experts in PE proposed playful activities that include one or more basic motor competencies with technology, both EG and CG; (b) circuit activities proposed by generalist teachers, alternating activities (a) and (b) every 10 minutes for 3 times;
- final phase alternating team games and recovery.

Table 1. Sample's Anthropometric Characteristics.

Group	Subgroup	N	Age [year] Mean ± SD	Weight [kg] Mean ± SD	Height [m] Mean ± SD	BMI Mean ± SD
Experimental	Nw	35	10.11±0.32	35.40±5.68	1.42±0.05	17.37±2.17
	Ow-Ob	25	10.80±0.27	50.70±7.98	1.42±0.06	24.87±3.55
Control	Nw	36	10.08±0.37	34.60±3.32	1.42±0.20	16.07±2.12
	Ow-Ob	24	10.06±0.21	49.52±8.67	1.45±0..6	25.03±3.20

Nw - Normal Weight, Ow-Ob - Overweight-Obese

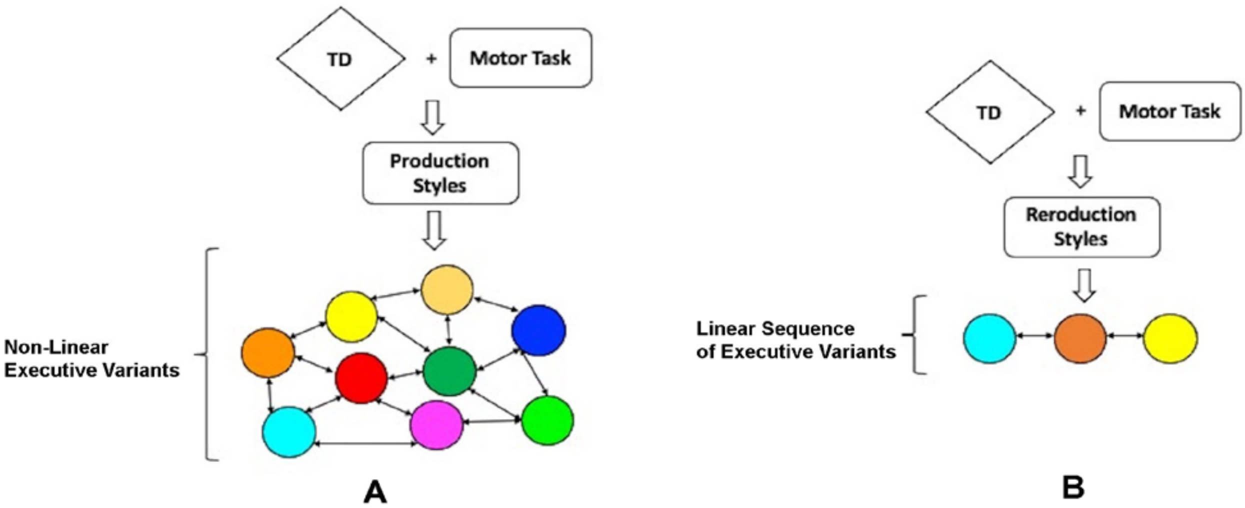

Figure 1. A - Motor Tasks based on TD (Technological devices) using production styles to generate non-linear and reticular learning of executive variants. B - Motor Tasks based on TD (Technological devices) using reproduction styles learning executive variants in a linear sequence

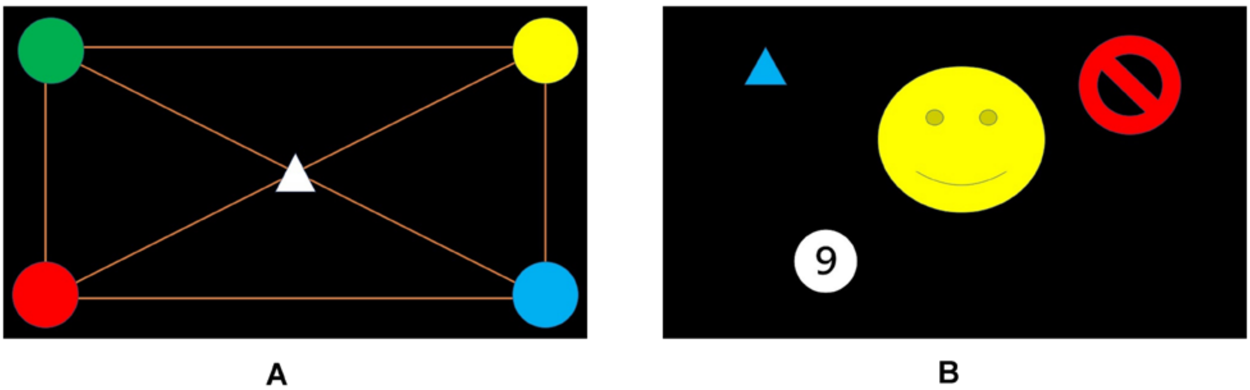

Figure 2. A - Motor Task asked children to move following white triangle movement through rings (green, red, yellow and blue). B - Motor Task asked children to hit or not to hit different targets appearing randomly

Experts in PE conducted only technology-based intervention, while all other activities were conducted by generalist teachers. Intervention took place two times a week during curricular physical education lessons. Figure 2 shows an example of a motor task in which children are asked to (a) follow the movements of the cursor (white triangle) through different gaits and basic motor patterns (running, side gallop, rolling, crawling, dribbling, jumping, etc.) and (b) hit the targets experimenting different launch modes, starting positions, distances. Assessment was conducted pre- and after one week at the end of intervention. Five experts in PE were directly recruited by the Didactic Laboratory of Motor Activities, in order to (a) assist the generalist teacher; (b) test and evaluate students; (c) use different teaching styles to mediate the transposition of the contents from the video to the class, in a non-linear didactic model [18,28].

Measures

The sample was divided into two groups according to BMI differences: normal weight (Nw) and overweight-obese (Ow-Ob) [29]. MOBAK 5-6 is a test instrument assesses basic motor qualifications in fifth and sixth grade school [24-25], divided in two areas of competence: object movement (Throwing, Throwing & Catching, Bouncing, Dribbling) and self-movement (Balancing, Rolling, Rope Skipping, Moving Variably). Scores in each test range from 0-2 points, with a minimum of

0 points to a maximum of 8 points in each area. The sum of scores of the two areas. (maximum 16) give results about total basic motor qualifications. Each subtest includes two attempts, with the following results: 2 attempts failed = 0 points, 1 successful attempt = 1 point, both successful attempts = 2 points. Only Throwing and Throwing & Catching provide for six attempts, and results are so obtained: 0-2 hits = 0 points, 3-4 hits = 1 pints, 5-6 hits = 2 points. The tests were carried out after the description and one demonstration by the teacher, as required by assessment protocol.

Statistical Analysis

In addition to descriptive statistics (M±SD), Shapiro-Wilk test was performed to assess normality of data. Since data violates the assumption of normality, Wilcoxon Signed-Rank nonparametric test was used to compare MOBAK items before and after intervention protocol, both on CutOff Groups (Normal Weight and Overweight-Obese) and on total sample. Mann-Whitney U-Test was performed to compare variables between Nw and Ow-Ob group, pre/post intervention. All significant indexes were set at $p<0.05$. Data analysis was carried out with SPSS version 25.0 for Windows (Chicago, IL, USA).

RESULTS

Results evidenced positive effects of intervention protocol on both categories in EG and on total sample, improving scores in all MOBAK subtest and total motor qualifications, while less positive effects can be observed in Control group for Normal-weight sample (bouncing, balancing, object control, self-movement and BMQ), Overweight-Obese (throwing, bouncing, balancing, self-movement and BMQ), and total sample (throwing & catching, balancing, object control, self-movement and BMQ).

Table 2. Differences in MOBAK-5 Assessment pre-post intervention (t_0 – t_1) in experimental and control group.

Measures	Experimental Group									Control Group								
	Nw			Ow-Ob			Tot			Nw			Ow-Ob			Tot		
	M	SD	p	M	SD	p	M	SD	p	M	SD	p	M	SD	p	M	SD	p
Thrw t_0	0.11	0.32	0.00	0.20	0.40	0.00	0.15	0.36	0.00	0.40	0.6	0.62	0.64	0.70	0.01	0.50	0.65	0.12
Thrw t_1	1.11	0.75		1.08	0.70		1.10	0.73		0.46	0.56		0.20	0.40		0.35	0.51	
Thrw & Cat t_0	0.29	0.57	0.00	0.08	0.27	0.015	0.20	0.48	0.00	0.40	0.73	0.79	0.12	0.33	0.09	0.28	0.61	0.48
Thrw & Cat t_1	0.83	0.89		0.52	0.82		0.70	0.87		0.37	0.64		0.32	0.62		0.35	0.63	
Boun t_0	0.51	0.70	0.00	0.16	0.37	0.001	0.37	0.61	0.00	0.74	0.85	0.01	0.32	0.62	0.03	0.57	0.78	0.00
Boun t_1	1.29	0.78		0.88	0.92		1.12	0.86		1.14	0.87		0.72	0.89		0.97	0.90	
Dribbl t_0	0.14	0.43	0.00	0.16	0.47	0.00	0.15	0.44	0.00	0.29	0.62	0.03	0.2	0.5	0.71	0.25	0.57	0.06
Dribblt$_1$	0.66	0.72		0.72	0.73		0.68	0.72		0.49	0.78		0.24	0.59		0.38	0.71	
Blnc t_0	0.89	0.71	0.00	0.4	0.57	0.00	0.68	0.7	0.00	1.00	0.76	0.00	0.48	0.65	0.01	0.78	0.76	0.00
Blnc t_1	1.74	0.5		1.24	0.77		1.53	0.67		1.54	0.71		1.00	91		1.32	0.83	
Roll t_0	0.11	0.47	0.00	0.08	0.4	0.00	0.10	0.44	0.00	0.11	0.47	1.00	0.08	0.4	1.00	0.1	0.44	1.00
Roll t_1	0.57	0.65		0.56	0.65		0.57	0.64		0.11	0.47		0.08	0.4		0.1	0.44	
Rope Skip t_0	0.06	0.34	0.001	0.04	0.2	0.01	0.05	0.28	0.00	0.14	0.49	0.41	0.08	0.27	0.41	0.12	0.41	0.25
Rope Skip t_1	0.4	0.6		0.32	0.55		0.37	0.58		0.23	0.54		0.16	0.47		0.2	0.51	
Mov Var t_0	0.89	0.75	0.00	0.52	0.77	0.00	0.73	0.77	0.00	1.4	0.77	0.25	1.04	0.88	0.25	1.25	0.83	0.10
Mov Var t_1	1.63	0.6		1.36	0.86		1.52	0.72		1.57	0.69		1.36	0.9		1.48	0.79	
Ob Control t_0	1.06	1.21	0.00	0.60	1.11	0.00	0.87	1.18	0.00	1.83	1.68	0.02	1.28	1.3	0.36	1.6	1.55	0.02
Ob Control t_1	3.89	1.95		3.2	2.36		3.6	2.14		2.46	1.66		1.48	1.63		2.05	1.71	
Self-Movm t_0	1.94	1.49	0.00	1.04	1.36	0.00	1.57	1.5	0.00	2.66	1.55	0.00	1.68	1.49	0.01	2.25	1.6	0.00
Self- Movm t_1	4.34	1.32		3.48	1.93		3.98	1.65		3.46	1.52		2.6	1.52		3.1	1.57	
BMQ t_0	3	2.14	0.00	1.64	1.8	0.00	2.43	2.1	0.00	4.49	2.61	0.00	2.96	2.28	0.00	3.85	2.57	0.00
BMQ t_1	8.23	2.22		6.68	3.63		7.58	2.97		5.91	2.3		4.08	2.46		5.15	2.52	

Thrw - Throwing, Thrw & Cat - Throwing & Catching, Boun - Bouncing, Dribbl - Dribbling, Blnc - Balancing, Roll-Rolling, Rope Skip - Rope Skipping, Mov Var - Moving Variably, Ob Control - Object Control, Self-Movm - Self-Movement, BMQ- Basic Motor Qualifications; t_0 - pre-intervention, t_1 - post-intervention.

Table 3. P-value referred to MOBAK-5 Assessment comparing Nw and Ow-Ob Children both pre-post intervention (t_0- t_1)

Measures	Experimental Group		Control Group	
	t_0	t_1	t_0	t_1
Thrw	0.363	0.833	0.157	0.061
Thrw & Cat	0.121	0.158	0.147	0.713
Boun	0.035	0.086	0.042	0.072
Dribbl	0.936	0.731	0.656	0.175
Blnc	0.008	0.005	0.009	0.018
Roll	0.766	0.953	0.766	0.766
Rope Skip	0.828	0.599	0.888	0.587
Mov Var	0.051	0.283	0.112	0.466
Ob Control	0.079	0.183	0.243	0.019
Self-Movm	0.010	0.052	0.017	0.039
BMQ	0.005	0.035	0.027	0.010

Thrw - Throwing, Thrw & Cat - Throwing & Catching, Boun - Bouncing, Dribbl - Dribbling, Blnc - Balancing, Roll-Rolling, Rope Skip - Rope Skipping, Mov Var - Moving Variably, Ob Control - Object Control, Self-Movm - Self-Movement, BMQ- Basic Motor Qualifications; t_0 - pre-intervention, t_1 - post-intervention

Table 2 contains differences pre- post-intervention both on Nw and Ow-Ob groups and in total sample, highlighting a significative increase in MOBAK subtest, in EG and CG respectively. Data analysis in Table 3 revealed statistical differences between Nw vs Ow-Ob group pre-intervention on bouncing (p=0.035), balancing (p=0.008), self-movement (p=0.010) and total basic motor qualifications (p=0.005) in EG; post intervention only balancing (p=0.005) and total basic motor qualifications (p=0.035) were statistically different. CG evidenced more differences between Nw and Ow-Ob, pre-and post- intervention, especially in object control (p=0.019). Experimental intervention in CG increased differences between Nw and Ow-Ob.

DISCUSSION

Socio-cultural transformations of the 21th century are progressively re-structuring epistemological and methodological of physical education. Three levels on analysis emerge. First, the possible contribution of technologies to extend, enhance and expanding [30] the opportunities for children to learn, play, and be physically active during physical education lessons, creating a hybrid learning environment. On a second perspective, the use of non-linear didactic approach promotes different learning methods (discovery, problem solving, etc.), and modifies the educational-communicative relationship between teacher and students, according to student's greater or lesser decision-making autonomy [26]. Third, the effectiveness of non-linear teaching in relation to BMI, as a tool can be used by teacher to promote, include and empower motor competencies development in overweight and obese children.

The mixed approaches proposed in the present study implies that the student does not perform in a sequentially way what is proposed in the video, but it implies a continuous re-elaboration, modification and adaptation of the motor task in relation to the video and the teacher's proposals. Being able to produce numerous and different motor responses, as happens by choosing production styles, means equipping students with a wide repertoire, quantitative and qualitative, of ways to solve problems, which is proportional to the motor experiences and opportunities received. Modifying the execution of a motor task, equipment and spaces with the use of video can lead to switch and adapt organizational methods, determining different learning methods, since a teaching style connects the disciplinary contents with the student's learning methods. Production styles promote original, creative and transferable motor executions, generating various matrices for subsequent learning.

The choice of teaching style has a strong impact on children's learning methods, concerning the proposal of motor tasks and the choice of organizational modalities, and should be encouraged not only to stimulate multiple and different cognitive competencies and ways of thinking of children [28]. Studies revealed that the use of different teaching styles, especially production styles, allow to (a) learn sport-oriented competencies and solicit cognitive function such as make decisions, select appropriate motor responses, be active in different game situations [31]; (b) develop motor competencies and ensure a greater retention in the medium-long term [32]; (c) contribute positively to affective and emotional though of children and adolescents [33].

Non-linear didactic and pedagogical approaches led teachers to extend the traditional set of contents of physical education, enhancing self-perception, motivation and enjoyment, factors that contribute to increasing the time children are physically active [34].

Another important result of the present study is the assessment of the effects of technology-based intervention integrated in a non-linear didactic model on motor competencies development, underlining differences between Nw and Ow-Ob groups. Results evidenced a significative increase both in Nw and Ow-Ob groups, proving effective in reducing the differences in relation to BMI: post intervention overweight and obese children showed lower levels of motor competencies in balancing and total basic motor qualifications respectively.

Studies confirmed that children with high BMI showed lower performances in static and dynamic postural balance test [35,36]. The study of Ye et al. [37], conducted on a total sample of 261 children, analyzed the effects of exergames integrated in physical education lessons after nine months of intervention. Results highlighted a progressive increase in musculoskeletal fitness, BMI management but not in object control skills. Findings showed negative correlations between motor coordination assessed with KTK [38] and body fat, with normal weight children evidenced better performances than overweight-obese ones [39]. Similarly, Madeiros et al. [40] assessed the effect of EXGs intervention program on gross motor competencies development with TGMD-2 [41] in a sample of 64 children divided into experimental group (EXGs group) and control group (physical education group), evidencing positive effects on gross motor competencies. No significant differences were found between EXGs group and physical education group. According to Valentini et al. [42] participation in physical activity and motor engagement are the most relevant factors explaining levels of motor competencies. However, a recent literature review revealed inconclusive results about the effects of AVGs on fundamental motor skills, while they seemed to be effective in improve physical fitness, balance, postural stability and agility [15]. Studies revealed that technological intervention can be useful to increase both children's perceived competence and motor competencies [43]. M Adank et al. [44] found that motor competencies are inversely related to sedentary behavior and positively related to moderate to vigorous physical activity.

The main limitations of the study concern (a) the small sample, (b) the absence of a third group making regular physical education lessons with generalist teacher, and (c) analysis of gender differences. Future research could be focused on the analysis of mediator factors, such as enjoyment, motivation, self-perception, but also physical activity levels, motor performances and cognitive functions, that contribute to motor competencies development, according to production and/or reproduction teaching styles.

CONCLUSION

The integration of technology into physical education lessons, combined with non-linear didactics approaches represents an innovative and effective way to develop motor competencies in primary school. The proposed activity mediated by technologies not only emphasizes the technological factor as an innovative teaching tool, which makes the learning environment hybrid, but also the centrality of the teacher in the educational process. Technological tools and devices are instruments used by teachers to enhance motor experience, re-oriented the traditional setting in physical education, offered the possibilities to contextualize and adapt motor tasks, expanding, and strengthening the relationship between teachings and/or areas of competencies. The way in which motor tasks are proposed encourage greater adherence to motor task practice: technological tools should be considered as a tool to support, integrate and enhance traditional physical education interventions and teachers, and not replace them at all.

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