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**Original Article**

# The effects of a 12-week interdisciplinary physical education program on gross motor skills and perceived motor competence in primary school children

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**Abstract**:
*Background:* Interdisciplinary physical education integrates the goals and content of physical education (PE) with those of one or more subject areas creating a cohesive learning experience. This approach aims to enhance concepts and skills across multiple disciplines. *Purpose:* This study aimed to valuate the impact of two PE teaching models on gross motor skills and perceived motor competence among Italian primary school children. *Materials and Methods:* A convenient sample of seventy-six children (40 males, 36 females), aged 7-9 years (mean age=8.40; SD=0.30), from two Italian primary schools, participated in a quasi-experimental study. Participants were divided into an experimental group (EG n=37) and a control group (CG n=39). Each group was involved in a 12-week intervention, for 2 hours a week: the EG took part in PE lessons conducted through an Interdisciplinary PE Program aimed to expand the repertoire of skilled motor acts, combine original action sequences with acquired movement variations and motor skills, and explore props or objects in different scenarios. The CG participated in PE lessons conducted through a drill-oriented teaching approach to perfecting skills and procedures. The Italian version of the Test of Gross Motor Development and the Perceived Motor Competence Subscale of the Italian Self-Description Questionnaire for Children and Pre-adolescents were administered. *Results:* At the pre-test, females scored significantly lower means than males in the object control sub-test and perceived physical competence. Females scored higher means than males in the locomotion sub-test. In the post-test, the Interdisciplinary PE Program had a significantly positive impact with large effects on object control skills in males' and females' EGs, and in locomotor skills in females' EG, compared to the CG. Results regarding differences between EG and CG in the perception of motor competence were inconclusive. *Discussion and conclusions:* An Interdisciplinary PE Program turned out to be more effective than the drill-oriented teaching approach for improving object control and locomotor skills. Insights on how to incorporate key aspects of Interdisciplinary PE to teach Physical Education creatively in primary school will be discussed.
**Key Words**: **Perceived Motor Competence, TGMD, Teaching, Primary School, Creativity**

## Introduction

Interdisciplinary Physical Education consists of a process in which the goals and contents of Physical Education (PE) are integrated with those of one or more subjects in a whole learning experience. The resulting lesson aims to enhance concepts and skills in each subject (Cone, Werner, & Cone, 2009). The basis of interdisciplinary education is our need to make meaning of the complexity around us, to relate events, things, concepts, and people, and to feel that we belong to the flow of those relationships (Cone, Werner, & Cone, 2009).

Firstly, in interdisciplinary education, integration among subjects is balanced because the uniqueness of each discipline is respected including specific goals and contents for each subject in one or more learning activities (Cone, Werner, & Cone, 2009). This could be achieved in many ways: i.e., if the common concept is rhythm in PE and Music, the common learning goal could be to develop rhythm. Then, teachers can plan together a learning activity in which PE exercises, such as various kinds of jumps or ball bouncing, can be performed following musical rhythms. Or, the activity could consist of a music choreography that contains different rhythmic changes to be associated with variations of one or more locomotion patterns. Furthermore, it is possible to assign tasks on the same topic, such as in Music and PE classes, and then involve students in a final single activity. So, students can exercise rhythm separately in music tasks or PE tasks and then, in the last lesson, they can find links between music and body movements. In these ways, interdisciplinary PE brings such experience to a higher level than simply including movement in a music lesson.

Another characteristic worth mentioning is that an interdisciplinary lesson is a concerted effort by teachers to understand connections between disciplines and planning a new activity. Teacher collaboration can be carried out at different levels and with varying degrees of commitment depending on the type of curricular integration being built. In an interdisciplinary model, two or more teachers share the planning and


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implementation phases of activities on topics or skills common to their disciplines.

Many authors have proposed teaching models that allow for different ways of combining disciplines (Fogarty, 1991; Frodeman, 2017), while few authors have addressed the integration of PE with other disciplines (Cratty, 1985; Mosston & Ashworth, 2008; Cone, Werner, & Cone, 2009; Nicolosi, Sgrò, & Lipoma, 2016; Nicolosi, Greco, & Di Stefano, 2017; Nicolosi, 2018; Nicolosi, 2020). Fogarty (1991) has developed a model that provides 10 different ways to create an integrated curriculum. However, Cone, Werner, & Cone (2009) found that despite the broadness of the model, the choice of one variation may overlap over another. The authors have thus experimented with the different interdisciplinary approaches, arriving at a model that involves only three variations.

Thus, starting from these studies, Nicolosi, Greco, & Di Stefano (2017) found that, in teaching practice, four teaching models have been preferred by primary school teachers in PE classes: webbed, shared, threaded, and integrated models. The Webbed model grounds learning activities on the development of a central idea with significant and meaningful content. The main topic is treated separately by each discipline involved, through one or more lessons. The final result is a set of lessons linked to a central topic. For example, if you choose the Olympic games as a topic, this can be covered by history, geography, arts, and PE. The Shared model is based on choosing concepts or skills shared by two or more disciplines, combined into a single activity. In this model, one or more topics are encapsulated in an activity integrating two or more disciplines. For example, the topic of effective communication can be addressed by Literature and PE in a single activity including verbal and nonverbal aspects. The Threaded model allows for the creation of an integrated curriculum path consisting of multiple units of learning, and is implemented according to a predetermined sequence. In this model, unlike the Webbed model, each activity integrates two or more disciplines and is implemented in a progressive sequence. For example, a set of learning activities from multiple disciplines can be placed within a story constituting the red thread throughout a curriculum. Finally, the Integrated model consists of the implementation of a learning experience, i.e., an embodied activity, in which each discipline has its own goal and clear content in the planned activities. For example, an orienteering activity in a park is a learning experience which includes both map-reading skills, physical skills, and natural science knowledge. From the Webbed model to the Integrated model, the level of integration of PE with other disciplines changes increasingly.

Numerous studies support the benefits of an interdisciplinary teaching method in learning different disciplines (Mathison & Freeman, 1997). While research in interdisciplinarity is vast, empirical studies that also include PE are only a few. Interdisciplinary educational interventions that include PE have had positive effects on the learning, motivation, and social skills of participating students (Kulinna, 2008). In particular, student improvements include both understanding the interdependence of complex topics and the ability to make decisions, to think critically and creatively, and to synthesize knowledge beyond disciplines (Nicolosi, Sgrò, & Lipoma, 2016).

However, Aberšek, Ropi, and Hus (2009) noted that a critical aspect was the application of interdisciplinary teaching methods by teachers. Studies analyzing teachers' perceptions have shown that continuous communication, mutual support and trust are needed to collaborate effectively, exchange information and engage in a constant process of self-analysis and correction of the weaknesses of teaching activities (Martinez de Ojeda Perez, Calderón Luquin, & Campos Sánchez, 2012; Chen, Cone, & Cone, 2011).

Interdisciplinary PE has also been linked to creativity (Pickard & Maude, 2014; Quay & Peters, 2012).

Creativity has been defined as the production of something new (for an individual or a culture) and is considered a systemic and multidimensional process (Torrance, 1988; Csikszentmihalyi, 2022; Antonietti, 2011). Torrance (1988) defined creativity as a process, in which an individual becomes sensitive to problems, identifies missing elements or dissonances, and then looks for solutions, either through trial and error or through the formulation of actual hypotheses (hypotheses are subject to repeated verification, eventually reformulated, again verified, and finally, results are communicated). Petter (2010) noted that creativity is an activity of thought, producing a mental product, a structure such as concepts-ideas-solutions-inventions-reasonings, in which rationality and fantasy are interconnected. However, the contribution of an individual is only part of a larger process that allows us to understand creativity. In this sense, creativity can be considered a systemic process because creativity can be found in the interaction between a person's thoughts and a socio-cultural context (Csikszentmihalyi, 2022).

In previous research, three macro-operations were identified in creative thinking (Antonietti, 2011), such as expanding the perspective, combining distant elements, and re-structuring a cognitive schema. The first operation is called expanding the perspective, which means widening the domain of a concept, a focus of reasoning, or the context of an action. Combining distant elements consists of selecting, linking, and organizing an idea, associating two or more distant objects/characteristics in a whole and comprehensive thought, artistic work, artefact, or a project. For example, Gianni Rodari in his Grammar of Fantasy (1973) defined the fantastic binomial (binomio fantastico) as the association between two words, randomly chosen in the dictionary, as starting points for children to invent stories. Re-structuring a cognitive schema means reorganizing an interpretation through which we interpret a situation or a problem, to find new options, ideas or solutions in order to get a better insight into something or someone. Guilford defined this operation as divergent thinking, opposed to convergent thinking that is typical of analytic reasoning, which instead consists of reaching a

conclusion or a single solution following the principles of causality, analogy, and deduction.

Over the past decades, there has been an increasing debate on creativity in education, but little research has addressed the relationship between creativity and PE (Welch, Alfrey, & Harris, 2021; Pickard & Maude, 2014; Scibinetti, 2019; Raiola, Esposito, & Sgrò, 2020; Sgrò, Barca, Schembri, & Lipoma, 2020; Tortella, Ceciliani, Fumagalli, Jidovtseff, Wainwright, Fjortoft, Sigmundsson, Haga, Sgro, Lipoma, & Sääkslahti, 2021; Sgrò, Coppola, Schembri, & Lipoma, 2021). Furthermore, there are few resources to assist educators in capturing the complexity and broadness of how creativity can be conceptualized, carried out and evaluated in PE teaching and learning (Pickard & Maude, 2014).

Based on the psychological theoretical frameworks and evidence considering creativity as a multidimensional construct, in this study the three operations identified in the creative processes by Antonietti (2011) were integrated into a PE interdisciplinary program, to develop learning tasks aimed at developing fundamental motor skills. Therefore, expanding the perspective in a PE context could widen the vocabulary of movement, performing a motor pattern in its variations or on various surfaces. Combining distant elements could consist of associating two or more distant motor schemas to create sequences, or combining a fantastic binomial of movements to invent a story (inserting two motor schemas randomly chosen from fundamental motor skills). And, finally, re-structuring a cognitive schema could mean reorganizing an interpretation through which we interpret a motor problem, in order to find new solutions; or, to explore a motor situation in the meaningful context of a story.

Moreover, this study aimed to assess the effects of two PE teaching models on gross motor skills and perceived motor competence in a sample of Italian primary school children. The experimental teaching model was an Interdisciplinary PE Program aimed to expand the repertoire of skilled motor acts, combine original action sequences with acquired movement variations and motor skills, and explore props or objects in different scenarios. A traditional teaching model consisted of a PE program conducted through a drill-oriented teaching approach perfecting skills and procedures.

Two hypotheses were tested:

H1: the interdisciplinary PE intervention positively and significantly affects the observed variables;

H2: the interdisciplinary PE intervention has a greater impact than a method based on a drill-oriented teaching approach.

**Material and methods**

*Research Design*

A quasi-experimental study with a 6-month pre-test/post-test group design was used to involve participants in this study. Class groups were maintained to allow for an ecological analysis of interventions, as suggested by Harvey and Jarrett (2013).

*Participants and procedures*

A convenient sample of seventy-six children were involved in this study: 40 males and 36 females, aged between 7 and 9 years (M= 8.40, SD= 0.30), attending the 3rd grade in two public primary schools. The primary schools are located in two towns in the South of Italy, in a similar socio-economic and cultural context.

Participants were divided into an experimental group (n=37; 20 males and 17 females) and a control group (n=39; 20 males and 19 females). The experimental group was engaged in PE lessons for 1 hour per week, and in interdisciplinary PE lessons for 1 hour per week, conducted through a student-centered approach. The remaining 38 children composed the control group, and participated in their regular PE lessons for 2 hours a week. PE lessons were carried out through a teacher-centered approach, with units of individual drills and repetition of exercises aimed at perfecting skills and procedures.

Each school's principal authorized the study and parents gave their approval in writing. A meeting was held with the teachers to explain the study's aims and procedures, and the goals of these educational activities.

A 10-week training was carried out during the previous school year, aimed to train teachers on interdisciplinary PE models. Before the beginning of the interventions, an additional 8-week period was spent planning interdisciplinary PE lessons by curricular teachers and by PE teachers (external experts). Interdisciplinary PE lessons were based on subject curriculums – including the PE curriculum.

In both the experimental group and the control group, assessments were carried out before (pre-test) and after the 12-week interventions (post-test).

After the pre-test, each curricular teacher delivered their subject area content in the classroom, and the PE teacher carried out PE and integrated PE lessons in the gym. The same PE teacher followed both groups.

*Experimental group: the Interdisciplinary PE Model*

The experimental group was engaged in interdisciplinary PE lessons, for 2 hours per week, conducted through a student-centered approach.

Each interdisciplinary PE lesson was aimed at developing two gross motor skills and coordination skills. Each time, the Interdisciplinary PE lesson was carried out with the following schema: warm-up (10 minutes); Interdisciplinary small-sided games carried out in cooperative learning structures were used to develop skill levels in children (40 minutes); cool down (10 minutes).

Four teaching models were used to allow different ways of combining PE with other disciplines (Webbed,

Shared, Threaded, and Integrated) (Fogarty, 1991; Cone, Werner, & Cone, 2009), which teachers had already learned and applied in a previous training course.

The topics developed in the learning units were already part of the curricula of the disciplines involved, including those of PE, but they were linked through the interdisciplinary program according to the models described, and alternated between individual learning and learning in pairs and small groups, both in the classroom and in the gym.

*Control-group: the PE program*

The control group participated in regular PE lessons, for 2 hours a week, conducted through a drill-oriented teaching approach as a means of perfecting skills and procedures. Each time, the Interdisciplinary PE lesson was carried out with the following schema: warm-up (10 minutes); tasks practice (40 minutes); cool-down (10 minutes).

*Measures*

At the beginning and at the end of educational interventions, the following measures were administered: the test of gross motor skills (TGM, Ulrich, 1992) and the Self-Description Questionnaire for Children (QDS, Camodeca, Di Michele, Mela, & Cioffi, 2010) physical ability perception scale.

All instruments were administered during school hours, before (January) and after the conclusion of the interdisciplinary PE program (May).

Data were collected at school in two administration sessions for each classroom.

The TGMD was administered in the school gymnasium, by all the authors of the article.

The Perceived Physical Abilities Scale of QDS was assessed, in a collective form, by the first author of this paper.

First, pupils were given full information beforehand about the aim of the study, how to perform the tests and fill out the questionnaire and were guaranteed confidentiality and anonymity of responses.

Pupils were offered the opportunity to refuse to participate in the research project, at any time and for any reason. In every administration session, the opportunity to clarify any doubts was provided. At the end of each administration, the correct compilation of each questionnaire was verified. To ensure the anonymity of the research protocols, each child's questionnaires and motor test sheets were paired with a unique code.

*Test of Gross Motor Development (TGMD)*

The first version of the Test of Gross Motor Development (TGMD, Ulrich, 1992) was used to measure the gross motor skills of participants.

The Test of Gross Motor Development (TGMD) is an individually-administered test that measures the gross motor functioning of children from 3 to 10 years of age. The TGMD has been widely used to assess motor skill development, identify strengths and weaknesses in behavioral components within the gross motor skill, and detect gross motor skill delays. The TGMD measures 12 gross motor skills grouped into two sub-tests which assess locomotor and object control skills. The Locomotion sub-test measures 7 skills (i.e., the run, gallop, hop on one leg, leap, jump forward, skip, and slide) and the Object Control sub-test assesses 5 skills (i.e., the two-hand strike, stationary bounce, catch, kick, and throwing a ball). It is a norm and criterion-referenced test, administered and scored consistently against a fixed set of predetermined criteria in children from 3 to 10 years (Locomotion subtest generalizability coefficient=.95; Object Control subtest generalizability coefficient=.97, *20-operator-based coefficient).

A digital video camera recorded all their performances. According to the author's guidelines, to obtain a higher validity, each child performed three trials of each skill and obtained a score of 1 (=present), when a criterion performance was executed two out of three times, or a score of 0 (=absent) when a criterion was not observed or was used inappropriately two out of three times.

The sum of the raw scores found for each item (maximum total score of 48) was converted into standard scores according to every child's age level. The standard scores are derived from the raw scores, according to the conversion tables provided by the TGMD manual. In addition, the standard scores allow to compare the results of the two sub-tests, identify the child's strengths and weaknesses, and report the level of functioning in locomotor and object control skills. As outlined in the manual, levels of functioning (from very low to above average) are assigned by pairing standard scores with the relevant proficiency level ratings.

*Perceived Physical Abilities Scale*

The sub-scale of Perceived Physical Abilities of the Self-Description Questionnaire for Children and Pre-adolescents (QDS) by Camodeca, Di Michele, Mela, and Cioffi (2010), was administered to measure the perceptions of their skills and interest in physical activities, sports, and moving games. This questionnaire is the Italian validation of the Self-Description Questionnaire-I by Marsh, Richards, Johnson, Roche, and Tremayne (1994), based upon the Shavelson model of self-concept (Marsh & Shavelson, 1985; Shavelson, Hubner, & Stanton, 1976). The Self-Description Questionnaire was developed to measure self-concept in four nonacademic areas (Physical Ability, Physical Appearance, Peer Relations, and Parent Relations) and three academic areas (Reading, Mathematics, and General School), and a General Self-Concept scale. The Italian version retains the psychometric properties of the original instrument (Camodeca, Di Michele, Mela, & Cioffi, 2010). In this study only the Physical Ability Scale was used, which consists of 9 statements on abilities and interests toward physical activities, sports and exercise games (Cronbach' Alpha =.87). In each statement, children were asked to

answer on a 5-point Likert scale, from 1 to 5 (1= false; 2= fairly false; 3= sometimes false, sometimes true; 4= fairly true; 5= true). High scores account for high levels in the corresponding dimension, except for 11 statements that indicate negative meaning instead, whose scores should be reversed before calculating the total for each scale.

**Results**

According to the TGMD manual, standard scores were assigned to the levels of competence (from very low to above average). The percentages of levels obtained by males and females in the pre- and post-tests are shown in Tables 1 and 2. In the pre-test, children who scored average or above average were less than those who scored below average or less, except for males in the Object Control sub-test. In the Locomotion sub-test, males and females in both groups, in experimental and control groups, rated very low or low in the pre-test and improved in the post-test (moving to below-average or average levels). In the Object Control sub-tests, however, the improvement was less marked.

**Table 1. Levels of competence (in percentage) obtained by standardized scores on the Locomotion and Object Control Sub-tests of the TGMD (males)**

| Level | Locomotion Sub-test | | | | Object Control Sub-test | | | |
|---|---|---|---|---|---|---|---|---|
| | Experimental Group (M=20) | | Control Group (M=20) | | Experimental Group (M=20) | | Control Group (M=20) | |
| | Pre-test (%) | Post-Test (%) | Pre-test (%) | Post-Test (%) | Pre-test (%) | Post-Test (%) | Pre-test (%) | Post-Test (%) |
| Very low | 19.23 | 7.69 | 47.37 | 10.53 | 11.54 | 0 | 21.05 | 5.26 |
| Low | 26.92 | 3.85 | 31.58 | 31.58 | 15.38 | 3.85 | 21.05 | 15.79 |
| Below average | 46.15 | 23.08 | 21.05 | 31.58 | 11.54 | 3.85 | 15.79 | 21.05 |
| Average | 7.69 | 61.54 | 0 | 26.32 | 61.54 | 65.38 | 42.11 | 42.11 |
| Above average | 0 | 3.85 | 0 | 0 | 0 | 26.92 | 0 | 15.79 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

**Table 2. Levels of competence (in percentage) obtained by standardized scores on the Locomotion and Object Control Sub-tests of the TGMD (females)**

| Level | Locomotion Sub-test | | | | Object Control Sub-test | | | |
|---|---|---|---|---|---|---|---|---|
| | Experimental Group (F=17) | | Control Group (F=19) | | Experimental Group (F=17) | | Control Group (F=19) | |
| | Pre-test (%) | Post-Test (%) | Pre-test (%) | Post-Test (%) | Pre-test (%) | Post-Test (%) | Pre-test (%) | Post-Test (%) |
| Very low | 15.38 | 15.38 | 15.79 | 5.26 | 19.23 | 11.54 | 42.11 | 10.53 |
| Low | 26.92 | 7.69 | 26.32 | 21.05 | 30.77 | 15.38 | 15.79 | 31.58 |
| Below average | 26.92 | 30.77 | 42.11 | 52.63 | 23.08 | 19.23 | 21.05 | 31.58 |
| Average | 30.77 | 42.31 | 15.79 | 21.05 | 23.08 | 42.31 | 21.05 | 26.32 |
| Above average | 0 | 3.85 | 0 | 0 | 3.85 | 11.54 | 0 | 0 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Comparisons by gender with a two-sample T-test in all the variables, before and after the interventions, are shown in Table 3.

**Table 3. Means, standard deviations, comparisons by gender with T-Test in the overall sample (n=76)**

| Variables | T1 | | | | | T2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Males (n=40) | | Females (n=36) | | t | Males (n=40) | | Females (n=36) | | t |
| | M | SD | M | SD | | M | SD | M | SD | |
| Perc. Motor Comp. | 4.51 | .39 | 3.88 | .58 | 5.50*** | 4.51 | .45 | 4.02 | .636 | 3.89*** |
| Locomotion | 4.41 | 1.92 | 5.56 | 2.52 | -2.22* | 7.03 | 2.86 | 7.00 | 2.80 | .038 |
| Object Control | 6.51 | 2.65 | 4.97 | 2.24 | -2.71** | 9.30 | 3.21 | 6.97 | 2.83 | 3.33*** |

Note: *p< .05 *p< .01 ***p< .00. T1: Before Intervention Assessment; T2: After Intervention Assessment; M: Mean; SD: Standard Deviation; Perc. Motor Comp.: Perceived Motor Competence

Then, differences between groups and teaching interventions were tested with an ANOVA for Repeated Measures (rmANOVA), to verify if the changes detected by descriptive analysis were statistically significant. In the rmANOVA, the independent variable was the time of assessments: in our case, there were two data collections, at the beginning (pre-test) and at the end (post-test) of the educational intervention. The dependent variables were the scores in TGMD, that is Locomotion and Object Control subtests, and in the Perceived Motor Competence scale of QDS. The between-subjects factor was the group, with two levels: experimental and control group. Among males, results revealed significant effects of the intervention on dependent variables Locomotion and Object Control, and a significant interaction between time and group (Table 4). No effect was observed in both groups in Perceived Motor Competence. In the post-test of both groups, TGMD sub-tests scores were significantly higher than in the pre-test. In pairwise comparisons with rmANOVA, results showed mean

differences between groups in the locomotion and object control sub-tests, experimental group means were significantly higher than those in the control group. Differences can be observed due to the intervention, and the interaction between the intervention and the group. In the Locomotion subtest, Cohen's d index revealed a large effect in both groups, with a larger effect in the experimental group. In the Object Control subtest, Cohen's d showed a moderate effect, with a larger effect in the experimental group (Table 4). Females in the Experimental Group significantly improved in Locomotion and Object control sub-tests, compared with females in the Control Group (Table 5). Concerning the Locomotion Sub-tests, changes over time in the Experimental group seem to be due to the intervention, whereas in Object Control Sub-tests, changes could be attributed to the intervention and an interaction Intervention x Group. Furthermore, there was a small effect on Locomotion scores and a moderate effect on Object control scores in the Experimental group, as shown by Cohen's d index. In the Control group, results showed only a significant difference in Perceived Motor Competence between pre and post-tests, but no effect of the Intervention or Intervention x Group.

**Table 4. Means, standard deviations, comparisons with rmANOVA, and Cohen's d test in males**

| Var | EG (n=20) | | | | t | Cohen's d | CG (n=20) | | | | t | Cohen's d | Int. | Int. x group |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-test | | Post-test | | | | Pre-test | | Post-test | | | | | |
| | M | SD | M | SD | | | M | SD | M | SD | | | | |
| PMC | 4.53 | .41 | 4.62 | .44 | -.92 | -.22 | 4.45 | 0.39 | 4.37 | 0.47 | .73 | -.19 | ns | ns |
| LOC | 5.19 | 1.88 | 8.23 | 2.41 | -6.30*** | -1.44 | 3.84 | 1.68 | 5.85 | 2.66 | 3.88*** | -.93 | <0.001 | 0.002 |
| OC | 7.69 | 2.88 | 10.19 | 2.43 | -3.70*** | -.96 | 5.89 | 2.33 | 7.80 | 3.29 | -4.04** | -.69 | <0.001 | 0.004 |

Note: * p< .05 ** p<.01 *** p< .001. M: Mean; SD: Standard Deviation; EG: Experimental Group; CG: Control Group; PMC: Perceived Motor Competence; LOC: Locomotion; OC: Object Control; Int.: Intervention; Int x group: interaction between Intervention and Group.

**Table 5. Means, standard deviations, comparisons with rmANOVA, and Cohen's d test in females**

| Var. | EG (n=17) | | | | t | Cohen's d | CG (n=19) | | | | t | Cohen's d | Int. | Int. x group |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pre-test | | Post-test | | | | Pre-test | | Post-test | | | | | |
| | M | SD | M | SD | | | M | SD | M | SD | | | | |
| PMC | 3.97 | 0.56 | 3.98 | 0.68 | .09 | -.02 | 3.80 | 0.60 | 4.13 | 0.58 | -2.108* | -.58 | ns | ns |
| LOC | 6.04 | 2.81 | 7.42 | 3.19 | -2.06* | -.47 | 5.74 | 2.16 | 6.26 | 1.94 | -.820 | -.26 | 0.05 | ns |
| OC | 5.81 | 2.80 | 7.96 | 3.12 | -3.51** | -.74 | 4.89 | 2.26 | 6.11 | 2.05 | -1833 | -.58 | 0.001 | 0.04 |

Note: * p< .05 ** p< .01 *** p< .001. M: Mean; SD: Standard Deviation; EG: Experimental Group; CG: Control Group; PMC: Perceived Motor Competence; LOC: Locomotion; OC: Object Control; Int.: Intervention; Int x group: interaction between Intervention and Group.

**Discussion**

This study aimed to assess the effects of two PE teaching models on gross motor skills and perceived motor competence, in a sample of Italian primary school children. The first hypothesis verified whether the interdisciplinary PE intervention positively and significantly affected the observed variables (H1).

The results showed statistically significant improvements due to the interdisciplinary PE intervention. However, the first hypothesis can only be partially accepted. In fact, the intervention had significant effects in the locomotion and object control skills of children in the experimental group of both genders. However, no significant improvement was observed in the experimental group's perceived physical abilities. Conversely, with regard to females in the control group, a significant improvement was observed. Whereas, the mean scores in the perception of physical abilities among males of both groups are close to the maximum of the range (1-5), so an improvement in this sub-group would still be minor. These results seem to be due to the age group of the participants. As Stodden, Goodway, Langendorfer, Roberton, Rudisill, Garcia, and Garcia (2008) noted, children in this age group demonstrate limited accuracy in the perception of motor skills compared to the motor skills actually exhibited. In addition, children could not yet possess the cognitive skills to accurately distinguish between motor skills, abilities and effort (Roberts, Treasure, & Conroy, 2007; Nicholls, 1989). Females in the control group may, therefore, have overestimated their motor skills and perceived themselves as more skilled than the motor tests actually detected. Whereas males may have rated their skills with high scores from the beginning. Another aspect concerns the instrument used to describe physical skills, the QDS, which contains both items related to specific gross motor skills, such as "I am good at throwing the ball", "I can run fast", or "I am strong", and statements regarding general assessments of physical activities, such as "I like sports and games" or "I am a good athlete". Although the instrument has good psychometric qualities, the physical skills scale may have limited the description of children in the experimental group, who, in the intervention, learned how to differentiate between specific gross motor skills. Alternatively, a further explanation for the results on the perception of physical skills could instead be the improved ability of children in the experimental group to perceive their skills in a more balanced way, precisely because they participated in the project. Finally, another possible explanation can be found in previous studies that have shown that physical self-concept and its specific dimensions, such as the perception of physical abilities, are more stable and vary more slowly than currently

exhibited motor skills (Shavelson, Hubner, & Stanton, 1976; Marsh, Richards, Johnson, Roche, & Tremayne, 1994; Nicolosi, Ortega-Ruiz, & Benítez-Sillero, 2021).

The second hypothesis was whether the interdisciplinary PE intervention has a greater impact than a method based on a drill-oriented teaching approach (H2). The impact of the interdisciplinary intervention was significantly greater than the PE intervention in locomotion and object control skills, although learning-related improvements were also observed in the control group. In addition, the results show differences between genders. Among males of the experimental group, the effects detected by Cohen's d index are large in both sub-tests of the TGMD, while among females of the experimental group, moderate effects are observed in object control but small ones in locomotion. The increase in these skills seems to be due to a difference in the content and methods of interdisciplinary teaching. The provision of a meaningful context and the connection of all disciplinary and interdisciplinary in-depth activities, facilitated the acquisition of relevant knowledge, by making complex theoretical aspects and the practice of motor skills interesting and fun. However, the second hypothesis can only be partially accepted as only the girls in the control group showed significant changes in perceived motor competence.

**Conclusion**

The results of this study showed that interdisciplinary PE methods strengthened the learning processes of fundamental gross motor skills. The several degrees of integration between disciplines as well as the several degrees of collaboration between teachers contributed to the construction of meaningful learning contexts in which PE objectives, content, and activities were integrated into a single curriculum. The improvement of gross motor skills did not require an additional number of hours, but differences in teaching methods, which required the teachers' commitment in all phases of the project, a great deal of organizational effort, high self-assessment skills of the well-established professional practice, and a remarkable openness to change. The interdisciplinary PE program had positive results mainly because integration and collaboration were achieved at multiple levels, especially in the relationships among all participants (students, teachers and research team).

The discouraging pre-test results among study participants confirmed the great importance and need for PE teachers, only recently included in the staff of teachers in the fourth and fifth grades of Italian primary school (Italian Law no.234/2021). However, as noted in previous studies (Nicolosi, Alba, & Pitrolo, 2023; Nicolosi, Pitrolo, & Alba, 2023), the inclusion of physical education teachers is only an initial response to the educational needs of pupils in PE. The enhancement of EF teachers' training in cooperative and interdisciplinary teaching methods is deemed essential to promote not only physical but also cognitive, social and emotional development in pupils, as shown in this study and an earlier study (Nicolosi & Ancona, 2020). As noted by Nicolosi and Ancona (2020), a PE program based on cooperative games had a significantly positive impact on perceived motor competence in boys, and girls lowered their levels in the external locus of control.

The results of this study showed that making connections between multiple disciplines through interdisciplinary methods, actually improved the gross motor skills of participating pupils. These results seem consistent with the findings of a recent literature review (Bandeira, Ravagnani, Barbosa Filho, de Oliveira, de Camargo, Tenório, & Silva, 2022), which included among teaching strategies promoting active and healthy lifestyles through PE, the integration of PE contents with other disciplines, and the inclusion of cross-cutting themes of PE.

Interdisciplinarity provides an opportunity for growth in numerous curriculum areas, beyond PE, it allows for deeper and richer learning, multiple investigations in several interrelated topics, and lays the foundation for a creative PE project (Quay & Peters, 2012).

However, a limitation of this study was that the effects of the interdisciplinary PE intervention on creativity and divergent thinking were not measured. A study on the effects of physical activity on creativity in a sample of students (Büning, Jürgens, & Lausberg, 2021) showed that the positive effects of sports activities on creativity are given not by participation per se, but by divergent learning experiences that are based on the characteristics of time, peer interaction, and variety of teaching methods. In particular, the authors emphasized that the variety of teaching methods creates a learning environment that enables students to develop their inherent creative potential. Time and interaction with peers also enable students to reflect, explore new ideas, find original alternatives and evaluate the feasibility of different solutions. As Morin (2001) suggested, to promote “relevant knowledge it is necessary to develop the natural aptitude of the human mind to situate all information in a context, and as a whole. It is necessary to teach methods that enable one individual to grasp the mutual relations and mutual influences among the parts and the whole in a complex world” (p.12).

The educational purposes and contents of PE cannot be considered accomplished merely in a transfer of content (such as the acquisition and practice of motor skills needed for participation in a variety of physical activities). They also include the construction of connections among individuals, their motor experience, the meanings and values of practicing physical activity throughout life (Whitehead, 2010).Physical Education allows the development of motor skills and physical competence, confidence and motivation, through well-designed teaching activities in an educational setting focused on mastery.Triggering this process from childhood not only is an educational challenge, but also a cultural one.

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**Author contributions**
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