

THE IMPACT OF FUNCTIONAL ADVANCED DIDACTICS (FAD) IN EDUCATIONAL CONTEXTS: A SMALL STUDY ON THE INTEGRATION OF AN EMBODIED BASED APPROACH IN PRIMARY SCHOOLS

L'IMPATTO DELLA FUNCTIONAL ADVANCED DIDACTICS (FAD) NEI CONTESTI EDUCATIVI: UNO SMALL STUDY SULL'INTEGRAZIONE DI UN APPROCCIO EMBODIED BASED NELLA SCUOLA PRIMARIA



Santolo Ciccarelli¹

Università degli studi di Napoli Parthenope
santolo.ciccarelli001@studenti.uniparthenope.it



Maria Giovanna Tafuri

Pegaso University
mariagiovanna.tafuri@unipegaso.it



Francesco V Ferraro

Clinical Exercise and Rehabilitation Research Centre, University of Derby, United Kingdom
f.ferraro@derby.ac.uk



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ABSTRACT

This study explores the effect of a new embodied-based teaching method called Functional Advanced Didactics (FAD), which integrates physical exercise with conventional academic subjects. To verify its usefulness, a study was conducted involving 15 students attending a primary school in the city of Naples. At the end of the six-month trial, significant improvements in geometry learning emerged.

Questo studio esplora l'effetto di un nuovo metodo di insegnamento embodied based, denominato Functional Advanced Didactics (FAD), il quale integra l'esercizio fisico con le materie didattiche convenzionali. Per verificarne l'utilità, è stato condotto uno studio che ha coinvolto 15 studenti frequentanti una scuola primaria della città di Napoli. Al termine della sperimentazione, della durata di un semestre, sono emersi dei miglioramenti significativi riguardanti l'apprendimento della geometria.

KEYWORDS

Embodied theories; Gamified Learning; Innovative Didactics; Social Sciences

Teorie Embodied; Apprendimento Gamificato; Didattica Innovativa; Scienze Sociali

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Introduction

The reduced levels of physical activity among new generations, partly due to digital entertainment platforms (Beltrán-Carrillo et al., 2022; Ludyanti, 2019) and partly due to an educational system that includes teaching activities often characterized by prolonged periods of physical inactivity (Kariippanon et al., 2021; Leiss & Kim, 2022), negatively impact academic performance (Bautista et al., 2024) and, consequently, the future prospects of students. (Salomon, 2020).

This phenomenon is highlighted by a 5-year observational-longitudinal study conducted in Spain by Ortiz Sánchez (2024), which aimed to determine the effects of sedentary behavior on body composition, physical condition, and academic performance.

At the end of the study, which involved a sample of 86 male and female students (reduced to 70 by the end of the investigation), engaged in the transition phase between primary and secondary school; A relationship has been highlighted between sedentary behavior and worse outcomes both in terms of body composition and physical condition, as well as in the academic performance of the respondents.

Given these results and considering the difficulties related to a potential paradigm shift regarding the use of the aforementioned technologies (Wesugi, 2019), the introduction of a teaching method in schools that aligns with the principles of embodied cognition theory. (Tanton, 2023). A doctrine according to which learning is shaped through the bodily component and its interaction with the environment. (Yin & Goller, 2024). It could promote the association between educational elements, gestures, and body movements, leading, in addition to a potential reduction in sedentary levels (Chen & Fang, 2014; Tancredi, 2023), to an improvement in academic performance among learners. (Abrahamson et al., 2020; Bremmer, 2021; Kosmas et al., 2019; Varela et al., 1991).

In the same way, the adoption of a playful approach, which can be traced back to the methodology of gamification. (Ali et al., 2023). A strategy that integrates elements typical of games within contexts detached from games themselves, such as educational spaces (Carmichael et al., 2022; Giacobbo & Souza, 2023); It could promote engagement and continuous interaction during lessons, which are fundamental elements to encourage an active and engaging learning process (An, 2020; González-González, 2023).

Taking into account the aforementioned strategies, in 2020 Dalvi conducted a qualitative study on a sample of 19 students from a preschool located in the State of Espírito Santo. (Brazil). The aim of the research was to evaluate the effectiveness of an innovative approach designed to promote the teaching of basic geometric

concepts, called "The Circuit of Geometric Shapes." This method integrated elements of embodied learning within a playful-educational context, postulated through an experimental protocol where participants engaged in a structured educational-motor activity. Specifically, each student had to manipulate a two-dimensional representation of a geometric shape while navigating through a grid of images laid out on the floor. The goal was to identify and match corresponding geometric shapes through a specific motor action. (jumping with both feet along the path).

At the end of the experiment, the results highlighted improvements in shape recognition, their association, spatial perception, and geometric vocabulary.

In light of these results and the theories discussed, this study aims to experiment with Functional Advanced Didactics (FAD) in a primary school in the city of Naples (Italy), an experimental teaching method based on the principles of embodied cognition theory and utilizing gamification methodology.

The research hypothesis is that the introduction of this method, which integrates conventional school subjects with physical exercise in place of the regular curriculum lessons, may promote the improvement of academic performance among students.

1. Method

1.1 Design

This small single-group study, which included a preparatory phase followed by a pretest-posttest phase, was conducted to explore the possible effects of the FAD method on the assimilation of concepts and notions related to conventional school subjects.

The research hypothesis suggests that the use of a gamified teaching approach, based on the principles of embodied cognition theory such as FAD, may lead to an improvement in the learning process among learners.

1.2 Sample

To explore the usefulness of the FAD method, an experiment was conducted in the city of Naples (Italy), which involved 13 students (5 females and 8 males) attending the third year of a primary class at the Adelaide Ristori comprehensive school.

The inclusion criteria included: Being a native Italian speaker, being able to read, having participated in at least 50% of the activities, not having neurodevelopmental

disorders such as those related to the autism spectrum, and not presenting specific learning disorders.

The participants were recruited from January 9 to May 30, 2023.

1.3 Measures

Five questionnaires developed by the research team in collaboration with the teachers of the students involved in the project have been administered. The aforementioned tests aimed to assess the understanding of concepts and notions related to mathematics (calculation and reasoning skills), English (image-word association to measure the learning of new vocabulary), geometry (recognition of geometric shapes), history, and geography. (multiple choice questions).

The scores were estimated based on the number of correct answers obtained from each questionnaire.

1.4 Intervention

The FAD (Table 1) was implemented in place of conventional teaching methods for 21 weeks. The intervention, which involved the presence of 2 educators, consisted of a 10-minute introductory warm-up phase, primarily aimed at training basic motor patterns, self-control, and laterality. Subsequently, the nuclear phase was introduced, during which the research team explained to the students the rules to follow and the tasks to be carried out for each educational and motor activity through practical demonstrations. At the end of each activity, before moving on to the next educational unit, educators and students engaged in a brief debriefing session, which was useful for verifying the understanding of the concepts covered and for clarifying any doubts from the students.

Finally, at the end of each lesson, there was a feedback phase, during which a brief "emotional education" activity lasting 10 minutes was proposed.

During this phase, practices such as comparison, dialogue, and the recognition of specific emotions were employed to promote understanding and acceptance of oneself and one's peers.

Knowledge phase	Nuclear phase	Retroactive phase
During this section, the students engage in motor exercises specifically designed to enhance their lateralization and concentration. The aim is to facilitate the development of physical and mental skills applicable in various areas of everyday life. Specifically, during this phase, the teacher coordinates the class group using vocal commands that dictate three execution rhythms: "Green" for maximum speed, "Yellow" for an intermediate pace, and "Red" for stopping. In fact, through these 3 inputs, students can rely on clear references and accurately execute the assigned motor patterns. The purpose of these activities is to pursue the development of the ability to modulate one's rhythm and adapt to changing contexts, as well as to encourage a deeper body awareness and refinement of laterality.	This phase represents the main section of the intervention, as it includes training sessions that refer to conventional educational subjects. For example, in pursuing the teaching of the English language, one of the proposed activities involves creating an individual point-based game. This game involves laying out two "speed ladders" on the floor, one meter apart from each other, inside of which sheets of paper with printed words in English will be placed. Additionally, plastic cones will be placed at the center of this station, which will represent the interactive element of the activity. This exercise requires the teacher to show the participant images with drawings related to the phrases written on the sheets placed in the center of the speed ladders. Each student's task will be to perform single-leg jumps until they reach the point where the sheet containing the corresponding word is located, and then place the marker on top of it. Once their turn is over, which ends at the first mistake or upon completing the exercise, the student	At the end of the teaching session, a moment of collective reflection called "education to feelings" is introduced. This session has been designed to alleviate any tensions that may have arisen during the competitions and to promote a process of physical decompression among the students. During this phase, the students are invited to arrange themselves in a circle, with the aim of creating an atmosphere of intimacy and relaxation. Once this atmosphere is established, a catalyst in the form of a rubber ball is introduced. Such a subsidy, which takes on a significant symbolic role, passes from hand to hand in a non-random manner, as the recipients of the throw are intentionally chosen by the previous holder; based on interpersonal dynamics that emerged during the lesson. In fact, the ball can be passed to a teammate with whom there have been tensions or, on the contrary, with whom a particular rapport has been established during the activities.

must return to the line to make room for the other participants. Through the use of this strategy, the aim is not only to make learning more engaging and interactive, but also to promote the development of linguistic, memory, and motor coordination skills, effectively integrating different areas of learning into a single comprehensive activity.	It should be specified that, at the time of the exchange, the educators invite the students involved to stand up. Through this gesture, a constructive dialogue and direct contact between the two involved parties is encouraged. Such an exercise is not just a simple tool for conflict resolution, but also presents a valuable opportunity to develop social and emotional skills, transforming potential frictions into occasions for collective growth.
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Table 1. The schematic structure of distance learning with a detailed description of the phases that compose it.

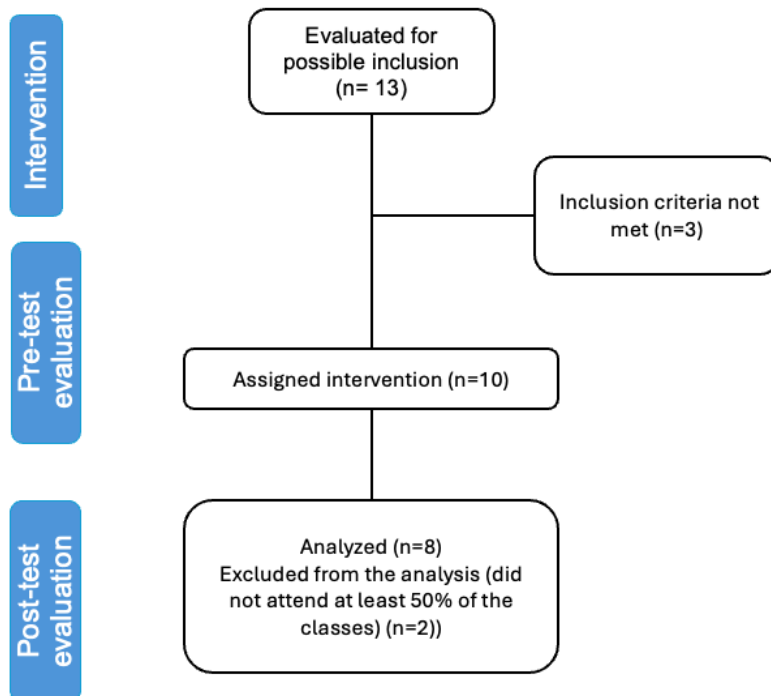
1.5 Procedures

Before the experiment, the participants provided written informed consent. The experiment, lasting 5 months, included 2 online learning sessions per week, replacing the regular classes, each lasting 1 hour. During the first two and a half months, the students learned the educational and motor activities of the FAD method, with educational content that was not yet relevant to the educational objective. Once this phase was completed, tests designed by the authors were administered to measure the participants' foundational learning in relation to mathematics, geometry, history, geography, and the English language. These tests covered topics that had not yet been addressed and were not covered during the curriculum lessons for the entire academic year.

Subsequently, the second part of the experiment lasting an additional two and a half months was initiated, during which educational content related to the educational objective was provided. At the end of the experiment, a new administration of the same educational tests was carried out, this time consistent with the topics covered.

The experiment involved 13 students, of whom 8 met the inclusion criteria, as 2 children did not satisfy the inclusion criteria related to neurodevelopmental disorders, while another child had specific learning disorders. Additionally, two other children did not attend 50% of the activities.

The authors state that all procedures strictly adhere to the ethical standards established by the relevant national and institutional committees regarding human experimentation. Informed consent was obtained from the parents of the participants, and the data were anonymized and collected in accordance with the General Data Protection Regulation (GDPR) of the European community and the guidelines of the Declaration of Helsinki of 1975, revised in 2013 by the World Medical Association.



Graph. 1 The flowchart shows the sequence of the phases of the study.

1.6 Data analysis

The data have been organized and processed using version 29.0.2.0 of SPSS. For all the variables, descriptive statistics were calculated and based on the results of the Shapiro-Wilk normality test, which followed a normal distribution, the parametric Student's T-test was used. Furthermore, effect sizes have been calculated for all estimates.

2. Results

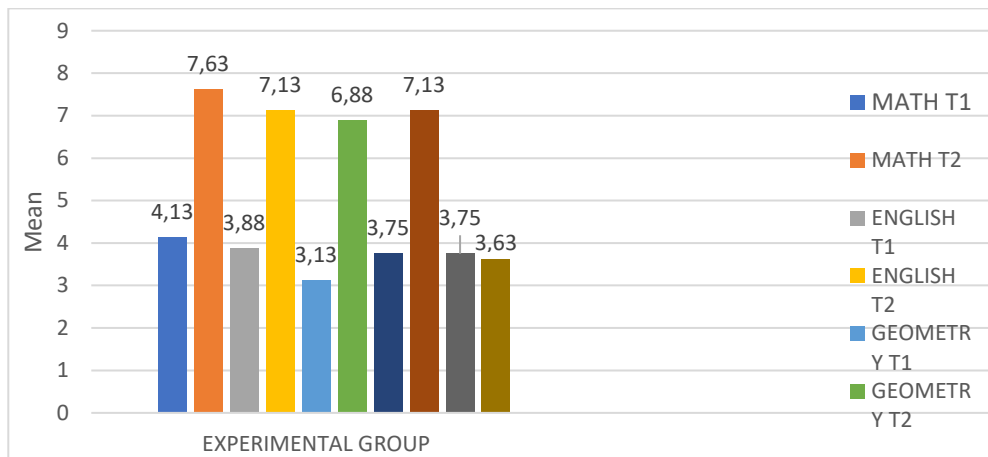
Table 2 shows the main descriptive data of the scores related to the participants' learning at the time of the first administration of the educational tests and the results of the post-intervention.

The data are presented as mean $\pm$ standard deviation, the P value refers to the significance index, while the *d* value is related to the effect size.

Tests	T1	T2	P Value	d Value (Effect size)
English	3.87 $\pm$ 1.80	7.12 $\pm$ 3.27	0.007 0.014	0.122
Arithmetic	4.12 $\pm$ 4.51	7.62 $\pm$ 4.40	0.025 0.050	0.078
History	3.75 $\pm$ 1.58	7.12 $\pm$ 2.29	0.012 0.023	0.171
Geography	3.75 $\pm$ 2.60	3.62 $\pm$ 1.40	0.408 0.815	0.005
Geometry	3.12 $\pm$ 2.53	6.87 $\pm$ 1.88	0.001* 0.002*	0.168

Table 2. Results of the pre-test and post-test regarding the educational questionnaires administered.

The data that emerged indicate that the participants achieved significantly higher scores, compared to the previous test, in the geometry assessment, with a small effect size ($p = 0.001 - 0.002$, $d = 0.168$). While for the other measures, no statistically significant differences were found between the results obtained after the first administration of the tests and those from the post-intervention. Figure 2 shows histograms that display the average scores obtained by participants in both tests. Such representation highlights a non-significant improvement in post-test scores regarding mathematics, English language, and history, while for geography, the data show a stable trend.



Graph. 2 Graphical representations of the average scores in the pre-test phase (T1) and post-test. (T2).

3. Discussion

The increase in sedentary levels is proving to be a rapidly rising phenomenon that affects the new generations. (Pettinicchio et al., 2023). This trend, in addition to the already known possible health repercussions (Singh et al., 2024), can lead to a decrease in academic performance (Laujac et al., 2022; Lima et al., 2019; Oliveira et al., 2024; Pellerine et al., 2023) with potential consequences for the future of students. (Rahman, 2023).

Therefore, a change in direction is necessary to promote a renewal of educational environments, which, in line with the principles of embodiment (Francesconi & Tarozzi, 2019; Gibbs, 2005; Rotter et al., 2021) and through the use of practices related to gamification methodology (Maia Miranda et al., 2022; Piki et al., 2020), can serve as spaces of "care" not only for the intellect but also for the bodily component. (Frauenfelder et al., 2018).

In fact, through the application of these techniques, it would be possible to promote not only a reduction in levels of sedentariness but also the adoption of interactive pedagogical approaches that focus on bodily interactions and intersubjective dynamics (Laroche et al., 2014), elements capable of enhancing students' scientific understanding. (Ibrahim-Didi et al., 2017).

However, it should be specified that the adoption of these strategies presents significant challenges, such as the resistance of educators to embrace a shift in

perspective towards viewing the body as an integral part of the learning process (Lopez-Ozieblo, 2023) rather than as a mere shell detached from the mind. (Baker & Morris, 2002; Christofidou, 2018). In the same way, the design of appropriate content and the application of suitable methods to effectively promote critical thinking can pose a challenge in adhering to these practices (Deng et al., 2023); The limited willingness of teachers who are not experienced in physical education to use methods that involve the body in relation to learning is a significant aspect in the adoption of embodied teaching. (Almarcha et al., 2023; Gomez Paloma et al., 2016).

Yet, despite the aforementioned challenges, educational practices that support the adoption of teaching methods grounded in an embodied philosophy have already been tested in the literature. (Skulmowski & Rey, 2018; Yang, 2017). For example, during an experiment conducted by Hraste (2018) on a sample of 36 fourth-grade primary school students. (19 del gruppo sperimentale e 17 del gruppo di controllo). An integrated physical activity protocol combined with mathematics and geometry was used, lasting 45 minutes per session over a period of 3 weeks. The results showed that children engaged in studying mathematics and shapes while moving and doing physical activities achieved better results compared to children who followed lessons through a conventional teaching method. In line with the results obtained by Hraste, in another experiment conducted by

Segura & Julià (2018), which involved 45 students aged between 10 and 11 years, attending the fifth year of a private Spanish school (divided into a control group of 21 students and an experimental group of 24 students); who have experienced a teaching-motor strategy called "The Apprentice Detectives." The study, which included 5 sessions aimed at enhancing students' spatial orientation through physical activities and games; it included 5 distinct activities such as: 1) the memorization and reproduction of figures, 2) the localization of hidden objects, 3) the creation and participation in oriented relays, 4) the drafting of maps, and 5) the completion of routes following instructions.

At the end of the study, the students in the experimental group, in addition to having improved their spatial orientation scores in the post-test, showed a high level of motivation and a good inclination towards teamwork.

Consistent with this work, the study conducted by the research team highlighted encouraging results that underscored significant improvements in the learning of concepts and notions related to geometry.

However, given the limitations of the study, partly due to the sample size and partly due to the absence of a control group, we intend to continue experimenting with distance learning through a more robust study that can include, in addition to the

participation of a larger sample, its implementation based on the exercises used to teach geometry.

Conclusions

The FAD seems to be a promising approach, as the study conducted by the research team has produced encouraging results regarding the learning of concepts and notions specific to geometry. However, further studies are necessary to verify its effectiveness on a larger sample that could include a control group and a longer duration of the intervention. Furthermore, the aim is to explore the impact of this method on the socio-relational aspects and executive functions of the students involved.

In conclusion, this small study, in addition to providing outcomes to work on to refine the FAD method, offers some initial evidence on how the integration of physical activity with other educational disciplines can not only be a means to promote higher levels of physical activity among learners but also an effective strategy for learning school subjects such as geometry itself.

Limitations

The main limitations of this work concern the sample size, the duration of the experiment, and the lack of a control group. Furthermore, there are limitations in the assessment of executive functions, which, given their close correlation with academic performance and the bodily component (Calma-Birling et al., 2023; Jahitha Begum et al., 2021; Shi et al., 2024), should be analyzed using tests validated in the literature.

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