education sciences

MDPI

Article

"Active Mathematics"—A Classroom-Based Physical Active Learning Intervention in an Elementary School: An Experimental Pilot Study

Liliana Ramos *, Vera Simões and Susana Franco

Sport Science School of Rio Maior—Polytechnic Institute of Santarém, Sport Physical Activity and Health Research & INnovation CenTer—SPRINT, 2040 Rio Maior, Portugal; verasimoes@esdrm.ipsantarem.pt (V.S.); sfranco@esdrm.ipsantarem.pt (S.F.)

* Correspondence: lilianaramos@esdrm.ipsantarem.pt

Abstract: This experimental pilot study aimed to compare the amount of physical activity (PA) of children in a second-year class of an elementary school that had a mathematics class while performing PA, based on playful math games, with children that had a mathematics class seated in a traditional room, for 12 weeks 1 day/week 45 min/class; furthermore, the other two mathematics regular seated classes were attended equally by both groups, and whether both groups showed similar results concerning mathematics grading was assessed. Children (n = 22) were randomly divided into a control group (CG) and an experimental group (EG). In both groups, the number of steps (PA) was measured with a pedometer, before and during all sessions of the intervention program, and an initial diagnostic and a final assessment mathematics test were carried out. EG significantly improved the amount of PA levels in the intervention program, when compared to CG and to the initial baseline (before the program started), with no significant differences between groups in the results of mathematics grading. The introduction of active classes based on playful maths games increases the amount of PA levels in children, and having one math class per week using PA, instead of seating in a traditional room, does not negatively affect the results in terms of mathematics grading. These positive results can contribute to more approaches, at schools, that combine PA and mathematics content.

Keywords: classroom-based physical active learning; mathematics; children; elementary school; pilot study; random control trial

check for updates

Citation: Ramos, L.; Simões, V.; Franco, S. "Active Mathematics"—A Classroom-Based Physical Active Learning Intervention in an Elementary School: An Experimental Pilot Study. *Educ. Sci.* **2024**, *14*, 637. https://doi.org/10.3390/educsci14060637

Academic Editor: Federico Corni

Received: 7 May 2024
Revised: 28 May 2024
Accepted: 5 June 2024
Published: 13 June 2024

Copyright: © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

1.1. Physical Activity for Children and School as a Key Factor for Their Improvement

There is a wealth of scientific evidence which demonstrates that the regular practice of physical activity (PA) is associated with health benefits. PA is a very important variable, with a high positive impact, on children's and youth's physical and mental health [1]. It is important to include PA programs in the school's daily routines and encourage students to be physically active, to reduce weight and increase health and academic performance [2]. Notably, childhood obesity is at the top of the political agenda of the WHO and is considered a serious public health condition around the world [3]. It is predicted that the prevalence of obesity in children and adolescents, between 2020 to 2035, will rise. It is expected that 14% of girls and 21% of boys will be affected in 2035 by obesity. This will have a very high economic impact. In Portugal, the projected trends in the prevalence of obesity, among boys and girls, between the period 2020–2035, will increase by 3.5%, havingvery high economic and social impacts [4].

Considering that the daily environments, in society, have been changing, significantly, in recent years, and current society characteristics are now very different, compared to a few years ago, and sufficient levels of regular PA are becoming increasingly difficult, leading

to the increased sedentary behaviours of the population, the World Health Organization (WHO) developed a European PA strategy that refers to the schools as an important key to develop and implement PA projects to increase levels of PA in children [5]. Considering that children and youth spend most of their time at school, this is the ideal space to implement these PA programs to promote higher levels of PA and healthy behaviours [2]. The Global Action Plan on Physical Activity 2018–2030 also suggests an inclusive school approach, where the school environment allows the participation and integration of PA in different educational contexts [6]. Interdisciplinary educational programs that included PA could be related to the development of the PA student's habits, across their lives. When students develop PA habits in school, they are more likely to transfer to other contexts, outside the school [7]. Young people who participate in PA programs have more skills and competences to execute attentional tasks that require a higher level of cognitive control (planning, organization, solving problems, and memory) [8,9].

1.2. Interdisciplinary Approaches—Background and Previous Studies

A way to increase PA levels and at the same time learn academic content could be the implementation of PA projects in schools that contain and explore academic content. PA can be used in the teaching–learning process, namely, in the introduction or consolidation of contents.

In recent years, there has been a growing interest in interdisciplinary educational approaches, in the areas of Science, Technology, Engineering, Arts/Humanities, and Mathematics (STEAM), due to their positive effect on the attitudes and learning of children and young people [10] and the need to stimulate their interest and involvement with the contents of these curricular areas. In this context, outdoor spaces and natural areas are resources that can serve as a complement to conventional classrooms, as they offer a significant context for STEAM education, enabling numerous informal and formal learning experiences [11]. The Portuguese report on the State of Education 2020 [12] recommends an understanding of school outdoor spaces as educational spaces, in which students could experience learning in outdoor spaces, becoming little explorers, researchers, scientists, and artists. Some advantages related to the use of outdoor spaces in education are the increase in enthusiasm and motivation to learn, the development of cooperation, social cohesion, and interpersonal skills [13,14]. Furthermore, the use of outdoor spaces improves attention, observation, and academic performance [15], having also a positive impact on health, with physical and psychological benefits [16,17]. Despite the potential of outdoor education, it tends not to be used in the educational practices of most teachers [11]. Some barriers for teachers not using this type of approach include the lack of confidence and training of teachers, the overload of work and responsibilities they have, and the extension of curricular programs [11].

Considering the evidence provided by the scientific literature, classroom-based PA has been associated with higher levels of health and higher levels of academic results in youth [2–18]. The classroom-based PA could be defined as PA carried out during regular class time, inside or outside the classroom, and can take place in three forms [18], namely, in active breaks, where short periods of PA are performed as a break in the academic lesson but not related to them [19], curriculum-focused active breaks, where short periods of PA are included in the academic lesson and are related to them [20], and physically active lessons, which integrate PA in all the academic lesson and having a longer duration than the other two forms [21]. A considerable amount of scientific evidence suggests that PA brings benefits to the cognitive and academic performance of children and youth. Exercises, related to coordination and aerobics, could have an important role in academic performance [2]. Different studies were designed, presenting different approaches, with the main goal of reducing sedentary time and increasing PA levels of students, in a school context [22]. However, traditionally, schools, usually, were focused on increasing literacy and numeracy skills, rather than the detriment of promoting more PA behaviours [23].

A possible benefit of integrating PA into academic subjects is that it has the potential to not only increase PA but also foster achievement, particularly in mathematics [24]. The last international Programme for International Student Assessment (PISA), which evaluated 81 countries from OECD member and partner economies in mathematics, lecture, and science, indicated that, in 2022, Portugal exhibited an inferior result than that in 2018 in the three areas, with mathematics being the worse, with 20.6% fewer points. However, Portugal has in line with the mean of all countries, that, in general, obtained fewer results than in 2018 [25]. These results were highly associated with the COVID-19 pandemic and the restrictions in the habitual process of learning. Specifically, for the subject of mathematics in the first cycle (second grade), the results of the 2023 benchmark tests show that only 10.9% of students were able to complete the exercises in the field of numbers and operations without difficulty, only 19.4% of students were able to complete the exercises in the field of geometry and measurement without difficulty, and only 39.2% of students were able to complete the exercises in the field of data organization and processing without difficulty. All results of that study were lower than in 2022, but it should be noted that 2023 was the first year in which the tests were taken digitally, which may have influenced the results [25].

The benefits of PA on academic performance, specifically on mathematics subject student performance, need to be further explored, and more studies, in this field, need to be carried out [24]. Ângelo et al. [26] carried out a study, in Portugal, where they verified how games can influence the learning of mathematics. With a sample of 23 students, 6 sessions were held over 3 weeks, with games with different motor skills, where mathematics content was also worked on. The results concluded that experiencing mathematics content through games may have led to improvements in learning and consolidation of mathematical concepts as well as greater interest in the field.

Maybe, more than at other school levels, the mathematics subject must be experienced in elementary schools. This experience should involve the manipulation of different materials, using, or not, technology, and also the resolution of practical and contextual problems.

However, to develop and implement projects related to classroom-based PA, it is very important to change some variables, such as teachers' perceptions and changing school environments [2]. It is also important to develop skills and competences in teachers with training that allow them to competently work with exercise professionals, sports coaches, or physical education teachers in the development and implementation of programs based on classroom PA curriculum, as a very important strategy to increase children´s PA levels in the school context but also to improve knowledge and enthusiasm in the learning process [27].

1.3. Objectives

Integrating PA programs in elementary schools (6–9 years old), with mathematics content, seems to be efficacious. However, the literature states that it is important to conduct more studies in this field, to prove such results, using more robust methodologies [21]. Considering this, to increase PA levels while improving the mathematics subject learning process, the "Active Mathematics" project was implemented. This pilot project, financed by Portuguese government (*Instituto Português do Desporto e Juventude, I.P.* [*IPDJ*]—Portuguese Institute of Sports and Youth), was developed by exercise professionals in articulation with elementary school teachers. The main goal of "Active Mathematics" project was the implementation of a PA program, with contents related to the mathematics subject, in a Portuguese elementary school, with children in the second-year class, to verify if the implementation of this project is possible to improve or maintain mathematics learning, and, at the same time, increase students' PA levels.

The present experimental pilot study, integrated into the "Active Mathematics" project, aimed to compare the amount of PA (number of steps) of children who had a mathematics class performing PA with children who had mathematics class seated in a traditional room and to assess if both groups had similar results concerning mathematics grading. The first hypothesis is that children who had a mathematics class performing PA had significantly

more amount of PA in those school days, compared with the initial baseline and with children who had mathematics class seated in a traditional room. The second hypothesis is that there is equality in mathematics grading between children who had mathematics class performing PA and children who had mathematics class seated in a traditional room, after the intervention program.

2. Materials and Methods

2.1. Participants

Before starting the intervention program, permission from the ethics committee of the Polytechnic University of Santarém was obtained (no. 28A-2022ESDRM). Then, the research team contacted the head of the school and the teacher from the target class involved to fully explain the study. After their agreement and interest in participating in this intervention program, the student's families were contacted to explain the project and obtain their permission, and all signed written consent.

Two groups of students from a second-year class of an elementary school in Rio Maior, Portugal, were randomly divided, aleatory, by the head teacher, into a control group (CG) and an experimental group (EG), with 11 students each (n = 22). CG had 7 female and 4 male students, and EG had 6 female and 5 male students. Both groups had students between 7 and 8 years old (mean age in both groups = 7.09 $\pm$ 0.29 years old).

2.2. Procedures

In this random control trial study (RCT), during 12 weeks of the intervention program, implemented in the year 2022, besides the other regular classes (seated mathematics classes twice a week, equal for both groups), once a week, CG had 45 min of mathematics class seated in a traditional room and EG had a 45 min class in a sports field performing PA, led by an exercise professional, while learning the same mathematics contents as the CG.

The exercise professionals who accompanied the EG coordinated weekly with the head teacher (who accompanied the CG and taught all classes of other subjects) and planned the mathematics contents of the classes, based on the national mathematics program and curriculum goals [28]. Also, after the exercise professional made the plan of the session and before its application, the head teacher approved the exercises and their correspondence with the mathematics contents, ensuring that both taught the same content.

The PA performed in the intervention program was based on playful mathematics games that developed one or more conditional physical capacities (e.g., strength, speed, endurance, and flexibility) and coordination abilities (e.g., orientation, balance, coordination, and reaction).

The structure of the session is constituted by an initial instruction and a warm-up (around 5 min), made with 1 or 2 games, followed by the main part (around 35 min) with about 4 games, ending with a cool-down game and a final instruction (5 min). All sessions were performed in a sports field, outside, that belongs to the school (approximately 250 m from the school room), with the exception that, when it is raining, the activities were performed in a small field with a shed (approximately 50 m from the school room).

During the 12 sessions of the intervention program, both groups used a pedometer (Yamax—EX-510) throughout the day in the school (9:00 A.M. to 3:30 P.M.; including class, lunch, and recreation time), to count the number of steps of that day as a measure of the amount of PA. To know how many steps the children took during the exercise session with the mathematics content, the value that children of the EG had until the beginning of the class was recorded, and then, after the session, the value at the end of the class was recorded, being the number of session steps counted by subtracting the steps at the end of the session from those at the beginning of the session.

Also, one week before the intervention program started, the students used the same pedometer to obtain the initial baseline number of steps that they usually perform during a school day, with no intervention. This procedure is important for children to get used to the pedometer and to see if the groups are similar in their daily PA before the interventions

start. It is important to note that the children were not informed about the purpose of the study, trying, this way, that there no influence on the results.

No significant differences in the initial baseline of the amount of PA were found between groups (Table 1), considering that both groups had a similar amount of PA at school before the intervention program started.

Both groups, in the week before the intervention program started, underwent an initial diagnostic mathematics test, and, in the week after the program ended, underwent a final assessment mathematics test, to know mathematics grading (scale 0–100). Both tests were developed by the head teacher and were applied to students in a traditional classroom. The themes of the mathematics test were in line with the mathematics contents that were addressed before the intervention (diagnostic test) and that were addressed during the intervention (final test), being exactly the same for both groups.

No significant differences in initial mathematic grading were found between groups (Table 3), with both groups starting from a similar mathematic level.

2.3. Statistical Analysis

Descriptive statistics were used to characterize participant's age (minimum, maximum, mean, and standard deviation), gender (frequency), and mean steps of the 12 sessions.

The *t*-test was used to compare both groups (CG and EG) in terms of the mean number of steps (PA) at the initial baseline and at the initial diagnostic mathematics test. Its assumptions were verified: normality (tested with Shapiro–Wilk) and equality of variances (tested with Levene's test).

To compare mathematics grading in both groups, before and after the intervention program, the two-way mixed ANOVA was used. Also, to compare mean steps in both groups, before and after the intervention program, the two-way mixed ANOVA was used. For those tests, the assumptions were verified: normality (tested with Shapiro–Wilk) and equality variances (tested with Levene's test).

For both tests, statistical significance was established at $p \leq 0.05$ (95% confidence interval—CI).

The IBM SPSS Statistics version 29 software was used to conduct the statistical analysis.

3. Results

Table 1 shows the amount of PA (number of steps) of the CG and EG during the initial baseline day and during the school day of the 12 sessions of the intervention program (mean of the 12 sessions), measured by a pedometer throughout the day in the school. EG increased the number of steps with the intervention (mean: 7201 ± 1463), considering the initial baseline (mean: 5894 ± 1827), having completed more steps than the CG (mean: 4705 ± 1472) throughout the 12 weeks of the program.

Table 1. Number of steps at baseline and mean number of steps in the 12 sessions of the intervention program, in both groups (control group and experimental group): descriptive statistics (mean and standard deviation) and comparison (*t*-test and two-way mixed ANOVA).

	Mean ± Standard Deviation		***p***	
	Control Group	**Experimental Group**	***t*-Test**	**Two-Way Mixed ANOVA**
Number of steps at initial baseline	4683 ± 2181	5894 ± 1827	0.087	
Mean number of steps in the 12 sessions of the program	4705 ± 1472	7201 ± 1463		
Moment				0.008 *
Moment * Group				0.010 *

Moment: initial baseline in the week before the intervention program; 12 weeks of the intervention program. Groups: the control group and the experimental group. * $p \leq 0.05$

Results, in terms of main effects, show that there was a significant effect on the number of steps (amount of PA) considering the moment (initial baseline and intervention program; $p = 0.008$) and interaction between moment and group ($p = 0.010$), revealing the fact that EG significantly increased its amount of PA with the intervention program when compared to CG and to initial baseline.

Table 2 shows the steps that each child of the EG performed during the sessions. It is possible to note that the mean steps of the 12 sessions are nearly 1900, with a standard deviation of 266 steps. The maximum number of steps during the session was 2313.8 and the minimum number of steps during the session were 1454.8.

Table 2. Steps for session of the experimental group (descriptive statistics, mean, and standard deviation).

Sessions EG	1	2	3	4	5	6	7	8	9	10	11	12	M ± SD Steps for Session
1	2083	2107	2081	2649	2750	1874	1769	2113	2525	2525	2201	3089	2313.8 ± 328.1
2	1495	2089	1918	1710	2403	1573	1268	1195	1629	2097	1434	2370	1765.1 ± 341.9
3	1224	1470	1679	1367	2214	1179	1180	1297	1248	1715	1771	1432	1481.3 ± 242.3
4	1576	1433	2350	1896	2165	1155	1407	1246	1958	1960	1365	2588	1758.3 ± 394.6
5	1641	2017	2492	1976	2595	1828	2129	1806	*	2755	2316	1852	2127.9 ± 299.5
6	1534	1292	1432	1416	2219	946	860	1281	1506	2299	1506	1166	1454.8 ± 298.4
7	1606	1504	2111	1512	2855	1648	1662	*	1753	1919	1809	2726	1918.6 ± 352.1
8	1851	2152	2009	1968	2858	1489	1513	2183	2034	2241	2699	2890	2157.3 ± 347.5
9	1572	1342	1591	1331	2486	1101	1339	1359	1740	1749	1690	1544	1570.3 ± 234.3
10	2093	2302	2698	2171	3265	*	2146	*	1982	2457	2645	2381	2414.0 ± 281.8
11	1692	1738	1879	1774	2640	1589	1759	1958	1851	2167	2465	1585	1924.8 ± 255.2
M ± SD steps during 12 sessions:													1898.7 ± 266.2

* Children missed the session.

Table 3 exhibits the results of the mathematics grading of the EG and CG in the initial diagnostic mathematics test and the final mathematics test.

Table 3. Initial and final mathematic grading in both groups (control group and experimental group): descriptive statistics (mean and standard deviation) and comparison (*t*-test and two-way mixed ANOVA).

	Mean ± Standard Deviation		*t*-Test	Two-Way Mixed ANOVA
	Control Group	Experimental Group	*p*	*p*
Mathematics grading in the initial diagnostic test	82.36 ± 8.06 (n = 10)	79.49 ± 15.58	0.322	
Mathematics grading in the final test	78.14 ± 17.42 (n = 10)	79.09 ± 12.76		
Mathematics test				0.617
Mathematics test * Group				0.708

Note: one of the children did not perform the final mathematics tests, so only 10 subjects were considered in this variable. Mathematics tests: the initial mathematics diagnostic test and the final mathematics test. Groups: the control group and the experimental group. * $p \leq 0.05$

Results in terms of main effects show that there was no significant effect on the mathematics grading, considering the mathematics test (initial mathematics diagnostic test and final mathematics test; $p = 0.617$) and interaction between mathematics test and group ($p = 0.708$), revealing the fact that the EG having one math class per week using PA,

instead of seating in a traditional room, does not negatively affect the results in terms of mathematics grading.

Even though there were no significant differences between the groups, it was verified that, in the initial diagnostic mathematics test, the CG presented higher values (82.36 ± 8.06) in relation to the EG (79.49 ± 15.58). However, after implementing the intervention program, and after both groups completed the final mathematics test, it was found that the EG presented better results (79.09 ± 12.76) than the CG (78.14 ± 17.42) in the mathematics grading.

4. Discussion

One of the main goals of the present pilot study was to compare the amount of PA of the two groups of children from a second-year class of a Portuguese elementary school that performed an intervention program, besides the other regular seated mathematics classes twice a week: the EG had one of the classes in an exterior sport field, performing PA based on playful mathematics games, while the CG had mathematics class seated in a traditional room, with both groups learning the same mathematics contents, during 12 weeks, 1 day/week 45 min/class). After the 12 weeks of the intervention program, the EG significantly improved the amount of PA (number of steps) when compared to the CG and to the initial baseline. The fact that, on average, the EG take approximately 1900 steps per session can justify the significant differences between groups. These results show a daily increase in PA in the EG, which is important for children to improve their health and life quality, meeting guidelines regarding the amount of daily PA and recommendations made by WHO. The recommendations are that children and adolescents should perform at least 60 min per day of moderate-to-vigorous-intensity PA across the week, mostly aerobic, and 3 days a week of vigorous-intensity aerobic activities and/or strength training [2,4]. The WHO also indicates, in their guidelines, that performing some PA is better than doing nothing, and even if children do not meet the recommendations, performing a small amount of PA will be good for their health and well-being [29]. Our results are in line with a study conducted by Schmidt et al. [30], which implemented a classroom-based PA program in adolescent students and found that the program increases their PA levels and also improves the student's psychosocial health and well-being. A study made by Erwin et al. [31] also found that 10 min of PA maths classes, once a day, in an intervention period of 13 days, also significantly increased the number of steps in the EG than that at the baseline and 33% more steps compared to the CG. In a systematic review [32] of methods and results about physically active lessons, such as PA and educational interventions, there were differences in PA levels in eight of the eleven identified studies, comparing the EG and the CG, with the EG obtaining better values in terms of steps per day, similar to the results of our study. Although the use of pedometers has its limitations, their use for quantifying the amount of PA has been high, due to the low associated costs and the ease of handling and using this type of equipment [33]. Some studies have tried to match the number of steps taken per day, in children, with moderate-to-vigorous physical activity. A study by Tudor-Locke et al. found that, in elementary school children, a volume of 13,000 to 15,000 steps per day (in boys) and 11,000 to 12,000 steps per day (in girls) may be sufficient to achieve 60 min of moderate-to-vigorous PA [34]. Considering that the steps taken in our study were only measured until approximately 3 pm, an increase of 1900 steps, on average, for the EG, it may be important for children to achieve sufficient levels of physical activity by the end of the day.

The second goal of our study is to compare the mathematics grading between children who had a mathematics class performing PA and children who had a mathematics class seated in a traditional room. In the present study, the results of the mathematics grading of the EG and the CG in the initial diagnostic mathematics test and the final mathematics test reveal the fact that the EG having one math class per week using PA, instead of sitting in a traditional room, does not negatively affect the results in terms of the mathematics grading. Even though there were no significant differences between the groups, it was

verified that, in the initial diagnostic mathematics test, the CG presented higher values (82.36 ± 8.06) in relation to the EG (79.49 ± 15.58); however, after implementing the PA program for the EG, and after both groups completed the final mathematics test, it was found that the EG presented better results (79.09 ± 12.76) than the CG (78.14 ± 17.42). These results corroborate the hypothesis established for this study and are in line with several studies [30,35,36] that showed that PA practice is associated with higher levels of health, higher levels of children's physical and psychosocial well-being [1,22], and also the development and increase in the cerebral connections that are involved in the learning process. In this study, it was verified that combined teaching of physically active academic sessions could be a good strategy to increase the PA levels in children, suggesting that higher PA levels affect, positively, the acquisition of knowledge and skills related to mathematics contents. Romani and Klausen [37], in their research, stated that the inclusion of active games in academic learning tasks implies higher levels of intrinsic motivation and lesser academic stress. Lubans et al. [38], as well, verified that PA programs had a significant positive effect on mathematics performance in adolescents. Mavilidi et al. [39] conducted research that evaluated the effectiveness of a short 8-week intervention program denominated "Move for Thought" that integrated PA practice during mathematics lessons. The results indicated that integrating PA with mathematics content learning has a stronger effect on mathematics grading than breaks and traditional instruction. In a study conducted in Portugal that used games related to the mathematics content, students learned and consolidated more of the math themes addressed and also revealed more motivation to learn the mathematics subject [26].

Also, several scientific proofs, which use combined PA programs with mathematical calculations, are associated with successful results in academic performance of children and adolescents. Several studies carried out in this field that use mathematical games and problem solving with active/movement games motivate schoolchildren, and the inclusion of PA classes with mathematics contents develops intellectual fluidity. The regular practice of PA is highly related to improvements in mental performance, and students with high levels of PA experience improvements in their cognitive system in terms of attention, concentration, creativity, and mathematical calculations [40–43].

On the other hand, it seems that PA programs that use playful mathematics games could promote the improvement in physical condition and academic performance but also self-concept/esteem and social skills, as presented in a study developed by Cámara-Martinez et al. [44]. These authors analyse the effects of an integrated active lessons programme based on playful mathematics games of 10-week duration (30 min/day—2 days/week) on self-concept, self-esteem, and social skills in preschool children. The EG showed significant improvements in self-concept compared to the CG and their personal and academic self-esteem levels increased significantly, and the EG exhibited significant improvements in social self-esteem and social skills.

The Global Action Plan on Physical Activity 2018–2030 suggests the integration of PA into different educational contexts and the use of different school environments for learning [6]. The use of outdoor spaces, such as the sports field used in the present study, for STEAM education, can have a positive impact on physical and psychological health [16,17] and can increase the enthusiasm and motivation to learn, develop cooperation, social cohesion, and interpersonal skills [13,14], and improve attention, observation, and academic performance [15].

The "Active Mathematics" project, as verified in this research, allowed students of the second-year class of an elementary school to increase their levels of PA and engage in the learning of mathematics contents with a different method, learning math through a specific PA program. It should be noted that, to accomplish these main goals, it is very important to have a multidisciplinary team, which involves children, their families, and their teachers, training them with knowledge and appropriate pedagogical approaches for this purpose. This multidisciplinary team should perform collaborative work with exercise professionals

and/or physical education teachers and/or sport coaches who are experts in the exercise area and could provide integrated coordination and guidance for these interventions.

This is a pilot study and aims to improve the reflection about more "active learning" in Portuguese schools. The significant differences in the number of steps, without compromising the mathematics learning, could be a very important result to make the reflection about the way that professors teach the mathematics content to our children.

As referred before, this is a pilot study and presents some limitations. One of that limitations was related to the small sample size and the fact that only 12 sessions were carried out. It is suggested that, in future research, a longitudinal study be carried out over, for example, one semester with more children and in different schools and school levels. The use of a pedometer may be a limitation because children could change their normal behaviour throughout the day, and it is also suggested that future research uses an accelerometer, which would allow to analyse of a higher number of variables related to PA.

5. Conclusions

This study demonstrates that the "Active Mathematics" project, whose main goals were the application of a PA program including active games with mathematics contents, significantly increases the PA levels of students in second-year classes of an elementary school and allows the students to maintain their results in terms of mathematics grading.

The use of PA programs with the inclusion of active games with mathematics contents is recommended as support for the increase in PA levels and consequently brings health benefits and improves children's physical condition. These positive results can contribute to more pedagogical approaches at schools that combine PA and mathematics content.

Even though the findings of this study were in line with other previous studies in this field, the results should be interpreted with caution, considering it is a pilot study, and that they indicate a positive effect on PA levels.

Lastly, it is recommended that more studies on the implementation of PA programs with longer durations (more than 12 weeks), active lessons more times a week, and a higher number of students and with different ages.

Author Contributions: L.R., V.S. and S.F. conceptualized the study. L.R. acquired funding. L.R. supervised project administration and data collection. S.F. analysed the data. L.R., V.S. and S.F. were all involved in drafting the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the Portuguese Institute of Sports and Youth, grant number N CP/224/DDT/2022—Sports Development Program.

Institutional Review Board Statement: This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Institute Polytechnic of Santarém (No. 28A-2022ESDRM).

Informed Consent Statement: Informed consent was obtained from parents of all subjects involved in this study.

Data Availability Statement: The data used to support the findings of this study are available from the corresponding author upon request.

Acknowledgments: We acknowledge the director of the school where the program took place, the exercise professional who accompanied the children in the PA program, the head teacher of the class, students, and parents.

Conflicts of Interest: The authors declare that they have no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. Biddle, J.H.; Ciaccioni, S.; Thomas, G.; Vergeer, I. Physical Activity and Mental Health in Children and Adolescents: An Updated Review of Reviews and an Analysis of Causality. *Psychol. Sport Exerc.* **2019**, *42*, 146–155. [CrossRef]
2. Latino, F.; Tafuri, F. Physical Activity and Academic Performance in School-Age Children: A Systematic Review. *Sustainability* **2023**, *15*, 6616. [CrossRef]
3. Bel-Serrat, S.A.; Ojeda-Rodríguez, M.M.; Heinen, M.; Buoncristiano, S.; Abdrakhmanova, V.; Duleva, V.F.; Sant'Angelo, A.; Fijałkowska, T.; Hejgaard, C.; Huidumac, J.; et al. Clustering of Multiple Energy Balance-Related Behaviors in School Children and Its Association with Overweight and Obesity—Who European Childhood Obesity Surveillance Initiative (Cosi 2015–2017). *Nutrients* **2019**, *11*, 511. [CrossRef] [PubMed]
4. Lobstein, T.R.; Jackson-Leach, J.; Powis, J.; Brinsden, H.; Gray, M. *World Obesity Atlas 2023*; World Obesity Federation, Ed.; World Obesity Federation: London, UK, 2023. Available online: https://data.worldobesity.org/publications/?cat=19 (accessed on 15 January 2024).
5. World Health Organization. *Physical Activity Strategy for the Who European Region 2016–2025*; WHO Regional Office for Europe: Copenhagen, Denmark, 2016. Available online: https://apps.who.int/iris/handle/10665/329407 (accessed on 15 January 2024).
6. World Health Organization. *Global Action Plan on Physical Activity 2018–2030: More Active People for a Healthier World*; World Health Organization: Geneva, Switzerland, 2018. Available online: https://apps.who.int/iris/bitstream/handle/10665/272722/9789241514187-eng.pdf (accessed on 15 January 2024).
7. Jiménez-Parra, J.F.; Valero-Valenzuela, A. Impact of an Interdisciplinary Educational Programme on Students' Physical Activity and Fitness. *Healthcare* **2023**, *11*, 1256. [CrossRef]
8. Trudeau, F.; Shephard, R.J. Physical Education, School Physical Activity, School Sports and Academic Performance. *Int. J. Behav. Nutr. Phys. Act.* **2008**, *5*, 10. [CrossRef] [PubMed]
9. Tomporowski, P.D.; Davis, C.L.; Miller, P.H.; Naglieri, J.A. Exercise and Children's Intelligence, Cognition, and Academic Achievement. *Educ. Psychol. Rev.* **2008**, *20*, 111–131. [CrossRef] [PubMed]
10. Dejarnette, N. America's Children: Providing Early Exposure to Stem (Science, Technology, Engineering, and Math) Initiatives. *Education* **2012**, *133*, 77–84.
11. Van Dijk-Wesselius, J.E.; Van den Berg, A.E.; Maas, J.; Hovinga, D. Green Schoolyards as Outdoor Learning Environments: Barriers and Solutions as Experienced by Primary School Teachers. *Front. Psychol.* **2020**, *10*, 484511. [CrossRef] [PubMed]
12. Conselho Nacional de Educação. *Estado Da Educação 2020*; Conselho Nacional de Educação (CNE): Lisboa, Portugal, 2021.
13. Waite, S.; Bølling, M.; Bentsen, P. Comparing Apples and Pears?: A Conceptual Framework for Understanding Forms of Outdoor Learning through Comparison of English Forest Schools and Danish Udeskole. *Environ. Educ. Res.* **2016**, *22*, 868–892. [CrossRef]
14. Ozer, E.J. The Effects of School Gardens on Students and Schools: Conceptualization and Considerations for Maximizing Healthy Development. *Health Educ. Behav.* **2005**, *34*, 846–863. [CrossRef]
15. Asma, M.; Yıldız, K. Orienteering as a Supportive Educational Tool: The Case of Mathematics and Science. *Int. J. Eurasian Educ. Cult.* **2023**, *8*, 272–300. [CrossRef]
16. Reese, R.F. A Qualitative Exploration of the Barriers and Bridges to Accessing Community-Based K-12 Outdoor Environmental Education Programming. *J. Outdoor Environ. Educ.* **2018**, *22*, 21–37. [CrossRef]
17. Louv, R. *Last Child in the Woods: Why Children Need Nature, How It Was Taken from Them, and How to Get It Back*; Algonquin Books of Chapel Hill: Chapel Hill, NC, USA, 2005.
18. Watson, A.; Timperio, A.; Brown, H.; Keren, B.; Hesketh, K.D. Effect of Classroom-Based Physical Activity Interventions on Academic and Physical Activity Outcomes: A Systematic Review and Meta-Analysis. *Int. J. Behav. Nutr. Phys. Act.* **2017**, *14*, 114. [CrossRef] [PubMed]
19. Jasmin, K.M.; Lucy, M.R.; Brendon, J.G. Four Minutes of in-Class High-Intensity Interval Activity Improves Selective Attention in 9- to 11-Year Olds. *Appl. Physiol. Nutr. Metab.* **2014**, *40*, 238–244. [CrossRef] [PubMed]
20. Matthew, T.M.; Murphy, S.K.; Rowe, D.A.; Golden, J.A.; Shields, T.; Raedeke, T.D. Effects of a Classroom-Based Program on Physical Activity and on-Task Behavior. *Med. Sci. Sports Exerc.* **2006**, *38*, 2086–2094. [CrossRef]
21. Riley, N.; Lubans, D.R.; Holmes, K.; Morgan, P.J. Findings from the Easy Minds Cluster Randomized Controlled Trial: Evaluation of a Physical Activity Integration Program for Mathematics in Primary Schools. *J. Phys. Act. Health* **2015**, *13*, 198–206. [CrossRef] [PubMed]
22. Amor-Barbosa, M.; Ortega-Martínez, A.; Carrasco-Uribarren, A.; Bagur-Calafat, M.C. Active School-Based Interventions to Interrupt Prolonged Sitting Improve Daily Physical Activity: A Systematic Review and Meta-Analysis. *Int. J. Environ. Res. Public Health* **2022**, *19*, 15409. [CrossRef]
23. Montesano, P.; Mazzeo, F. Sports Activities in Obese Teenagers Improve Social Inclusion and Health. *Sport Mont* **2019**, *17*, 55–60. [CrossRef]
24. Greco, G.; Luca, P.; Roberto, C.; Antonino, P.; Francesco, F.; Stefania, C. Effects of a Complex Physical Activity Program on Children's Arithmetic Problem Solving and Arithmetic Reasoning Abilities. *Eur. J. Investig. Health Psychol. Educ.* **2023**, *13*, 141–150. [CrossRef]
25. OECD. *PISA 2022 Results (Volume I): The State of Learning and Equity in Education*; PISA, OECD Publishing: Paris, France, 2023. [CrossRef]

26. Ângelo, A.C.; Campos, F.; Leandro, C.R. Os Jogos e a Matemática no 1.º Ceb: Uma Abordagem Interdisciplinar. *J. Sport Pedagog. Res.* **2021**, *5*, 23.
27. Goh, T.L.; Chee, H.L.; Brusseau, T.A.; James, H. Children's Physical Activity Levels Following Participation in a Classroom-Based Physical Activity Curriculum. *Children* **2019**, *6*, 76. [CrossRef] [PubMed]
28. Ministério da Educação e Ciência, *Programa e Metas Curriculares Matemática-Ensino Básico*; Ministério da Educação e Ciência: Lisbon, Portugal, 2013. Available online: https://www.dge.mec.pt/sites/default/files/Basico/Metas/Matematica/programa_matematica_basico.pdf (accessed on 30 January 2024).
29. World Health Organization. *WHO Guidelines on Physical Activity and Sedentary Behaviour*; World Health Organization: Geneva, Switzerland, 2020.
30. Schmidt, S.K.; Bratland-Sanda, S.; Bongaardt, R. Young Adolescents' Lived Experience with Teacher-Led Classroom-Based Physical Activity: A Phenomenological Study. *Teach. Teach. Educ.* **2022**, *116*, 103777. [CrossRef]
31. Erwin, H.E.; Mark, G.A.; Beighle, A.; Beets, M.W. Promoting Children's Health through Physically Active Math Classes: A Pilot Study. *Health Promot. Pract.* **2011**, *12*, 244–251. [CrossRef] [PubMed]
32. Norris, E.; Shelton, N.; Dunsmuir, S.; Duke-Williams, O.; Stamatakis, E. Physically Active Lessons as Physical Activity and Educational Interventions: A Systematic Review of Methods and Results. *Prev. Med.* **2015**, *72*, 116–125. [CrossRef] [PubMed]
33. Sulla-Torres, J.; Vidal-Espinoza, R.; Avendaño Llanque, C.; Calla Gamboa, A.; Zúñiga Carnero, M.; Cossio-Bolaños, M.; Gomez-Campos, R. Quantification of the Number of Steps in a School Recess by Means of Smart Bands: Proposal of Referential Values for Children and Adolescents. *Children* **2023**, *10*, 915. [CrossRef]
34. Tudor-Locke, C.; Craig, C.L.; Beets, M.W.; Belton, S.; Cardon, G.M.; Duncan, S.; Hatano, Y.; Lubans, D.R.; Olds, T.S.; Raustorp, A.; et al. How many steps/day are enough? for children and adolescents. *Int. J. Behav. Nutr. Phys. Act.* **2011**, *8*, 78. [CrossRef] [PubMed]
35. Ruiz-Ariza, A.; Suárez-Manzano, S.; López-Serrano, S.; Martínez-López, E.J. La Actividad Física Como Medio Para Cultivar La Inteligencia En El Contexto Escolar. *Rev. Española Pedagog.* **2021**, *79*, 161–177. [CrossRef]
36. Martínez-López, M.; Torre-Cruz, M.J.; Suárez-Manzano, S.; Ruiz-Ariza, A. 24 Sessions of Monitored Cooperative High-Intensity Interval Training Improves Attention-Concentration and Mathematical Calculation in Secondary School. *J. Phys. Educ. Sport* **2018**, *18*, 1572–1582. [CrossRef]
37. Romani, A.Q.; Klausen, Q.B. Physical Activity and School Performance: Evidence from a Danish Randomised School-Intervention Study. *Scand. J. Educ. Res.* **2017**, *61*, 479–502. [CrossRef]
38. Lubans, D.R.; Mark, R.; Beauchamp, T.M.; Diallo, O.; Peralta, L.R.; Bennie, A.; White, R.L.; Owen, K.; Lonsdale, C. School Physical Activity Intervention Effect on Adolescents' Performance in Mathematics. *Med. Sci. Sports Exerc.* **2018**, *50*, 2442–2450. [CrossRef]
39. Mavilidi, M.F.; Spyridoula, V. Classroom-Based Physical Activity and Math Performance: Integrated Physical Activity or Not? *Acta Paediatr.* **2021**, *110*, 2149–2156. [CrossRef] [PubMed]
40. Ruiz-Ariza, A.; Grao-Cruces, A.; Loureiro, N.E.M.; Martínez-López, E.J. Influence of Physical Fitness on Cognitive and Academic Performance in Adolescents: A Systematic Review from 2005–2015. *Int. Rev. Sport Exerc. Psychol.* **2017**, *10*, 108–133. [CrossRef]
41. Mavilidi, M.F.; Drew, R.; Morgan, P.J.; Lubans, D.R.; Schmidt, M.; Riley, N. Effects of Different Types of Classroom Physical Activity Breaks on Children's on-Task Behaviour, Academic Achievement and Cognition. *Acta Paediatr.* **2020**, *109*, 158–165. [CrossRef] [PubMed]
42. Mavilidi, M.F.; Lubans, D.R.; Morgan, P.J.; Miller, A.; Eather, N.; Karayanidis, F.; Lonsdale, C.; Noetel, M.; Shaw, K.; Riley, N. Integrating Physical Activity into the Primary School Curriculum: Rationale and Study Protocol for the "Thinking While Moving in English" Cluster Randomized Controlled Trial. *BCM Public Health* **2019**, *19*, 379. [CrossRef] [PubMed]
43. Owen, K.B.; Parker, P.D.; Astell-Burt, T.; Lonsdale, C. Effects of Physical Activity and Breaks on Mathematics Engagement in Adolescents. *J. Sci. Med. Sport* **2018**, *21*, 63–68. [CrossRef]
44. Cámara-Martínez, A.; Ruiz-Ariza, A.; Suárez-Manzano, S.; Cruz-Cantero, R.M.; Martínez-López, E.J. Effect of an Integrated Active Lessons Programme through Playful Maths Games on Self-Concept, Self-Esteem and Social Skills in Preschool Children. *Behav. Sci.* **2023**, *13*, 260. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.