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The effect of an in-service PE teacher training programme on the fitness levels of learners

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Although physical education (PE) provides a school-based platform for the enhancement of learners' physical health, implementation challenges can have a detrimental effect on learners' motivation to participate in physical activities and their fitness levels. Within the framework of the Self-determination Theory (SDT), meeting learners' basic psychological needs of autonomy, competence and relatedness in the PE class, can promote their fitness levels by enhancing their intrinsic motivation to be physically active. The purpose with this study was to investigate the effect of an in-service PE teacher training programme including needs-support teaching strategies on the physical and motor fitness levels of the learners of the participating teachers. Using a pre- and post-test experimental design, the fitness of 1 control and 4 experimental groups were assessed using standardised tests before and after the intervention programme. The intervention included implementing the needs-support teaching strategies acquired by the teachers during the once-off, 5-day teacher training programme, for 4 months while receiving continued support from the instructors of the course during those 4 months. The results show that the programme had a positive effect on the fitness levels of the learners in most of the tested fitness components, warranting the recommendation of SDT-based in-service training of PE teachers to support learners' motivation towards physical activity and fitness.

Keywords: fitness; in-service teacher training; physical education; self-determination theory; teacher training

Introduction

Physical inactivity, low levels of physical fitness and obesity during childhood, which are often carried over into adulthood and linked to risk factors for cardiovascular disease, pose serious concerns worldwide (World Health Organization [WHO], 2020). Researchers (Chen, Wang, Wang & Zhou, 2020; Du Toit, 2019) agree that the school setting is an ideal environment to increase physical activity levels and improve cardiorespiratory fitness by means of physical education (PE) and school-based physical activity intervention.

Literature Review

Effective PE programmes, as stated by the United States' Society of Health and Physical Educators ([SHAPE] America, n.d.) and the United Nations Educational, Scientific and Cultural Organization ([UNESCO], n.d.), should relay knowledge necessary for a physically-active lifestyle and cultivate responsible personal and social behaviour while inspiring physical activity and developing fitness. Participation in regular physical activities in PE is also recommended by researchers in studies where moderate to high levels of physical fitness (specifically cardiorespiratory endurance) and motor fitness (specifically motor coordination and perceptual-motor skills) have been shown to correlate with higher levels of academic performance and cognitive function (Berrios-Aguayo, Latorre-Román, Salas-Sánchez & Pantoja-Vallejo, 2022) as well as mental and physical health in children (Gallotta, Emerenziani, Iazzoni, Iasevoli, Guidetti & Baldari, 2017). However, studies in both developed (Beni, Fletcher & Chróinín, 2017) and developing countries (Lubans, Smith, Morgan, Beauchamp, Miller, Lonsdale, Parker & Dally, 2015; Stroebel, Hay & Bloemhoff, 2019) show that PE often faces challenges regarding the effective implementation thereof, which includes the low perceived status of PE, a lack of facilities and equipment, and a lack of specialist PE teachers. These obstacles often lead to low motivation levels of teachers to teach and learners to participate in PE lessons, which again has a detrimental effect on child development, including the physical fitness levels of learners (Ha, Lonsdale, Lubans & Ng, 2020).

Theoretical Framework

One theoretical framework that has been used in recent literature (Gallotta et al., 2017; Hernández, Fabra & Moreno-Murcia, 2020) to investigate the motivational levels of teachers and learners in the context of physical activity and fitness levels in the PE class, is the Self-determination Theory (SDT) (Ryan & Deci, 2020), and we conducted our study through the lens of this framework. According to SDT, every person wants to satisfy three basic psychological needs in order to develop intrinsic motivation to persist with an activity and to achieve personal growth and well-being (Ryan & Deci, 2020). The three basic psychological needs are autonomy, which includes the employment of a sense of choice and personal endorsement in one's actions; competence, which entails being equipped with knowledge, feeling optimally challenged and capable of achieving goals; and relatedness, which encompasses the feeling of being close to and accepted by others (Ryan & Deci, 2020). From the SDT (Ryan & Deci, 2020) point of view in the context of a PE class, learners must have these basic psychological needs satisfied to be more motivated to participate in physical activities in the PE class and to improve their fitness levels, while the fulfilment of these needs of PE teachers will enhance the teachers' intrinsic motivation to teach PE effectively. Learners can satisfy their need for autonomy in the PE class if they can choose some aspects of learning (like having a choice between specific movement activities) and feel their opinions are being taken into account (Hernández et al., 2020). Competence can be promoted when learners believe that they can successfully perform movement activities (Ha et al., 2020) and the need for relatedness can be fulfilled by good socialising among classmates and when learners feel comfortable with one another (Gairns, Whipp & Jackson, 2015). To satisfy the need for autonomy in teaching, PE teachers need to be able to make choices in their teaching strategies, and take ownership of their teaching (Abós, Haerens, Sevil-Serrano, Morbée, Julián & García-González, 2019), while the teachers need to feel that they have the knowledge and skills to be effective in promoting physical activities in the PE classroom satisfying the need for competence (Abós et al., 2019; Washburn, Richards & Sinelnikov, 2020). To satisfy the need for relatedness, PE teachers need to value PE for its value in promoting learning outcomes and good health (Washburn et al., 2020).

The needs-support approach of SDT was incorporated in this study by supporting the needs of the teachers in the teacher training programme, and also training the teachers to apply needs-support teaching strategies in their PE classes.

Aim of the Research

In South Africa, where learners' physical activity and fitness levels are declining (Stroebel et al., 2019), the need for in-service PE teacher development to counter the detrimental effect of a lack of trained PE-teachers on the effective implementation of PE, has been pointed out by various scholars (Du Toit, 2019; Stroebel et al., 2019; Van Deventer, 2012). In response to this need, the aim with this study was to investigate the effect of an in-service PE teacher training and support programme, based on the approach of SDT regarding the support of psychological needs and including needs-support teaching strategies on the physical and motor fitness levels of the participants' learners. The hypothesis was that, if teachers are trained and supported to implement needs-support teaching strategies during PE lessons, their learners' fitness levels would improve due to their higher intrinsic motivation to participate in physical activities.

Methodology

Research Design and Paradigm

In this study we employed quantitative data methodology using a quasi-experimental, pre- and post-test design with experimental and control groups. The study was done within the paradigm of positivism, grounded in SDT. Positivism relies on scientific evidence such as experiments and statistics to accept or reject a hypothesis regarding human behaviour (Park, Konge & Artino, 2020).

Setting

The study ran together with a 5-day in-service PE teacher training programme (short course), which was developed for in-service PE teachers, based on the prescriptions and content of the South African National Curriculum and Assessment Policy Statement (CAPS) (Department of Basic Education [DBE], Republic of South Africa [RSA], 2011) for PE within life orientation. The subject group, movement education in the Faculty of Education of the North-West University (NWU) in South Africa, presented the training programme, followed by a support programme of 4 months. The teachers enrolled for the in-service programme, were all qualified teachers in the Senior and Further Education and Training (FET) Phase. Only some of the participating teachers were trained to teach life orientation, although the training had been that of the governmental life orientation training which included one afternoon of PE training, such as the teacher concerned with the control group. Thus, none of the participating teachers had had specialised PE training when enrolling for the training programme.

Study Sample

For the purpose of this study, purposive and convenience sampling were used (Maree & Pietersen, 2016). Four PE teachers were purposefully selected from the participants enrolled in the PE teacher training programme, and one class of Grade 7 (12- to 13-year old) learners from each of the four teachers was selected as participants. The total number of learners in these classes were 69 learners, from four schools of different socio-economic backgrounds in four different towns in the North-West province, forming four experimental groups. One 12- to 13-year old Grade 7 class (n = 29) from one school in the Potchefstroom area from a low-to-middle socio-economic background, whose PE teacher had done the Provincial Department's training in life orientation but who had not had any other formal PE teacher training was asked to act as the control group. The control group's teacher thus had the same PE training as the other teachers in the experimental groups, except for the in-service training programme that was presented to the control group. Table 1 shows the demographic information of the learners in the four experimental groups, as well as the control group.

Table 1 Demographic information of the experimental and control groups (N = 98)

School	Number of participants in groups: Total (n)	Male (n)	Female (n)	School's socio-economic status
Control group school	29	14	15	Low to middle
Experimental group school 1	29	15	14	Low
Experimental group school 2	11	5	6	Middle
Experimental group school 3	10	6	4	Low
Experimental group school 4	19	4	15	High

The PE Training and Support Programme

The 5-day programme was based on all the prescribed PE content for the Senior and FET Phase in the national curriculum (DBE, RSA, 2011), which is categorised into the themes of physical fitness, sport and games, and recreational movement activities such as educational dance and gymnastics. Theoretical lectures which constituted 10 two-hour sessions, addressed the place and value of PE, theoretical concepts applicable to each PE theme, as well as pedagogical issues. In the practical sessions which were offered in 10 sessions of 1 to 2 hours each, practical skills, activities and teaching strategies pertaining to each PE theme were presented and the teachers participated in these as far as they were physically able.

In the context of SDT (Ryan & Deci, 2020), the theoretical and practical training included lectures on needs-support teaching strategies with the aim of meeting learners' needs of autonomy, competence and relatedness (Ryan & Deci, 2020). These needs-support strategies were practised by applying them with regard to co-participants in the practical lectures of the training programme. Needs-support teaching strategies to support autonomy included providing learners with a variety of physical activities, choices regarding physical activities and roles that they play in PE classes, and allowing learners to help plan PE activities. Needs-support teaching strategies for competence support included the presentation of achievable but challenging activities adapted to developmental levels. Teaching strategies to support relatedness included helping learners internalize the value of PE for themselves, being positive and caring during activities, facilitating group activities which develop feelings of inclusivity, integration, trust and respect among peers, and facilitating enjoyable, creative, different and fun activities. With the teacher training programme we strove to meet the teachers' needs of autonomy, competence and relatedness by presenting them with new knowledge, skills and teaching strategies, as well as activity and improvisation ideas that they could apply in their PE classes. The training also addressed the assessment of all the major themes of PE, and the improvisation of equipment from waste material.

The participants' competence was firstly assessed by means of a written test and a practical presentation of a PE lesson at the end of the training programme, which was evaluated according to specific criteria (among others, the demonstration and explanation of activities, implementation of needs-support teaching strategies, learner activity levels, class set-up and organisation, and assessment in the PE lesson). For the participants to be deemed competent, they had to pass the theory and practical assessments with a minimum mark of 50%. Secondly, the participants had to submit a portfolio of several practical assignments (four PE lessons and fitness assessments) that had to be completed during the following 4 months, and which were judged according to similar criteria against a minimum benchmark of 50%.

The training programme was followed by a 4-month teacher support programme facilitated by the instructors in the form of communication on an electronic platform (forums, questions and answers, encouragement, physical activity ideas, lesson ideas, and more), e-mails, and telephonic interaction, thus also supporting the teachers' needs for relatedness by affording them the opportunity to feel part of a group (including the instructors) that shared problems and solutions.

Ethical Considerations

This study was approved (ethics no. NWU-HS-2016-227) by the NWU Education, Management, and Economic Sciences, Law, Theology, Engineering and Natural Sciences Research Ethics Committee (NWU-EMELTEN-REC), and written informed assent and consent was obtained from the teachers, learners and their parents before the start of the study. Permission was also obtained from the North-West Department of Education and the school principals of the five schools involved. All applicable ethical guidelines and principles outlined by the National Health Research Ethics Council (Department of Health, RSA, 2015), including anonymity in the results report, confidentiality and non-maleficence of research participants, were followed in the study.

Data Collection

As part of the PE teacher training programme, participating teachers were trained in the assessment of physical and motor fitness, and conducted six tests with their learners. The tests were derived from the standardised test batteries of the EUROFIT (Adam, Klissouras, Ravazzolo, Renson, Tuxworth, Kemper, Van Mechelen, Hlobil, Beunen & Levarlet-Joye, 1993) and the Presidential Physical Fitness Award (President's Council on Fitness, Sports and Nutrition [PCFSN], 2016) as well as one other standardised test (the stork stand) (Mackenzie, 2000), which had been chosen for its practical value. The EUROFIT (Adam et al., 1993) is a standardised test battery with acceptable reliability and validity (Cvejić, Pejović & Ostojić, 2013), which has been used extensively in literature relating to physical fitness. The test battery comprises nine tests measuring cardio-respiratory endurance, muscle strength, muscular endurance, flexibility, running speed, agility, and balance. The sit-ups, standing broad jump and 10 x 5-metre shuttle run tests from the EUROFIT were used in our study. The Presidential Physical Fitness Award is a national programme in the United States of America allowing schools to participate in the programme which rewards learners who achieve certain levels of the standardised physical fitness tests (PCFSN, 2016). For the purpose of this study, the V-sit Reach test was used to assess flexibility, and the one-mile walk or run was used to assess cardio-respiratory endurance (PCFSN, 2016).

Although physical fitness is usually considered to consist of the components of cardiorespiratory endurance, muscle strength, muscular endurance, flexibility and body composition, and motor fitness is regarded to include the components of coordination, balance, agility, speed and explosive power (Haga, Gísladóttír & Sigmundsson, 2015), only tests to assess the physical fitness components of muscular endurance, flexibility and cardiorespiratory endurance, and the motor fitness components of explosive power, agility and balance, were chosen for the purpose of this study. These tests were chosen due to their practical value, because they are easy to administer, and can be applied in schools where there is no apparatus available. The participating teachers conducted the tests in their PE classes, with one class of learners at the beginning and end of the 4 months' support programme following the teacher training programme. The following standardised fitness tests were conducted by the participating teachers with their learners, to include the indicated components of physical and motor fitness:

Sit-ups (Adam et al., 1993) – The number of sit-ups that learners were able to perform in 30 seconds was recorded to measure functional abdominal strength and muscular endurance.

Standing broad jump (Adam et al., 1993) – The test evaluates the explosive power of the lower body and leg extensors. The distance the participants jumped from a two-legged take off, was measured and recorded to the nearest 0.01m. Learners had one trial-jump, after which the distance was recorded.

Shuttle run 10 x 5 metres (Adam et al., 1993) – Agility and running speed were assessed with a 10 x 5-metre shuttle-run test in which participants attempted to touch each marker five times over a 5 metre distance. The total time taken was recorded.

V-sit-reach (PCFSN, 2016) – To measure flexibility of the hamstrings and lower back, the learners' feet were placed 20 to 30 cm apart on a line marked on the floor, the baseline, which was then crossed by a measuring line which runs parallel to the legs, between the legs. The measuring line ran 61 cm to each side of the baseline and the point where the baseline and measuring line intersected, was the "0" line. The learner then clasped his or her thumbs so that the hands were together with palms facing downwards, and placed them on the measuring line. While keeping the legs straight and the toes facing forward (pointed), the learner had to exhale and reach forward as far as possible with the hands on the line. Three trials were permitted and the fourth trial was recorded.

One mile walk or run (PCFSN, 2016) – To measure cardio-respiratory endurance, learners began the endurance run or walk on a safe and marked course of 1.6 km (1 mile) on the signal "Ready, go." Learners could walk the course but they were encouraged to try to finish the course in the shortest time possible. The time to complete the course was recorded in minutes and seconds.

Stork stand test (Mackenzie, 2000) – To measure balance, the participants were required to first stand comfortably on both feet with hands on the hips and instructed to lift one leg and place the toes of that foot against the knee of the other leg. The participant then was asked to raise the heel and stand on their toes on command for as long as possible. The learners had one trial, after which the maximum time was recorded in seconds.

Data Analysis

The data were analysed using Statistical Product and Service Solutions (SPSS) version 21 software, with the help of the Statistical Services of the NWU. The descriptive characteristics were expressed as means and variances. The comparisons between the experimental and control groups at the baseline and post-test measurements were evaluated using hierarchical linear modelling (Hancock & Mueller, 2010), as the teachers were nested within their schools, and the learners who were participants were nested within the classes and in connection to their specific teachers. According to Hancock and Mueller (2010), when participants are clustered into naturally occurring hierarchies like these, the responses of participants from the same cluster are likely to show some degree of relatedness with one another, because they were sampled from the same organisational unit. Hierarchical linear modelling allowed us to adjust for and model according to this non-independence (Hancock & Mueller, 2010). For the purpose of the hierarchical linear modelling, the results of the male and female groups were analysed separately due to the well-known differences between genders with regard to physical and motor fitness performances (Hands, Parker, Larkin, Cantell & Rose, 2016). For all statistical analyses a probability level of 0.05 or less was taken to indicate significance. Furthermore, as the groups were relatively small, paired sample statistics, including parametric dependent *t*-tests as well as non-parametric (Wilcoxon rank sum) tests were used.

To examine the practical significance of differences with regard to the hierarchical linear modelling, the results were interpreted as recommended by Ellis and Steyn (2003). In this regard, Ellis and Steyn (2003) propose that an effect size (Cohen's *d*-value) of close to 0.2 represents a small effect, 0.5 a medium effect and 0.8 a large effect. Cohen's *d*-values were also calculated for the paired samples parametric dependent *t*-tests (Ellis & Steyn, 2003:52). For the results of the Wilcoxon rank-sum test, the non-parametric values of $r \approx 0.1$, 0.3 and 0.5 respectively, were used as guideline indicators of a small, medium and large effect (Field, 2009).

Results

The results of the comparison between pre- and post-test values of the female and male learners by means of the hierarchical linear modelling, are shown in Table 2 and Table 3.

Table 2 Comparison between pre- and post-test values of the female experimental and control groups by means of hierarchical linear modelling (HLM), taking into account the dependency of learners within schools

	M				Variances		*p*			Effect sizes (*d*)			
Variable	Pre-test		Post-test							Difference pre-test & post-test		Difference between C & E over time	
	C	E	C	E	MSE	Between schools	Test	Group	Test* group	C	E	Pre-test	Post-test
Stork stand	18.94	16.52	20.85	22.35	37.20	93.50	0.005	0.888	0.141	0.17	0.51□	0.21ɤ	0.13
V-sit & reach	8.00	8.95	6.33	11.78	13.33	78.39	0.46	0.259	0.006*	0.17	0.30ɤ	0.10	0.57□
Standing broad jump	127.53	167.74	115.27	170.80	134.45	756.57	0.07	0	0.003*	0.41□	0.10	1.35□	1.86□
Sit-ups	9.73	23.92	9.33	26.36	4.15	42.87	0.024	0	0.002*	0.06	0.36ɤ	2.07□	2.48□
10 x 5 m shuttle run	10.19	12.02	10.38	11.45	0.34	1.64	0.134	0.001	0.004*	0.14	0.41□	1.30□	0.75□
One-mile run	11.28	13.36	11.05	12.51	1.10	6.70	0.021	0.035	0.082	0.08	0.30ɤ	0.74□	0.53□

Note. E = Experimental group, C = Control group; MSE = Mean square error; m = metres; * = indication of statistical significance where $p \leq 0.05$; Effect sizes: $d \approx 0.2$ indicates small effect (ɤ), $d \approx 0.5$ a medium effect (□) and $d \approx 0.8$ a large effect (□).

From Table 2 showing the female results, it can be seen that before the intervention, the mean test values of the experimental group were, in practice, better than those of the control group with regard to the standing broad jump (167.74 cm and 127.53 cm; *d* = 1.35, showing a large effect) and the sit-ups (23.92 and 9.73; *d* = 2.07, showing a large effect), while the control group had better scores in the tests of the shuttle run (10.19 seconds and 12.02 seconds; *d* = 1.30, showing a large effect) and the one-mile run (11.28 minutes and 13.36 minutes; *d* = 0.74, showing a large effect). In the post-tests, the differences between the experimental and control groups were similar, while the experimental group's mean scores were still better, showing large effects, in the tests of the standing broad jump (170.80 cm and 115.27 cm; *d* = 1.86) and the sit-ups (26.36 and 9.33; *d* = 2.48); the control group's mean scores showing large and medium effects were still better than those of the experimental group in the shuttle run (10.38 seconds and 11.45 seconds; *d* = 0.75) and the one-mile run (11.05 minutes and 12.51 minutes; *d* = 0.53). However, with regard to the stork stand, shuttle run and one-mile run, the *d*-values for the differences between the experimental and control groups were smaller at post-test and pre-test, reflecting the improved scores of the experimental group and the weaker scores of the control group (except for the one-mile run where the control group also improved) at post-test. Also, in the V-sit-and-reach test, the control group obtained a weaker mean score at post-test than at pre-test, whereas the experimental group scored better in the post-test than in the pre-test, with a difference of practical significance showing a medium effect (*d* = 0.57).

The male results of the comparison between pre- and post-test values by means of the HLM, are shown in Table 3.

Table 3 Comparison between pre- and post-test values of the male experimental and control groups by means of hierarchical linear modelling (HLM), taking into account the dependency of learners within schools

	M				Variances		*p*			Effect sizes (*d*)			
Variable	Pre-test		Post-test							Difference between pre-test & post-test		Difference between C & E over time	
	C	E	C	E	*MSE*	Between schools	Test	Group	Test* group	C	E	Pre-test	Post-test
Stork stand	20.16	23.61	24.35	29.09	22.96	119.04	0	0.274	0.558	0.35	0.46□	0.29ɤ	0.49□
V-sit & reach	7.21	7.73	7.64	8.01	2.24	4.00	0.253	0.023	0.95	0.05	0.04	0.08	0.07
Standing broad jump	163.93	169.60	145.57	184.77	423.47	501.61	0.737	0.013	0.001*	0.6	0.5	0.19ɤ	1.29□
Sit-ups	14.36	26.63	11.57	29.10	6.47	37.84	0.785	0	0*	0.39ɤ	0.37ɤ	1.84□	2.63□
10 x 5 m shuttle run	9.70	10.77	9.81	10.39	0.15	0.89	0.116	0.013	0.008*	0.1	0.38ɤ	1.05□	0.57□
One-mile run	10.26	11.69	10.23	11.00	2.11	5.34	0.691	0.057	0.612	0.01	0.11	0.52□	0.65□

Note. * = indication of statistical significance where $p \leq 0.05$; Effect sizes: $d \approx 0.2$ indicates small effect (ɤ), $d \approx 0.5$ a medium effect (□) and $d \approx 0.8$ a large effect (□).

From Table 3 it can be seen that before the intervention, the mean test values of the male experimental group were better than those of the control group with regard to the stork stand (23.61 and 20.16, *d* = 0.29, showing a small effect), standing broad jump (169.60 cm and 163.93 cm; *d* = 0.19, showing a small effect) and the sit-ups (26.63 and 14.36; *d* = 1.84, showing a large effect), while the control group had better scores in the tests of the shuttle run (9.70 seconds and 10.77 seconds; *d* = 1.05, showing a large effect) and the one-mile run (10.26 minutes and 11.69 minutes; *d* = 0.52, showing a medium effect). In the post-tests, with regard to all the tests, the experimental group showed better mean scores than in their pre-tests. The control group showed better mean values in the post-test as opposed to their pre-test in the stork stand and the one-mile run, but poorer values on the standing broad jump, sit-ups and shuttle run tests. Furthermore, the experimental group's mean scores were still better than those of the control group in the tests of the stork stand (29.09 seconds and 24.35 seconds, *d* = 0.49, showing a medium effect) and the standing broad jump (184.77 cm and 145.57 cm; *d* = 1.29, now showing a large effect). The control group's mean score in the sit-ups test weakened while the experimental group's score improved (29.10 and 11.57; *d* = 2.63, showing a larger effect than in the pre-test) and the control group's mean scores were still better than those of the experimental group, but now showing a medium effect (*d* = 0.57), in the shuttle run (9.81 seconds and 10.39 seconds) and the one-mile run (10.23 minutes and 11.00 minutes; *d* = 0.65, still showing a medium effect).

In summary, although the experimental and control groups both improved most of their motor and physical fitness scores from the pre-test to the post-test, there seemed to be a tendency where the experimental group showed a greater improvement in most of the tests (specifically the V-sit-reach test for the females, and the standing broad jump and sit-ups for both genders) while the control group deteriorated in some tests (specifically the V-sit-reach for the females, and the standing broad jump for both genders and the sit-ups for the males).

As the numbers of learners in each group were relatively small, paired sample statistics, as well as non-parametric (Wilcoxon rank sum) tests, were conducted. Table 4 shows the results of the paired sample tests with regard to the motor fitness tests.

Table 4 Results of the paired sample statistics regarding the motor fitness tests

	School	Pair	*M*	*n*	*SD*	Paired samples *t*-test *p*	Paired samples *t*-test *d-value*	Wilcoxon rank-sum test *p*	Wilcoxon rank-sum test *r*
Stork stand (seconds)	1 (C)	1	19.53	29	12.53	0.055	0.24□	0.001*	0.64□
			22.54	29	11.12				
	2 (E)	1	15.78	29	11.34	0.000*	0.79□	0.000*	0.84□
			24.78	29	11.47				
	3 (E)	1	25.81	11	12.87	0.008*	0.25□	0.010*	0.78□
			29.01	11	11.50				
	4 (E)	1	26.94	10	10.66	0.050*	0.64□	0.013*	0.79□
			33.76	10	5.46				
	5 (E)	1	17.99	19	11.34	0.311	0.13	0.314	0.23□
			19.42	19	11.90				
Standing broad jump (cm)	1 (C)	3	145.10	29	34.60	0.000*	-0.44□	0.002*	0.58□
			129.90	29	37.62				
	2 (E)	3	155.72	29	33.17	0.070	0.37□	0.081	0.32□
			168.07	29	31.42				
	3 (E)	3	169.18	11	18.90	0.159	0.23□	0.130	0.46□
			173.45	11	19.31				
	4 (E)	3	171.10	10	29.64	0.130	0.25□	0.109	0.51□
			178.50	10	23.22				
	5 (E)	3	186.42	19	27.77	0.155	0.18□	0.111	0.37□
			191.42	19	19.87				
10 x 5 m shuttle run (seconds)	1 (C)	5	9.96	29	0.89	0.210	0.17□	0.076	0.33□
			10.10	29	0.85				
	2 (E)	5	10.83	29	0.83	0.005*	-0.15	0.001*	0.61□
			10.70	29	0.90				
	3 (E)	5	10.85	11	2.73	0.104	-0.19ɤ	0.014*	0.74□
			10.33	11	1.80				
	4 (E)	5	10.76	10	1.03	0.012*	-0.2ɤ	0.028*	0.69□
			10.55	10	1.07				
	5 (E)	5	13.20	19	0.69	0.000*	-1.72□	0.001*	0.78□
			12.03	19	0.92				

Note. *n* = number; *SD* = standard deviation; * = $p \leq 0.05$ indicating statistical significance; $d \approx 0.2$ indicates small effect (ɤ), $d \approx 0.5$ a medium effect (□) and $d \approx 0.8$ a large effect (□); $r \approx 0.1$ indicates small effect (ɤ), $r \approx 0.3$ a medium effect (□), and $r \approx 0.5$ a large effect (□).

With regard to the stork stand test, Table 4 shows that the control group improved their scores from the pre- to the post-tests, with the dependent *t*-test showing a small effect (d = 0.24), the Wilcoxon rank-sum test showing that this improvement was statistically significant (p = 0.001) and the non-parametric r showing a large effect (r = 0.64). Three of the experimental groups also improved their stork-stand scores significantly (p–values ranging from 0.000 to 0.050), with d-values showing small to large effects (0.25, 0.64, and 0.79, respectively) and r-values showing large effects (0.78, 0.79 and 0.84, respectively). In the standing broad jump (p = 0.000, d = -0.44 indicating a medium effect, and p = 0.002 with r = 0.58, indicating a large effect), the control group shows weaker scores from the pre- to the post-tests, while the experimental groups all show improvement in their scores, with d-values (0.18 to 0.37) and r-values (0.32 to 0.51) indicating small to large effects. With regard to the shuttle run (d = 0.17, indicating a small effect, and r = 0.33, indicating a medium effect), the control group's scores also decreased, while all the experimental groups showed improvement (d = 0.19 to 1.72, indicating small to large effects and r = 0.61 to 0.78, indicating large effects).

Table 5 Results of the paired sample statistics regarding the physical fitness tests

	School	Pair	*M*	*n*	*SD*	Paired samples *t*-test *p*	Paired samples *t*-test *d*	Wilcoxon rank-sum test *p*	Wilcoxon rank-sum test *r*
Sit-ups	1 (C)	1	11.97	29	5.09	0.025*	-0.30ɤ	0.35*	0.39□
			10.41	29	3.10				
	2 (E)	1	20.52	29	4.14	0.000*	0.79□	0.000*	0.82□
			23.79	29	4.85				
	3 (E)	1	34.55	11	5.68	0.025*	0.19ɤ	0.030*	0.65□
			35.64	11	5.97				
	4 (E)	1	33.50	10	7.35	0.375	0.15	0.124	0.49□
			34.60	10	6.59				
	5 (E)	1	22.21	19	6.61	0.009*	0.41ɤ	0.005*	0.65□
			24.89	19	4.51				
V-sit-and-reach (cm)	1 (C)	3	7.62	29	3.83	0.414	-0.19ɤ	0.508	0.12ɤ
			6.97	29	4.81				
	2 (E)	3	7.72	29	3.42	0.086	0.10	0.132	0.05
			7.95	29	3.83				
	3 (E)	3	10.85	11	1.64	0.004*	1.56□	0.007*	0.81□
			13.41	11	2.11				
	4 (E)	3	8.60	10	1.52	0.007*	1.35□	0.015*	0.77□
			10.65	10	2.29				
	5 (E)	3	10.26	19	13.57	0.003*	0.27□	0.004*	0.67□
			13.92	19	11.30				
One-mile run (minutes)	1 (C)	5	10.79	29	1.68	0.352	-0.08	0.452	0.06
			10.65	29	1.79				
	2 (E)	5	10.16	29	1.59	0.079	0.13	0.922	0.02
			10.37	29	2.45				
	3 (E)	5	18.22	11	1.99	0.004*	-0.84□	0.008*	0.80□
			16.54	11	1.89				
	4 (E)	5	11.75	10	2.07	0.626	0.10	0.513	0.07
			11.70	10	2.29				
	5 (E)	5	13.64	19	1.37	0.003*	-0.52□	0.001*	0.75□
			12.93	19	1.43				

Note. * = $p \leq 0.05$ indicating statistical significance; $d \approx 0.2$ indicates small effect (ɤ), $d \approx 0.5$ a medium effect (□) and $d \approx 0.8$ a large effect (□); $r \approx 0.1$ indicates small effect (ɤ), $r \approx 0.3$ a medium effect (□), and $r \approx 0.5$ a large effect (□).

The results of the paired sample tests with regard to the physical fitness tests are presented in Table 5. Referring to the sit-ups test, Table 5 shows that the control group's scores deteriorated from the pre- to the post-tests, with the results of the Wilcoxon rank-sum test showing statistical significance (p = 0.035), the *d*-value (0.30) indicating a small effect and the *r*-value (0.39) indicating a medium effect. Three of the experimental groups improved their sit-ups scores significantly (p ranging from 0.000 to 0.030), with *d*-values showing small to large effects (0.19 to 0.79) and *r*-values showing large effects (0.49 to 0.82). The values of the control group decreased from the pre- to the post test in the V-sit-and-reach test (d = 0.19, indicating small effects and r = 0.58, indicating large effects), while the values of the experimental groups all increased, with the results of three of the experimental groups showing statistical significance (p = 0.003 to 0.015), *d*-values (0.27 to 1.56) indicating small to large effects and *r*-values (0.67 to 0.81) indicating large effects. In the one-mile run test, of all the groups only two experimental groups showed significant changes in their times from the pre- to the post tests, with statistically significant improvements (*p*-values ranging from 0.001 to 0.008), *d*-values indicating medium and large effects (d = -0.52 and d = -0.84), and *r*-values indicating large effects (r = 0.75 and r = 0.80).

The results of the paired samples analysis can thus be summarised by stating that, with the exception of the stork stand in which the control group had improved their test scores, the control group did not show improvement in any of the motor and fitness tests, while several experimental groups showed significant improvement in every test.

Discussion

The aim with this study was to investigate the effect of an in-service PE teacher training and support programme, based on the principles of SDT, on the physical and motor fitness levels of learners. The results show that the programme had a positive effect on most of the motor and physical fitness components in the experimental group, most notably flexibility (among the females), explosive leg power, and abdominal muscular endurance. The control group had also improved in some cases, possibly because the learners were familiar with the tests the second time round.

The results of our study support the notion of SDT (Ryan & Deci, 2020) that meeting the need for competence by providing learners with knowledge pertaining to fitness, and teachers with knowledge and skills to use suitable teaching activities in the PE class, can enhance learners' physical and motor fitness. Literature (Guijarro-Romero, Mayorga-Vega, Casado-Robles & Viciana, 2020; Lubans et al., 2015) further shows that, when meeting the psychological needs of learners during PE classes based on the needs-support approach of SDT, a positive connection can be formed between learners' autonomous forms of motivation towards physical activity during PE classes, which can impact their physical and motor fitness levels. In the 4 months following the teacher training and support programme in our study, the teachers could convey their newly acquired knowledge of the benefits of physical and motor fitness to their learners, and offer a variety of physical activities with an emphasis on choice and fun, meeting the learners' needs for autonomy and competence and enhancing the learners' levels of motivation to be physically active during PE classes. This is supported by the results of recent studies on the effects of intervention programmes promoting autonomy-support of learners in the PE class, by emphasising the benefits of physical activity and including elements of choice and fun (Ha et al., 2020; Ulstad, Halvari, Sørebø & Deci, 2018). Ha et al. (2020) designed a Self-determined Exercise and Learning For FITness (SELF-FIT) intervention, which consists of a 2-day teacher training workshop in learners' need support in PE, followed by an 8-week implementation in schools in Hong Kong. The provision of opportunities to choose activities, and the fostering of an enjoyable PE experience by focusing on fun and variety in lessons, were two of the primary elements included in the SDT-based intervention which had a positive effect on the participants' competence and autonomy need satisfaction as well as physical activity levels in the PE class (Ha et al., 2020). Similarly, Ulstad et al. (2018) found that self-perceived autonomy and competence, as well as physical fitness levels of learners had improved after a year-long implementation of needs-support teaching strategies acquired by teachers in a teacher training programme in Norway, which included letting learners choose and plan activities.

Other studies that focused on the development of teachers' autonomy and competence support teaching strategies, found significant improvement in learners' fitness levels. In this regard, Lubans et al. (2015) report an improvement in muscular fitness and a reduction in recreational screen time of 361 adolescent boys after a 20-week intervention programme guided by SDT principles. The intervention programme aimed to meet the learners' need for autonomy and competence by including the professional development of teachers, enhanced school sport sessions, research-led seminars and the provision of fitness equipment to the involved schools (Lubans et al., 2015). Investigating the effect of learners' self-determined motivation on their cardiorespiratory fitness in a 9-week intervention programme, Guijarro-Romero et al. (2020) found that learners with high self-determined motivation levels showed significant improvements in their cardiorespiratory fitness. Behzadnia, Mohammadzadeh and Ahmadi (2019) further investigated the impact of teachers' autonomy-supportive behaviour on enhancing the knowledge structures and motor-skill learning of 30 adolescents in PE, and found significant increases in the participants' scores in the motor-skill tests as well as an autonomous motivation questionnaire after a 14-week intervention programme.

The effects of applying relatedness-support teaching strategies such as the ones acquired by the teachers in the teacher training programme in our study (assisting learners to understand the value of PE for themselves, emotional support during activities, and facilitating group activities to develop feelings of inclusivity and respect among peers) on the motivational levels of learners to be physically active and indirectly to improve their fitness levels, are also supported by literature. In a meta-analytic review of studies involving SDT in PE, Vasconcellos, Parker, Hilland, Cinelli, Owen, Kapsal, Lee, Antzcak, Ntoumanis, Ryan and Lonsdale (2020) conclude that together with teachers, peers influence each other's sense of relatedness and intrinsic motivation to participate in PE. Teaching strategies to support the need for relatedness in the PE class should, therefore, include cooperative learning and organising activities in small groups (Vasconcellos et al., 2020). Similarly, Gairns et al. (2015) postulate that relatedness is supported by both teachers and peers in the PE class, and that teachers should be trained to create a supportive learning environment through social interactions among learners.

Another contributing factor to the improvement of the learners' fitness levels in our study could be the enhanced effectiveness, enthusiasm and intrinsic motivation of the PE teachers after the training and support programme. Meeting the needs of the teachers in the training programme through their planning of activities, the new knowledge, skills and teaching strategies they had acquired, and affording them to be part of a group that shared problems and solutions, could have enhanced their autonomous motivation to teach PE. Consistent with this statement, Gorozidis, Tzioumakis, Krommidas and Papaioannou (2020) report that Greek PE teachers were more self-efficient and autonomously motivated to teach PE after a teacher training programme aimed at meeting the psychological needs of the teachers. As autonomously motivated PE teachers who enjoy and value their teaching will have better job performance (Abós et al., 2019; Washburn et al., 2020), it follows that the needs-support approach of the training and support programme could have indirectly contributed to the improved fitness levels of the learners by enhancing their teachers' intrinsic motivation to teach PE more effectively.

After their review of studies involving SDT in PE, Vasconcellos et al. (2020) conclude that SDT provides a useful theoretical framework to understand learners' motivational processes in PE, and a basis for effective interventions designed to improve PE outcomes such as physical and motor fitness.

Conclusion, Limitations and Recommendations

The results of this study should be considered in light of certain limitations. Firstly, relatively small numbers of participants were involved, decreasing the generalisability of the results. The control group and experimental groups were also not compatible on all levels, such as gender distribution and numbers, which could have potentially impacted on the results. Secondly, neither body composition nor psychological constructs of the participants were measured, which could have provided more accurate evidence for the mechanisms through which the intervention was most effective. Thirdly, we did not control for other variables which could have had an influence on the learners' participation in the PE class and their fitness levels, such as the physical circumstances at the schools, the time available for PE in the school timetable, the motivation levels of the learners before the onset of the study, gender differences, and the teachers' personal beliefs and attitudes towards PE before and after the teacher training.

Future research incorporating larger and more compatible groups from different areas of the country and including the measurement of the above-mentioned variables, as well as controlling for the mentioned variables, will help refine intervention design.

Although further research is needed in this field, the conclusion can be made that PE teachers should be trained and supported to encourage learners' motivation toward PE and fitness by supporting their psychological needs and applying specific motivational teaching strategies during PE lessons.

Authors' Contributions

SVDW presented a part of the in-service training and support programme, wrote the manuscript and provided data for the tables. DDT and NVDM presented parts of the in-service training and support programme, and supervised the fitness tests. All authors reviewed the final manuscript.

Notes

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ii.
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