EFFECTS OF A WEB-BASED NEED-SUPPORTIVE INTERVENTION PROGRAMME ON PHYSICAL EDUCATION TEACHER OUTCOMES

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Abstract:

Interventions aimed at enhancing need-supportive behaviours have predominantly focused on assessing their effects on student outcomes, thereby placing comparatively less emphasis on gains experienced by teachers. This study investigated whether a web-based need-supportive intervention programme for physical education (PE) teachers would also provide significant gains in enhancing PE teachers need-supportive behaviours, psychological need satisfaction, intrinsic motivation to teach, teaching efficacy and reducing their controlling behaviours. Participants were 74 PE teachers (54 women). Their average age was 46.04 years (SD = 12.64), and they had an average teaching experience of 17.33 years (SD = 13.83). Participants were allocated into experimental and control conditions. PE teachers in the experimental group completed a four-week web-based need-supportive intervention programme. Results demonstrated that the experimental group PE teachers demonstrated significant gains in their autonomy support, competence support and teaching efficacy compared to the control group PE teachers within a one-month follow-up. These results suggest that our web-based need-supportive intervention programme for PE teachers was partially effective to produce gains for PE teachers themselves.

Key words: *autonomy support, competence support, relatedness support, controlling behaviour, motivation, teaching efficacy*

Introduction

Enhancing autonomy supportive behaviours among physical education (PE) teachers plays a crucial role in shaping experiences of intrinsic motivation among their students (Raabe, Schmidt, Carl, & Höner, 2019; Vasconcellos, et al., 2020; White, et al., 2021). The possible mechanism behind this process is most likely that autonomy supportive behaviours enhance students' experiences of basic psychological need satisfaction, and, in turn, students experience higher levels of intrinsic motivation (Kalajas-Tilga, Koka, Hein, Tilga, & Raudsepp, 2020). Moreover, recent research has demonstrated that not only students, but also teachers themselves gain various benefits when they become more autonomy supportive towards their students (Cheon, Reeve, Yu, & Jang, 2014; Tilga, Kalajas-Tilga, Hein, Raudsepp, & Koka, 2021a). However, based on the self-determination theory (SDT; Ryan & Deci, 2020), one should aim to fulfil all three basic psychological needs for autonomy, competence, and relatedness. Based on recent classification system of need supportive behaviours (Teixeira, et al., 2020), a need supportive intervention programme for PE teachers was developed, indicating several important gains in students' experiences after their teachers participated in this need supportive intervention programme. One might argue that teachers also gain even greater benefits when they learn how to become more need supportive. However, there is no research so far testing the effectiveness of not only autonomy-supportive training, but also competence supportive and relatedness supportive training on teacher's outcomes. Thus, the current study was designed to test the efficacy of a need supportive intervention programme on PE teachers' outcomes.

Self-determination theory (Ryan & Deci, 2020) posits three primary psychological needs—autonomy, competence, and relatedness—that are essential for fostering intrinsic motivation and well-being. Autonomy refers to the need to feel a sense of volition and choice in one's actions; competence involves the need to feel effective and capable within one's environment; and relatedness is the need to feel connected and supported by others (Ryan & Deci, 2020). In educational contexts, interventions that aim to enhance need-

supportive behaviours, such as autonomy support, typically focus on helping teachers provide students with choice, encourage self-initiation, and respect students' perspectives (Vasconcellos, et al., 2020). When these pre-intervention (antecedent) variables, such as autonomy support, are strengthened, they positively impact post-intervention (consequence) variables, like students' need satisfaction and motivation. Research has demonstrated that fulfilling these psychological needs leads to increased intrinsic motivation, improved well-being, and higher engagement in students (Kalajas-Tilga, et al., 2020; Cheon, et al., 2014) and can concurrently enhance teachers' own teaching efficacy and reduce controlling behaviours (Tilga, et al., 2021a).

In this research, SDT (Ryan & Deci, 2020) was used as a theoretical background for explaining how autonomy supportive, competence supportive and relatedness supportive behaviours exhibited by PE teachers is beneficial to teachers themselves. Based on the SDT, individuals strive to satisfy their basic psychological needs for autonomy, competence, and relatedness. Fulfilment of these needs is related to intrinsic motivation and, in turn, to various adaptive outcomes. A great number of studies have shown that students benefit from receiving autonomy-supportive teaching (e.g., Raabe, et al., 2019). However, only a few of recent studies have demonstrated that teachers also experience several adaptive outcomes when they provide need support (Cheon, et al., 2014; Tilga, et al., 2021a). For example, Cheon and colleagues (2014) found that teachers who participated in an autonomy-supportive face-to-face intervention demonstrated after the intervention greater teaching motivation. Moreover, teachers also reported higher psychological need satisfaction, autonomous motivation and intrinsic goals (Cheon et al., 2014). Furthermore, teachers perceived greater level of overall well-being, including increased vitality and job satisfaction, but lower emotional and physical exhaustion. Additionally, their teaching skills, as reflected in teaching efficacy, demonstrated increase. In another study by Tilga and colleagues (2021a), it was found that after participating in a web-based multidimensional autonomy-supportive intervention programme teachers reported significant gains in their multidimensional autonomy-supportive behaviours and in teaching efficacy for students' engagement. Similarly to a study by Tilga and colleagues (2021a), we also adopt a web-based approach in this study for the following reasons: (1) web-based interventions are cost-effective; (2) web-based interventions are convenient and easily accessible; (3) web-based interventions can afford attendees' anonymity (Murray, 2012). The use of web-based interventions has become increasingly prevalent in the field of PE and beyond, providing a flexible and accessible platform for training. This study adopts a web-based approach for several practical and empirical reasons. First, web-based interventions are often more cost-effective than in-person programmes, as they reduce the need for physical materials, venues, and travel expenses (Murray, 2012). This cost-efficiency makes it possible to reach a wider audience, particularly in cases where resources may be limited. Second, web-based interventions offer convenience and accessibility, allowing participants to engage with the content at times and locations that suit them, which is particularly valuable for busy professionals like PE teachers (Tilga, Kalajas-Tilga, H., Hein, V., & Koka, 2021c). Additionally, online platforms enable a degree of anonymity that can encourage more open participation, as teachers may feel more comfortable engaging with the content privately (Murray, 2012). Empirical evidence also supports the effectiveness of web-based training in promoting autonomy-supportive behaviours among PE teachers (Tilga, et al., 2021a), suggesting that these digital interventions can successfully enhance the quality of teaching and, consequently, students' outcomes in PE. This combination of accessibility, cost-effectiveness, and supportive evidence underlines the decision to implement a web-based intervention in the present study.

Most of the SDT-driven intervention programmes conducted in the context of PE have focused on enhancing PE teachers' autonomy-supportive behaviours (e.g., Raabe et al., 2019; Su & Reeve, 2011). Only few studies have aimed to educate PE teachers how to provide autonomy, competence, and relatedness support to their students (Paap, Koka, Meerits, & Tilga, 2024). To our best knowledge, there is also one effective need-supportive intervention programme for parents to increase their need-supportive behaviour towards their children (Meerits, Tilga, & Koka, 2022, 2023). Adopting need-supportive techniques from a classification system provided by Teixeira and colleagues (2020) was aimed in this study to enhance PE teachers' autonomy, competence and relatedness support towards their students. In total, there are 21 motivational and behavioural change techniques (MBCT) proposed by Teixeira and colleagues (2020): there are seven autonomy support techniques, seven competence support techniques and seven relatedness support techniques. There are several reasons why we expect that it is beneficial to PE teachers to adopt these need-supportive techniques. Firstly, PE teachers who have successfully passed this need-supportive intervention programme most likely exhibit higher teaching efficiency. The reason for this is that this need-supportive intervention most likely provides teachers with acknowledged teaching strategies that help to deliver classroom instructions more efficiently. Secondly, there might be reciprocal associations between students' and teachers' outcomes (e.g., Jang, Kim, & Reeve, 2012; Pelletier,

Séguin-Lévesque, & Legault, 2002; Reeve, 2013). Specifically, it is likely that when students experience gains in their motivational outcomes, then their teachers also might exhibit higher experiences in their motivational outcomes. Thirdly, previous studies have shown that teachers with higher scores of need-supportive behaviours are more likely to report greater motivational outcomes (Roth, Assor, Kanat-Maymon, & Kaplan, 2007; Stebbings, Taylor, Spray, & Ntoumanis, 2012; Taylor, Ntoumanis, & Standage, 2008). Based on this, one might argue that giving need support to other would enhance the giver's own motivational experiences.

The present study

The present study seeks to address a significant gap in the literature on need-supportive interventions for physical education (PE) teachers by focusing on a web-based approach. While traditional, face-to-face interventions have shown efficacy in promoting autonomy-supportive behaviours among teachers (Cheon, et al., 2014), there is a relative scarcity of research examining the impact of web-based interventions in this context. Given that web-based approaches offer advantages such as cost-effectiveness, accessibility, and convenience (Murray, 2012), they hold promise for broader application in teacher training programmes. Despite the potential benefits, few studies have rigorously tested the effects of web-based need-supportive interventions on PE teachers' own psychological experiences, such as autonomy support, competence support, and relatedness support, as well as on critical outcomes like teaching efficacy, motivation, and behaviour management skills (Tilga, et al., 2021a).

Therefore, this study aims to test the efficacy of a web-based intervention programme specifically designed to enhance PE teachers' need-supportive behaviours. Based on SDT (Ryan & Deci, 2020) and previous research in autonomy-supportive interventions (Cheon, et al., 2014; Tilga, et al., 2021c), we hypothesize that, PE teachers in the experimental group, compared to PE teachers in the control group, would perceive:

H_1: higher provision of autonomy, competence, and relatedness support at follow-up.
H_2: lower controlling behaviours at follow-up.
H_3: higher psychological need satisfaction at follow-up.
H_4: higher intrinsic motivation to teach at follow-up.
H_5: higher teaching efficacy at follow-up.

By addressing these hypotheses, this study contributes to the growing field of digital interventions in education, providing insights into how web-based platforms can enhance teacher behaviour and potentially improve students' outcomes in physical education settings.

Methods

Participants

Participants were 74 PE teachers (20 men and 54 female) from 90 schools throughout Estonia who voluntarily agreed to participate in the study. Teachers were on average 46.04 years old (SD = 12.64, range 22-68), and had an average of 17.33 years of teaching experience (SD = 13.83, range = 1-45). These 74 PE teachers expressed an interest in the study via survey they received that provided them detailed information about the survey, followed by agreement to participate in this survey. There was approval from the local ethical committee obtained to conduct the survey (approval number: 327/T- 4).

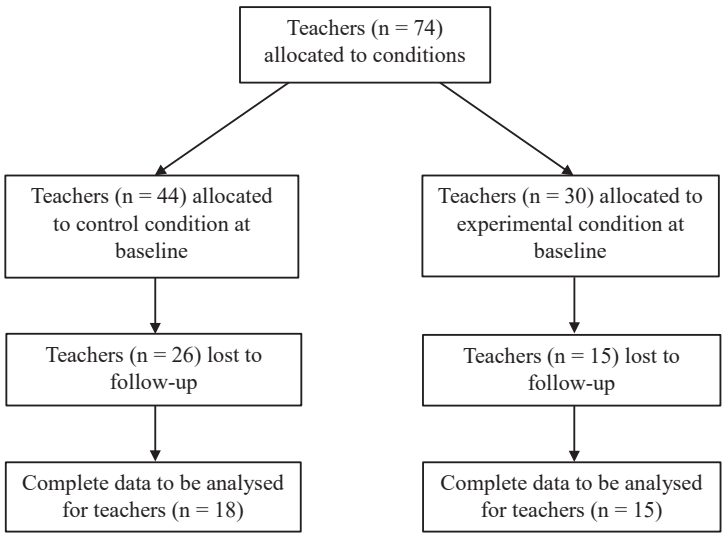

Figure 1. Participant flow diagram.

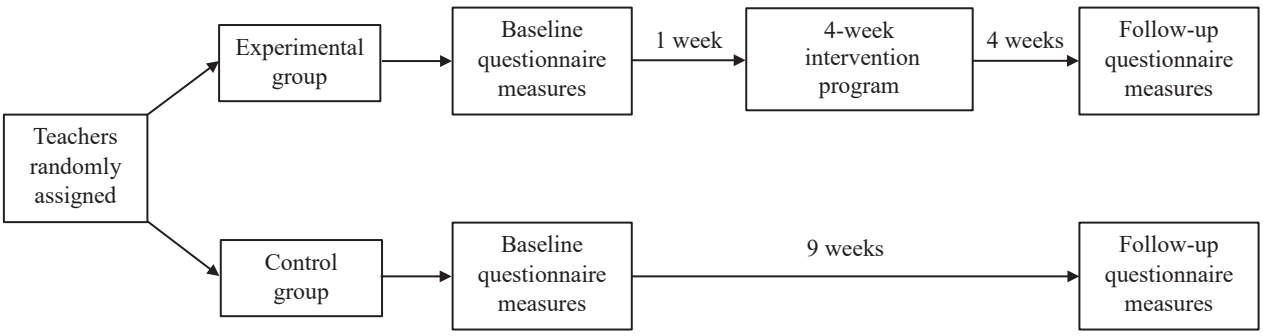

Figure 2. Overall study design.

Procedure

A randomized controlled research design was adopted in which teachers were randomly assigned to either the experimental or control group. More detailed participant selection flow chart appears in Figure 1. At baseline, 74 PE teachers completed a questionnaire about their perceptions of self-reported autonomy, competence, and relatedness need-supportive behaviours, self-reported controlling behaviours, self-reported perceptions of their own basic psychological need satisfaction, self-reported intrinsic motivation to teach and self-reported teaching efficacy. One week later, the web-based need-supportive four-week intervention programme for the PE teachers was initiated in the experimental group. PE teachers completed the follow-up questionnaire four weeks after the intervention ended (see Figure 2 for the overall study design).

Measures

Self-reported need support by PE teachers. PE teachers reported providing of autonomy support to their students by filling in the modified version of *Perceived Autonomy Support Scale for Exercise Setting* (PASSES; Hagger, et al., 2007), shortened and modified by Kalajas-Tilga and colleagues (2022a). PE teachers reported provision of competence and relatedness support to their students by filling in the *Perceived Psychological Needs Support from the Teacher in PE* (PPNST-PE; Standage, Duda, & Ntoumanis, 2005), adapted to Estonian context by Viira and Koka (2012). Example items are following: "I offer students choices and how to be physically active" (autonomy support), "I help students feel that they are competent at physical education" (competence support), and "I make my students feel that I respect them" (relatedness support). In this study, 7-point Likert scale was used ranging from "1 – completely disagree with the statement" to "7 – completely agree with the statement". Previous studies have shown that PASSES and PPNST-PE are reliable and valid (e.g., Kalajas-Tilga, et al., 2022a, 2022b).

Self-reported controlling behaviours by PE teachers. PE teachers reported provision of controlling behaviours to their students by filling in the modified version of multidimensional *Controlling Coach Behaviours Scale* (CCBS; Bartholomew, Ntoumanis, & Thøgersen-Ntoumani, 2010), adapted to PE (Hein, Koka, & Hagger, 2015). An example items is following: "I try to control everything the students do". In this study, 7-point Likert scale was used ranging from "1 – completely disagree with the statement" to "7 – completely agree with the statement". Previous studies have shown that CCBS is reliable and valid (e.g., Koka, Tilga, Kalajas-Tilga, Hein, & Raudsepp, 2019; Koka, Tilga, Kalajas-Tilga, Hein, & Raudsepp, 2020; Tilga, Kalajas-Tilga, Hein, Raudsepp, & Koka, 2020a).

Self-reported basic psychological needs satisfaction. PE teachers reported their own basic psychological needs satisfaction by filling in the modified version of the *Basic Psychological Need Satisfaction and Need Frustration Scale* (BPNSNF, Chen, et al., 2015), adapted to PE (Haerens, Aelterman, Vansteenkiste, Soenens, & Van Petegem, 2015). PE teachers were presented with a common stem: "During the teaching …", followed by the items tapping three subscales: need satisfaction for autonomy (e.g., " … I felt freedom of choice in my actions"), competence (e.g., " … I felt I could successfully complete difficult tasks"), and relatedness (e.g., " … I felt that the students I cared about also cared about me"). In this study, 7-point Likert scale was used ranging from "1 – completely disagree with the statement" to "7 – completely agree with the statement". Previous research has supported the reliability and factor structure of the BPNSNF (e.g., Tilga, et al., 2020a).

Self-reported intrinsic motivation to teach. PE teachers reported intrinsic reasons to teach by filling in the modified version of the *Perceived Locus of Causality* (PLOC, Goudas, Biddle, & Fox, 1994), adapted by Cheon and colleagues (2014). An example items is following: "I teach because I enjoy it". In this study, 7-point Likert scale was used ranging from "1 – completely disagree with the statement" to "7 – completely agree with the state-

ment". Previous research has supported the reliability of the PLOC (e.g., Tilga, Kalajas-Tilga, Hein, Raudsepp, & Koka 2021b).

Self-reported teaching efficacy. PE teachers reported their teaching efficacy by filling in the short form of the *Teachers' Sense of Efficacy Scale* (TSES, Tschannen-Moran & Hoy, 2001). An example items is following: "I can contribute so that students feel that they can cope with their school work". In this study, 9-point Likert scale was used ranging from "1 – not at all true" to "9 – very true". Previous research has supported the reliability of the TSES (e.g., Tilga, et al., 2021a).

Web-based need-supportive intervention programme

The experimental group PE teachers were asked to participate in a web-based need-supportive intervention programme. It was designed as a four-week online training aimed at introducing various need-supportive behaviour techniques for PE teachers with the aim to support students' intrinsic motivation towards physical activity during PE classes. The online intervention programme consists of 21 short instructional videos (each video averaging four to five minutes in length), in which examples are provided to give PE teachers knowledge about these behaviour techniques and how to support students' psychological basic needs for autonomy, competence, and relatedness in PE class. The videos are structured as follows: first, an explanation is given about the basic psychological need that the introduced technique supports; second, the content of the behaviour technique is briefly introduced; third, a sample situation of the negative application of the behaviour technique is presented; and fourth, a sample situation of the positive application of the behaviour technique is presented. The instructional videos are compiled based on the results of scientific literature (Teixeira, et al., 2020).

In the first week of the web-based intervention programme, PE teachers were required to review six videos as part of the intervention programme. The focus was on the following motivational techniques: (1) elicit perspectives on condition or behaviour (supporting the need for autonomy), (2) explore life aspirations and values (supporting the need for autonomy), (3) acknowledge and respect perspectives and feelings (supporting the need for relatedness), (4) encourage asking questions (supporting the need for relatedness), (5) clarify expectations (supporting the need for competence), and (5) help develop a clear and concrete plan of action (supporting the need for competence). To ensure whether PE teachers understood the learning materials or not, a test consisting of nine multiple-choice questions had to be taken after watching the videos. At the end of the week, a forum post from PE teachers was required, analysing the application of the learned techniques during the week.

In the second week of the web-based intervention programme, PE teachers needed to familiarize themselves with five videos, and the intervention programme focused on the following techniques: (1) use non-controlling, informational language (supporting the need for autonomy), (2) provide choice (supporting the need for autonomy), (3) acknowledge and respect perspectives and feelings (supporting the need for relatedness), (4) assist in setting optimal challenge (supporting the need for competence), and (5) offer constructive, clear, and relevant feedback (supporting the need for competence). After watching the videos, a test for the second week consisting of five multiple-choice questions had to be completed. At the end of the week, a forum post from PE teachers was required, analysing the application of the learned techniques during the week.

In the third week of the web-based intervention programme, PE teachers had to work through five videos, and the techniques taught in the course were: (1) prompt identification of sources of pressure for behaviour change (supporting the need for autonomy), (2) demonstrate/show interest in the person (supporting the need for relatedness), (3) prompt identification and seek available social support (supporting the need for relatedness), (4) address obstacles for change (supporting the need for competence), and (5) explore ways of dealing with pressure (supporting the need for competence). After watching the videos, a test for the third week consisting of five multiple-choice questions had to be completed. At the end of the week, a forum post from PE teachers was required, analysing the application of the learned techniques during the week.

In the fourth week of the web-based intervention programme, teachers needed to familiarize themselves with five videos, where the techniques taught for the week were: (1) provide a meaningful rationale (supporting the need for autonomy), (2) encourage the person to experiment and self-initiate the behaviour (supporting the need for autonomy), (3) show unconditional regard (supporting the need for relatedness), (4) providing opportunities for ongoing support (supporting the need for relatedness), and (5) promote self-monitoring (supporting the need for competence). After watching the videos, a test for the fourth week consisting of two multiple-choice questions had to be completed. At the end of the week, a forum post from PE teacher was required, analysing the application of the learned techniques during the week.

Data analysis

The SPSS Statistics version 23.0 statistical package was used for statistical analyses. The skewness and kurtosis estimates of each item were estimated, which ranged between –2 to + 2 and were considered acceptable to support normal univar-

iate distribution (Byrne, 2010). A series of separate confirmatory factor analyses (CFAs) were conducted to test the validity of the proposed factor structure of the scales used in this study. The following indices were used: the comparative fit index (CFI), the Bentler–Bonett non-normed fit index (NNFI), and the root mean square error of approximation (RMSEA). An acceptable fit of the data with the hypothesised model was indicated by values ≥ .90 for the CFI and NNFI, and value ≤ .08 for the RMSEA (Hu & Bentler, 1999). The reliability of the scales in this study was assessed using Cronbach's alpha, with values ranging from .70 to .95, indicating acceptable internal consistency (Nunnally, 1978). For preliminary analysis the chi-square tests and independent samples t-tests were performed to examine baseline differences between the study groups (i.e., randomization check) and to examine differences between the group of those who remained in the study and the group of those who were lost to follow-up (i.e., attrition check). For main analysis a series of analyses of covariance (ANCOVAs) were performed to examine the effectiveness of the web-based need-supportive intervention programme on PE teachers' psychological experiences. Specifically, variables of PE teachers' self-reported autonomy support, competence support, relatedness support, controlling behaviours, psychological needs satisfaction, intrinsic motivation to teach, and teaching efficacy were used as dependent variables, whereas study group (i.e., experimental group and control group) was used as the independent variable. The respective baseline variable was included as a covariate in each of the ANCOVA analysis. Partial eta squared was used as a measure of the effect size for ANCOVA.

Results

Preliminary analysis

Reliability and validity of the study instruments. Results of a series of CFAs for each of the study measures indicated acceptable goodness-of-fit statistics: PASSES (CFI = .94; NNFI = .93; RMSEA = .07), PPNST-PE (CFI = .95; NNFI = .94; RMSEA = .07), CCBS (CFI = .94; NNFI = 94; RMSEA = .07), BPNSNF (CFI = .96; NNFI = .94; RMSEA = .06), PLOC (CFI = .91; NNFI = .90; RMSEA = .08), TSES (CFI = .92; NNFI = .92; RMSEA = .08). Cronbach's alpha values of the scales used in the study were as follows: PASSES (α = .74), PPNST-PE (α = .86), CCBS (α = .79), BPNSNF (α = .89), PLOC (α = .71), TSES (α = .73). Please note that all the scales used in this study were used in the context of PE and PE teachers used these scales to provide self-reported experiences. Please see the section Measures for more specific information of which part and how these scales were used in this study.

Randomization check. The characteristics of the participants at baseline are reported in Table 1. Results of the independent samples t-test showed that there were no significant differences in the study variables between the study groups (i.e., experimental and control group) at baseline (*p*s>.06). Also, there were no significant differences in the groups of male and female participants in the experimental and control groups ($\chi^2 = 0.349$, *p*=.61).

Attrition check. The characteristics of the participants who remained in the study and those who were lost to follow-up are reported in Table 2. Results of the independent samples t-test demonstrated that there were no significant differences at baseline between those who remained in the study and those who were lost to follow-up (*p*s>.22). Also, there were no significant sex differences between the participants who remained in the study and those who were lost to follow-up ($\chi^2 = 0.324$, p=.61).

Main analysis

Between-group change comparisons. The results of the ANCOVA are reported in Table 3. Results indicated that PE teachers in the experimental group reported significantly higher provision of autonomy support (p<.002), competence support (p<.009), and higher experiences of teaching efficacy (p<.006) at follow-up compared to PE teachers in the control group. No significant study group effects were found on provision of relat-

Table 1. Comparisons of the baseline variables between the experimental and control group

Variable	Experimental group (n = 30)	Control group (n = 44)	t or χ^2	p
	M (SD)	M (SD)		
Autonomy support	6.11 (0.62)	6.10 (0.54)	t = 0.65	.31
Controlling behaviour	3.79 (1.07)	3.90 (0.90)	t = -0.48	.33
Competence support	6.61 (0.41)	6.40 (0.61)	t = 1.67	.06
Relatedness support	6.51 (0.54)	6.36 (0.62)	t = 1.10	.32
Psychological need satisfaction	5.87 (0.56)	5.65 (0.64)	t = 1.49	.41
Intrinsic motivation to teach	6.23 (0.65)	5.81 (0.87)	t = 1.57	.13
Teaching efficacy	7.55 (0.88)	7.29 (1.03)	t = 1.10	.42
Gender	7/23	13/31	$\chi^2 = 0.349$	.60

Table 2. Comparisons of the variables between those who remained in the study and those who were lost to follow-up

Variable	Remained in the study (n = 33)	Lost in follow-up (n = 41)	t or χ^2	p
	M (SD)	M (SD)		
Autonomy support	6.03 (0.60)	6.17 (0.54)	t = -1.06	.29
Controlling behaviour	3.87 (0.98)	3.85 (0.97)	t = 0.057	.96
Competence support	6.51 (0.55)	6.47 (0.55)	t = 0.35	.72
Relatedness support	6.38 (0.66)	6.45 (0.53)	t = -0.52	.61
Psychological need satisfaction	5.77 (0.71)	5.71 (0.53)	t = 0.40	.69
Intrinsic motivation to teach	6.13 (0.61)	5.90 (0.95)	t = 1.23	.22
Teaching efficacy	7.54 (1.04)	7.28 (0.92)	t = 1.16	.25
Gender	10/23	10/31	χ^2 = 0.324	.61

Table 3. Comparisons of the variables between study groups at follow-up

Variable	Experimental group (n = 15)	Control group (n = 18)	F (1,33)	p
	M (SD)	M (SD)		
Autonomy support	6.65 (0.50)	6.07 (0.47)	11.43	.002
Controlling behaviour	3.15 (1.12)	3.67 (1.14)	1.69	.203
Competence support	6.71 (0.58)	6.13 (0.59)	7.82	.009
Relatedness support	6.50 (0.50)	6.18 (0.12)	3.50	.071
Psychological need satisfaction	5.73 (0.58)	5.50 (0.51)	1.29	.266
Intrinsic motivation to teach	5.89 (0.89)	5.40 (0.89)	2.22	.146
Teaching efficacy	8.23 (1.01)	7.19 (0.98)	8.93	.006

edness support, controlling behaviour, experiences of psychological needs satisfaction, and intrinsic motivation to teach.

Discussion and conclusions

This study aimed to investigate whether the web-based need-supportive intervention programme for PE teachers led to changes in PE teachers' provision of autonomy support, competence support, relatedness support, controlling behaviours, experiences of basic psychological needs satisfaction, intrinsic motivation to teach, and teaching efficacy. The findings demonstrated that this web-based need-supportive intervention programme for PE teachers was partially effective.

First, it was hypothesized that the PE teachers in the experimental group, compared to the PE teachers in the control group, would perceive higher provision of autonomy, competence, and relatedness support at follow-up. This hypothesis was partly supported because PE teachers in the experimental group reported that they provided significantly higher autonomy support and competence support to their students after they participated in this four-week web-based need-supportive intervention programme. In other words, PE teachers reported that they offered to their students' choices and provided information on how to be more physically active (i.e., provided autonomy support), and helped their students to feel that they were competent at physical education lesson (i.e., provided competence support) after they had completed this web-based intervention programme. This finding is similar to a previous study by Tilga et al. (2021a) that a web-based intervention programme for PE teachers could have a direct effect on PE teachers self-reported autonomy support. Although the previous study based on students' reports has indicated that PE teachers effectively become more competence-supportive towards their students after they have completed web-based need-supportive intervention programme (Paap, et al., 2024), there are no previous studies assessing changes in provision of competence and relatedness support from the PE teacher perspective. The possible reason why PE teachers demonstrated significant gains in their self-reported provision of competence support might be related to the reason that PE teachers acquired various knowledge on how to make their students feel more competent. The possible reason why PE teachers did not demonstrate significant gains in their self-reported provision of relatedness support might be related to the reason that the provision of relatedness support also implies more specific interaction with their students which might imply that PE teachers need a longer period of time to apply provision of relatedness support. However, based on previous findings and based on students' self-

reports, PE teachers might become more relatedness-supportive towards their students after they have participated in the web-based need-supportive intervention programme (Paap, et al., 2024).

Second, it was hypothesized that the PE teachers in the experimental group, compared to the PE teachers in the control group, would perceive significantly lower provision of controlling behaviours at follow-up. This hypothesis was not supported because there were no significant differences between the experimental and control group PE teachers' self-reports at follow-up on their provision of controlling behaviours to their students. The possible reason for this might be that PE teachers had to focus on mastering very many different motivational behaviours. Also, this web-based need-supportive intervention programme for PE teachers exclusively focused on increasing their autonomy, competence, and relatedness support toward their students, but there was no specific focus on how to avoid controlling behaviours towards their students. For example, in a previous study, based on students' self-reports, the intervention programme was effective in reducing the experimental group PE teachers' controlling behaviours (Tilga, et al, 2021c). Also, in this study by Tilga et al. (2021c), the focus was only on increasing autonomy support and reducing controlling behaviours towards students, which might make it easier to PE teachers to acquire new knowledge. Previous studies have also indicated that it is important to not only increase the autonomy support, but also reduce the experiences of controlling behaviours because autonomy support and controlling behaviours are related to students' outcomes via separate pathways (Haerens, et al., 2015; Tilga, et al., 2020a).

Third, it was hypothesized that the PE teachers in the experimental group, compared to the PE teachers in the control group, would perceive their own psychological needs higher satisfaction at follow-up. This hypothesis was not supported because there were no significant differences between the experimental and control group PE teachers' self-reports in their own basic psychological need satisfaction at follow-up. The possible reason for this might be that it takes more time for PE teachers before they experience gains in their own basic psychological needs satisfaction when providing need support to their students. This finding is similar to previous research by Tilga et al. (2021a), in which there was no direct effect from web-based intervention on PE teachers own basic psychological need satisfaction. However, in a study by Cheon et al. (2014), teachers reported higher psychological need satisfaction after they completed autonomy-supportive intervention programme. The possible reason for this might be that face-to-face intervention programme by Cheon et al. (2014) enabled to provide more personal approach to teachers that might help in inducing teachers experiences of psychological need satisfaction compared to web-based intervention programme. However, previous studies have demonstrated that the greatest intervention effects might be found when face-to-face and web-based intervention programmes are combined (Tilga, et al., 2021c).

Fourth, it was hypothesized that the PE teachers in the experimental group, compared to the PE teachers in the control group, would experience higher intrinsic motivation to teach at follow-up. This hypothesis was not supported because there were no significant differences between the experimental and control group PE teachers' perceptions of intrinsic motivation to teach at follow-up. This finding is similar to a study by Tilga et al. (2021a), in which web-based intervention had no direct effect on PE teachers' intrinsic motivation. The possible reason for this might be that intrinsic reasons to teach take time to consolidate. It might be that PE teachers need more time to professionalize these need-supportive behaviours before they experience greater intrinsic motivation to teach their students. However, in a study by Cheon et al. (2014), teachers experienced higher intrinsic motivation to teach after they have completed face-to-face autonomy-supportive intervention programme. The possible reason for this might be that focusing exclusively on autonomy support behaviours might enable greater opportunities to experience gains in intrinsic motivation to teach. Previous research has clearly shown that perceived autonomy support is exclusively related to experiences of intrinsic motivation (e.g., Kalajas-Tilga, et al., 2020). Another reason might be that face-to-face approach by Cheon et al. (2014) enabled more personalized approach to induce intrinsic motivation in teachers. However, based on previous research (Tilga, et al., 2021c), the greatest intervention effects might occur to combine face-to-face and web-based approaches in delivering knowledge about need-supportive behaviours to PE teachers.

Fifth, it was hypothesized that the PE teachers in the experimental group, compared to the PE teachers in the control group, would experience higher teaching efficacy at follow-up. This hypothesis was supported because there were significant differences between the experimental and control group experiences of teaching efficacy at follow-up. More specifically, after completing the intervention programme, the PE teachers in the experimental group reported significant gains in their teaching efficacy at follow-up compared to those PE teachers who were in the control group. This finding is similar to a study by Cheon et al. (2014), in which intervention group teachers exhibited significant gains in their teaching efficacy compared to the control group at follow-up. The possible reason for this finding is that PE teachers used strategies to

provide need support to their students that resulted in their more effective teaching.

The main findings of the study indicate that the web-based need-supportive intervention programme for PE teachers was partially effective. The PE teachers who participated in the intervention reported significantly higher provision of autonomy support and competence support to their students, aligning with previous research by Tilga et al. (2021a) and Paap et al. (2024), which also found enhancements in these areas following similar interventions. However, the intervention did not lead to significant gains in the provision of relatedness support, suggesting that this aspect may require more time or specific strategies to implement effectively—a point not extensively addressed in earlier studies. Additionally, there were no significant reductions in controlling behaviours, possibly because the programme did not specifically focus on reducing these behaviours, contrasting with studies like Tilga et al. (2021c) that did address such reductions when targeting controlling practices. The intervention also did not result in significant improvements in PE teachers' own psychological need satisfaction or intrinsic motivation to teach, mirroring findings from Tilga et al. (2021a) but differing from Cheon et al. (2014), where face-to-face interventions yielded positive results in these areas. This suggests that the mode of delivery may influence the effectiveness of interventions on teachers' internal experiences. Notably, the study found significant gains in teaching efficacy among the experimental group, consistent with Cheon et al. (2014), indicating that need-supportive interventions can enhance teachers' confidence in their teaching abilities.

Practical implications

The findings from this study offer several practical implications for PE teacher training. The web-based need-supportive intervention programme was effective in enhancing teachers' autonomy and competence support, as well as their overall teaching efficacy. Based on these results, PE teachers are encouraged to adopt autonomy-supportive strategies, such as providing students with choice, using non-controlling language, and encouraging self-initiated behaviour, which are likely to promote students' intrinsic motivation and engagement in PE classes. Similarly, competence-supportive practices, like setting optimal challenges and offering constructive feedback, may enhance students' sense of competence and engagement.

Additionally, while the decrease in teachers' controlling behaviours was not statistically significant when compared with the control group, the trend observed in reduced controlling behaviours post-intervention is noteworthy. This slight decrease suggests that implementing need-supportive strategies may contribute to a natural reduction in controlling behaviours, even if the primary focus is on fostering autonomy and competence. As controlling behaviours can detract from students' motivational experiences, teachers are encouraged to reflect on their practices and gradually incorporate strategies that minimize controlling interactions. By reducing these behaviours, teachers may foster a more positive and autonomy-supportive classroom environment, aligning with the broader objectives of SDT to promote motivation and well-being.

Looking ahead, web-based interventions hold substantial promise for advancing PE teacher training and professional development. Given the convenience, accessibility, and scalability of online platforms, web-based programmes can reach a larger population of educators than traditional face-to-face workshops. This is especially relevant in PE, where teachers often have limited time and resources for continuous professional development. Web-based interventions also provide a flexible learning environment that allows teachers to engage with training content at their own pace, revisit materials as needed and apply newly learned strategies directly to their practice. Additionally, as demonstrated in this study, web-based formats can successfully promote need-supportive behaviours, which are critical for fostering students' motivation and positive experiences in PE classes. As digital technology continues to evolve, there is potential to enhance these interventions further with interactive elements, peer collaboration, and personalized feedback. This could deepen the impact of training programmes by allowing teachers to receive more tailored support and guidance. Future research should continue to explore and refine web-based approaches, particularly focusing on how they can sustain long-term improvements in teaching efficacy and classroom climate in PE settings. Highlighting the potential of these digital interventions offers exciting prospects for scalable, high-impact teacher development that aligns with the broader educational goals of promoting physical activity, motivation, and well-being in students.

Limitations and future directions

Although there are several strengths of this study, there are also several limitations related to this study that should be acknowledged. First, in this study we relied on teachers' self-reported measures to examine intervention effects. However, there might be great differences between self-reports and actual behaviour (Aguado-Gómez, Diaz-Cueto, Hernández-Álvarez, & López-Rodríguez, 2016). Future studies would do well by videotaping PE lessons to capture actual changes in PE teachers' behaviours or PE lessons could be observed and rated by external observers (Aelterman, Vansteenkiste, Van Keer, & Haerens, 2016). Second, in this

study, PE teachers' data of only one-month follow-up was examined. Based on previous studies, one-month follow-up data might demonstrate changes in most study variables among experimental group (e.g., Tilga, Hein, & Koka, 2019a), but 15-month of follow-up data might reveal fewer enduring effects on the study variables (Tilga, Kalajas-Tilga, Hein, Raudsepp, & Koka, 2020b). Future studies are recommended to test intervention effects based on longer follow-up period. Third, in this study perceptions of controlling behaviours were measured via experiences of negative conditional regard, controlling use of grades, and intimidation (Hein, et al., 2015). In a recent study by De Meyer, Soenens, Aelterman, De Bourdeaudhuij, and Haerens (2016), framework of externally and internally controlling teaching behaviours was proposed and a scale to measure faces of PE teachers' behaviours was developed and validated (Burgueño, Abós, García-González, Tilga, & Sevil-Serrano, 2021). Future research could test changes in different dimensions of controlling behaviours such as externally and internally controlling teaching as promising predictors of basic psychological need satisfaction and frustration (Burgueño, et al., 2021, Koka, Tilga, Hein, Kalajas-Tilga, & Raudsepp, 2021, Viksi & Tilga, 2022). Fourth, in this study, autonomy support was considered as a unidimensional construct. Previous studies have demonstrated that multidimensional approach to autonomy-supportive behaviour (Tilga, Hein, & Koka, 2017) enables to describe a larger amount of variance in motivational outcomes (Zimmermann, Tilga, Bachner, & Demetriou, 2020, 2021). Thus, future studies could adopt a multidimensional approach to measure autonomy support from PE teachers. Fifth, perceived structure and chaos from the circumplex model (Aelterman, et al., 2019), were not measured in this study. Recent research has demonstrated that perceived structure and chaos are important predictors of motivational outcomes in the field of PE (Diloy-Peña et al., 2024; Tilga, Vahtra, & Koka, 2023). Future research could do well by adopting scales to measure constructs from the circumplex model. Sixth, in this study we relied on a classification system of motivational behaviours proposed by Teixeira and colleagues (2020). However, classification system of motivational behaviours proposed by Teixeira and colleagues (2020) is more relevant to health context. In a recent study by Ahmadi and colleagues (2023), a classification system for teachers' motivational behaviours recommended in self-determination theory interventions for educational context was developed. Also, classification system developed by Ahmadi et al. (2023) also provides a list of need-thwarting behaviours that should be avoided. It is important to not only teach how to provide need support, but also to provide information on how to avoid need thwarting because controlling behaviours dampen the effect of need support (Tilga, Hein, Koka, Hamilton, & Hagger, 2019b), and need satisfaction and need thwarting are related to respective outcomes via separate pathways (Haerens, et al, 2015; Tilga, et al., 2020c). Future studies that rely on Ahmadi and colleagues' (2023) classification system could do well by developing intervention programme for teachers to enhance their motivational behaviours.

In conclusion, the current study provides initial information that our developed web-based need-supportive intervention programme for PE teachers is effective to increase their self-reported autonomy support, competence support and teaching efficacy. Thus, teachers are recommended to study specific motivational behaviours proposed by Teixeira and colleagues (2020), if the aim is to increase teachers' perceptions of their autonomy support, competence support and teaching efficacy towards their students.

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