

Research article

Web-Based and Face-To-Face Autonomy-Supportive Intervention for Physical Education Teachers and Students' Experiences

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Abstract

The most of the previous autonomy-supportive interventions conducted have been partially effective and used only web-based or face-to-face approach. In the current study, a combined web-based and face-to-face intervention for physical education (PE) teachers was tested to examine whether it would lead to significant changes in students' self-reports of autonomy-supportive and controlling behaviours, psychological need satisfaction and frustration, and intrinsic motivation. Participants were 57 PE teachers ($M_{\text{age}} = 45.70$, $SD = 12.79$) and their 858 middle-school students ($M_{\text{age}} = 13.22$, $SD = 0.75$). A randomized controlled design was adopted in which PE teachers and their students were assigned to the combined face-to-face and web-based, face-to-face alone, web-based alone or control group. Face-to-face intervention was provided to PE teachers within one day in an 8-hour workshop and web-based intervention was provided to PE teachers for a period of four weeks. The combined face-to-face and web-based intervention group was the only study group that demonstrated statistically significant changes in all the study variables (i.e., significant increase in cognitive, organisational, and procedural autonomy-supportive behaviour, in psychological need satisfaction for autonomy, competence and relatedness, and in intrinsic motivation, whereas significant decrease in intimidation, controlling use of grades, and negative conditional regard, and in psychological need frustration for autonomy, competence, and relatedness) compared to the control group at a one-month follow-up. There were no significant differences in any of the study variable, except organisational autonomy support and intimidation, between the web-based intervention group and face-to-face intervention group. Both web-based and face-to-face study group students reported significant gains in most of the study variables compared to the control group students at a one-month follow-up. The current findings suggest that future autonomy-supportive interventions for PE teachers should aim to use combined interventions of face-to-face and web-based approach to gain the greatest intervention effects.

Key words: Autonomy support, controlling behaviour, psychological needs, intrinsic motivation, physical education, intervention program.

Introduction

In physical education (PE), teachers have a unique opportunity to motivate their students towards lifelong healthy behaviours. By doing so, teachers rely on various motivating styles, for example providing their students with autonomy support (Cheon et al., 2016; 2018; Sevil-Serrano et al., 2020; Su and Reeve, 2011; Tilga et al., 2021a). Teachers' autonomy-supportive interpersonal style is vital because it enhances students' psychological needs (Haerens et al., 2015), increases students' intrinsic motivation (Tilga et al.,

2020c) and is positively related to students' physical activity (Kalajas-Tilga et al., 2020). On the other hand, being under pressure, the teacher may also express controlling interpersonal style toward their students (Reeve, 2009). Teachers' controlling interpersonal style is destructive because it frustrates students' psychological needs (Haerens et al., 2015; Trigueros et al., 2019), is related to students' external regulation, and lower levels of students' physical activity (Koka et al., 2019). Previous studies have demonstrated that both face-to-face (e.g., Su and Reeve, 2011; Cheon et al., 2016; 2018; Tilga et al., 2021a) and web-based (e.g., Tilga et al., 2019a) interventions in which teachers adopt autonomy-supportive techniques have found to be partially effective in changing students' perceptions on psychosocial variables. A recent systematic review conducted by Vaquero-Solis and colleagues (2020) also indicated several partly effective interventions on children's and adolescent's psychosocial variables suggesting that future research should adopt combined interventions that would have a greater effect on the participants' perceptions. We argue that combining face-to-face and web-based autonomy-supportive interventions might have an advantage in improving PE teachers' interpersonal behaviour. Therefore, in the current study we aim to test the effects of a face-to-face intervention combined with a web-based intervention to enhance PE teachers' autonomy-supportive and minimizing controlling behaviour.

Previous research has increasingly adopted self-determination theory (SDT; Ryan and Deci, 2017) as a framework of humans' motivation to explain the effects of social factors (e.g., teachers' autonomy-supportive and controlling behaviour) on humans' (e.g., students') adaptive outcomes in PE (Hagger and Chatzisarantis, 2016). On the bright side of social factors there is the autonomy-supportive behaviour which is characterised as an interpersonal teaching style when someone in a position of authority (e.g., a teacher) adopts the others' (e.g., students) perspective, recognises his or her feelings, and provides opportunities for choice and relevant feedback (Black and Deci, 2000). Previous intervention programs with the aim to promote PE teachers' autonomy-supportive behaviour have mostly used face-to-face approach and have been effective in changing students' perceptions (e.g., Su and Reeve, 2011; Cheon et al., 2016; 2018). However, in these previous studies students' perception of their PE teachers' autonomy-supportive behaviour was measured as a global construct (e.g., Cheon et al., 2016; 2018). It is suggested by Ryan and Deci (2020) that future SDT research should use multidimensional scaling because SDT sees this as an important tool to assess the functional significance and

specific meaning of events.

Stefanou and colleagues (2004) have proposed the multidimensional characterization of autonomy-supportive behaviour by using three distinctive dimensions (i.e., cognitive, procedural, and organisational). Multidimensional approach to autonomy-supportive behaviour allows to examine distinctive aspects of autonomy-supportive behaviour such as cognitive (e.g., being interested in what students want to do), procedural (e.g., explaining why we learn certain exercises), and organisational (e.g., accepting different solutions in learning of exercises). Recently, several studies have adopted the multidimensional approach in measuring students' perceptions of autonomy-supportive behaviour (e.g., Burgueño et al., 2020; Koka et al., 2021; Montero-Carretero and Cervelló, 2020; Tilga et al., 2017; 2019b; Zimmermann et al., 2020; Trigueros et al., 2020). To our best knowledge, two intervention studies have been conducted so far that aimed to increase PE teachers' multidimensional autonomy-supportive behaviours by using either a face-to-face approach (Tilga et al., 2021a) or a web-based approach (Tilga et al., 2019a). Both interventions had the potential to change students' perceptions of their PE teachers' multidimensional autonomy-supportive behaviour in a favourable direction.

On the darker side of social factors, teachers may also use controlling behaviour such as intimidation to keep students in line during the lesson (Reeve, 2009). Recent research has indicated that the presence of teacher autonomy support does not imply the absence of teacher control (e.g., Haerens et al., 2015; Tilga et al., 2019b). In addition, providing autonomy support might not counter the detrimental effect of perceived controlling behaviour on students' health-related quality of life (Tilga et al., 2019b) and intrinsic motivation (Tilga et al., 2020b). Possible reason for this might be that students are sensitive to the teachers' controlling behaviour, even if the presence of the controlling behaviours according to the observers is low (De Meyer et al., 2014). Another possible reason might be that students' perception of their PE teachers' autonomy-supportive and controlling behaviour are related to students' adaptive outcomes through separate pathways (Tilga et al., 2019b). Taking this into account, autonomy-supportive interventions should not only include increasing autonomy-supportive behaviour, but also decreasing controlling behaviours. Based on the three dimensions of controlling behaviours (i.e., intimidation, controlling use of praise and extrinsic rewards, and negative conditional regard) proposed by Bartholomew and colleagues (2010), several recent studies have adopted multidimensional approach of controlling behaviours (e.g., Hein et al., 2018, Koka et al., 2019; 2020; Tilga et al., 2019b). Multidimensional approach of controlling behaviours examines unique aspects of controlling behaviours such as intimidation (e.g., shouting at students in front of others to make him/her comply), controlling use of praise and extrinsic rewards or grades (e.g., teacher promises to give students a good grade only if they do well) and negative conditional regard (e.g., paying students less attention if they have displeased him or her). Two intervention studies using either a face-to-face approach (Tilga et al., 2021a) or a web-based approach (Tilga et al., 2019a) demonstrated the moderate efficiency

in changing students' perceptions of their PE teachers' multidimensional controlling behaviour.

Central in the SDT (Ryan and Deci, 2017; Vansteenkiste et al., 2020) are three basic psychological needs for autonomy (i.e., to feel self-determined in one's actions rather than feeling controlled), competence (i.e., to feel competent in interactions with the environment and experience opportunities in which to express their capabilities), and relatedness (i.e., to feel a secure sense of belongingness to others). Fulfilment of these basic psychological needs is associated with students' intrinsic motivation (Kalajas-Tilga et al., 2020). Students' experience of intrinsic motivation is important because it assists students' adaptive outcomes such as intention to participate in optional PE and concentration in the PE classes (Ntoumanis, 2005), and effort and physical self-esteem (Hein and Caune, 2014), and health-related quality of life (HRQoL; Koka, 2014; Standage and Gillison, 2007; Standage et al., 2012), optimal functioning (Vansteenkiste et al., 2020). On the other hand, frustration of basic psychological needs for autonomy, competence and relatedness is related to sub-optimal functioning, ill-being, and maladaptive outcomes such as controlled motivation, amotivation or anger (Bartholomew et al., 2011; De Meyer et al., 2016; Haerens et al., 2015; Hein et al., 2015; Vansteenkiste and Ryan, 2013). Autonomy-supportive intervention programs for PE teachers have been effective to increase their students' experiences of psychological need satisfaction and decrease psychological need frustration (e.g., Cheon et al., 2018). However, Cheon and colleagues (2018) did not measure the unique change in each psychological need for autonomy, competence, and relatedness separately. To the best of our knowledge, two autonomy-supportive intervention studies conducted so far have assessed changes in students' psychological need satisfaction and frustration for autonomy, competence, and relatedness separately (Tilga et al., 2019a; 2021a). Results revealed that both interventions were moderately effective in changing students' experiences of psychological need satisfaction and frustration. The current study adds to the extant literature by combining the face-to-face autonomy-supportive intervention program for PE teachers (ASIP-PE; Tilga et al., 2021a) and web-based autonomy-supportive intervention program for PE teachers (WB-ASIP; Tilga et al., 2019a) to test the combined intervention effects based on the students' psychological experiences in a PE lesson.

The present study was based on the SDT (Ryan and Deci, 2017) as a theoretical framework and aimed to examine the main and interaction effects of face-to-face, web-based and combined face-to-face and web-based autonomy-supportive intervention programs for PE teachers. In this study, PE teachers were trained in three different groups to provide their students cognitive, organisational, and procedural autonomy support and avoid intimidation, negative conditional regards and controlling use of grades. Intervention effects were examined through the changes in SDT-based study variables including students' perceived dimensions of autonomy-supportive and controlling behaviours from teachers, students' perceived satisfaction and frustration of psychological needs, and students' self-reported intrinsic motivation in PE. Based on the above, we

hypothesised:

(1) The students of teachers assigned to the combined face-to-face and web-based intervention group would exhibit greatest change in the study variables compared to the students of teachers assigned to the face-to-face and web-based intervention group alone and students of teachers assigned to the control group at a one-month follow-up.

(2) The students of teachers assigned to the web-based and face-to-face intervention group alone would exhibit significant change in the study variables compared to the students of teachers assigned to the control group at a one-month follow-up.

(3) There would be no significant differences in the effects of the web-based and face-to-face interventions on changes in students' self-reports at one-month follow-up.

Methods

Participants

The Estonian Ministry of Education has a list of schools labelled as "Innovation Schools" and "Innovation Friends", which brings together schools in Estonia who are willing to closely collaborate with our university. We contacted with all the PE teachers from those schools and offered them opportunity to participate in this study. Based on the sample of PE teachers who agreed to participate in this study, the students of those PE teachers were also offered an opportunity to participate in this study. In total, 57 experienced PE teachers (25 men and 32 women) and their 858 middle school students (389 boys and 469 girls) from 46 different schools in Estonia agreed to participate in this study. Teachers' age was on average 45.70 years ($SD =$

12.79, range = 24-64) with 17.48 years of experience in teaching on average ($SD = 13.53$, range = 3-44). Students' age was on average 13.22 years ($SD = 0.75$) ranging from 12 to 15 years. All the teachers and students voluntarily agreed to participate in this study and were provided with detailed information about the survey. An approval to conduct this study was obtained from the Research Ethics Committee of the University of Tartu (252/T-7). The current study was conducted in the period from October 2019 to February 2020.

Procedure

In this study, we adopted a randomized controlled design in which teachers and their students were assigned to the combined face-to-face and web-based experimental, face-to-face experimental, web-based experimental or control group (see Figure 1). A baseline questionnaire was completed by all 858 students including measures of students' perceptions of their PE teachers' multidimensional autonomy-supportive and controlling behaviour, self-reports of satisfaction and frustration of basic psychological needs, and self-reports of intrinsic motivation. One week later, combined face-to-face and web-based experimental group teachers, and face-to-face experimental group teachers participated in a one-day ASIP-PE workshop. In addition, combined face-to-face and web-based experimental group teachers, and web-based experimental group teachers participated in a four-week WB-ASIP. All experimental group students completed the follow-up questionnaires four weeks after the end of intervention, whereas control group students completed the follow-up questionnaire nine weeks after the baseline questionnaires (see Figure 2).

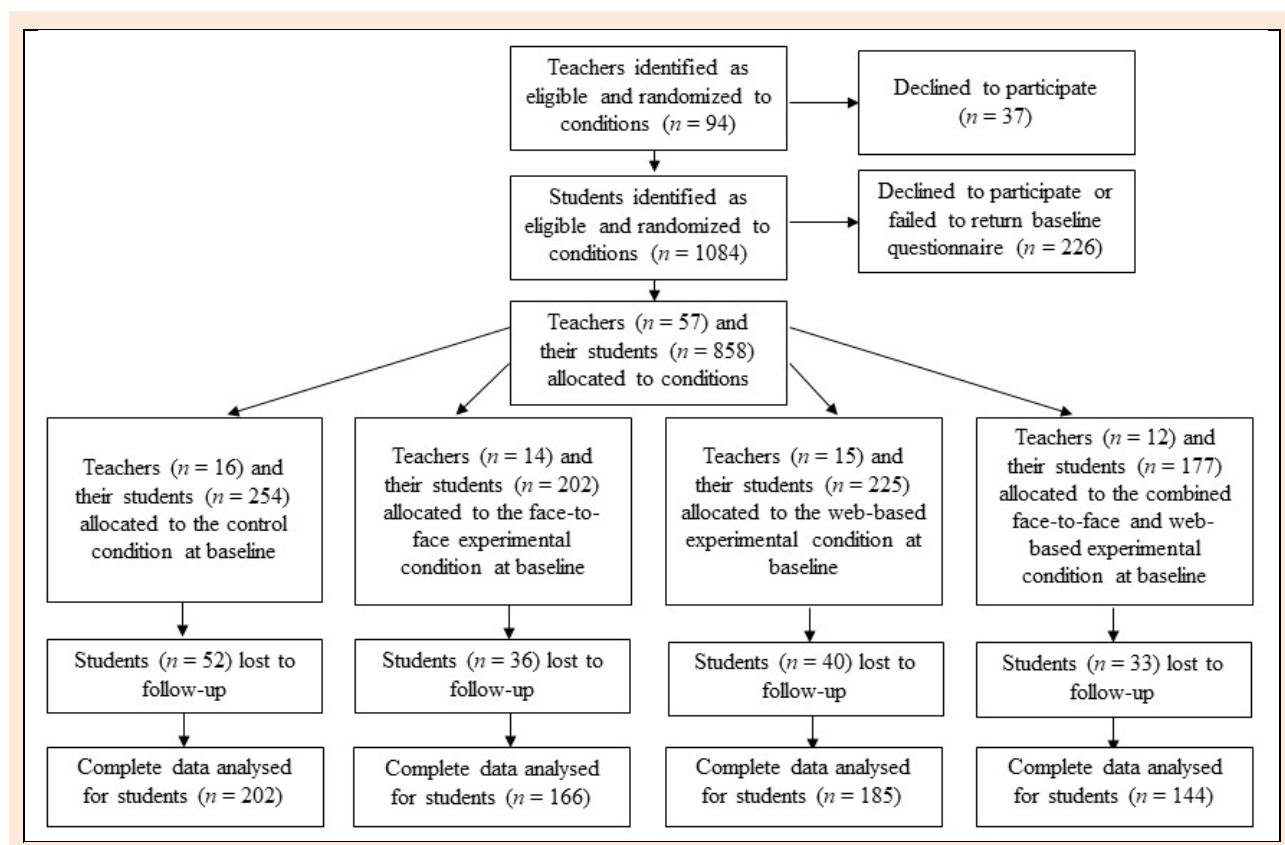


Figure 1. Participant flow chart.

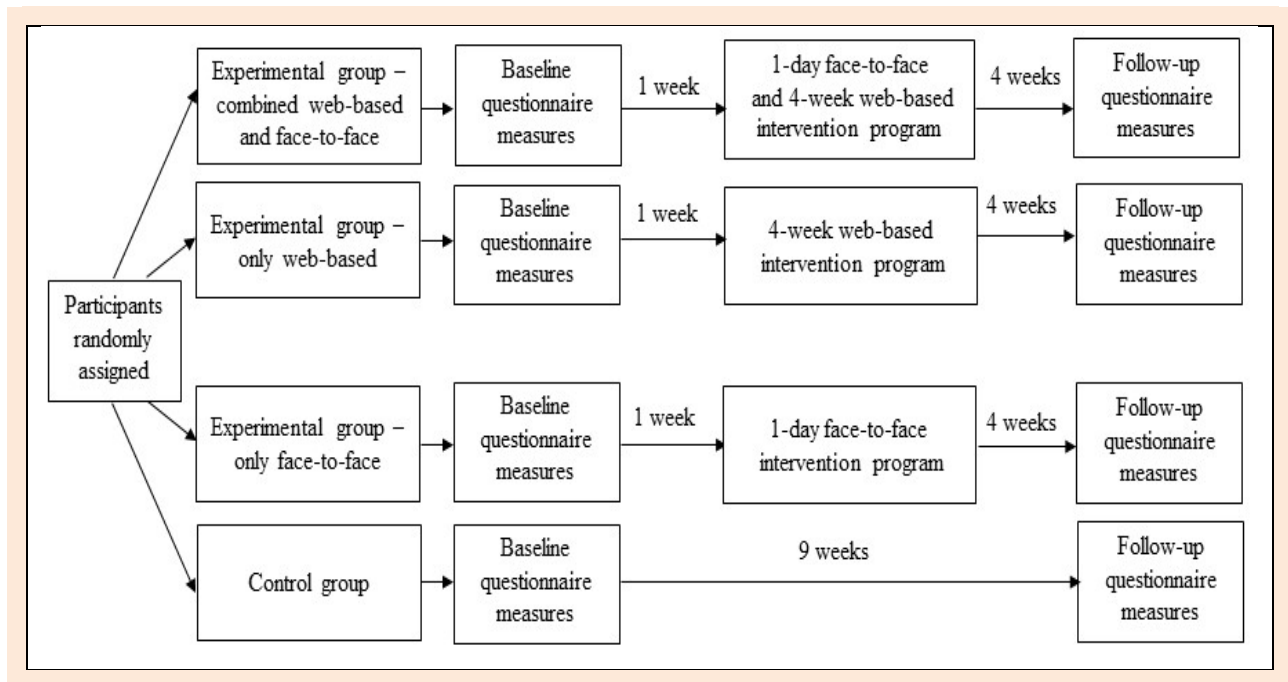


Figure 2. Overall study design.

ASIP-PE and WB-ASIP

We provided ASIP-PE within one day in an 8-hour workshop and WB-ASIP for a period of four weeks. The following description introduces how the study material was delivered to the PE teachers during ASIP-PE (Tilga et al., 2021a) and WB-ASIP (Tilga et al., 2019a).

ASIP-PE

Part 1. In the first part of the ASIP-PE, central tenets of SDT were introduced with a special focus on different forms of motivational regulations (i.e., intrinsic motivation, identified regulation, introjected regulation, external regulation and amotivation) that students may experience as a consequence of perceived satisfaction or frustration of basic psychological needs for autonomy, competence, and relatedness during the lessons. First, PE teachers had to share their previous experiences on how they have motivated their students during PE lessons. Next, PE teachers were provided with several examples for each form of motivational regulation in the context of PE. There was a group discussion of how different forms of motivational regulations were understood by PE teachers and how to identify these forms among students in a PE lesson. Also, PE teachers completed a short self-reported questionnaire about different forms of motivational regulations. Based on the study materials provided, PE teachers had to identify as to what form of motivational regulation each item assesses and explain their decision. Later there was a group discussion on what features characterise each form of motivational regulation. Finally, PE teachers had to complete a short interactive test about different forms of motivational regulations to ensure whether they learned the study materials.

Part 2. In the second part of the ASIP-PE, multidimensional autonomy-supportive (i.e., cognitive, organisational, and procedural) and controlling behaviour (i.e., intimidation, negative conditional regard and controlling use

of grades) was introduced to PE teachers. PE teachers were provided with several examples about multidimensional autonomy-supportive and controlling behaviours in the context of PE including previously recorded video examples. In a group discussion, PE teachers were asked to (i) reflect how they currently use autonomy-supportive and controlling behaviour in their lessons, (ii) discuss on how implementing autonomy-supportive behaviour could be useful both for themselves and students, (iii) identify possible obstacles in terms of implementing autonomy-supportive and abandoning controlling behaviours and why PE teachers sometimes tend to use controlling behaviours toward students. In addition, PE teachers were asked to complete a short self-reported questionnaire about multidimensional autonomy-supportive and controlling behaviours. Based on the study materials provided, PE teachers had to identify as to what dimension of behaviour each item assesses and explain their decision. Later there was a group discussion on what features characterise each dimension of autonomy-supportive and controlling behaviour, followed by the discussion on how these behaviours could be related to students' perceived satisfaction and frustration of basic psychological needs and, in turn, different forms of motivation. Finally, PE teachers had to complete a short interactive test about multidimensional autonomy-supportive and controlling behaviours to ensure whether they learned the study materials.

Part 3. In the third part of the ASIP-PE, PE teachers took part in two different consecutive PE lessons that were delivered by our research team – one highly controlling and another highly autonomy-supportive. PE teachers were not informed before the example lesson whether it would be highly autonomy-supportive or controlling PE lesson. The content of both lessons was similar – PE teachers had to complete different tasks in several preinstalled exercise stations while one member from our research team delivered instructions using a highly controlling way in the first

example lesson, whereas highly autonomy-supportive way in the second example lesson. After each lesson, PE teachers were asked to reflect their experience during the example lessons. This experience was linked with previously introduced multidimensional autonomy-supportive and controlling behaviours and PE teachers had to identify different aspects of these behaviours experienced in example lessons. Finally, PE teachers were asked to share their professional experience on how they would improve these two example lessons in terms of PE teachers' interpersonal behaviour.

Part 4. In the final part of the ASIP-PE, PE teachers in small groups were asked to prepare short PE lessons to other participants in which they had to implement autonomy-supportive behaviour with dimensions of cognitive, organisational, and procedural autonomy support and avoid controlling behaviour while delivering the content of the lessons. Each short lesson was followed by a group discussion focused on interpersonal behaviour of the teacher who delivered the lesson. Specifically, PE teachers were asked to identify all the dimensions of autonomy-supportive behaviours exhibited by the teacher during the lesson. In addition, they were asked to share their experiences during these lessons. Finally, in a summarising group discussion all the PE teachers provided feedback for the intervention and what they had learned for their teaching.

WB-ASIP

Week 1. During the first week of the WB-ASIP, PE teachers were provided with video lectures on multidimensional autonomy-supportive and multidimensional controlling behaviour. In total, there were two video lectures in this week – first one introducing cognitive, organisational, and procedural autonomy support and second one presenting negative conditional regard, controlling use of grades, and intimidation. Several examples of teacher-student communication in life-like situations were included in these videos to make it easier for PE teachers to identify and understand these described behaviours. It was highlighted how autonomy-supportive behaviour is beneficial to students and to PE teachers themselves. Also, it was emphasized how controlling behaviour is detrimental to students. PE teachers were asked to use autonomy-supportive and avoid controlling behaviour during their PE lessons in the next week. Finally, PE teachers had to fill in a multiple-choice test about study materials to ensure whether they learned the study materials.

Week 2. During the second week of the WB-ASIP, PE teachers were provided with video lectures on basic psychological need frustration and satisfaction for autonomy, competence, and relatedness of students with a special focus on their relationship with perceived interpersonal behaviour of teachers. Also, PE teachers were asked to report how they provided autonomy support and avoided controlling behaviour during their PE lesson on the previous week and encouraged to continue with providing autonomy support and avoiding controlling behaviour during their PE lesson in the next week. Finally, PE teachers had to fill in a multiple-choice test about study materials to ensure whether they learned the study materials.

Week 3. During the third week of the WB-ASIP,

PE teachers were provided with video lectures on different forms of motivation (i.e., amotivation, extrinsic and intrinsic motivation) with a special focus on their relationships with students' psychological need satisfaction and frustration and perceived interpersonal behaviour of teachers. Similar to the second week of the WB-ASIP, PE teachers were asked to report how they provided autonomy support and avoided controlling behaviour during their PE lesson on the previous week. PE teachers were also encouraged to continue with providing autonomy support and avoiding controlling behaviour during their PE lessons in the next week. Finally, PE teachers had to fill in a multiple-choice test about study materials to ensure whether they learned the study materials.

Week 4. During the final week of the WB-ASIP, all the study materials were rehearsed by the PE teachers. Specifically, PE teachers had to go through all the materials once again regarding PE teachers' multidimensional autonomy-supportive and controlling behaviours, students' psychological need satisfaction and frustration, and students' amotivation, extrinsic and intrinsic motivation. At the end of this week, PE teachers had to complete a comprehensive test based on all the study materials.

The web-based experimental group PE teachers' adherence to the web-based intervention and completion of online tasks were monitored via web-based platform. For the intervention fidelity, all the PE teachers in the web-based intervention reported each week in a web-based forum exactly how they implemented autonomy-supportive behaviours and avoided controlling behaviour. Based on the content analysis of the teachers' written responses, we were able to evaluate whether study materials were understood by the PE teachers and based on this information PE teachers were provided with feedback on how to improve their interpersonal behaviour.

Measures

Students' perceived autonomy-supportive behaviour

We measured students' perceptions of their PE teachers' autonomy-supportive behaviour by using the Multi-Dimensional Perceived Autonomy Support Scale for Physical Education (MD-PASS-PE; Tilga et al., 2017). Items were presented with the common stem: "My PE teacher ...," followed by the items tapping the three subscales: (a) cognitive autonomy support (e.g., "... answers to me when I express my opinion"), (b) organisational autonomy support (e.g., "... allows me to do exercises using different methods"), and (c) procedural autonomy support (e.g., "... explains the effect of exercises"). There were five items for each subscale with responses ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Previous studies have supported the factor structure and reliability of the current instrument (Burgueño et al., 2020; Montero-Carretero and Cervelló, 2020; Zimmermann et al., 2020, 2021; Tilga et al., 2017; Tilga et al., 2020a).

Students' perceived teachers' controlling behaviour

We measured students' perceptions of their PE teachers' controlling behaviour by using the multidimensional controlling coach behaviours scale (Bartholomew et al., 2010) adapted to PE (Hein et al., 2015). Items were presented

with the common stem: “My PE teacher ...,” followed by the items tapping the three subscales: (a) intimidation (e.g., “... shouts at me in front of others to make me comply”), (b) negative conditional regard (e.g., “... is less supportive of me when I do not exercise and perform well”), and (c) controlling use of grades (e.g., “... only uses grades so that I stay focused on tasks during lesson”). There were three items for each subscale with responses ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Previous studies have supported the factor structure and reliability of the current instrument (Hein et al., 2018; Tilga et al., 2020a).

Students’ experiences of satisfaction and frustration of basic psychological needs

We measured students’ experiences of satisfaction and frustration for basic psychological needs in PE by using the basic psychological need satisfaction and need frustration scale (Chen et al., 2015) adapted for PE (Haerens et al., 2015). Items were presented with the common stem: “During the PE lesson ...,” followed by the items tapping the six subscales: (a) autonomy satisfaction (e.g., “... I felt a sense of choice and freedom in the things I undertake”), (b) competence satisfaction (e.g., “... I felt capable at what I did”), (c) relatedness satisfaction (e.g., “... I felt close and connected to the class members who are important to me”), (d) autonomy frustration (e.g., “... I felt pressured to do too many exercises”), (e) competence frustration (e.g., “... I felt like a failure because of the mistakes I made”), and (f) relatedness frustration (e.g., “... I felt excluded from the group I want to belong to”). There were four items for each subscale with responses ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Previous studies have supported the factor structure and reliability of the current instrument (Koka et al., 2019; Tilga et al., 2020a).

Students’ self-reported intrinsic motivation

We measured students’ intrinsic motivation in PE by using the perceived locus of causality questionnaire (Goudas et al., 1994). Items were presented with the common stem: “I do PE ...,” followed by the items tapping the intrinsic motivation (e.g., “... because I enjoy PE”) subscale. There were four items for intrinsic motivation subscale with responses ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Previous studies have supported the validity and reliability of the current instrument (Kalajas-Tilga et al., 2020; Kalajas-Tilga et al., 2021).

Data analysis

The data analysis was conducted by using the SPSS Version 23.0 statistical package. There were no missing data as the online questionnaire forced participants’ responses. For the preliminary analyses, the randomisation check was conducted to examine the baseline differences between study groups by using the series of analysis of variance (ANOVA) and the chi-square test. The attrition check was conducted to examine the differences between those who remained in the study and those who were lost to follow-up by using the independent samples *t*-test and the chi-square test. The manipulation check was conducted by examining the content of written forum posts and written descriptions for the short PE lessons to assess the extent to

which experimental group PE teachers had engaged with the autonomy-supportive behaviour and disengaged with the controlling behaviour.

For the main analysis, the effects of the intervention condition and time on the dependent variables was tested by using a 4 (intervention condition: combined vs web-based vs face-to-face vs control group) \times 2 (time: baseline vs follow-up) multivariate analysis of covariance (MANCOVA). Based on the absence of statistical significance ($p = 0.078$) in the Box’s *M* test, the Wilks’ *A* was used as a test statistic in MANCOVA (Field, 2017). The dependent variables were cognitive autonomy support, organisational autonomy support, procedural autonomy support, negative conditional regard, intimidation, controlling use of grades, autonomy need satisfaction, competence need satisfaction, relatedness need satisfaction, autonomy need frustration, competence need frustration, relatedness need frustration, and intrinsic motivation. The independent variable was the study group and respective baseline scores of aforementioned variables were included as covariates. Partial eta squared (η_p^2), which measures the proportion of variance explained by a given variable, was used as a measure of the effect size. The effect size was interpreted as follows: $0.01 > \eta_p^2$ – small effect size, $0.01 < \eta_p^2 < 0.06$ – medium effect size, $0.14 < \eta_p^2$ – large effect size.

Fidelity of interventions

During the four-week intervention period, all the PE teachers continued the teaching according to the national curriculum. PE teachers from all the study groups, except the control group, were instructed to implement autonomy-supportive and avoid controlling behaviour during their PE lessons. The fidelity of the interventions was assessed in two ways. First, the students’ perceptions of their PE teachers’ autonomy-supportive and controlling behaviours prior to the intervention and four weeks after the intervention were assessed. Second, the web-based group PE teachers’ weekly written forum posts on how they have implemented autonomy-supportive behaviour instead of using controlling behaviour in their lessons during a four-week intervention period were content analysed. In addition, the face-to-face group PE teachers’ specific descriptions on how they intend to implement autonomy-supportive behaviour instead of using controlling behaviour in their lessons written at the final part of a one-day intervention were content analysed.

Results

Preliminary Results

Randomization check

The results of the ANOVAs indicated that there were no significant differences between the study groups in any of the study variable at baseline ($F_s = 0.12$ - 1.78 , $p_s > 0.15$). Based on the results of the chi-square test, there were no significant differences in the proportion of girls and boys between any study group ($\chi^2 = 2.13$, $p = 0.55$).

Attrition check

The results of the independent samples *t*-test indicated that there were no significant differences in any of the study

variables between the participants who were lost to follow-up and who remained in the study ($t_s = -1.44-1.58, p_s > 0.12$). Based on the results of the chi-square test, there were no significant differences in the proportion of girls and boys between the students who remained in the study and who were lost to follow-up ($\chi^2 = 1.11, p = 0.29$).

Manipulation check

The content analysis of the written forum posts during a four-week web-based intervention by web-based group PE teachers and written descriptions by the face-to-face group PE teachers indicated that all the PE teachers reported a detailed description how they implemented autonomy-supportive behaviour instead of controlling behaviour during the intervention period. Specifically, all the PE teachers from all the experimental groups [combined group, $n = 12$ (100%); web-based group, $n = 15$ (100%); face-to-face group, $n = 14$ (100%)] reported specific situations of how they provided cognitive, organisational, and procedural autonomy support to their students during their PE lessons. More specifically, based on the written forum posts during a four-week web-based intervention and based on the written descriptions by the face-to-face group PE teachers, we identified that PE teachers provided specific plan, for example, how they convey confidence in students' ability to do well in the PE lesson (i.e., cognitive autonomy support), how they explain the effect of exercises to students (i.e., procedural autonomy support), and how they provide to choose between different exercises (i.e., organisational autonomy support). In addition, all PE teachers [combined group, $n = 12$ (100%); web-based group, $n = 15$ (100%), face-to-face group; $n = 14$ (100%)] described situations from their PE lessons in which they would usually use controlling behaviours and how they instead provided autonomy support to their students. More specifically, based on the written forum posts during a four-week web-based intervention and based on the written descriptions by the face-to-face group PE teachers, we identified that PE teachers provided specific plan, for example, how they avoid being less supportive of students who do not exercise and perform well (i.e., negative conditional regard), how

they avoid using grades to keep students focused on tasks during lessons (i.e., controlling use of grades), and how they avoid intimating students into doing something that teacher wants them to do (i.e., intimidation).

Main Results

Between-group change comparisons

The results of the MANCOVA revealed a significant multivariate main effect for the intervention conditions (Wilks' $\Lambda = 0.84, F(39, 1979) = 3.14, p < 0.001, \eta_p^2 = 0.057$). Univariate ANOVAs indicated significant effects of the intervention conditions on the cognitive autonomy support ($F(3, 697) = 13.63, p < 0.001, \eta_p^2 = 0.057$), organisational autonomy support ($F(3, 697) = 14.17, p < 0.001, \eta_p^2 = 0.059$), procedural autonomy support ($F(3, 697) = 11.97, p < 0.001, \eta_p^2 = 0.050$), negative conditional regard ($F(3, 697) = 12.12, p < 0.001, \eta_p^2 = 0.051$), intimidation ($F(3, 697) = 4.14, p = 0.006, \eta_p^2 = 0.018$), controlling use of grades ($F(3, 697) = 9.61, p < 0.001, \eta_p^2 = 0.041$), autonomy need satisfaction ($F(3, 697) = 9.75, p < 0.001, \eta_p^2 = 0.041$), competence need satisfaction ($F(3, 697) = 9.92, p < 0.001, \eta_p^2 = 0.042$), relatedness need satisfaction ($F(3, 697) = 8.91, p < 0.001, \eta_p^2 = 0.038$), autonomy need frustration ($F(3, 697) = 11.08, p < 0.001, \eta_p^2 = 0.047$), competence need frustration ($F(3, 697) = 11.05, p < 0.001, \eta_p^2 = 0.046$), relatedness need frustration ($F(3, 697) = 5.35, p = 0.001, \eta_p^2 = 0.023$), and intrinsic motivation ($F(3, 697) = 4.79, p = 0.003, \eta_p^2 = 0.021$). Tukey's HSD (i.e., Honestly Significant Difference) post-hoc comparisons are presented in the Table 1. HSD post-hoc comparisons demonstrated that post-intervention all the study variables, except organisational autonomy support, intimidation and autonomy need satisfaction, were significantly different in the combined intervention group sample compared to any other intervention group or control group. Also, HSD post-hoc comparisons indicated that post-intervention there were no significant differences in any of the study variable, except organisational autonomy support and intimidation, between the web-based intervention group and face-to-face intervention group.

Table 1. Pairwise comparisons of the variables between study groups at a one-month follow-up. Data are means (\pm SD).

Dependent variables	Study groups			
	Combined group	Web-based group	Face-to-face group	Control group
Cognitive autonomy support	6.29 \pm 0.67 ^{b**,c**,d***}	6.03 \pm 0.68 ^{a**,d**}	6.08 \pm 0.67 ^{a**,d***}	5.83 \pm 0.67 ^{a**,b**,c***}
Procedural autonomy support	6.14 \pm 0.76 ^{b**,c**,d***}	5.81 \pm 0.76 ^{a**,d*}	5.90 \pm 0.76 ^{a**,d*}	5.65 \pm 0.75 ^{a**,b**,c**}
Organisational autonomy support	5.89 \pm 0.92 ^{c**,d***}	5.70 \pm 0.92 ^{c*,d***}	5.48 \pm 0.93 ^{a**,c*,d***}	5.28 \pm 0.92 ^{a**,b**,c*}
Negative conditional regard	2.15 \pm 0.83 ^{b**,c**,d***}	2.57 \pm 0.83 ^{a**}	2.46 \pm 0.82 ^{a**,d*}	2.67 \pm 0.82 ^{a**,c*}
Controlling use of grades	2.95 \pm 1.01 ^{b**,c**,d***}	3.41 \pm 1.01 ^{a**}	3.35 \pm 1.00 ^{a**}	3.52 \pm 1.01 ^{a**}
Intimidation	1.29 \pm 0.61 ^{d**}	1.35 \pm 0.61 ^{d**}	1.34 \pm 0.62 ^{d*}	1.50 \pm 0.61 ^{a**,b**,c*}
Autonomy need satisfaction	5.55 \pm 0.94 ^{c**,d***}	5.36 \pm 0.94 ^{d***}	5.26 \pm 0.94 ^{a**,d*}	5.02 \pm 0.94 ^{a**,b**,c*}
Competence need satisfaction	5.65 \pm 0.84 ^{b*,c**,d***}	5.41 \pm 0.84 ^{a*,d**}	5.26 \pm 0.84 ^{a***}	5.18 \pm 0.84 ^{a**,b**}
Relatedness need satisfaction	6.06 \pm 0.73 ^{b**,c*,d***}	5.73 \pm 0.73 ^{a***}	5.85 \pm 0.73 ^{a*,d*}	5.67 \pm 0.74 ^{a**,c*}
Autonomy need frustration	2.62 \pm 0.95 ^{b*,c**,d***}	2.87 \pm 0.95 ^{a*,d**}	2.95 \pm 0.94 ^{a**,d*}	3.20 \pm 0.94 ^{a**,b**,c*}
Competence need frustration	2.46 \pm 1.00 ^{b**,c**,d**}	2.94 \pm 0.88 ^{a***}	2.85 \pm 0.99 ^{a**,d*}	3.06 \pm 0.99 ^{a**,c*}
Relatedness need frustration	1.70 \pm 0.73 ^{b*,c**,d***}	1.87 \pm 0.73 ^{a*}	1.93 \pm 0.73 ^{a**}	2.01 \pm 0.74 ^{a***}
Intrinsic motivation	5.63 \pm 0.98 ^{b*,c**,d***}	5.41 \pm 0.99 ^{a*}	5.31 \pm 0.99 ^{a**}	5.25 \pm 0.98 ^{a***}

^a significantly different from the combined group. ^b significantly different from the web-based group. ^c significantly different from the face-to-face group. ^d significantly different from the control group. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Discussion

The current study aimed to examine the effectiveness of face-to-face, web-based and combined face-to-face and web-based autonomy-supportive intervention programs for PE teachers. The main finding of this study was that the combined face-to-face and web-based intervention group was the only study group that demonstrated statistically significant changes in all the study variables compared to the control group at a one-month follow-up. The finding supported one of our main expectations that combining the face-to-face and web-based autonomy supportive interventions for PE teachers may be the most beneficial in changing students' psychological experiences in PE.

Turning first in a more detail to the hypothesis that the students of teachers assigned to the combined face-to-face and web-based intervention group would exhibit the greatest change in the study variables compared to the students of teachers assigned to the face-to-face and web-based intervention group alone and students of teachers assigned to the control group at a one-month follow-up. As already stated, as a result of a PE teachers' intervention, students from the combined experimental group reported significant changes in all the study variables compared to the control group at one-month follow-up. This is in line with Vaquero-Solis and colleagues (2020) that combined interventions might have the greatest effect on the participants' perceptions. Results also indicated that students from the combined experimental group reported significant changes in all the study variables, except in organisational autonomy support, intimidation and autonomy need satisfaction, compared to the web-based experimental group at one-month follow-up. In other words, combined experimental group teachers did not significantly benefit from the face-to-face intervention program to provide organisational autonomy support, avoid intimidation or support students' need for autonomy compared to the PE teachers who participated only in the web-based intervention program. Previously, web-based intervention has demonstrated enduring effects on students' perceptions of their PE teachers' organisational autonomy support and on students' self-reported need satisfaction for autonomy (Tilga et al., 2020b). Based on this, one might argue that a web-based intervention program alone can provide for PE teachers strong basis to provide their students with organisational autonomy support and supporting their students need for autonomy. The possible reason why no significant differences were found between combined and web-based group students' reported intimidation at one-month follow-up might be that the baseline score for intimidation was low at baseline and there was little room for the improvement. However, combined intervention group demonstrated significant decrease in intimidation compared to the control group at one-month follow-up. Results also demonstrated that only students of teachers assigned to the combined face-to-face and web-based intervention group reported significant increase in intrinsic motivation compared to the control group at one-month follow-up. Previously, neither web-based intervention (Tilga et al., 2019a) nor face-to-face intervention (Tilga et al., 2021a) alone have been

enough to demonstrate significant changes in students' intrinsic motivation. The current study indicates that combining both web-based and face-to-face autonomy-supportive interventions for PE teachers has advantages on several students' self-reported psychosocial experiences.

Turning next to the hypothesis that the students of teachers assigned to the web-based and face-to-face intervention group alone would exhibit significant changes in the study variables compared to the students of teachers assigned to the control group at a one-month follow-up. As a result of a PE teachers' intervention, the web-based intervention group students reported significant changes in all study variables, except for negative conditional regard, controlling use of grades, relatedness need satisfaction, competence need frustration, relatedness need frustration, and intrinsic motivation, compared to the control group at one-month follow-up. This is similar to the previous study in which significant changes were reported from the experimental group students for the cognitive, organisational and procedural autonomy support, intimidation, need satisfaction for autonomy, competence and relatedness, and need frustration for autonomy compared to the control group at one-month follow-up (Tilga et al., 2019a). However, in the current study web-based experimental group students did not report significant changes in relatedness need satisfaction. One possible reason for this might be that the baseline score for web-based experimental group students' relatedness need satisfaction was high and there was little room for the improvement. Results also indicated that the face-to-face intervention group students reported significant differences in all the study variables, except for controlling use of grades, competence need satisfaction, relatedness need frustration and intrinsic motivation, compared to the control group at one-month follow-up. This is similar to the previous study in which significant changes were reported from the experimental group students for the cognitive and procedural autonomy support, intimidation, negative conditional regard, autonomy need satisfaction and frustration (Tilga et al., 2021a). It is worth to note that in the current study face-to-face experimental group students reported significant changes also in organisational autonomy support. The possible reason for this might be that as there were no significant changes in organisational autonomy support in previous face-to-face intervention program (Tilga et al., 2021a), special focus was this time on the organisational autonomy support. In the current study, face-to-face experimental group students did not report significant changes in competence need satisfaction. However, in a previous study by Tilga et al. (2021a), the effect size of the change in competence need satisfaction was large (i.e., $\eta_p^2 = 0.551$). Due to this inconsistency, future research is needed to re-test the effect of face-to-face autonomy-supportive intervention on students' psychological need for competence.

Finally, it was hypothesised that there would be no significant differences in the effects of the web-based and face-to-face interventions on changes in students' self-reports at one-month follow-up. As a result of these PE teachers' interventions, there were no significant differences in any of the students' self-reports at one-month fol-

low-up, except perceived organisational autonomy support, between the web-based intervention group alone and face-to-face intervention group alone. Specifically, it was found that after the intervention, web-based experimental group students perceived significantly higher organisational autonomy support from their PE teacher compared to the face-to-face experimental group students. Previous research has shown that PE teachers use web-based autonomy-supportive intervention program effectively to learn how to provide their students with organisational autonomy support at one-month follow-up (Tilga et al., 2019a). Recent research has demonstrated that web-based autonomy-supportive intervention program has long-lasting effects on students' perceptions of their PE teachers' organisational autonomy support at 15-month follow-up (Tilga et al., 2020b). The possible reason for this might be that a web-based intervention allows PE teachers to review study materials whenever they feel necessary. Also, a web-based intervention allows participants a third-person view through video materials that might be effective in introducing different solutions for organisational autonomy support.

Limitations and Future Directions

The current study is not without limitations. First, the main limitation of the present study is related to the fidelity of the current intervention. Specifically, the present study relied mainly on students' self-reports to examine teachers' application of proposed autonomy-supportive behaviours and prevention of using controlling behaviours during the intervention period. Although such an approach may not reflect the complete picture because there might be significant differences between students' perceptions and reality (Aguado-Gómez et al., 2016). However, based on the students' perceptions of their PE teachers' interpersonal behaviour, we may argue that PE teachers from all intervention groups did increase autonomy-supportive behaviour and decrease controlling behaviour. Future research, however, is recommended to supplement these self-reports from students with more objective techniques to investigate teachers' actual in-class behaviours during the intervention period. For instance, PE lessons could be videotaped or observed by academic experts, and behaviours of interest could be rated by external observers using the relevant coding scheme (Aelterman et al., 2016). Second, socio-demographic variables (e.g., parental education and income) were not measured, leaving out potential moderators influencing the study variables (Hagger et al., 2016). Third, in this study only one-month follow-up data was assessed. Previous research has shown, for example, that at one-month follow-up web-based autonomy-supportive intervention is effective on most of the study variables (Tilga et al., 2019a), but at 15-month follow-up there are only a few enduring effects on the study variables (Tilga et al., 2020b). Future studies are recommended to test the long-lasting effects of combined autonomy-supportive intervention program for PE teachers on students' self-reported psychological outcomes. Fourth, it should be acknowledged that one of the reasons for the intervention effect might have been discrepancy of the duration of the web-based vs. face-to-face intervention, respectively (i.e., four-week period vs.

one-day eight-hour workshop for a web-based and face-to-face intervention, respectively). However, based on the results, students of teachers assigned to the combined intervention group demonstrated significant changes in most of the study variables compared to students of teachers assigned to any other experimental group or control group. Moreover, PE teachers of the web-based intervention group alone also received a four-week intervention program, but on several occasions combined intervention group students reported significant gains in several study variables compared to web-based group alone students. This demonstrates that the time might have not been a key reason for the intervention effects, but also a short one-day eight-hour face-to-face intervention aspect is important when delivering the autonomy-supportive intervention. Fifth, in the current research we measured students' perceptions of their PE teachers' negative conditional regard, controlling use of grades, and intimidation. Intimidating behaviour and controlling use of praise (e.g., grades) from the PE teachers foster students' external regulation (Hein et al., 2015), and can be categorized as externally controlling behaviours. Negative conditional regard such as appealing on students' experiences of anxiety, shame, and guilt can be categorized as internally controlling behaviour. Recently, De Meyer and colleagues (2016) proposed the framework of externally and internally controlling teaching behaviours and later a specific scale to measure these faces of PE teachers' behaviours was developed and validated (Burgueño et al., 2021). Future research could do well to test the effect of autonomy-supportive interventions on students' perceptions of externally and internally controlling teaching as promising predictors of basic psychological need satisfaction and frustration (Burgueño et al., 2021). Sixth, in the current research we did not control for students' agentic engagement (i.e., the student's intentional, proactive, and constructive contribution into the flow of the guidance he or she receives such as making a suggestion or expressing a preference; Reeve and Tseng, 2011) during PE lessons. Previous research has found that students' agentic engagement can potentially predict longitudinal increases in perceived autonomy-supportive teaching (Matos et al., 2018). Thus, future research could add in understanding the effectiveness of interventions if students' agentic engagement is controlled in different study groups. Sixth, recent face-to-face (Cheon et al., 2014) and web-based (Tilga et al., 2021b) autonomy-supportive intervention studies have demonstrated that not only students, but also PE teachers' themselves benefit after they adopt autonomy-supportive behaviours. Future research could test the combined face-to-face and web-based autonomy-supportive intervention effects on PE teacher outcomes. Finally, the current study aimed only to change PE teachers' autonomy-supportive behaviour. However, recent SDT-based research has highlighted that autonomy support is an essential part of a need-supportive style along with competence support (or structure) and relatedness support (e.g., Aelterman et al., 2019; Leo et al., 2020; Rocchi et al., 2017). Similarly, controlling (or autonomy-thwarting) behaviours represent a meaningful part of a need-thwarting (or demotivating) style together with competence-thwarting (or chaos) and relatedness-thwarting

(cold environment) behaviours (e.g., Aelterman et al., 2019; Leo et al., 2020; Rocchi et al., 2017). Future research could do well when adopting a broader conceptualization of PE teachers' interpersonal behaviour as a theoretical framework.

Conclusion

The combined web-based and face-to-face autonomy-supportive intervention program was effective in providing PE teachers with the knowledge of how to provide their students with cognitive, organisational, and procedural autonomy support. This resulted in their students' increased need satisfaction for autonomy, competence, and relatedness at one-month follow-up. Based on their students' self-reports, the combined web-based and face-to-face autonomy-supportive group PE teachers also learned how to avoid negative conditional regards, intimidation and controlling use of grades. This is a possible reason for their students' lower need frustration for autonomy, competence, and relatedness at one-month follow-up. The combined web-based and face-to-face autonomy-supportive intervention was also effective in increasing students' intrinsic motivation at one-month follow-up. The current study provides initial evidence that combined intervention program of web-based and face-to-face autonomy-supportive intervention program for PE teachers has great potential in changing their students' perceptions compared to the web-based or face-to-face autonomy-supportive intervention program alone.

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Key points

- The effectiveness of a combined web-based and face-to-face intervention was tested.
- Physical education teachers enrolled on a web-based and face-to-face intervention.
- Teachers gained knowledge how to provide autonomy support to their students.
- Teachers learned how to avoid controlling behaviour toward their students.
- The combined intervention was the most effective based on the students' experiences.

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