


## Article

# Effects of a Web-Based Autonomy-Supportive Intervention on Physical Education Teacher Outcomes

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**Abstract:** The current study tested the efficacy of a web-based autonomy-supportive intervention program on changes in physical education (PE) teachers' self-reports of autonomy support, psychological need satisfaction, intrinsic motivation, and teaching efficacy for students' engagement. In this study, 101 secondary school PE teachers and their 652 students were randomized either to a web-based autonomy-supportive experimental group or to the control group. Manipulation checks indicated that the intervention was effective as students perceived the experimental group PE teachers as more autonomy-supportive and less controlling compared to the control group at the one-month follow-up. In the main analysis, results of the path analysis demonstrated direct effects of the intervention on changes in teachers' self-reported autonomy-supportive behaviour, and on teaching efficacy for students' engagement. There were also significant direct effects from changes in autonomy-supportive behaviour on changes in psychological need satisfactions, from psychological need satisfaction on intrinsic motivation, and from intrinsic motivation on teaching efficacy for students' engagement. Finally, the intervention had an indirect effect on changes in teaching efficacy for students' engagement via changes in teachers' autonomy-supportive behaviour, psychological need satisfaction, and intrinsic motivation. These findings provided insight on the effects of a web-based autonomy-supportive intervention for PE teachers on several teachers' outcomes in the context of PE.

**Keywords:** autonomy support; psychological need satisfaction; intrinsic motivation; teaching efficacy; physical education; web-based intervention



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## 1. Introduction

A vast number of studies have demonstrated that face-to-face autonomy-supportive intervention programs for physical education (PE) teachers are effective in changing their students' perceptions of their teachers' behaviour [1–4]. A recent study has demonstrated that a web-based autonomy-supportive intervention program (WB-ASIP) for PE teachers is also effective in changing students' perceptions of teachers' autonomy-supportive and controlling behaviour, as well as their own psychological need satisfaction and frustration [5], with enduring effects at 15-month follow-up [6]. It has been additionally found that PE teachers themselves benefit from giving their students autonomy support after participating in a face-to-face autonomy supportive intervention program [7]. To our best knowledge, there are currently no studies examining the effect of WB-ASIP on PE teacher outcomes. The current study was designed to test the efficacy of a WB-ASIP on PE teachers' changes in teaching efficacy for students' engagement mediated by the variables specified in a motivational sequence of the self-determination theory (SDT) [8] such as changes in PE teachers' autonomy-supportive behaviour, changes in psychological need satisfaction during teaching, and changes in intrinsic motivation to teach.

We use the SDT [8] as a theoretical framework to explain how autonomy-supportive behaviour exhibited by PE teachers is beneficial to their students and to the teachers themselves. Central to the SDT are individuals' (e.g., students) basic psychological needs for

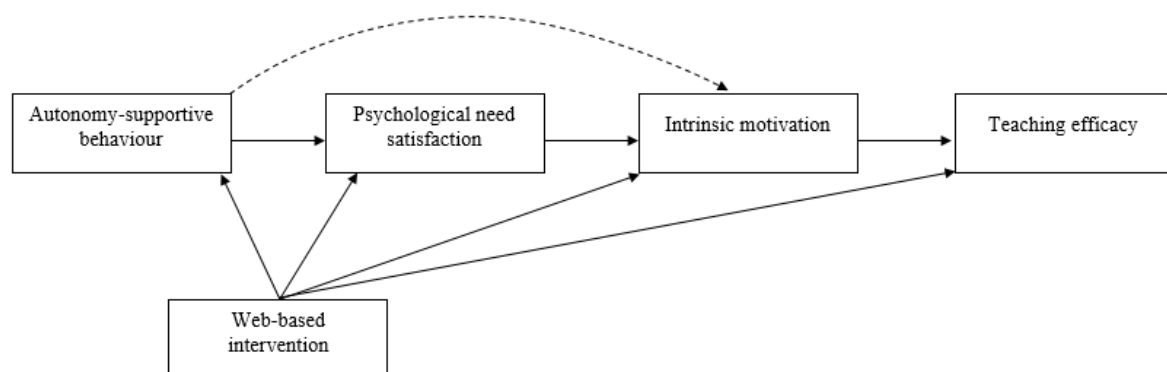
autonomy, competence, and relatedness [9], which have shown to be fulfilled by perceived autonomy-supportive behaviour from significant others [10,11]. The fulfilment of needs is related to autonomous forms of motivation such as intrinsic motivation and, in turn, to several adaptive students' behavioural outcomes such as daily physical activity [12], higher levels of active engagement [13], and enhanced concentration and effort [14] in PE classes. Based on previous studies, when PE teachers learn how to be autonomy-supportive toward their students, then their students gain various benefits such as greater need satisfaction for autonomy, competence and relatedness, and higher intrinsic motivation [1–4]. In a study by Cheon and colleagues [7], the focus was not on the students' benefits, but on the teachers themselves with the main aim to investigate what the benefits are to teachers themselves if they participated in the face-to-face ASIP. It was found that after the face-to-face ASIP, the PE teachers themselves gained various benefits such as greater teaching motivation, increased teaching efficacy, and higher teaching well-being [7]. This led us to expect that teachers who participated in a WB-ASIP designed to guide them become more autonomy supportive could also experience greater psychological need satisfaction, teaching motivation, and teaching efficacy.

In this study, PE teachers were provided with WB-ASIP within four weeks, and we focused on whether the intervention had effects on changes in PE teachers' own perceptions. There are several reasons why we expect the intervention to have an effect on changes in PE teachers' self-reported psychological experiences. Based on the work of Stefanou et al. [15] and Tilga et al. [16], during these four weeks, PE teachers are shown short video lessons on how to provide students with autonomy-supportive behaviour including dimensions of cognitive, procedural, and organisational autonomy support to support students' intrinsic motivation and psychological need satisfaction. Specifically, PE teachers are taught how to convey confidence in students' ability to do well in the PE lesson (i.e., cognitive autonomy support), how to guide students in finding solutions (i.e., procedural autonomy support), and how to accept different solutions in learning of exercises (i.e., organisational autonomy support). In addition, based on the study by Hein et al. [17], PE teachers are shown short video lessons on how to reduce controlling behaviour with dimensions of intimidation, negative conditional regard, and controlling use of grades when communicating with their students to refrain from frustrating students' psychological needs. Specifically, PE teachers are taught how to avoid being less supportive of students when they do not exercise and perform well (i.e., negative conditional regard), how to avoid using grades only to keep students stay focused on tasks during lessons (i.e., controlling use of grades), and how to avoid intimidating students into doing the things that the PE teachers wants them to do (i.e., intimidation). Therefore, the WB-ASIP provides PE teachers with new opportunities for professional development. It is thus likely that the WB-ASIP will have direct effects on the PE teachers' autonomy-supportive behaviour as well as on their teaching efficacy because the content of WB-ASIP is expected to make their teaching practice more efficient. According to previous studies [7,18], suggesting that giving autonomy support facilitates the satisfaction of the giver's own psychological need as much as does receiving it from others, we also expect the WB-ASIP to be satisfying and intrinsically motivating for PE teachers. Consequently, it is likely that teachers who take part in the WB-ASIP would deliver post-training classroom instructions in a more autonomy-supportive way compared to pre-training and that they themselves would also experience greater psychological need satisfaction, intrinsic motivation to teach, as well as teaching efficacy for students' engagement.

## 2. The Present Study

The present study examined the effectiveness of the WB-ASIP based on the self-determination theory [8] in promoting changes in PE teachers' self-reported autonomy-supportive behaviour, psychological needs satisfaction, intrinsic motivation, and teaching efficacy for students' engagement. The main premise of the current study was that the WB-ASIP for PE teachers would account for changes in the teacher's self-reported psychological

variables across the baseline prior to the intervention and at post-intervention follow-up. Overall, it was expected that changes in the variables specified in a motivational sequence of the self-determination theory (i.e., changes in teachers' self-reported autonomy-supportive behaviour, psychological need satisfaction during teaching, and intrinsic motivation to teach) mediate the effect of the WB-ASIP on changes in teacher's self-reported teaching efficacy for students' engagement. Consequently, it was proposed that the effects of the WB-ASIP are modelled as predictors of change in variables specified in a motivational sequence of the self-determination theory. In terms of specific hypotheses, it was expected that the WB-ASIP have an effect on changes in PE teachers' self-reported autonomy-supportive behaviour, which, in turn, have an effect on changes in PE teachers' psychological need satisfaction during teaching. In addition, consistent with the tenets of self-determination theory, it was expected that PE teachers' psychological need satisfaction during teaching is the primary predictor of PE teacher's intrinsic motivation to teach and that changes in psychological need satisfaction would mediate the effect of changes in autonomy-supportive behaviour on changes in intrinsic motivation to teach. Finally, it was expected that changes in PE teachers' intrinsic motivation would predict changes in teaching efficacy for students' engagement. Overall, it was expected that the WB-ASIP would have a statistically significant indirect and total effect on changes in teaching efficacy for students' engagement via the sequence specified in the model. It was expected that the proposed effects hold while controlling for teachers' gender and age. The hypothesized effects of the path model are presented in Figure 1.



**Figure 1.** The Path Model of Hypothesized Effects. Note: The hypothesized model also includes gender and age predicting all other study variables. For clarity, gender and age are omitted from the figure. Broken lines indicate paths freed in the test of the model but expected to be zero.

### 3. Method

#### 3.1. Participants

In total, 101 experienced PE teachers (39 men and 62 women) and their 652 students (300 boys and 352 girls) agreed to participate in this study. Teachers were on average 46.23 years old ( $SD = 10.44$ , range = 25–61), and students were on average 13.19 years old ( $SD = 0.75$ , range = 12–15). The inclusion criteria for the teachers were that they had to be teaching students from the 6th to 8th grade, and the adolescents had to be students of those teachers. All the students and teachers were given detailed information about the study, and they agreed to participate in the current survey voluntarily. An approval to conduct this survey was issued from the Research Ethics Committee of the University of Tartu, Estonia (268/M-6).

#### 3.2. Procedure

In the current study, a randomized controlled design was adopted in which students and their PE teachers were assigned to the web-based experimental or control group (see Figure 2). A battery of baseline questionnaires was filled in by 101 PE teachers including

measures of self-reported autonomy-supportive behaviour, psychological need satisfaction during teaching, intrinsic motivation to teach, and teaching efficacy for students' engagement and by their 652 students including the measures of perceived autonomy-supportive and controlling behaviour from their PE teachers. One week later, the web-based experimental group of PE teachers participated in a four-week WB-ASIP. The experimental group PE teachers and their students completed the follow-up questionnaires four weeks after the intervention ended, and the control group PE teachers and their students completed the follow-up questionnaires nine weeks after the baseline measures (see Figure 3). All the questionnaires were assigned online and were designed so that participants could not skip any of the items.

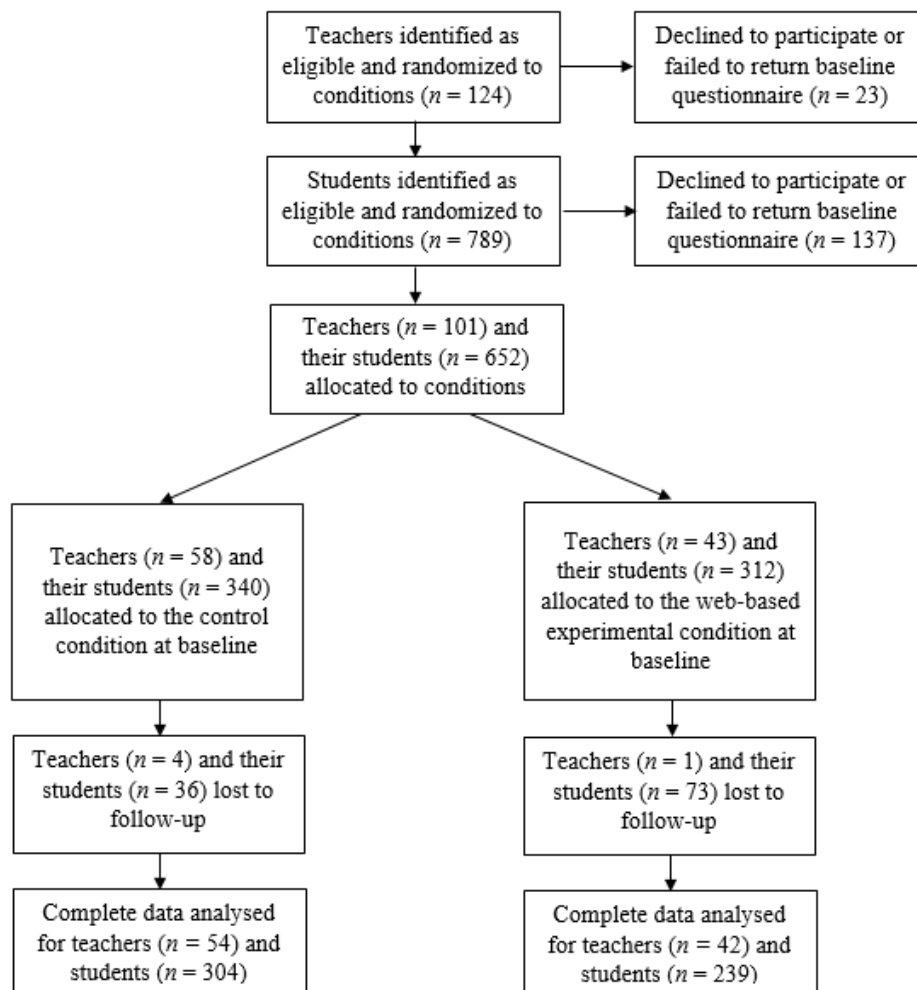


Figure 2. Participant flow chart.

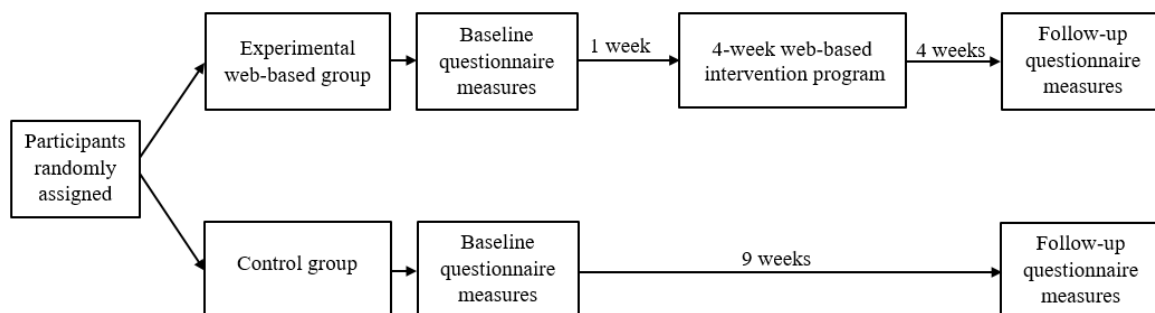


Figure 3. Overall study design.

### 3.3. WB-ASIP

WB-ASIP was provided to the PE teachers within four weeks. We briefly introduce how the study materials were presented to the PE teachers during WB-ASIP. A more detailed description is presented in the previously published publication on the WB-ASIP [5].

#### 3.3.1. Week 1

In the first week of the WB-ASIP, there were video lectures on multidimensional autonomy-supportive and multidimensional controlling behaviour provided for PE teachers. The first video lecture presented cognitive, organisational, and procedural autonomy support and the second video lecture introduced controlling teacher behaviours such as negative conditional regard, controlling use of grades, and intimidation. In these videos several examples of teacher–student interaction in life-like situations were included to make it easier for PE teachers to identify and understand respective behaviours. It was highlighted how autonomy-supportive behaviour can be beneficial to students and to the PE teachers themselves. In addition, it was emphasized how controlling behaviour can be detrimental for students' outcomes. The PE teachers were asked to use autonomy-supportive techniques and avoid controlling behaviour during their PE lesson in the next week. Finally, the PE teachers had to complete a multiple-choice test about study materials to ensure whether they learned the study materials.

#### 3.3.2. Week 2

In the second week there was a video lecture on basic psychological need satisfaction and frustration for autonomy, competence, and relatedness. The special focus was on how perceived autonomy-supportive and controlling behaviour is related to students' basic psychological needs. PE teachers were told to report on a web-based forum how they increased autonomy-supportive and decreased controlling behaviour during their teaching. PE teachers were encouraged to continue with autonomy-supportive teaching during their PE lessons. Finally, PE teachers had to complete a multiple-choice test about study materials to ensure whether they learned the study materials.

#### 3.3.3. Week 3

In the third week, there was a video lecture on autonomous and controlled forms of motivation. The special focus was on how perceived autonomy-supportive and controlling behaviour and students' basic psychological needs are related to different forms of students' motivation. The PE teachers were again told to report how they increased autonomy-supportive and decreased controlling behaviour during teaching in a PE lesson on a web-based forum. The PE teachers were again encouraged to continue with autonomy-supportive teaching during their PE lesson. Finally, the PE teachers had to fill in a multiple-choice test about study materials to ensure whether they learned the study materials.

#### 3.3.4. Week 4

In the final week, the PE teachers had to review all the study materials. Specifically, the 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 autonomous and controlled forms of motivation. At the end of this final week, the PE teachers completed a comprehensive test based on all the study materials.

The adherence to the web-based intervention and completion of online tasks by the web-based experimental group of PE teachers was monitored through a web-based platform. For the web-based intervention fidelity, all the PE teachers reported each week in a web-based forum exactly how they used autonomy-supportive behaviours and avoided controlling behaviour toward their students. Based on the content analysis of the PE teachers' written responses on web-based forums, we evaluated whether the study materi-



als were understood by the teachers, which was the basis to provide feedback to the PE teachers on how to improve their interpersonal behaviour.

### 3.4. Measures

#### 3.4.1. Student Measures

##### Perceived Teachers' Autonomy-Supportive Behaviour

Students' perception of their PE teachers' autonomy-supportive behaviour was measured by the multidimensional autonomy-supportive scale for physical education (MD-PASS-PE) [16]. Students were presented with a common stem: "My PE teacher ... ", followed by the items tapping the cognitive autonomy support (e.g., "... answers to me when I express my opinion"), procedural autonomy support (e.g., "... guides students in finding solutions"), and organisational autonomy support (e.g., "... accepts different solutions in learning of exercises") subscale. In total, there were 15 items with five items in each subscale ranging from 1 (strongly disagree) to 7 (strongly agree). Previous studies have supported the validity and reliability of this instrument [5,19–25].

##### Perceived Teachers' Controlling Behaviour

Students' perception of their PE teachers' controlling behaviour was measured by the PE-adapted [17] multidimensional controlling coach behaviours scale (CCBS; Bartholomew et al., 2010). Students' were presented with a common stem: "My PE teacher ... ", followed by the items tapping negative conditional regard (e.g., "... pays me less attention if I have displeased him/her"), intimidation (e.g., "... shouts at me in front of others to make me comply"), and controlling use of grades (e.g., "... only uses grades so that I stay focused on tasks during lesson") subscale. In total, there were nine items with three items in each subscale ranging from 1 (strongly disagree) to 7 (strongly agree). Previous studies have supported the validity and reliability of this instrument [24–29].

#### 3.4.2. Teacher Measures

##### Teachers' Self-Reported Autonomy-Supportive Behaviour

Teachers' self-reported autonomy-supportive behaviour toward their students in PE was measured by the MD-PASS-PE [16]. This instrument was adapted for the current study by slightly changing the common stem presented to the PE teachers. Teachers were presented with a common stem: "During the PE lesson I ... ", followed by the items tapping cognitive autonomy support (e.g., "... answer to students when they express their opinion"), procedural autonomy support (e.g., "... guide students in finding solutions"), and organisational autonomy support (e.g., "... accept students' different solutions in learning of exercises") subscale. In total, there were 15 items with five items in each subscale ranging from 1 (strongly disagree) to 7 (strongly agree).

##### Teachers' Psychological Need Satisfaction during Teaching

Teachers' psychological need satisfaction in PE was measured by the PE-adapted [30] basic psychological need satisfaction and need frustration scale (BPNSNF) [31]. This instrument was adapted for the current study by slightly changing the common stem and items to the PE teachers' perspective. Teachers were presented with a common stem: "During the teaching ... ", followed by the items tapping autonomy need satisfaction (e.g., "... I felt a sense of choice and freedom in the things I undertake"), competence need satisfaction (e.g., "... I felt capable at what I did"), and relatedness need satisfaction (e.g., "... I felt that the students I care about also cared about me") subscale. In total, there were 12 items with four items in each subscale ranging from 1 (strongly disagree) to 7 (strongly agree).

##### Teachers' Intrinsic Motivation to Teach

Teachers' intrinsic motivation to teach in PE was measured by the perceived locus of causality questionnaire [32]. The four-item intrinsic motivation subscale was used in the

current study. An example item is “The reason I teach my PE classes is because I enjoy it.”, ranging from 1 (strongly disagree) to 7 (strongly agree). Previous studies have supported the validity and reliability of this instrument [7].

#### Teaching Efficacy for Students’ Engagement

Teachers’ self-reported teaching efficacy for students’ engagement was measured by teachers’ sense of efficacy scale short form [33]. The four-item teaching efficacy for student engagement subscale was used in the current study. An example item is “How much can you do to motivate students who show low interest in schoolwork?”, ranging from 1 (strongly disagree) to 9 (strongly agree). Previous studies have supported the validity and reliability of this instrument [7].

#### 3.5. Data Analysis

The data analysis was carried out by using the SPSS Amos Version 23 and SPSS Version 23 statistical package. No missing data was recorded as the online questionnaire forced participants’ responses. Composite scores for the students’ perceived autonomy-supportive behaviour and controlling behaviour from teachers were calculated as the average of the items scores for both scales. The randomization check was carried out to test the baseline differences of study groups by using the chi-square test and the series of analysis of variance (ANOVA). The attrition check was carried out to test the differences between those who remained in the study and those who were lost to follow-up by using the chi-square test and the independent samples *t*-test. The manipulation check was carried out by assessing the effectiveness of WB-ASIP based on students’ perceptions of their PE teachers’ autonomy-supportive and controlling behaviour. The effectiveness of the WB-ASIP was estimated by conducting a series of analyses of covariance (ANCOVAs). Specifically, students’ perceptions of their PE teachers’ autonomy-supportive and controlling behaviour were used as dependent variables, whereas study group (experimental group vs. control group) was used as the independent variable. The baseline value for in each of the ANCOVA was used as a covariate. In addition, PE teachers’ written forum posts were content analysed to examine the extent to which experimental group PE teachers had adopted the autonomy-supportive behaviour and renounced the controlling behaviour.

For the main analysis, the effects of the intervention were tested by using the path analysis. Prior to the path analysis the change variables were computed as residualized change scores derived from the regression of the follow-up assessment of the variable on its baseline score. The intervention effects on teachers’ outcomes were examined by predicting changes in teaching efficacy for students’ engagement, changes in teachers’ intrinsic motivation to teach, changes in teachers’ psychological need satisfaction during teaching and changes in perceived autonomy-supportive behaviour by a dichotomous intervention variable coded as 1 = control group and 2 = experimental group. Teachers’ gender and age were included as covariates predicting all other variables in the model. The model fit of confirmatory factor analysis (CFA) was examined by using the following goodness-of-fit indices [34]: the comparative fit index (CFI > 0.90), the Bentler–Bonett non-normed fit index (NNFI > 0.90), and the root mean square error of approximation (RMSEA < 0.08).

#### 3.6. Fidelity of WB-ASIP

During the web-based intervention period of four weeks, all the PE teachers continued the teaching according to the national curriculum. The experimental group PE teachers were instructed to use autonomy-supportive techniques and avoid controlling behaviour during their teaching practice in PE lessons. The fidelity of the web-based intervention 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 PE teachers’ weekly written forum posts on how

they have applied autonomy-supportive behaviour instead of using controlling behaviour in their PE lessons during a four-week intervention period was content analysed.

## 4. Results

### 4.1. Preliminary Analysis

#### 4.1.1. Randomization Check

The results of the ANOVAs demonstrated that there were no significant differences between the study groups in any of the study variable at baseline in the sample of teachers ( $F_s = 0.03\text{--}3.34$ ,  $p_s > 0.07$ ) and in the sample of students ( $F_s = 0.02\text{--}1.85$ ,  $p_s > 0.17$ ). In addition, no significant differences were found in the proportion of males and females between any study group in the sample of teachers ( $\chi^2 = 2.22$ ,  $p = 0.15$ ) and in the sample of students ( $\chi^2 = 0.05$ ,  $p = 0.88$ ).

#### 4.1.2. Attrition Check

The results of the independent samples *t*-test demonstrated 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 in the sample of teachers ( $t_s = -1.09\text{--}1.22$ ,  $p_s > 0.23$ ) and in the sample of students ( $t_s = 0.76\text{--}1.87$ ,  $p_s > 0.07$ ). In addition, there were no significant differences in the proportion of males and females between the students who remained in the study and who were lost to follow-up in the sample of teachers ( $\chi^2 = 3.31$ ,  $p = 0.07$ ) and in the sample of students ( $\chi^2 = 2.73$ ,  $p = 0.10$ ).

#### 4.1.3. Manipulation Check

The results of the ANCOVAs indicated that students in the experimental group ( $M = 5.80$ ;  $SD = 0.92$ ) reported significantly higher perceptions of autonomy-supportive behaviour at follow-up ( $F(3, 543) = 13.31$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.024$ ) compared to the students in the control group ( $M = 5.63$ ;  $SD = 0.98$ ). In addition, students in the experimental group ( $M = 2.40$ ;  $SD = 1.10$ ) reported significantly lower controlling behaviour at follow-up ( $F(3, 543) = 5.98$ ,  $p = 0.015$ ,  $\eta_p^2 = 0.011$ ) compared to the students in the control group ( $M = 2.59$ ;  $SD = 1.09$ ). Additionally, the content analysis of the forum posts written by PE teachers during a four-week web-based intervention program revealed that all the PE teachers had a specific plan for how they will increase their autonomy-supportive behaviour and decrease their controlling behaviour.

### 4.2. Main Analysis

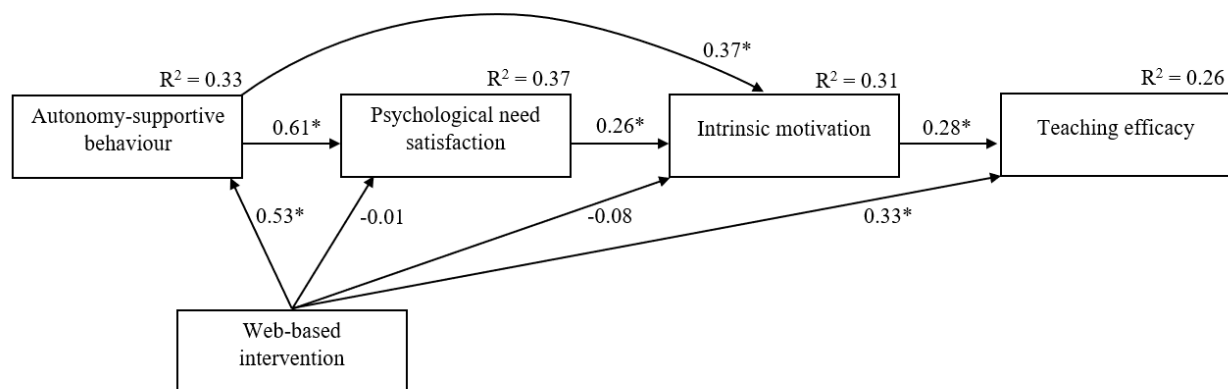
Zero-order correlation coefficients among study variables used in the path analysis are reported in Table 1. The path analysis including standardized parameter estimates of the proposed model is presented in Figure 4. The model demonstrated very good fit with the data ( $\chi^2 = 2.64$ ,  $df = 2$ ,  $p = 0.267$ ; CFI = 0.996; NNFI = 0.956; RMSEA = 0.057). In addition, the model accounted for a significant portion of variance in the dependent variables: changes in autonomy-supportive behaviour ( $R^2 = 0.33$ ), changes in teachers' psychological need satisfaction during teaching ( $R^2 = 0.37$ ), changes in teachers' intrinsic motivation to teach ( $R^2 = 0.31$ ), and changes in teaching efficacy for students' engagement ( $R^2 = 0.26$ ). The results indicated statistically significant effects of the intervention on changes in autonomy-supportive behaviour ( $\beta = 0.53$ ,  $p = 0.001$ ) and changes in teaching efficacy for students' engagement ( $\beta = 0.33$ ,  $p = 0.001$ ). Statistically significant direct effects of changes in perceived autonomy-supportive behaviour on changes in psychological need satisfaction ( $\beta = 0.61$ ,  $p = 0.001$ ) and on changes in intrinsic motivation ( $\beta = 0.37$ ,  $p = 0.023$ ) were found. In addition, a statistically significant direct effect of changes in psychological need satisfaction on changes in intrinsic motivation ( $\beta = 0.26$ ,  $p = 0.028$ ), and a statistically significant direct effect of changes in intrinsic motivation on changes in teaching efficacy for students' engagement ( $\beta = 0.28$ ,  $p = 0.012$ ) were found.



**Table 1.** Zero-order intercorrelations for study variables among teachers sample.

Variable	1	2	3	4	5	6
1. Age						
2. Gender	0.06					
3. Web-based intervention	−0.18	0.15				
4. Autonomy-supportive behaviour	−0.09	0.09	0.57 ***			
5. Psychological need satisfaction	−0.19	0.06	0.34 ***	0.61 ***		
6. Intrinsic motivation	−0.20	0.10	0.26 *	0.50 **	0.47 ***	
7. Teaching efficacy	−0.16	−0.05	0.41 ***	0.44 ***	0.28 **	0.37 ***

Gender—a dichotomous variable coded as 1 = male and 2 = female; Web-based intervention—a dichotomous variable coded as 1 = control group and 2 = experimental group. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .



**Figure 4.** Standardized parameter estimates of effects in the path model of the self-determination-based model's intervention effects. Note: All psychometric variables were residualized change scores. Change scores for all study variables were calculated by regressing the score of each variable measured at follow-up on its score measured at baseline. The model also includes gender and age predicting all other study variables. For clarity, gender and age are omitted from the figure. All the paths from gender and age to all other study variables were not significant. \*  $p < 0.001$ .

In terms of indirect effects, a statistically significant indirect effect of the intervention on changes in psychological need satisfaction via changes in autonomy-supportive behaviour was found ( $\beta = 0.32$ ,  $p = 0.001$ ). In addition, a statistically significant indirect effect of the intervention on changes in intrinsic motivation via changes in autonomy-supportive behaviour and changes in the satisfaction of psychological needs was found ( $\beta = 0.27$ ,  $p = 0.001$ ). Finally, a statistically significant indirect effect of the intervention on changes in teaching efficacy for students' engagement was found via the changes in autonomy-supportive behaviour, the changes in the satisfaction of psychological needs, and the changes in intrinsic motivation found ( $\beta = 0.06$ ,  $p = 0.007$ ). These effects resulted in a statistically significant total effect of the intervention on changes in teaching efficacy for students' engagement ( $\beta = 0.38$ ,  $p = 0.001$ ).

## 5. Discussion

### 5.1. General Discussion

The current study examined the effectiveness of WB-ASIP intervention on changes in PE teachers' self-reported autonomy-supportive behaviour, psychological need satisfaction during teaching, intrinsic motivation to teach, and teaching efficacy for students' engagement guided by SDT [8]. The findings of our intervention study revealed that WB-ASIP has direct effects on changes in PE teachers' autonomy-supportive behaviour and on changes in PE teachers' teaching efficacy for students' engagement. In addition, significant direct effects from changes in autonomy-supportive behaviour on changes in psychological need satisfactions, from psychological need satisfaction on intrinsic motivation, and from intrinsic motivation on teaching efficacy for students' engagement were found. Finally,

the intervention had indirect and total effects on changes in PE teachers' teaching efficacy for students' engagement via changes in PE teachers' autonomy-supportive behaviour, changes in psychological need satisfaction during teaching, and changes in intrinsic motivation to teach.

The results of the current study have important implications for the SDT model as a model of prediction and as a model that guides the intervention. As a model of prediction, all of the premises of the model are supported by the results. More specifically, a change in teachers' self-reported autonomy-supportive behaviour predicted a change in teachers' psychological need satisfaction, a change in psychological need satisfaction predicted a change in teachers' intrinsic motivation to teach, and a change in intrinsic motivation predicted a change in teaching efficacy for students' engagement. This is in line with the tenets of SDT in the context of PE that social factors influence experiences of psychological needs, which, in turn are related with intrinsic motivation, and finally, which predicts several cognitive outcomes [11]. It is also important to note that a significant direct association between changes in autonomy support and changes in intrinsic motivation was found. Thus, the change in psychological needs partially mediated the relationship between change in autonomy support and change in intrinsic motivation. The possible reason for this might be that the WB-ASIP was specifically focused on changes in the key variables such as multidimensional autonomy-supportive behaviour. In addition, the intervention highlighted the important role of psychological need satisfaction and intrinsic motivation in relation to perceived autonomy-supportive behaviours. One might, therefore, conclude that during the four-week WB-ASIP PE teachers were provided with opportunities for professional development that resulted in a greater post-intervention teaching efficacy for students' engagement. Overall, our results supported findings of previous studies which have modelled change predictions in SDT-based models [35,36].

As a model that guides intervention to change PE teachers' autonomy-supportive behaviour toward their students, psychological need satisfaction during teaching, intrinsic motivation to teach and teaching efficacy for students' engagement, current results only support the effectiveness of the intervention in directly predicting the change in PE teachers' autonomy-supportive behaviour toward their students and teaching efficacy for students' engagement. The WB-ASIP was specifically designed to change PE teachers' autonomy-supportive behaviour, which was also directly supported by the results. Specifically, the results revealed that the students in the experimental group reported significantly higher perceptions of autonomy-supportive behaviour from teachers at follow-up compared to the students in the control group. One may, therefore, argue that PE teachers used more effective post-intervention autonomy-supportive behaviour than they used pre-intervention. This also explains the significant direct effect of the intervention on changes in PE teachers' self-reported autonomy-supportive behaviour.

Results of the present study demonstrated that the intervention significantly predicted changes in PE teachers' teaching efficacy for students' engagement. The possible reason for this might be that PE teachers who participated in the WB-ASIP expanded their existing knowledge by adopting cognitive, organisational, and procedural autonomy-supportive behaviours toward their students. It is likely that the knowledge of how to provide autonomy support to students in several ways increases PE teachers teaching repertoire of strategies on how to approach their students more effectively. This is consistent with the findings of previous study of Cheon et al. [7] revealed that PE teachers experienced greater teaching efficacy after the face-to-face autonomy support intervention. The current study adds to this by demonstrating that web-based intervention might also be effective for PE teachers to produce gains in their teaching efficacy for students' engagement. The teaching efficacy of teachers is important because it is a significant predictor of teachers' job satisfaction [37] and teaching motivation [38].

In the current research, the intervention did not significantly predict the satisfaction of the PE teachers' psychological needs during teaching or the intrinsic motivation to teach. One possible reason might be that these variables are more distal to the content of WB-ASIP

and, therefore, the WB-ASIP did not have a direct effect on PE teachers' psychological experiences such as psychological need satisfaction during teaching and intrinsic motivation to teach. Autonomy-supportive behaviour and teaching efficacy for students' engagement are, on the other hand, variables that are both directly related to teaching practices rather than teachers' psychological experiences. Another possible reason for a non-significant direct effect of the WB-ASIP on PE teachers' psychological need satisfaction and intrinsic motivation might be that the content of WB-ASIP focused on students' psychological need satisfaction and intrinsic motivation, rather than on the respective variables of the PE teachers. Previously, however, it has been found by Cheon and colleagues [7] that PE teachers themselves experienced greater satisfaction of psychological needs and autonomous motivation to teach after the face-to-face autonomy-supportive intervention. The path analytic approach of the current study extended these findings by demonstrating that PE teachers gain benefits such as feelings of greater need satisfaction during teaching and higher intrinsic motivation to teach as a result of becoming more autonomy-supportive toward their students. That being said, it might not be the intervention per se that influences the satisfaction of PE teachers' psychological needs and intrinsic motivations, but rather the effect of the intervention on autonomy-supportive behaviour of teachers that, in turn, affected the PE teachers' need satisfaction and intrinsic motivation. In other words, PE teachers should first become more autonomy-supportive toward their students, and then they might experience gains in their own psychological need satisfaction during teaching and in intrinsic motivation to teach. To sum up, the intervention had indirect effects on PE teachers' psychological need satisfaction via autonomy-supportive behaviour, and on PE teachers' intrinsic motivation via autonomy-supportive behaviour and psychological need satisfaction.

The results of the current study also demonstrated significant indirect and total intervention effects (including the direct effect) on changes PE teachers' teaching efficacy for students' engagement via changes in autonomy support, changes in psychological needs and changes in intrinsic motivation. The possible reason for this might be that the PE teachers used their professional development to adopt cognitive, organisational, and procedural autonomy-supportive behaviour toward their students. Possibly the PE teachers in WB-ASIP experimental group used their postintervention knowledge in practical situations during PE classes which resulted in their greater teaching efficacy for students' engagement because PE teachers' psychological needs were satisfied during teaching, and they were intrinsically motivated to teach their students. It is important to note that there was also a significant direct effect of the intervention on changes in teachers' teaching efficacy, which leads us to conclude that changes in teachers' perceived autonomy support, need satisfaction and intrinsic motivation only partially mediated this relationship on teachers' teaching efficacy. Thus, the WB-ASIP was effective on changes in PE teachers' teaching efficacy for students' engagement both directly and indirectly via the motivational sequence of the SDT including perceived autonomy support, teachers' need satisfaction during teaching and teachers' intrinsic motivation to teach.

## 5.2. Strengths, Limitations, and Future Research

The current research has numerous strengths including the recruitment of a large sample size of PE teachers and their students, the use of previously tested effective web-based autonomy-supportive intervention program for PE teachers, the use of valid and reliable psychological measures to test intervention effects, and the targeting of a crucial research question, specifically, whether the intervention with the aim to enhance PE teachers' autonomy-supportive interpersonal style predicts changes in their own psychological need satisfaction during teaching, intrinsic motivation to teach, and perceptions of their teaching efficacy for students' engagement.

However, there are also some limitations related to the current research that should be acknowledged. One possible limitation is relatively short and only web-based PE teacher training was compared to programs adopted in previous intervention studies [7]. Future

intervention research should adopt both web-based and face-to-face autonomy-supportive interventions as a combined intervention has demonstrated the greatest intervention effects [39]. Another limitation is relying purely on self-reported measures when testing intervention effects. Future research should adopt objective observations to provide additional data from trained evaluators. In addition, a relatively short one-month follow-up period is a possible limitation of the current research. Previous research has shown that WB-ASIP has enduring effects of students' self-reports on a 15-month follow-up [6]. Future research should examine whether the teacher benefits endure in a longer follow-up period. Finally, the current research exclusively focused on the 'bright side' of the SDT sequence. Future research could possibly assess the intervention effects on perceived PE teachers external and internal faces of controlling behaviours [40], perceived demanding, domineering, abandoning, and awaiting behaviours [41], experiences of need frustration, controlled forms of motivation, teachers' depression, and burnout.

## 6. Conclusions

The current study provides initial evidence that the autonomy-supportive intervention for PE teachers delivered using entirely a web-based format is effective in eliciting benefits not only on students' perceptions, but also on several outcomes in PE teachers themselves. Specifically, after participating in the WB-ASIP, PE teachers demonstrated significant gains in their teaching efficacy for students' engagement. This is possibly because PE teachers who participated in the WB-ASIP effectively learned how to become more autonomy-supportive toward their students. Significant gains in PE teachers' autonomy-supportive behaviour possibly satisfies PE teachers' basic psychological needs during teaching, which, in turn, enhances their intrinsic motivation to teach their students. Based on this, PE teachers are encouraged to adopt organisational, procedural, and cognitive autonomy-supportive behaviour and avoid negative conditional regard, intimidation, and controlling use of grades. The reason for this is that adopting autonomy-supportive behaviours and avoiding controlling behaviours toward their students possibly leads to gains in PE teachers' teaching efficacy for students' engagement. In sum, the current study supports the finding by Cheon and colleagues [7] that giving autonomy support after the intervention using a face-to-face delivery benefits teacher in much the same way that receiving it benefits their students.

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## References

1. Cheon, S.H.; Reeve, J.; Song, Y.-G. A Teacher-Focused Intervention to Decrease PE Students' Amotivation by Increasing Need Satisfaction and Decreasing Need Frustration. *J. Sport Exerc. Psychol.* **2016**, *38*, 217–235. [[CrossRef](#)]
2. Cheon, S.H.; Reeve, J.; Ntoumanis, N. A needs-supportive intervention to help PE teachers enhance students' prosocial behavior and diminish antisocial behavior. *Psychol. Sport Exerc.* **2018**, *35*, 74–88. [[CrossRef](#)]
3. Su, Y.-L.; Reeve, J. A Meta-analysis of the Effectiveness of Intervention Programs Designed to Support Autonomy. *Educ. Psychol. Rev.* **2011**, *23*, 159–188. [[CrossRef](#)]
4. Tilga, H.; Kalajas-Tilga, H.; Hein, V.; Raudsepp, L.; Koka, A. Effects of a brief one-day autonomy-supportive intervention on improving basic psychological needs, motivation, and behaviours of physical activity among middle-school students: A multidimensional approach. *Int. J. Sport Psychol.* in press.
5. Tilga, H.; Hein, V.; Koka, A. Effects of a Web-Based Intervention for PE Teachers on Students' Perceptions of Teacher Behaviors, Psychological Needs, and Intrinsic Motivation. *Percept. Mot. Ski.* **2019**, *126*, 559–580. [[CrossRef](#)] [[PubMed](#)]

6. Tilga, H.; Kalajas-Tilga, H.; Hein, V.; Raudsepp, L.; Koka, A. 15-Month Follow-Up Data on the Web-Based Autonomy-Supportive Intervention Program for PE Teachers. *Percept. Mot. Ski.* **2019**, *127*, 5–7. [[CrossRef](#)]
7. Cheon, S.H.; Reeve, J.; Yu, T.H.; Jang, H.-R. The Teacher Benefits from Giving Autonomy Support During Physical Education Instruction. *J. Sport Exerc. Psychol.* **2014**, *36*, 331–346. [[CrossRef](#)]
8. Ryan, R.M.; Deci, E.L. *Self-Determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*; Guilford Publications: New York, NY, USA, 2017.
9. Ryan, R.M.; Deci, E.L. Intrinsic and extrinsic motivation from a self-determination theory perspective: Definitions, theory, practices, and future directions. *Contemp. Educ. Psychol.* **2020**, *61*, 101860. [[CrossRef](#)]
10. Vansteenkiste, M.; Ryan, R.M.; Soenens, B. Basic psychological need theory: Advancements, critical themes, and future directions. *Motiv. Emot.* **2020**, *44*, 1–31. [[CrossRef](#)]
11. Vasconcellos, D.; Parker, P.; Hilland, T.; Cinelli, R.; Owen, K.B.; Kapsal, N.; Lee, J.; Antczak, D.; Ntoumanis, N.; Ryan, R.M.; et al. Self-determination theory applied to physical education: A systematic review and meta-analysis. *J. Educ. Psychol.* **2020**, *112*, 1444–1469. [[CrossRef](#)]
12. Kalajas-Tilga, H.; Koka, A.; Hein, V.; Tilga, H.; Raudsepp, L. Motivational processes in physical education and objectively measured physical activity among adolescents. *J. Sport Health Sci.* **2020**, *9*, 462–471. [[CrossRef](#)] [[PubMed](#)]
13. Ntoumanis, N. A self-determination approach to the understanding of motivation in physical education. *Br. J. Educ. Psychol.* **2001**, *71*, 225–242. [[CrossRef](#)]
14. Standage, M.; Duda, J.L.; Ntoumanis, N. A model of contextual motivation in physical education: Using constructs from self-determination and achievement goal theories to predict physical activity intentions. *J. Educ. Psychol.* **2003**, *95*, 97–110. [[CrossRef](#)]
15. Stefanou, C.R.; Perencevich, K.C.; Dicintio, M.; Turner, J.C. Supporting Autonomy in the Classroom: Ways Teachers Encourage Student Decision Making and Ownership. *Educ. Psychol.* **2004**, *39*, 97–110. [[CrossRef](#)]
16. Tilga, H.; Hein, V.; Koka, A. Measuring the perception of the teachers' autonomy-supportive behavior in physical education: Development and initial validation of a multi-dimensional instrument. *Meas. Phys. Educ. Exerc. Sci.* **2017**, *21*, 244–255. [[CrossRef](#)]
17. Hein, V.; Koka, A.; Hagger, M.S. Relationships between perceived teachers' controlling behaviour, psychological need thwarting, anger and bullying behaviour in high-school students. *J. Adolesc.* **2015**, *42*, 103–114. [[CrossRef](#)]
18. Deci, E.L.; La Guardia, J.; Moller, A.C.; Scheiner, M.J.; Ryan, R.M. On the Benefits of Giving as Well as Receiving Autonomy Support: Mutuality in Close Friendships. *Pers. Soc. Psychol. Bull.* **2006**, *32*, 313–327. [[CrossRef](#)] [[PubMed](#)]
19. Burgueño, R.; Macarro-Moreno, J.; Medina-Casaubón, J. Psychometry of the Multidimensional Perceived Autonomy Support Scale in Physical Education with Spanish Secondary School Students. *SAGE Open* **2020**, *10*. [[CrossRef](#)]
20. Koka, A.; Tilga, H.; Hein, V.; Kalajas-Tilga, H.; Raudsepp, L. A multidimensional approach to perceived teachers' autonomy support and its relationship with intrinsic motivation of students in physical education. *Int. J. Sport Psychol.* in press.
21. Montero-Carretero, C.; Cervelló, E. Teaching Styles in Physical Education: A New Approach to Predicting Resilience and Bullying. *Int. J. Environ. Res. Public Health* **2019**, *17*, 76. [[CrossRef](#)]
22. Zimmermann, J.; Tilga, H.; Bachner, J.; Demetriou, Y. The German Multi-Dimensional Perceived Autonomy Support Scale for Physical Education: Adaption and Validation in a Sample of Lower Track Secondary School Students. *Int. J. Environ. Res. Public Health* **2020**, *17*, 7353. [[CrossRef](#)]
23. Zimmermann, J.; Tilga, H.; Bachner, J.; Demetriou, Y. The Effect of Teacher Autonomy Support on Leisure-Time Physical Activity via Cognitive Appraisals and Achievement Emotions: A Mediation Analysis Based on the Control-Value Theory. *Int. J. Environ. Res. Public Health* **2021**, *18*, 3987. [[CrossRef](#)] [[PubMed](#)]
24. Tilga, H.; Hein, V.; Koka, A.; Hagger, M.S. How Physical Education Teachers' Interpersonal Behaviour is Related to Students' Health-Related Quality of Life. *Scand. J. Educ. Res.* **2020**, *64*, 661–676. [[CrossRef](#)]
25. Tilga, H.; Kalajas-Tilga, H.; Hein, V.; Raudsepp, L.; Koka, A. How does perceived autonomy-supportive and controlling behaviour in physical education relate to adolescents' leisure-time physical activity participation? *Kinesiology* **2020**, *52*, 265–272. [[CrossRef](#)]
26. Bartholomew, K.J.; Ntoumanis, N.; Thogersen-Ntoumani, C. The Controlling Interpersonal Style in a Coaching Context: Development and Initial Validation of a Psychometric Scale. *J. Sport Exerc. Psychol.* **2010**, *32*, 193–216. [[CrossRef](#)] [[PubMed](#)]
27. Koka, A.; Tilga, H.; Kalajas-Tilga, H.; Hein, V.; Raudsepp, L. Perceived Controlling Behaviors of Physical Education Teachers and Objectively Measured Leisure-Time Physical Activity in Adolescents. *Int. J. Environ. Res. Public Health* **2019**, *16*, 2709. [[CrossRef](#)] [[PubMed](#)]
28. Koka, A.; Tilga, H.; Kalajas-Tilga, H.; Hein, V.; Raudsepp, L. Detrimental Effect of Perceived Controlling Behavior from Physical Education Teachers on Students' Leisure-Time Physical Activity Intentions and Behavior: An Application of the Trans-Contextual Model. *Int. J. Environ. Res. Public Health* **2020**, *17*, 5939. [[CrossRef](#)]
29. Tilga, H.; Hein, V.; Koka, A.; Hamilton, K.; Hagger, M.S. The role of teachers' controlling behaviour in physical education on adolescents' health-related quality of life: Test of a conditional process model\*. *Educ. Psychol.* **2019**, *39*, 862–880. [[CrossRef](#)]
30. Haerens, L.; Aelterman, N.; Vansteenkiste, M.; Soenens, B.; Van Petegem, S. Do perceived autonomy-supportive and controlling teaching relate to physical education students' motivational experiences through unique pathways? Distinguishing between the bright and dark side of motivation. *Psychol. Sport Exerc.* **2015**, *16*, 26–36. [[CrossRef](#)]



31. Chen, B.; Vansteenkiste, M.; Beyers, W.; Boone, L.; Deci, E.; Van Der Kaap-Deeder, J.; Duriez, B.; Lens, W.; Matos, L.; Mouratidis, A.; et al. Basic psychological need satisfaction, need frustration, and need strength across four cultures. *Motiv. Emot.* **2015**, *39*, 216–236. [[CrossRef](#)]
32. Goudas, M.; Biddle, S.; Fox, K. Perceived locus of causality, goal orientations, and perceived competence in school physical education classes. *Br. J. Educ. Psychol.* **1994**, *64*, 453–463. [[CrossRef](#)]
33. Tschannen-Moran, M.; Hoy, A.W. Teacher efficacy: Capturing an elusive construct. *Teach. Teach. Educ.* **2001**, *17*, 783–805. [[CrossRef](#)]
34. Hu, L.T.; Bentler, P.M. *Structural Equation Modeling: Concepts, Issues, and Applications*; Sage Publications: Thousand Oaks, CA, USA, 1995.
35. Kalajas-Tilga, H.; Hein, V.; Koka, A.; Tilga, H.; Raudsepp, L.; Hagger, M.S. Application of the trans-contextual model to predict change in leisure time physical activity. *Psychol. Health* **2021**, 1–25. [[CrossRef](#)]
36. Polet, J.; Lintunen, T.; Schneider, J.; Hagger, M.S. Predicting change in middle school students' leisure-time physical activity participation: A prospective test of the trans-contextual model. *J. Appl. Soc. Psychol.* **2020**, *50*, 512–523. [[CrossRef](#)]
37. Caprara, G.V.; Barbaranelli, C.; Borgogni, L.; Steca, P. Efficacy Beliefs as Determinants of Teachers' Job Satisfaction. *J. Educ. Psychol.* **2003**, *95*, 821–832. [[CrossRef](#)]
38. Guskey, T.R. The Influence of Change in Instructional Effectiveness upon the Affective Characteristics of Teachers. *Am. Educ. Res. J.* **1984**, *21*, 245–259. [[CrossRef](#)]
39. Vaquero-Solís, M.; Gallego, D.I.; Tapia-Serrano, M.Á.; Pulido, J.J.; Sánchez-Miguel, P.A. School-based Physical Activity Interventions in Children and Adolescents: A Systematic Review. *Int. J. Environ. Res. Public Health* **2020**, *17*, 999. [[CrossRef](#)]
40. Burgueño, R.; Abós, Ángel, Á.; García-González, L.; Tilga, H.; Sevil-Serrano, J. Evaluating the Psychometric Properties of a Scale to Measure Perceived External and Internal Faces of Controlling Teaching among Students in Physical Education. *Int. J. Environ. Res. Public Health* **2021**, *18*, 298. [[CrossRef](#)] [[PubMed](#)]
41. Aelterman, N.; Vansteenkiste, M.; Haerens, L.; Soenens, B.; Fontaine, J.R.J.; Reeve, J. Toward an integrative and fine-grained insight in motivating and demotivating teaching styles: The merits of a circumplex approach. *J. Educ. Psychol.* **2019**, *111*, 497–521. [[CrossRef](#)]