



Modeling indicators and outcomes of students' perceived teacher relatedness support in high school physical education



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ABSTRACT

Research based in self-determination theory has demonstrated the importance of social agents for motivational processes in school-based physical education (PE). To focus more closely on the relational processes that underpin students' motivation in PE, there have been calls for researchers to explore the specific teacher behaviors that facilitate students' relatedness in PE. Our aim was to test a higher-order measurement model comprising distinct relatedness-supportive teacher behaviors, and to explore the ways in which students' perceptions about their teacher directly and/or indirectly predict relatedness need satisfaction and motivation in PE. To test our higher-order model (Study 1), 656 high-school PE students reported the extent to which their teachers engaged in relatedness-supportive behaviors. In Study 2, 570 high-school PE students reported their motivational regulations for PE, as well as the extent to which their teacher engaged in relatedness-supportive behaviors, and satisfied their need for relatedness. We found support for the higher-order relatedness support model, and observed predictive pathways that were consistent with theory. Students reported satisfaction of their need for relatedness when they felt relatedness support from their teachers ($\beta = 0.52, p < 0.001$) and relatedness need satisfaction was in turn positively related to intrinsic ($\beta = 0.51, p < 0.001$), identified ($\beta = 0.49, p < 0.001$), and introjected ($\beta = 0.25, p < 0.001$) regulations for PE. These findings demonstrate the importance of relatedness-supportive teaching in PE, and implications of these data are discussed.

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School-based physical education (PE) provides widespread, formalized access to regular physical activity, and thus, it is no surprise that researchers have focused attention toward understanding the social factors that contribute to students' motivation and engagement within this setting. In seeking to understand the ways in which students' in-class perceptions are shaped, much attention has been focused around the role that teachers play in determining the motivational dynamics within the classroom (see Furrer & Skinner, 2003; Koka & Hagger, 2010). Similar to more traditional classroom settings, the interpersonal style of the PE teacher has been shown to influence student motivation and engagement in school PE (e.g., Cox, Duncheon, & McDavid, 2009;

Taylor & Ntoumanis, 2007). Alongside pertinent in-class outcomes, studies in this area have also shown that motivational experiences in PE may also align with greater leisure-time physical activity (Chatzisarantis & Hagger, 2009; Jackson, Whipp, Chua, Dimmock, & Hagger, 2013).

A number of PE-based studies have explored the role of the teacher in shaping students' motivation through the lens of self-determination theory (SDT; Deci & Ryan, 1985), a theoretical framework concerned with the individual and social factors that elicit different types of motivation. According to SDT, one's motives to pursue an activity may fall along a *self-determination continuum*, ranging from highly autonomous (or self-determined) to highly controlled behavioral regulations. Self-determined forms of motivation are characterized by participation in an activity for fun, interest, enjoyment (i.e., intrinsic motivation), in light of its consistency with one's values/identity (i.e., integrated regulation), and/or valued outcomes that it provides (i.e., identified regulation). These types of motivation are theorized to nourish persistence, engagement, and psychological well-being (Deci & Ryan, 2000). Within SDT, needs for autonomy (i.e., a sense of choice and

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volition), competence (i.e., feeling capable in one's pursuits), and relatedness (i.e., feeling valued/supported by, and connected to, significant others) are considered universal psychological nutrients through which self-determined motivation is catalyzed. When important others engage in behaviors that support one's needs for autonomy, competence, and relatedness, therefore, it is proposed that relatively more self-determined forms of motivation will result through the fulfillment of each psychological need. Consequently, perceptions of highly need-supportive environments will indirectly support various desirable outcomes (e.g., engagement, persistence, enjoyment), through need satisfaction and the endorsement of higher-quality (i.e., self-determined) motivation. Based on these proposed relationships, researchers within and beyond PE have focused on the role of need-supportive teaching in facilitating self-determined motivation and positive in-class engagement.

The specific teacher instructional practices that students feel are supportive of their needs in PE have received some empirical attention (Chatzisarantis & Hagger, 2009; Cheon, Reeve, & Moon, 2012). Importantly though, much of this work has focused on autonomy-supportive teacher behaviors, with less attention devoted to support for competence, and in particular, relatedness (see Standage & Emm, 2014; Van den Berghe, Vansteenkiste, Cardon, Kirk, & Haerens, 2014). Indeed, relatively limited attention has been directed toward charting the specific relatedness-supportive or *interpersonally involving* practices in which PE teachers engage, and the extent to which these behaviors satisfy students' feelings of relatedness. The few studies focusing on students' perceptions of relatedness support have examined teachers' emphasis on cooperation (Ntoumanis, 2001) and provision of autonomy support (see Standage, Gillison, & Treasure, 2007), as well as emotional support and promotion of a mastery climate (Cox & Williams, 2008) as predictors of students' relatedness support. Within sporting contexts, need support studies have shown that athletes' sense of relatedness is supported by both coach facilitation of friendship with peer athletes (Keegan, Harwood, Spray, & Lavalley, 2009) and provision of assistance and emotional support (Reinboth, Duda, & Ntoumanis, 2004). Importantly, feeling meaningfully related to significant others is critical to the process of internalization (i.e., people's "taking in" of attitudes, values, or opinions of others into one's identity or sense of self), a driver of self-determined motivation (Deci & Ryan, 1985). In light of the fundamental need that individuals have for experiencing close interpersonal connections and the central importance of relatedness need satisfaction for the internalization of prescribed values and behaviors (Baumeister & Leary, 1995; Deci & Ryan, 2000), it is important to understand students' perceptions about the distinct teacher behaviors that serve to foster a sense of relatedness in PE.

With limited work devoted to the relatedness-supportive teacher behaviors likely to help students feel socially connected, and fully internalize the value of behaviors, there have been recent calls for researchers to more closely explore the specific teacher behaviors that underpin relatedness support in PE (Standage & Emm, 2014; Van den Berghe et al., 2014). Guided by this recommendation, and using SDT as a foundation, Sparks and colleagues (Sparks, Dimmock, Whipp, Lonsdale, & Jackson, 2015) interviewed a sample of high school PE students with the aim of identifying specific instructional practices demonstrated by their current and past PE teachers that they considered to be relatedness-supportive in nature. Teacher behaviors identified as highly relatedness-supportive emerged in relation to individualized conversation, task-related support, promotion of cooperation and teamwork, demonstrating awareness, showing care, and engaging in general friendly communication. Analyses also revealed a number of putative outcomes that stemmed from relatedness-supportive

instruction, reflecting positive affective responses as well as high levels of in-class engagement, intrinsic motivation, and efficacy beliefs. Importantly, these findings not only provided insight into the discrete instructional practices that students consider to be relatedness-supportive, but also reinforced the implications that these behaviors have for students' PE experiences. In line with this work, our aim was to test a higher-order measurement model containing teacher behaviors viewed as relatedness-supportive (Sparks et al., 2015), and to explore the ways in which students' perceptions about their teacher directly and/or indirectly predict relatedness need satisfaction and motivation in PE.

1. Study 1: second-order factor analytic model

Our focus in Study 1 was to investigate a set of relatedness-supportive teacher behaviors previously identified (Sparks et al., 2015) by (a) identifying existing instruments that adequately represent each teacher behavior (dimension), and (b) employing a second-order confirmatory factor analysis utilizing the established instruments to examine the factor structure of our hypothesized model. To determine the various measures that would be entered into the second-order factor analysis, we conducted a search of relevant literature with the goal of compiling instruments that have demonstrated validity evidence and that represented perceptions regarding the provision of individualized conversation, task-related support, cooperation and teamwork, enthusiasm, awareness, care, and general friendly communication. Any existing instruments that corresponded conceptually to each dimension of relatedness support were presented to two expert reviewers (both associate professors in sport and exercise psychology) who have conducted work within PE contexts utilizing a SDT framework. Reviewers were provided with a definition of each teacher behavior, as well as the various instruments purported to reflect each behavior. To establish content validity, expert reviewers were asked to provide qualitative feedback with respect to item content, and to assign each instrument to a specific teacher behavior construct. Following reviewer feedback and discussion between authors, instruments with the highest ratings were retained for inclusion in the second-order model, and this decision was based on (a) their appropriateness for use with high-school PE samples, and (b) the consideration that the items within the instrument mapped conceptually onto a specific relatedness-supportive teacher behavior identified by Sparks et al. (2015).

For all but one teacher behavior (i.e., individualized conversation), suitable instruments were identified to represent lower-order factors in the proposed model. For the *individualized conversation* construct, a pool of five items was created, which reflected the content of this behavior as specified by Sparks et al. (2015). As well, item development was informed by relevant SDT texts (e.g., Deci & Ryan, 2000), so that the conceptualization of this construct was reflected in the item content. Based on the conceptual definition provided by the first author, the expert reviewers were asked to provide qualitative feedback with respect to item ambiguity, understanding, overlap, representativeness, and jargon (Delgado-Rico, Carretero-Dios, & Ruch, 2012). Based on reviewer feedback, we made changes to the item pool. These items were modified/rewritten or removed when reviewers indicated they lacked specificity, were ambiguous, tapped into more than one concept, or did not accurately or fully represent the intended construct. Following several iterations of the review process, consensus was reached on an instrument comprising of five items (which were all given good ratings by the reviewers). As a result, the assessment of lower-order relatedness support factors comprised six established instruments and one newly-developed instrument.

The second purpose of Study 1 was to examine the factor structure of our hypothesized second-order model. From a

conceptual perspective, we expected that the proposed second-order model would display acceptable fit given that the seven constructs measured (i.e., first-order factors) would be positively related to each other, and that all seven constructs would also load strongly onto a global second-order factor (i.e., relatedness support). Fig. 1 illustrates the hypothesized second-order model, whereby relatedness support represents a higher-order factor accounting for the commonality among the seven first-order

teacher behavior factors. To test our hypothesized model, a second-order confirmatory factor analysis (CFA) was estimated among a sample of high-school PE students. Based on the conceptualization of relatedness support that exists within the SDT literature (Deci & Ryan, 2000, 2014), we expected that this model would display acceptable fit, and that the seven first-order factors would all load strongly onto a global latent relatedness support variable.

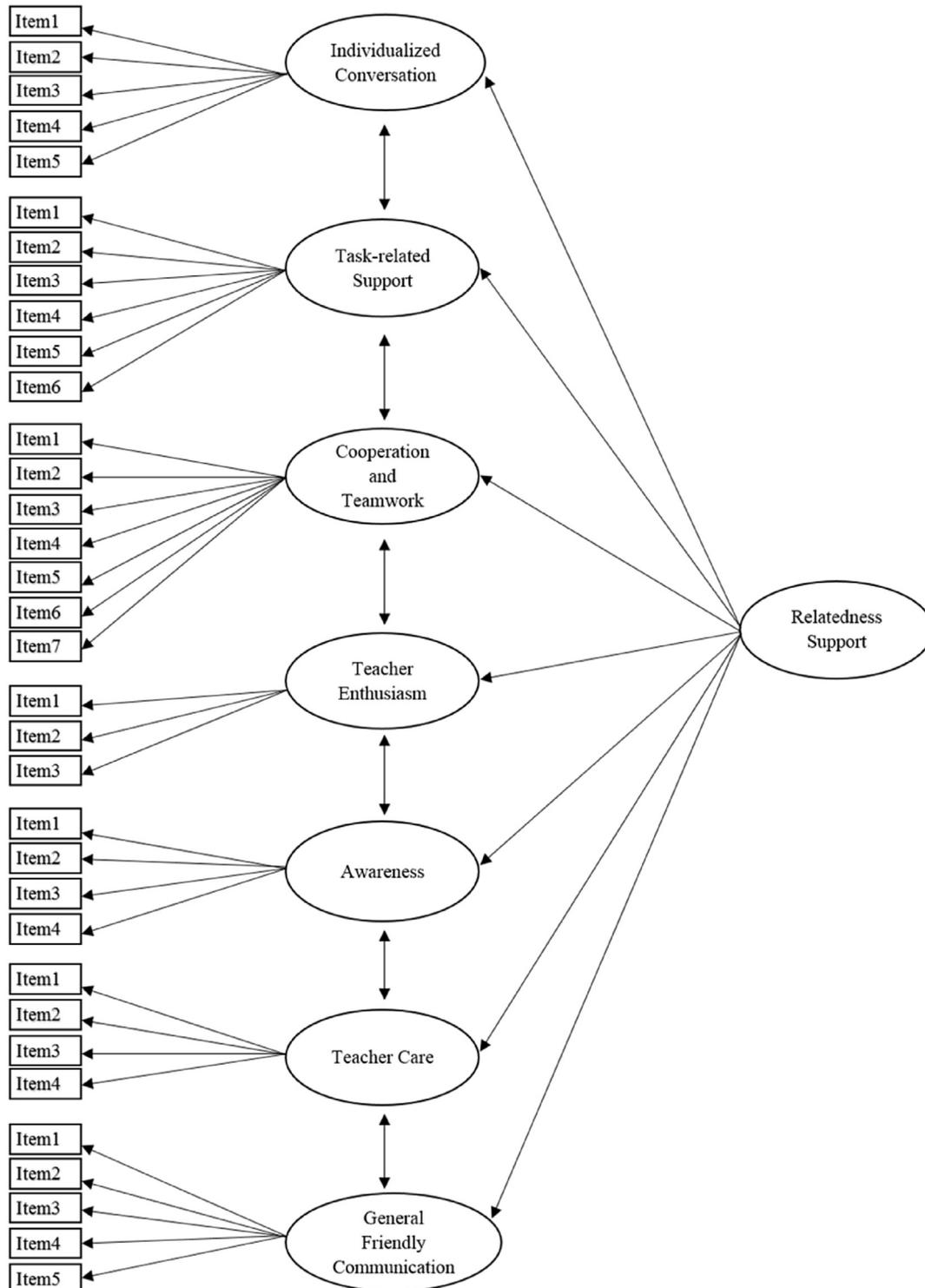


Fig. 1. Hypothesized second-order model of relatedness support. Bi-directional arrows indicate correlations between first-order factors.

1.1. Method

1.1.1. Participants

Data were provided by 656 male and female high school PE students (males = 509, females = 147, *M* age = 13.70, *SD* = 0.96). The students were recruited from 4 independent schools within Sydney Metropolitan Area, from a total of 32 different PE classes in grades 7, 8, and 9 (i.e., aged 11 to 14). All participants took part in weekly compulsory PE, which was delivered across two or three class periods each lasting 50 min.

1.1.2. Procedures

After obtaining permission to conduct the study from the Human Research Ethics Board at the lead authors' institution, recruitment letters were distributed to principals at several independent high schools. Potential participants were informed that participation was voluntary, that all responses would remain confidential at all times, and that any party could withdraw from the study at any time. After obtaining informed consent from principals and teachers, parent/guardian information sheets were distributed, in which parents/guardians were informed of the nature of the study and were provided with a pre-paid return envelope should they wish to withdraw their child from the study ahead of data collection. Appointments were subsequently made for a research assistant to visit each school between two and three weeks later to complete data collection. Data collection sessions were scheduled at the beginning of the students' PE class. Before collection commenced, students were provided with a written information sheet outlining that their participation was voluntary, their right to withdraw or refuse to answer any question, and that all data would remain confidential at all times. After being given the opportunity to ask questions, students provided their informed consent and completed the questionnaire. All instruments were completed before participation in scheduled PE, and students were directed to respond to each question in relation to how they felt at that moment in time.

1.2. Measures

1.2.1. Individualized conversation

A five-item measure of perceived individualized conversation was created to assess students' perceptions of how their teacher engages and converses with them. Items were created to capture teacher communication that showed a deeper understanding of the student and an interest in the student outside of the task at hand. Using a scale anchored at 1 (*strongly disagree*) and 5 (*strongly agree*), the five items were, "my PE teacher tries to get to know me as an individual", "my PE teacher asks me about my personal interests", "my PE teacher talks to me about things that are going on in my life", "my PE teacher talks to me in a friendly way", and "my PE teacher is interested in the things I do outside of PE".

1.2.2. Task-related support

Students' perceptions of task-related support provided by their teacher were measured using items from two sub-scales from the Perception of the Teacher's Feedback questionnaire (PTF; Koka & Hein, 2005). The sub-scales were 'positive general feedback' (three items) and 'knowledge of performance' (three items), and included, "in my PE class, I am frequently encouraged by my PE teacher" (positive general feedback), and "in my PE class, my PE teacher often gives me instruction and feedback" (knowledge of performance). Responses were made on a five-point scale anchored at 1 (*strongly disagree*) and 5 (*strongly agree*). Previous work with students has demonstrated support for the structural properties and internal consistency of measures derived from the PTF (Koka &

Hein, 2005).

1.2.3. Promoting cooperation and teamwork

Using a scale developed by Ryan and Patrick (2001) to measure social interaction in academic settings, students reported their perceptions of the extent to which their teacher promoted cooperation and teamwork in their PE class. To minimize redundancy and potential overlap at the request of the teachers, one item ("my teacher encourages us to get to know all the other students in class") was dropped from the scale given its conceptual similarity to another item (i.e., "my teacher encourages us to get to know our classmates' names"). The term "PE" was added to the items where appropriate, and students responded to seven items (e.g., "my teacher encourages us to be helpful to other students in PE") on a five-point scale ranging from 1 (*not at all true*) to 5 (*very true*). Ryan and Patrick (2001) demonstrated evidence of internal consistency, as well as convergent and discriminant validity by documenting associations between scores on this scale and assessments of social and academic efficacy, self-regulated learning, and disruptive behavior.

1.2.4. Teacher enthusiasm

Students' perceptions of their teacher's enthusiasm for teaching PE were captured by a three-item scale created by Kunter et al. (2008). The term "PE" was added before the word "teacher", and students responded to items (e.g., "my PE teacher seems to really enjoy teaching") on a four-point scale anchored at 1 (*strongly disagree*) and 4 (*strongly agree*). Previous work has demonstrated support for the structural validity and internal consistency of measures derived from this instrument (Kunter et al., 2008).

1.2.5. Teacher awareness

Students' perceptions of their PE teacher's awareness in the classroom were assessed using the individualized consideration subscale from the Transformational Teaching Questionnaire (TTQ; Beauchamp et al., 2010). The four-item subscale has responses anchored on a five-point rating scale from 0 (*not at all*) to 4 (*frequently*). Items included "my PE teacher tries to help students who might be struggling", and "my PE teacher recognizes the needs and abilities of each student in the class". Beauchamp et al. (2010) demonstrated evidence of acceptable internal consistency, as well as structural, content, and concurrent validity for measures derived from the TTQ.

1.2.6. Teacher care

To measure students' perceptions of teacher care, a four-item measure, modified by Ryan and Patrick (2001), was used to assess the degree to which students believed their teacher cared about and understood them as individuals. This measure has been used predominately in academic settings; therefore, "PE" was added before the word "teacher", and students responded to items (e.g., "does your PE teacher try to help you when you are sad or upset?") on a five-point scale anchored at 1 (*not at all*) and 5 (*very much*). Previous work has demonstrated evidence of construct validity and reliability for measures derived from this instrument in classroom settings (Cox et al., 2009; Ryan & Patrick, 2001).

1.2.7. General friendly communication

The three-item 'accessible' subscale from the Teacher Support Scale (Metheny, McWhirter, & O'Neil, 2008) was used to measure students' perceptions of how friendly and approachable their teacher is (e.g., "my PE teacher is easy to talk to about school things"). Metheny et al. (2008) provided evidence to support the construct validity and reliability of scores derived from this subscale. Two additional items (i.e., "my PE teacher knows when to

make jokes with students”, “my PE teacher is friendly and approachable”) were also developed to capture other verbal/non-verbal communication that were reported in previous research (Sparks et al., 2015). Item responses were anchored on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

1.2.8. Data analysis

Data were first examined for univariate (i.e., standardized scores, $|z| \geq 3.30$) and multivariate outliers (i.e., Mahalanobis distance at $p < 0.001$; Tabachnick & Fidell, 2007), and descriptive statistics were computed using IBM SPSS Version 22. To determine composite reliability estimates (Raykov, 1997) and to explore the factor structure of the proposed measurement model, a second-order CFA was conducted using Mplus Version 7.3. A second-order model was chosen to reflect the hypothesis that the seven conceptually distinct teacher behaviors would be related to one another and would be represented by (i.e., sit beneath) a global relatedness support construct. Given that students were nested within classes, we implemented a “Type = Complex” correction for nonindependence of observations based on student clustering (Rabe-Hesketh & Skrondal, 2006). Missing data (which comprised 0.4% of all cases) were handled using the Mplus default full information maximum likelihood (FIML) approach. We implemented maximum likelihood parameter estimates (MLR) with standard

errors and a chi-square test statistic that are robust to non-normality (Muthén & Muthén, 1998–2014). In line with recommendations by Tabachnick and Fidell (2007), and in accordance with the available output provided within Mplus, a range of indices were considered when assessing model fit. We examined the χ^2 goodness-of-fit index, the comparative fit index (CFI), Tucker-Lewis index (TLI), standardized root mean square residual (SRMR), and root mean square error of approximation (RMSEA). Close fit was judged when CFI and TFI ≥ 0.95 , SRMR ≤ 0.08 , and RMSEA ≤ 0.06 (Hu & Bentler, 1999; Tabachnick & Fidell, 2007). When interpreting the strength of factor loadings, we utilized Comrey and Lee’s (1992) recommendations (i.e., >0.55 = good, 0.45 – 0.55 = fair, 0.32 – 0.45 = poor, <0.32 = should not be interpreted).

1.3. Results

1.3.1. Descriptive statistics and item-level analyses

Skewness and kurtosis values were inspected for all perceptions of teacher behavior items; no major departures from normality were observed, and the deletion of items would not have improved internal consistency for any of the measures (see Table 1 for composite reliability estimates). All of the items (as described in the measures section) were retained for further analyses.

Table 1
Study 1 first-order CFA factor loadings and descriptive information.

Subscale and item	Factor loading	Mean	SD	ρ	ICC
Tries to get to know me as an individual	0.80	3.80	0.95	0.81	0.10
Asks me about my personal interests	0.69	3.14	1.10		
Talks to me about things that are going on in my life	0.62	2.84	1.13		
Talks to me in a friendly way	0.69	4.38	0.76		
Is interested in the things I do outside of PE	0.61	3.31	1.15		
I am frequently encouraged by my PE teacher	0.75	4.07	0.89	0.85	0.04
When I do well in PE, my PE teacher confirms that	0.72	4.12	0.90		
If my teacher sees that I try very hard in PE, I'll always get praise	0.70	3.72	1.02		
My teacher instructs me frequently	0.66	3.92	0.86		
My PE teacher often praises me	0.66	3.26	1.04		
My PE teacher often gives me instruction and feedback	0.72	4.09	0.92		
My teacher allows us to talk about the things we do in PE with classmates	0.70	3.85	0.99		
My teacher lets us ask other students for help if we need it	0.74	3.96	0.91	0.86	0.05
My teacher encourages us to share ideas with one another in class	0.76	3.93	0.92		
My teacher encourages us to get to know our classmates' names	0.62	4.15	0.99		
My teacher encourages us to be helpful to other students in PE	0.77	4.20	0.84		
If you have a problem in PE class, you can just talk to someone about it	0.68	3.85	1.00		
People in my PE class often work together	0.55	4.02	0.93		
My PE teacher seems to really enjoy teaching	0.84	3.56	0.59		
My PE teacher is an enthusiastic teacher	0.84	3.54	0.59		
My PE teacher is enthusiastic about the subject of PE	0.75	3.68	0.53	0.85	0.08
Shows that he/she cares about me	0.76	3.93	0.86		
Tries to know every student in the class	0.68	4.33	0.82		
Tries to help students who might be struggling	0.67	4.45	0.71		
Recognizes the needs and abilities of each student in the class	0.72	4.28	0.81	0.80	0.02
Does your PE teacher respect your opinion?	0.84	4.13	0.85		
Does your PE teacher really understand how you feel about things?	0.80	3.70	0.98		
Does your PE teacher try to help you when you are sad or upset?	0.68	4.54	0.84		
Can you count on your PE teacher for help when you need it?	0.85	4.04	0.98		
Will listen if I want to talk about a problem	0.83	4.02	0.91	0.87	0.05
Is easy to talk to about school things	0.84	4.01	0.95		
Is easy to talk to about things beside school	0.72	3.63	1.09		
Knows when to make jokes with students	0.63	4.25	0.93		
Is friendly and approachable	0.76	4.33	0.88		
				0.87	0.06

Note. ρ = composite reliability estimate, all were acceptable (≥ 0.70 ; Raykov, 1997); ICC = Intraclass correlation coefficient calculated by averaging the ICCs of the items in each scale.

1.3.2. CFA

Examination of the fit indices indicated that the data appeared to be an adequate fit for the 34-item model that included all measurement parameters and structural pathways, $\chi^2(520) = 1445.16$, $p < 0.001$, CFI = 0.91, TFI = 0.91, SRMR = 0.05, RMSEA = 0.05 (90% CI: 0.05, 0.06). To compare the fit of this model with one in which there was no higher-order construct specified, we examined a model with no higher-order relatedness support variable. The removal of the higher-order factor did not appear to alter model fit significantly, $\chi^2(506) = 1389.09$, $p < 0.001$, CFI = 0.91, TFI = 0.91, SRMR = 0.05, RMSEA = 0.05 (90% CI: 0.05, 0.06), and the χ^2 difference test indicated that the alternate model (no higher-order factor) was a significantly worse fit with the data when compared with the original model, $\Delta\chi^2(14) = 70.34$, $p < 0.001$; therefore, the original higher-order model was retained because the lower-order factors should, conceptually speaking, all load onto a global construct. To optimize model fit for this higher-order model, we used the modification indices that were provided in our initial analysis to specify a number of measurement-based model improvements. As a rule of thumb, modification indices above 5 are generally considered large enough for a researcher to consider amending a model (Kelloway, 1998). In accordance with this cut-off point, we implemented this approach based on Meehl's (1990) contention that, to a certain degree, all variables are related to all others. We incorporated nine feasible modifications to the model by specifying error covariances between selected indicators within some latent variables based on items sharing similar wording (e.g., "my teacher encourages us to get to know our classmates' names"/"my teacher encourages us to be helpful to other students in PE"), and items with high content overlap (e.g., "Does your PE teacher try to help you when you are sad or upset?"/"Can you count on your teacher for help when you need it?").

Following these modifications, we observed an improvement in fit indices, $\chi^2(510) = 1045.90$, $p < 0.001$, CFI = 0.95, TLI = 0.95, SRMR = 0.04, and RMSEA = 0.04 (90% CI: 0.04, 0.05), indicative of a relatively close-fitting model. Standardized factor loadings for the loading of items onto their respective first-order factors are presented in Table 1. All loadings were considered good (i.e., >0.55) according to Comrey and Lee's (1992) guidelines, with the exception of one loading within the 'promoting cooperation and teamwork' subscale, which was exactly 0.55 (i.e., rated as fair). Standardized factor loadings of the lower-order latent variables onto the higher-order global relatedness support variable are presented in Table 2, and all were considered good (i.e., >0.55). Mean scores and standard deviations for the indicators that represented the seven latent teacher behavior dimensions are presented in Table 1, alongside composite reliability estimates and the intraclass correlation coefficients (ICC; i.e., the variance in student responses accounted for by class membership) derived from scores obtained from these measures. The ICC was calculated for each latent variable (teacher behaviors) by averaging the ICCs of each scale's items.

Table 2
Loading of first-order factors on the second-order factor and descriptive information.

Subscale	Factor loading	Mean	SD
<i>Relatedness support</i>			
Individualized conversation	0.90	3.49	0.82
Task-related feedback	0.89	3.86	0.72
Promoting cooperation and teamwork	0.84	3.99	0.70
Teacher enthusiasm	0.77	3.59	0.50
Teacher awareness	0.97	4.24	0.63
Teacher care	0.88	4.10	0.75
General friendly communication	0.94	4.05	0.77

Standardized factor loadings for the second-order factor (relatedness support), as well as aggregate-level means and standard deviations, are presented in Table 2.

2. Study 2: path analysis

The purpose of Study 2 was to investigate how our operationalization of relatedness support was related to a series of theoretically-derived concepts. To confirm alignment with SDT (Deci & Ryan, 2000), we first sought to determine whether our relatedness support construct was a strong predictor of relatedness need satisfaction perceptions. In order to provide a more robust test of this relationship, however, we also controlled for other potential predictors of relatedness need satisfaction. Specifically, we modeled students' perceptions of autonomy support and structure (i.e., competence support) alongside relatedness support, given that the support for a given need (e.g., autonomy support) may promote satisfaction not only of that need (i.e., autonomy need satisfaction), but also other needs (Deci & Ryan, 2014). Similarly, we also sought to demonstrate that our relatedness support variable aligned strongly with relatedness need satisfaction while controlling for the potential effects associated with relevant individual difference variables. Dispositional factors – namely agreeableness and one's need to belong – were measured in light of the potential for individuals scoring differently on these variables to view their relationship with their teacher (and hence their relatedness need satisfaction) through a different lens (Carvalho & Gabriel, 2006; Jackson, Dimmock, Gucciardi, & Grove, 2011). Measures of motivational regulations (i.e., intrinsic, identified, introjected, external, amotivation) were selected as they represent important outcomes that are relevant in physical activity settings (Jackson et al., 2013), and so that indirect relations could be modeled between the relatedness support variable and the central motivational components outlined within SDT. Methods for modeling behavioral regulation using SDT-based instruments have often historically used a composite variable called the relative autonomy index (RAI; Ryan & Connell, 1989), whereby aggregate scores for each behavioral regulation are computed, and then weighted in order to provide a single score reflecting one's autonomous (relative to one's controlled) motivation. Given, though, that each behavioral regulation represents a theoretically distinct construct, it has been noted that combining the different regulations may result in an important loss of information (Chemolli & Gagné, 2014). For this reason, we implemented an approach in which each of the behavioral regulations were separated, allowing us to explore the unique pathways associated with each construct. We hypothesized that relatedness support, alongside both autonomy support and competence support, would be positively related to relatedness needs satisfaction. We also anticipated that relatedness need satisfaction would be associated positively with intrinsic motivation and identified regulation, and negatively associated with introjected regulation, external regulation and amotivation. Hypothesized direct relationships between variables are presented in Fig. 2.

2.1. Method

2.1.1. Participants and procedures

In total, 570 PE students (males = 200, females = 370, M age = 13.93, SD = 1.04), from grade seven through 10 participated in the study. The students were recruited from 34 different PE classes in four independent high schools in the Perth metropolitan area. All participants took part in weekly compulsory PE, which was delivered across two or three class periods each lasting 50 min. The study was approved by the Human Research Ethics Board at the

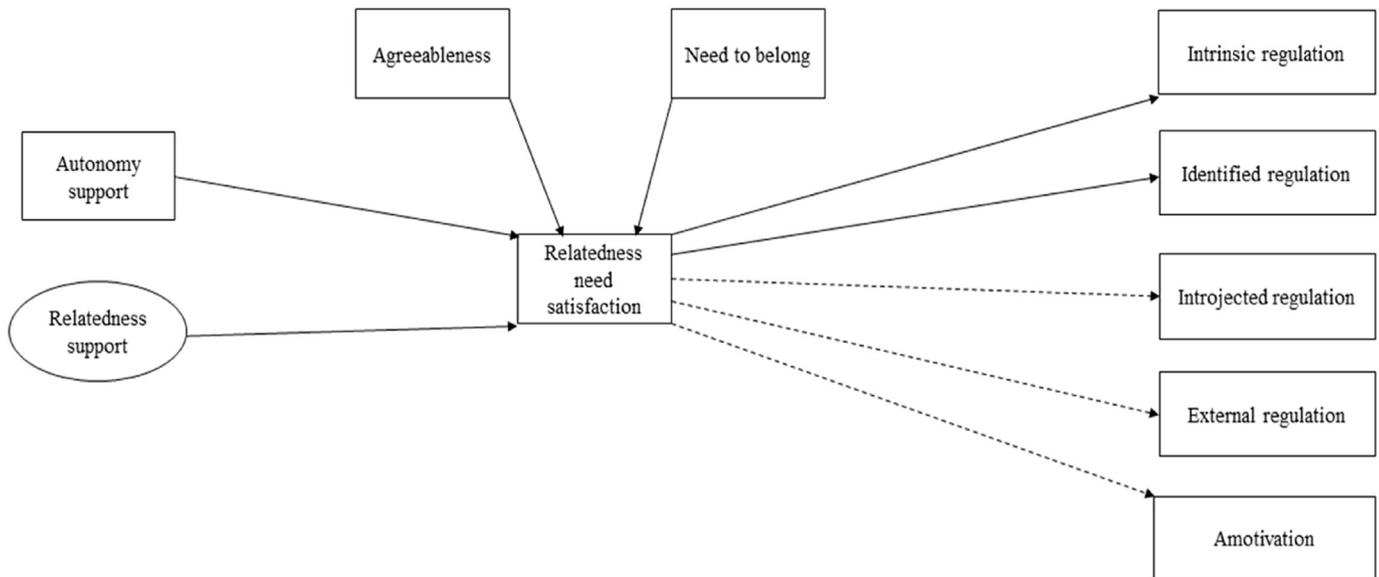


Fig. 2. Illustration of proposed model. Solid line indicates pathway was hypothesized to be positive in nature. Dashed line indicates that the relationship was hypothesized to be negative in nature. Relatedness support variable = composite score created by seven teacher behaviors (individualized conversation, task-related support, promoting cooperation and teamwork, teacher enthusiasm, teacher awareness, teacher care, and general friendly communication). In our analysis, pathways from relatedness need satisfaction were proposed to predict each of the five regulations separately.

lead authors' institution, and recruitment, consent, and data collection procedures were identical to those described in Study 1.

2.2. Measures

2.2.1. Relatedness support

Students' perceptions of relatedness support were assessed using all items from the seven subscales described in Study 1.

2.2.2. Agreeableness

The agreeableness subscale from the Big Five Inventory (BFI; John, Donahue, & Kentle, 1991) was utilized to measure students' general concern for social harmony (e.g., the degree to which individuals are altruistic, trusting, cooperative, and collegial in nature; Neuman & Wright, 1999). For each of the nine items, students answered on a scale from 1 (*disagree strongly*) to 5 (*agree strongly*). Preceding each statement, the instruction, "At school, I see myself as someone who ..." was presented, and sample items included "tends to find fault with others" (reverse scored), and "is considerate and kind to almost everyone". Means were calculated, with higher scores reflecting greater levels of agreeableness. Soto and John (2009) provided support for the reliability and validity of measures derived from the BFI.

2.2.3. Need to belong

To assess students' general need for connectedness, the 10-item Need to Belong Scale (NTBS; Baumeister & Leary, 1995) was used. For each item, students responded to statements (e.g., "If other people don't seem to accept me, I don't let it bother me") anchored at 1 (*strongly disagree*) and 5 (*strongly agree*). Mean scores were created, whereby higher scores indicated a stronger desire to relate to and be accepted by other people. Several studies have demonstrated acceptable psychometric properties of scores derived from the NTBS (e.g., Leary, Kelly, Cottrell, & Schreindorfer, 2013).

2.2.4. Relatedness need satisfaction

Students' perceptions of relatedness need satisfaction were measured using the five-item acceptance subscale from the Need

for Relatedness Scale (Richer & Vallerand, 1998). The stem presented was "With my teacher in this PE class I feel ...", and items pertained to feeling safe, valued, listened to, supported, and understood. All responses were answered on a seven-point scale anchored at 1 (*strongly disagree*) and 7 (*strongly agree*). A mean relatedness score was created, with higher scores indicating greater need satisfaction. A number of studies within the context of PE have provided evidence for reliability and validity of scores derived from this scale (Standage, Duda, & Ntoumanis, 2003; Standage, Duda, & Ntoumanis, 2005).

2.2.5. Autonomy support

To assess the degree to which students perceived their PE teacher to be autonomy supportive, we used a modified version of the six-item Learning Climate Questionnaire (LCQ; Standage, Duda, & Ntoumanis, 2006; Williams & Deci, 1996). Preceded by the stem, "In this PE class ...", students answered on a seven-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Example items included, "we feel that the PE teacher provides us with choices and options", and "the PE teacher encourages us to ask questions". A mean autonomy support score was calculated, with higher scores reflecting greater perceived autonomy supportive PE teacher behaviors. Existing work (e.g., Standage et al. (2006) has demonstrated support for the reliability and validity of scores derived from the six-item LCQ with a sample of PE students).

2.2.6. Competence support

To assess the degree to which students perceived their PE teacher to be competence supportive, a four-item scale developed by Standage et al. (2005) was administered. All items were anchored on a seven-point scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*), and example items included, "the PE teacher helps us to improve", and "the teacher makes us feel like we are good at PE". Standage et al. (2005) reported evidence of acceptable reliability for measures derived from this instrument with a sample of high school students.

Table 3
Zero-order correlations between relatedness support and all other variables.

Variable	2	3	4	5	6	7	8	9	10
1. Relatedness support	0.43*	0.16*	0.81*	0.77*	0.50*	0.47*	0.22*	-0.02	-0.32*
2. Agreeableness	–	0.22*	0.46*	0.44*	0.35*	0.33*	0.14*	-0.11*	-0.31*
3. Need to belong		–	0.16*	0.21*	0.12*	0.16*	0.28*	0.12*	-0.07
4. RNS			–	0.81*	0.51*	0.49*	0.25*	-0.01	-0.27*
5. Autonomy support				–	0.49*	0.49*	0.22*	-0.01	-0.27*
6. Intrinsic regulation					–	0.87*	0.53*	<0.01	-0.32*
7. Identified regulation						–	0.57*	0.06	-0.30*
8. Introjected regulation							–	0.45*	0.03
9. External regulation								–	0.42*
10. Amotivation									–

Note. Relatedness support variable = composite score created by seven teacher behaviors (individualized conversation, task-related support, promoting cooperation and teamwork, teacher enthusiasm, teacher awareness, teacher care, and general friendly communication); RNS = relatedness need satisfactions; * $p < 0.001$.

2.2.7. Motivation

To measure students' motivational regulations for PE, we used the 20-item Perceived Locus of Causality (PLOC) questionnaire (Goudas, Biddle, & Fox, 1994). Preceded by the stem "I take part in PE classes," the PLOC scale contains items assessing intrinsic motivation (four items, e.g., "because I enjoy learning new skills"), identified regulation (four items, e.g., "because I want to improve in sport"), introjected regulation (four items, e.g., "because I want the teacher to think I am a good student"), external regulation (four items, e.g., "because I'll get in trouble if I don't"), and amotivation (four items, e.g., "but I don't really know why"). Students responded on a seven-point scale anchored at 1 (*strongly disagree*) and 7 (*strongly agree*). Composite scores were created for each motivational construct, with higher scores reflecting greater levels of the regulation. Recent investigations have provided support for the reliability and validity of scores derived from the instrument (Jackson et al., 2013; Lonsdale, Sabiston, Taylor, & Ntoumanis, 2011).

2.2.8. Data analysis

Data were examined for univariate (i.e., standardized scores, $|z| \geq 3.30$) and multivariate outliers (i.e., Mahalanobis distance at $p < 0.001$; Tabachnick & Fidell, 2007), and descriptive statistics were calculated using IBM SPSS Version 22. Initially, an exploratory structural equation model (ESEM) was conducted using Mplus Version 7.3, and we again implemented a correction for nonindependence of observations (Rabe-Hesketh & Skrondal, 2006). The ESEM (Asparouhov & Muthén, 2009) technique conducted allowed for approximate zero cross-loadings between relatedness support, autonomy support, and competence support indicators with respect to their non-intended latent variables. This analysis was conducted on the basis of high correlations initially observed between relatedness support, autonomy support, and competence support latent variables, and other relevant literature reporting similar findings (Koka & Hagger, 2010; Taylor & Lonsdale, 2010). The aim of this ESEM was primarily to determine if the 35 relatedness support items loaded primarily (and meaningfully) onto their intended (higher order) latent variable (i.e., relatedness support), and to examine cross-loadings onto the other variables (i.e., autonomy support and competence support). Analyses revealed that all relatedness support items loaded primarily (and meaningfully) onto their intended latent variable; however, the initial ESEM analysis revealed problems with the competence support measure (i.e., the competence support items cross-loaded strongly onto the autonomy support latent variable, and loaded weakly onto their intended latent variable). For these reasons, we decided to remove the competence support measure from subsequent analyses. We have included further information about this analysis,

along with specific output, as supplementary material to the manuscript (see Table S1).

To examine the relations among variables, a path analysis was conducted. Consistent with Fig. 2, and for the sake of parsimony given the number of variables, we specified a single model in which all variables were modeled as single-item observed variables, with the exclusion of relatedness support, which was specified as a latent variable represented by aggregate scores from the seven teacher behavior dimensions. A composite reliability estimate ($\rho = 0.91$) was calculated for our latent relatedness support variable using aggregate scores from each of the seven perceptions of teacher behavior scales. The correction for nonindependence of observations (i.e., student clustering), estimation method (i.e., MLR) and handling of missing data (<0.5% of all cases) were all identical to Study 1, and we requested direct and indirect predictive pathways between variables of interest. Conclusions regarding model fit and factor loadings were based on the criteria outlined in Study 1.

2.3. Results

2.3.1. Descriptive statistics and fit indices

Mean (and SD) scores for the seven teacher behaviors ranged from 3.05 (0.74) to 3.84 (0.85), and ICCs (calculated for each latent variable by averaging the ICCs of each scale's items) ranged from 0.03 to 0.13. Standardized factor loadings for the seven indicators of relatedness support onto the latent variable were in the range 0.66–0.87. Zero-order correlations between all aggregate variables appear in Table 3. Correlations between relatedness support dimensions and autonomy support appear in Table S2 (range = 0.53 to 0.71), and correlations between all relatedness support dimensions appear in Table S3 (range = 0.41 to 0.76). The data were a close overall fit for a single model that included all measurement and structural parameters, $\chi^2(78) = 175.99$, $p < 0.001$, CFI = 0.98, TFI = 0.97, SRMR = 0.04, RMSEA = 0.05 (90% CI: 0.04, 0.06).

2.3.2. Direct pathways

Analyses revealed a number of significant direct effects (see Table 4). In line with recommended effect size criteria for path coefficients (i.e., 0.10 = small, 0.30 = moderate, 0.50 = large; Cohen, 1992), perceived relatedness support displayed a large positive association with relatedness need satisfaction. That is, students reported stronger relatedness need satisfaction regarding their teacher when they felt that their teacher engaged in relatedness-supportive (i.e., interpersonally-involving) behaviors. Perceptions of autonomy support provided by the teacher also positively predicted relatedness need satisfaction. It is worth noting that these effects upon relatedness need satisfaction occurred while accounting for students' agreeableness and need to belong (which

Table 4

Standardized output for all structural and covariate pathways specified within the model.

Pathway	Estimate	SE	p
<i>Directional pathways</i>			
Relatedness support → RNS	0.55	0.062	<0.001
Autonomy support → RNS	0.35	0.062	<0.001
RNS → Intrinsic regulation	0.51	0.058	<0.001
RNS → Identified regulation	0.49	0.055	<0.001
RNS → Introjected regulation	0.25	0.064	<0.001
RNS → External regulation	−0.01	0.050	0.871
RNS → Amotivation	−0.27	0.052	<0.001
<i>Covariate pathways</i>			
Agreeableness → RNS	0.06	0.032	0.088
Need to belong → RNS	−0.02	0.025	0.459

Note. Relatedness support variable = composite score created by seven teacher behaviors (individualized conversation, task-related support, promoting cooperation and teamwork, teacher enthusiasm, teacher awareness, teacher care, and general friendly communication). RNS = relatedness need satisfaction. Variance explained: RNS = 78%; Intrinsic regulation = 26%; Identified regulation = 24%; Introjected regulation = 6%; Amotivation = 8% (all $p < 0.05$); External regulation = <1% ($p = 0.94$).

were not significant predictors).²

Students' relatedness need satisfaction was hypothesized to positively predict students' intrinsic motivation and identified regulation for PE, while negatively predicting introjected regulation, external regulation and amotivation. Perceptions of relatedness need satisfaction displayed significant positive direct effects on intrinsic (a large effect) and identified (a moderate-to-large effect) regulations for PE. That is, students reported greater self-determined motives for PE (e.g., fun, enjoyment, value) when they felt supported, valued, and understood by their PE teacher. In terms of more controlled forms of motivation (i.e., introjected and external regulations), relatedness need satisfaction was not a significant predictor of external regulation; however, a small-to-moderate and positive effect was observed for relatedness need satisfaction in relation to introjected regulation. In other words, students reported greater introjection associated with their involvement in PE (i.e., guilt, worry, shame) when they perceived their PE teacher to be supportive, inclusive, and understanding. A significant, small-to-moderate negative effect was also found for students' relatedness need satisfaction in relation to amotivation; that is, students reported greater amotivation for PE when they felt less supported, valued, and understood by their PE teacher.

2.3.3. Indirect pathways

We requested estimates of all possible indirect effects between students' perceptions of relatedness support and each motivational regulation (via relatedness need satisfaction). For intrinsic motivation, we observed a significant pathway revealing a positive relationship linking students' perceptions of relatedness support with their intrinsic motivation, via relatedness need satisfaction ($\beta = 0.28$, $SE = 0.05$, $p < 0.001$). We observed a similar positive indirect pathway linking students' perceptions of relatedness support, relatedness need satisfaction, and identified regulation ($\beta = 0.27$, $SE = 0.05$, $p < 0.001$). A significant positive pathway linking relatedness support and introjected regulation also emerged (i.e., relatedness support → relatedness need

satisfaction → introjected regulation; $\beta = 0.14$, $SE = 0.04$, $p < 0.001$). Although no significant pathway was apparent for external regulation, a significant negative pathway was found linking relatedness support and amotivation via relatedness need satisfaction ($\beta = -0.15$, $SE = 0.04$, $p < 0.001$).

2.4. Discussion

To date, researchers have demonstrated that students' perceptions of a supportive and inclusive classroom – both within and beyond PE – are important in shaping positive in-class experiences (e.g., Cox et al., 2009; Wentzel, 1997). PE is characterized by frequent teacher-student interaction, and the quality of such interactions has been linked directly, and indirectly, to students' self-determined motivation in PE (Gairns, Whipp, & Jackson, 2015; Jackson et al., 2013). Recent work, however, has emphasized the need for further inquiry into the specific 'signals' that students use in forming their relatedness support appraisals (Standage & Emm, 2014; Van den Berghe et al., 2014). The aim of these studies, therefore, was to model a previously unexplored group of relatedness support indicators (i.e., perceptions of discrete teacher behaviors; Sparks et al., 2015), and to determine whether this operationalization of relatedness support predicted motivational outcomes in ways that would be expected on the basis of theory.

Guided by recent qualitative insight into the teacher behaviors deemed to be relatedness-supportive, we used existing and new instruments to quantify students' perceptions on these behaviors. By way of confirmatory factor analysis, Study 1 focused on testing a second-order model comprising seven lower-order factors (i.e., perceptions on the relatedness-supportive teacher behaviors), which were proposed to load onto a global relatedness support construct. Analyses provided support for a 7-factor, 34-item operational definition representing relatedness support and a network of indicators. Each discrete teacher behavior latent variable loaded strongly onto a higher-order latent relatedness support variable, demonstrating that collectively these (perceived) behaviors were good indicators of relatedness support. To further examine this operationalization, the aim of Study 2 was to again consider the loadings of all lower-order variables onto the higher-order construct, as well as to explore the direct and indirect relations between the higher-order construct and various theoretically-driven outcomes.

Using this method for modeling relatedness support, relationships between students' perceived relatedness support, relatedness need satisfaction, and discrete motivational regulations for PE were examined. In line with study hypotheses and SDT (Deci & Ryan, 2000), the higher-order latent relatedness support variable displayed a positive, direct relationship with relatedness need satisfaction. This finding endorsed the utility of the strategy that we used to model relatedness support. Also included in the analysis, however, were measures of autonomy support, hypothesized to also display direct relations to relatedness need satisfaction, given proposed interrelations among the three basic needs (Deci & Ryan, 2014). Notably, students' perceptions of relatedness-supportive teacher practices – as per our modeling strategy – emerged as the strongest predictor of relatedness need satisfaction when estimated alongside perceptions of autonomy. It is important to note that while we initially included competence support in the analysis, problems emerged with the measure derived from our chosen instrument (i.e., the competence support items cross-loaded strongly onto the autonomy support latent variable, and loaded weakly onto their intended latent variable.), and for these reasons, we decided to remove the competence support measure from subsequent analyses (see Table S1). Future work should aim to test relations between all three needs and relatedness need

² In addition to including agreeableness/need to belong as covariates in the path analysis, and at the request of an anonymous reviewer, we also examined whether the putative covariates may alternatively act as potential moderators of the relationship between students' relatedness support and relatedness need satisfaction perceptions. We report in more detail on this alternative modeling strategy in the 'Supplementary Material: Moderator Analysis' section.

satisfaction. In addition, the relationship between relatedness support and relatedness need satisfaction demonstrated a large effect while also controlling for potentially relevant individual difference parameters that may have independently accounted for students' relational perceptions (i.e., agreeableness, need to belong). Given that these traits represent a lens through which individuals view their interpersonal interactions (Baumeister & Leary, 1995; Jensen-Campbell & Graziano, 2001), this finding suggests that the detection of supportive behaviors from one's teacher is able to satisfy students' relatedness needs in PE irrespective of (aspects of) their interpersonal style.

In addition to the direct structural pathways specified, a number of indirect relations were proposed linking students' interpersonal perceptions about their PE teacher and in-class motivational outcomes via need satisfaction. Several indirect pathways were observed; most notably, relatedness support indirectly predicted more self-determined motives for PE (i.e., intrinsic motivation, identified regulation) through students' need satisfaction. In particular, when students felt that their PE teacher was relatedness-supportive, they reported greater satisfaction of the need for relatedness, which in turn aligned with more self-determined forms of motivation for PE. Aligning closely with theory (Deci & Ryan, 2014), experiences of individualized care and attention, which characterize relatedness-supportive interactions, linked with students' experiences of greater relatedness need satisfaction, thus creating the conditions that support more self-determined motives in PE.

We observed several direct relationships between relatedness need satisfaction and students' motivational regulations for PE. For both intrinsic motivation and identified regulation, positive direct effects were displayed, with the strongest pathway emerging between relatedness need satisfaction and intrinsic motivation. Contrary to our expectations, however, students also endorsed stronger introjected regulation (i.e., guilt, obligation, need to prove themselves) when they felt accepted and cared for by their teacher. One possible explanation for this finding is that the satisfaction of one's relatedness need through connections with one's teacher may induce perceptions of pressure to participate in PE and satisfy one's teacher. Recent work by Cheung and Pomerantz (2012) has demonstrated, for example, that despite representing an introjected (i.e., more controlling) motive, the desire to please a socialization figure can be an important motivating force to engage in an activity. Indeed, feeling closely connected to one's teacher might catalyze to the desire to want to fulfill, and live up to, the teacher's expectations during PE (Ryan & Deci, 2000). Thus, this perceived pressure might, in part, contribute to a heightened sense of introjection toward PE (e.g., feelings of guilt for not meeting perceived teacher expectations).

In reflecting on the contribution of this work, it is important to highlight implications of this study that serve to advance work in this field. First, this study offers a more detailed picture and operationalization of relatedness-supportive practices in PE, as demonstrated in two relatively large samples. Considering how relatedness support has been measured previously in PE-based studies (see Standage et al., 2005), the range of instruments used in this work serve to encapsulate a novel, and more comprehensive, understanding of relatedness-supportive instruction in PE. From a practical standpoint, these findings provide evidence for a set of discrete relatedness-supportive behaviors that may be utilized by PE teachers to facilitate positive in-class student outcomes. Given the value of teacher education and professional development aimed toward improving the quality of student-teacher interactions (Baroody, Rimm-Kaufman, Larsen, & Curby, 2014), practitioners and teachers may focus their attention on the development and training of strategies that display interest, warmth, and

support within the PE classroom to foster favorable interpersonal perceptions among students. Results from this study also showed support for the predictive effects of our relatedness support model, alongside a range of relevant variables (e.g., autonomy support), as well as indirect links between relatedness-supportive teacher practices and important in-class outcomes (i.e., motivational regulations). Considering the novel method for modeling relatedness support that was adopted in this study, it is worthwhile to note the significant links between relatedness support, relatedness need satisfaction, and each of the separate motivational dimensions. To our knowledge, no PE-based study has specifically explored links between relatedness need satisfaction and motivational regulations while separately modeling each behavioral regulation.

It is important to consider the high correlations between perceived autonomy and relatedness support reported in this study. As outlined within SDT (Deci & Ryan, 2014), it is possible that strong positive relations may exist between the three basic needs, and generally high correlations have been found between individuals' perceptions of the three distinct need support variables in previous work (Reinboth et al., 2004; Taylor & Ntoumanis, 2007). That being the case, although some degree of overlap between need support variables may be anticipated, it is worth cautioning that aspects of both autonomy support and competence support may be embedded within the instructional practices that students deem to be relatedness-supportive. For example, encouragement and providing positive feedback have been identified as sources of competence supportive in previous work (Mouratidis, Vansteenkiste, Lens, & Sideridis, 2008). It is entirely possible, given the strong correlations between autonomy and relatedness, that certain need-supportive practices may interchangeably satisfy more than one basic need, and consistent with this notion, existing work has demonstrated that autonomy and competence support can help satisfy one's relatedness needs (Koka & Hagger, 2010; Taylor & Lonsdale, 2010). Although the goal of this research was to – as best as possible – isolate relatedness-supportive teacher practices as identified by students, future work would be valuable in which redundancy and overlap between specific need supportive practices is examined.

Balanced against the strengths of this work, it is necessary to consider design limitations and accompanying future research directions. First, it is important to note that we obtained self-report measures from students at a single time point. In the future, it would be worthwhile incorporating more objective measures (e.g., observations, video) of specific teacher instructional practices that students believe to be relatedness-supportive in nature to further examine the degree to which teachers utilize these practices. As well, it would also be interesting to capture possible changes in students' perceptions of teacher relatedness support across middle and high school years given the shift in school structure during a crucial stage of development (Reddy, Rhodes, & Mulhall, 2003). It is also important to discuss the imbalance between male and female participants in study 1. Commonly, tests of gender invariance may be conducted on such data, particularly as results from past classroom-based studies have shown relatedness to relate more strongly to motivation for females than for males (Furrer & Skinner, 2003; Goodenow, 1993). Given the disproportionate amount of male participants in our sample, however, tests of invariance were not possible, and future work would benefit from conducting such analyses.

Alongside the support provided by their teachers, recent work has also begun to investigate the role that peers may play in supporting students' relatedness needs (Cox et al., 2009; Gairns et al., 2015). Considering the importance that peer relations have throughout adolescence (see Brustad & Partridge, 1996), examining the interplay between different social agents is valuable, and

research that adopts a holistic approach to examining caring, involving, and supportive classroom conditions that bolster student experiences is warranted. Finally, in terms of the measurement tool utilized for this study, it would be useful to closely examine item content. Considering the high correlations between relatedness support and autonomy support measures, and potential conceptual overlap with competence support, it may be worthwhile to seek to retain only those items that most clearly (conceptually and/or empirically) align with relatedness support from a SDT perspective.

Given that SDT (Deci & Ryan, 2000) is concerned with the social factors that may support or undermine self-determined motivation, our study focused on a set of novel, specific relatedness-supportive teacher behaviors as identified previously by students, and further examined the predictive nature of these behaviors with respect to motivational regulations for PE. Although our data do not allow for insight into causal relations between variables, this study highlights the importance of relatedness-supportive practices provided by the teacher in PE. Considering that the literature on relatedness-supportive practices in PE is not yet fully developed, this study serves as an important foundation for intervention work designed to enhance the teacher provision of caring, warm, and interpersonally-involving classrooms that may foster adaptive student outcomes. Although student-teacher relationships and interactions within a classroom social system are multi-faceted and complex, the quality of such interactions requires careful attention so that we can better understand and encourage student engagement and motivation. Collectively, the set of relatedness-supportive behaviors (and associated modeling approach) presented in this study may offer practical strategies for teachers, and help to identify the attentive, caring, and supportive 'signals' that support students' self-determined motivation within the PE classroom.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.psychsport.2016.06.004>.

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