Psychology of Sport and Exercise 28 (2017) 11–23

Contents lists available at ScienceDirect

Psychology of Sport and Exercise

journal homepage: www.elsevier.com/locate/psychsport

Effectiveness of a need supportive teaching training program on the developmental change process of graduate teaching assistants' created motivational climate

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ARTICLE INFO

Article history:
Received 6 December 2015
Received in revised form
23 September 2016
Accepted 23 September 2016
Available online 25 September 2016

Keywords:
Autonomy supportive
Graduate teaching
Pedagogy

ABSTRACT

Objectives: There is a common trend to train physical education teachers and coaches in need supportive teaching behaviors, however, little research has been done with graduate teaching assistants (GTAs) in college and university physical activity programs. The purpose of this study was to test the effects of a need supportive teaching training program on GTAs' ability to promote need support in college and university physical activity courses.
Design: Longitudinal and correlational.
Method: Participants were twelve GTAs from a midsized southeastern university in the United States, trained to deliver instruction in a positive motivational climate via in-person meetings, self-study materials, and tri-weekly meetings with researchers.
Results: Multi-level modeling revealed that the learning environment created by the GTAs improved across the duration of the study, with most of the growth between baseline and the first four intervention data points. Partial correlations seemed to indicate that these changes were influential among students, as evidenced through measurement of perceived autonomy support and motivational regulations.
Conclusions: Results revealed that the behavioral change process was carried out quickly (from the beginning of the training), suddenly (rather than gradually), and then leveled off until the end of the semester. These results provide some promise in being able to effectively train GTAs to be need supportive in a relatively short amount of time.

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1. Introduction

Instructional Physical Activity Programs (or sometimes referred to as Basic Instructional Programs) have traditionally played an important role in higher education institutions. Their presence serves as a foundation for students to lead a physically active lifestyle by providing the skills and knowledge that encourage physical activity and, overall, improve students' health and wellness behaviors (Jenkins, Jenkins, Collums, & Werhonig, 2006). Research suggests that the more physically active students are during their college and university career, the more likely they are to maintain their physical activity level (Sparling & Snow, 2002). Instructional physical activity programs have a wide variety of instructors teaching in this setting, including full time faculty, adjunct faculty, coaches and graduate teaching assistants (Sweeney, 2011). Many large institutions utilize graduate teaching assistants (GTAs) from the kinesiology discipline to teach the undergraduate physical activity classes and thereby encounter challenges to preparing these traditional young professionals for the classroom (Russell, 2010). Typical GTAs come in with distinct content knowledge or pedagogical content knowledge in the movement forms they are asked to teach. However, the instructional physical activity program

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http://dx.doi.org/10.1016/j.psychsport.2016.09.008
1469-0292/Published by Elsevier Ltd.

advisor or director(s) are left with the task of imparting the GTA with the pedagogical knowledge (i.e., knowledge of how to teach) [1] needed to be successful in the college and university setting. In addition, the GTA is responsible for creating a learning environment that can potentially influence motivation for physical activity after the course has ended. Thus, a major focus of this study was to test the use a specific training program, grounded in self-determination theory, to enhance motivational climate and student motivation.

2. Training programs for graduate teaching assistants

There are many different approaches with training and evaluating GTAs in physical activity programs (Russell, 2009, 2011). Their goal is to provide instructors with strategies they can use to make sport/fitness experiences more positive for students. However, very little research exists that supports the effectiveness of the training programs, some of which do not include structured development of pedagogical knowledge. Further, if pedagogical knowledge is developed, it is unclear whether such training is grounded in theoretical frameworks that deal specifically with enhancing motivation. One approach, which has seen success in traditional physical education (PE) courses and sport coaching, is to go beyond the provision of strategies, developing teachers' or coaches' conceptual understanding of motivational processes and their consequences in terms of positive sport/fitness experiences. Coupled with skill knowledge, the instructor can alter their communication with students. In such approach, it is assumed that this improved pedagogical knowledge will make it more likely that the "good practices" will be adopted, maintained and generalized to different situations (Duda, 2013).

3. Self-determination theory and motivational climate

Centered on the "why" of behavior, self-determination theory (SDT; Deci & Ryan, 1985, 2000) is one of the most relevant contemporary theories of motivation to support such an approach to training. One of the main postulates of SDT is that the degree of satisfaction of psychological basic needs (autonomy, competence, and relatedness) induces different types of motivation. According to SDT (see Ryan & Deci, 2000), individuals are motivated on a continuum from intrinsic motivation (engaging in an activity for fun or enjoyment) to amotivation (not engaging in an activity because of lack of interest). In between these extremes are four types of extrinsic motivation, which vary based on their degree of self-regulation; integrated regulation (valuing an activity for its potential benefits to the self), identified regulation (engaging in an activity because it is useful or important), introjected regulation (engaging in an activity due to shame or guilt), and external regulation (engaging in an activity for external reward). Within the continuum, it is possible for individuals to have varying levels of each type of extrinsic and intrinsic motivation.

Considering instructional physical activity programs, courses are set up in similar ways to post-secondary physical education, whereby students receive grades as extrinsic rewards for performance. This may limit the amount of intrinsic motivation a student may hold, and possibly influence levels of the external regulation they experience, even though they are able to choose which activity course they would like to participate in. Much of this could depend on how the instructor delivers the course. As such, an examination of motivational climate is warranted.

According to SDT, the motivational climate – defined as the social environment created by an authority figure (e.g., the teacher, the coach) – has the potential to influence an individual's motivational regulations for participating to an activity via the satisfaction or undermining of his/her basic psychological needs (Deci & Ryan, 2000). Further, Duda (2013) describes the motivational climate as one that includes the coach's words and actions as well as how he/she structures the learning environment. This includes the way the instructor communicates with students, the activities the instructor chooses to present, as well as the manner in which instructions are given. The motivational climate is a recurring and enduring pattern (Reeve & Cheon, 2014). For some coaches who tend to be prescriptive over and insistent about what athletes should think, feel and do, the need-thwarting aspect is particularly salient, whereas for other coaches who tend to be respectful of athletes' perspectives and supportive to their initiatives, the need-supportive aspect is more salient. A coach or PE teacher's motivational climate is an important feature because students of need-supportive teachers, compared to those of need-thwarting teachers, benefit in important and wide-reaching ways including greater need satisfaction, intrinsic motivation, and engagement in healthy behaviors such as physical activity participation (Cheon, Reeve, & Moon, 2012).

In the SDT literature, the motivational climate has been described traditionally as having six distinct dimensions: autonomy support, control, relatedness support, relatedness thwarting, structure, and chaos (Reeve, Jang, Carrell, Jeon, & Barch, 2004; Skinner & Edge, 2002). Regardless of the dimension, it is typically witnessed in the way a coach communicates with his/her athletes. Within the autonomy support dimension, coaches vitalize players' inner motivational resources, rely on informational language, provide explanatory rationales, display patience to allow players time to work in their own way, and acknowledge players' expressions of negative affect and accept that such complaining may be a valid reaction to coach-imposed requests (Reeve & Cheon, 2014). The controlling dimension includes offering tangible rewards, providing feedback that is controlling, exerting personal control over most of the practice time, promoting ego involvement, and using intimidation and conditional regard (Bartholomew, Ntoumanis, & Thogersen-Ntoumani, 2009). Relatedness support refers to interpersonal involvement (Skinner & Edge, 2002), which is clearly observed when teachers encourage caring, acceptance, inclusion, trust, and respect of their students (Van den Berghe, Vansteenkiste, Cardon, Kirk, & Haerens, 2012). In addition, coaches who utilize this behavior do so in a warm, positive, consistent manner that is not based on contingencies. Relatedness thwarting refers to hostility (Skinner & Edge, 2002), which is characterized as exhibiting behaviors that are cold, critical, and marked by acceptance being contingent upon desirable behavior(s) (Smith et al., 2015). One behavior, the use of conditional regard is at the border of both controlling and relatedness thwarting. Indeed, conditional regard can be see as internally controlling when a teacher use it to pressure students by appealing their self-worth (De Meyer, Soenens, Aelterman, De Bourdeaudhuij, & Haerens, 2016), or as relatedness thwarting when student's acceptance by the teacher is contingent upon desirable behavior (Smith et al., 2015). Thus, conditional regard could be a characteristic of controlling or need thwarting dimensions, based on how it is perceived and processed by the student or athlete, or by an external coder. Structure is identified as the coach's ability to provide athletes with clear instructions and organization to tasks along guidance throughout the learning process and specific expectations for each task (Jang, Reeve, & Deci, 2010; Skinner & Edge, 2002). Finally, chaos is represented as an environment that is confusing and lacking direction and prevents individuals from being effective and results in non-desirable outcomes (Skinner & Edge, 2002).

[1] In the literature on teacher professional development, pedagogical knowledge is a critical component of teaching effectiveness (see Shulman, 1987).

These six environmental dimensions are not mutually exclusive. For example, structure can be provided in either controlling or autonomy supportive ways (Deci & Ryan, 1985). In addition, recent examinations into coaching provide evidence that need-supportive and need-undermining behaviors can co-exist in a social context (Bartholomew, Ntoumanis, Ryan, and Thøgersen-Ntoumani, 2011). For instance, while a teacher cannot be autonomy-supportive and controlling at the same time, it is plausible that a teacher nurtures a student's need at one time, and thwarts this same need a few minutes later. An important implication of that is the necessity to measure both need-supportive and need-undermining dimensions. This is further illustrated in Tessier et al. (2013) and Smith et al. (2015), whereby need-supportive and need-undermining dimensions were examined independently to provide a more holistic observation of the coaching climate.

4. Autonomy support interventions and evaluation

Generally speaking, the evidence from previous investigations of motivational climate indicates that both teachers and students benefit from the process. As for the teachers, literature specifies that trainings increase teachers' need supportive behaviors while decreasing controlling behaviors (see Su & Reeve, 2011 for a review). In addition, a recent study revealed that these benefits for teachers also include greater teaching motivation (teachers' psychological need satisfaction, autonomous motivation, and intrinsic goals), teaching skill, and teacher well being (Cheon, Reeve, Yu, & Jang, 2014). Another intervention was successful in improving teachers' beliefs in their use of autonomy support, which was recognized by students and outside evaluators (Aelterman, Vansteenkiste, Van den Berghe, De Meyer, & Haerens, 2014). Few studies discuss the lasting effects of training, but Cheon and Reeve (2013) indicate that teachers who were trained to be autonomy supportive were able to maintain their use of autonomy supportive behaviors one year later. Pertaining the effects on the students, research conducted in PE showed that such teacher-focused interventions result in higher levels of perceived need satisfaction, autonomous motivation, classroom engagement, skill development, future intentions, and academic achievement (Cheon et al., 2012; Van den Berghe et al., 2012).

With regards to study participants, research reviewed by Van den Berghe et al. (2012), Ntoumanis and Standage (2009), Su and Reeve (2011) and Reeve and Cheon (2014) highlight that the majority of studies were conducted in secondary schools, with students aged 14 or older. The settings differ slightly based on country of origin study purpose, but Su and Reeve (2011) do mention that two of the studies chosen were in college level courses similar to those in the current study. In addition, Ntoumanis, Thøgersen-Ntoumani, Quested, and Hancox (2016) provides a close comparison to the current study, whereby exercise instructors were trained to adopt a communication style that was more need supportive. In this study, exercisers in the intervention group reported improvement in basic need satisfaction, motivation, and related outcomes. As more colleges and universities offer these types of programs, it is important to investigate which university exercise instructors training methods are the most adapted, and to examine the effectiveness of these training methods.

To do so, the meta-analysis of Su and Reeve (2011) is informative, as it reviewed a variety of training methods including extensive reading materials, brief one-time trainings, PowerPoint slide presentations, individualized tutoring, and general skills training, showing greater impact among interventions that include intensive training, with both face-to-face sessions and self-guided work. In building upon that idea, GTAs could benefit from this type of training, specifically by including presenting content in a way that is theoretically grounded, proposing practical applications of theoretical concepts, offering opportunities to individually and collectively reflect and discuss content, and providing follow-up guidance, would aid in the integration and implementation of concepts.

To assess the effect of such training, a variety of data collection methods were utilized, including student perceptions of autonomy support, basic need satisfaction and motivation, systematic observation of teachers via rating scales, and self-reported perceptions of autonomy support from teachers. The majority of research examined relied on self-reported measures, but the idea of instructor effectiveness being solely evaluated on the basis of student perception has been challenged over the last few years. Some researchers (e.g., Haerens et al., 2013; Smith et al., 2015; Tessier et al., 2013) address this issue, stating that objective evaluation of need support and related dimensions provides more information, which assists in the development and implementation of successful interventions. Direct observation of instructor behavior allows researchers to look for trends in what instructors actually say and do in the learning environment, instead of strictly relying on the perceptions of themselves, athletes or students. Several groups of researchers have developed objective measures of the motivational climate in both PE and sport contexts. First of all, Reeve and colleagues (e.g., Cheon et al., 2014; Reeve et al., 2004) measured three environmental dimensions (i.e., autonomy support, structure and interpersonal involvement) assuming that supporting and undermining dimensions are bipolar. Further, in an extension, Haerens and colleagues (Aelterman et al., 2014; Haerens et al., 2013) have provided initial validation for an observational system separately measuring need supportive and need undermining features in PE. But, the frequency style rating scale and anchor descriptions (e.g., 0 [never observed], 3 [observed all of the time]) could be questioned because to achieve a high score in a behavioral category, a teacher would have to exhibit the behavior “all of the time”. This becomes an issue because in natural learning environments, where it is difficult to maintain autonomy supportive behaviors across every teaching moment (Langdon, Webster, Monsma, & Hall, 2014). To overcome this issue, Smith et al. (2015) developed the Multidimensional Motivational Climate Observation System (MMCOS), which considers both quantity and quality (i.e., the psychological meaning) of the motivational climate; that is a combination of the frequency and the tone intensity of the coaches' behaviors. The MMCOS is designed to measure seven environmental dimensions, including autonomy support, control, task-involving, ego-involving, relatedness support, relatedness thwarting, and structure. In light of the literature, evaluation of need support interventions is ongoing (Aelterman et al., 2014; Cheon & Reeve, 2015; Cheon et al., 2012; Tessier, Sarrazin, & Ntoumanis, 2008, 2010) although not yet fully in the area of college and university physical activity courses.

5. Purpose of the study

While previous empirical research provides evidence that teachers (and students) reap benefits of such need-supportive teacher training, the rate of developmental change of teachers' or coaches' behaviors is unknown. Further, studies that do investigate effects of training do not consider more than three time points. Much like the study by Ntoumanis, Barkoukis, and Thøgersen-Ntoumani (2009), it is possible that teachers' rate of behavior change could vary. Additionally, previous studies that utilize need supportive interventions have not considered the occurrence of need supporting and need undermining teaching behaviors independently. Within the literature on instructional physical activity programs, there is a lack of investigations that address the ways in which instructors gain knowledge about teaching and creating a

positive motivational climate, especially those that have a focus on theories of motivation. The present study attempts to address these issues by examining the effects of an autonomy supportive focused, need supportive teaching training program on the change of GTAs' behaviors across 11 measurement occasions carried out in one semester. Based on the literature, it was hypothesized that the GTAs' need support behaviors would globally improve across time, and that the GTAs' need undermining behaviors would be globally reduced over time. Although the training was not completely focused on need-thwarting behaviors, it was expected that these behaviors would decrease as a side effect of the training itself, much like the interventions reported by Cheon, Reeve, and Song (2016), and Aelterman et al. (2014). Because of the scarcity of empirical studies examining the rate of change of each environmental dimension across time, no specific hypothesis was made. In addition, the impact of the teacher training on students' motivation and perceived autonomy support was also examined. Based on a previous study of exercise behavior (Edmunds, Ntoumanis, & Duda, 2008), it was hypothesized that the GTAs' training program would positively effect students' perceptions of autonomy support as well as motivational regulations.

6. Methods

6.1. Participants

Fourteen physical activity instructors from a midsized southeastern university in the United States were recruited for the study. Of these, two instructors were moved to research positions and therefore did not complete the study. The remaining twelve instructors (M_{age} = 23.31, *range* = 22–27) had between 1 and 2 semesters of teaching experience at the onset of the study. Of the 12 instructors, six were male and six were female. Ten out of the twelve were Caucasian (83.3%) and 2 were African-American (16.6%). Courses offered included aerobics, basketball, body conditioning, bowling, flag football, golf, racquetball, soccer, tennis, ultimate frisbee, volleyball, and yoga. All instructors provided informed consent and were told their participation was voluntary.

A total of 828 student-participants (M_{age} = 19.82, SD = 2.57) were considered in the current study. Among this group, 322 were male (38.8%) and 477 were female (57.6%). Twenty-nine students did not specify gender. The majority of participants were Caucasian (68.9%), followed by Black (27.9%), Asian (1.7%), Native American (0.5%), Native Hawaiian (0.1%), and other or not specified (0.9%). Only 196 indicated ethnicity, with 47 (24%) reporting non-Hispanic ethnicity and 149 (76%) reported Hispanic ethnicity. In terms of year in school, 37.8% were freshmen, 24.6% were sophomores, 17.7% were juniors, and 18.5% were seniors. Participants enrolled in the courses reported they had prior experience with the sport or fitness activity highlighted in their chosen course, ranging from 0 to 17 years (M = 5.32, SD = 4.13).

6.2. Instrumentation

6.2.1. Observation of need supportive/undermining behaviors

The MMCOS (Smith et al., 2015) was used to evaluate the effectiveness of the training. Although many types of instruments exist to evaluation coach climate, the MMCOS is unique in that it was developed under the auspices of specific motivation theories. More specifically, the MMCOS is grounded in SDT and AGT (achievement goal theory; Nicholls, 1989), and is organized in a hierarchical structure whereby observers code the coaching environment according to two higher-order factors (empowering and disempowering), seven environmental dimensions (autonomy support, controlling, task involving, ego involving, relatedness support, relatedness thwarting, and structure), and 32 lower-order coach behavioral strategies. Empowering and disempowering coaching are terms derived from the work of Duda and colleagues in the "Promoting Adolescent Physical Activity" project (for more details, see special issue of International Journal of Sport and Exercise Psychology, 2013). Within empowering coaching, it is emphasized that the motivational climates created by the coach matter, in terms of quality of sport experiences of sport participants (Duda, 2013). Thus, an **"empowering"** environment is one that is task-involving, autonomy supportive, and socially supportive. In contrast, a **"disempowering"** environment would be highly ego-involving, controlling, and relatedness thwarting.

For the purposes of this study, because the content of the training was based solely on SDT, we only coded the 5 environmental dimensions related to SDT (i.e., autonomy support, control, relatedness support, relatedness thwarting, and structure), and took into account 25 lower-order coach behavioral strategies. As an overall measure, the MMCOS has not been used in physical activity contexts. However, among the motivational climate observation systems in the field of sport and PE, it is the one that has demonstrated a high level of validity. This tool is composed of 7 environmental dimensions, which are independent. Coding only 5 of these dimensions does not impede its psychometric properties, as the fidelity parameters (Cohen's Kappa coefficients) reached satisfaction (see Table 1). In addition, it addresses both qualitative and quantitative components of evaluating dimensions.

Each dimension and higher-order factor is rated on a 4-point potency scale, ranging from 0 (not at all), to 1 (weak potency), to 2 (moderate potency), and to 3 (strong potency). Potency is based on the frequency and intensity/quality of the GTAs' communication with students. Decisions about potency ratings are based on a marking scheme, which includes anchor descriptions, as well as a list of 25 behavioral strategies that are believe to be differentially indicative of each of the environmental dimensions. For example, the following indicators are used for autonomy support: "acknowledges feelings and perspectives, provides meaningful choice, encourages intrinsic interest, provides rationale for tasks/requests/constraints, provides opportunity for player input, and encourages initiative taking" (Smith et al., 2015, p. 22). Validity and reliability of the measure was established in Smith et al. (2015), which included favorable levels of discriminant and predictive validity as well as inter-rater and intra-rater reliability.

Each GTA was recorded during his or her 50-min activity class on 12 separate occasions (2 for baseline and 10 during the intervention). Baseline scores were averaged into one measurement. Each recorded class was split into 4 equal timeframes and a total score (i.e., the mean of the 4 timeframes) was calculated for each behavior based on this division. For each of the 5 environmental dimensions observed, coders were asked to identify the presence of the lower-order behavioral strategies (via a checkmark), which were then used to inform their potency rating at the end of that block of time.

6.2.2. Perceptions of autonomy support

The 15-item Learning Climate Questionnaire (LCQ; Black & Deci, 2000) was used to assess students' perceived autonomy support. Students rate items related to their perceptions of their instructor on a 7 point Likert scale, anchored with 1 = strongly disagree, 4 = neutral, and 7 = strongly agree). Sample items include, "I feel that my instructor provides me choices and options," and "My instructor tried to understand how I see things before suggesting a new way to do things". Scoring of the questionnaire involved averaging all items into a total score. Previous research has tested the validity and reliability of the survey for use in college courses, finding a Cronbach's alpha of 0.93 (Black & Deci, 2000).

6.2.3. Self-regulation questionnaire

The Self-Regulation Questionnaire for Exercise (SRQ-E; Ryan & Connell, 1989) was used to assess why students exercise or engage in physical activity regularly. Specifically, the degree to which the individual feels autonomous in their decision to exercise or engage in physical activity was used. This measure was chosen based on the overall program goals in addition to its use in previous investigations of college-age students (Puente & Anshel, 2010). Participants indicate their reasons for exercising on 16 questions rated on a 7-point Likert scale ranging from 1 (not true at all) to 7 (very true). Sample items include "Because others would be angry at me if I did not (external regulation)", "Because I would feel bad about myself if I did not (introjected regulation)", "Because I feel like it's the best way to help myself (identified regulation)", and "Because it's a challenge to accomplish my goal (intrinsic motivation)". Scoring involves taking the average of the items in each of the constructs (external regulation, introjected regulation, identified regulation, and intrinsic motivation). Previous literature on reliability has reported a Cronbach's alpha of each category to range from 0.62 to 0.82. Validity of the measure was also evaluated in Ryan and Connell (1989) showing factorial validity of constructs.

6.3. Procedure

The study was conducted over the period of 9 months, March 2014 to December 2014, with baseline teaching videos collected in the spring semester 2014. The intervention did not begin until August 2014, corresponding with the beginning of the fall semester. Specific activities of the training program are highlighted below. For technical reasons it was not possible to assess students' motivation at pre-test. Students were given a survey to assess motivation during the 7th and 8th months of the program; roughly 10–14 weeks after the fall training began. See Fig. 1 for an illustration of the study timeline.

6.3.1. Training program

After IRB approval, baseline teaching videos were collected on the GTAs in the spring semester. This was to guarantee that each GTA had plenty of time to establish rapport with students and become comfortable with day-to-day teaching tasks. At the beginning of the fall semester, the GTAs received two 2-h training sessions on need supportive teaching that closely follows previous interventions in physical education (Su & Reeve, 2011). The two training sessions were given by the primary researcher who was well versed in the literature on autonomy support, had direct experience working with PE teachers and coaches in previous studies, and had experience implementing autonomy supportive teaching in PE and college courses. The needs support training was integrated into the normal training sessions given by the physical activity program directors. The regular fall training session as a whole lasted one week and focused on course content review, lesson planning, teaching demonstrations, proper teaching practices, and administrative tasks. In addition to the initial training sessions, the primary researcher met with each GTA on a tri-weekly basis to further discuss implementation of need supportive behaviors as well as provide feedback from video recordings.

The first 2-h training session consisted of a general overview of SDT and how teachers are able to influence student performance in general via use of need supportive behaviors. A lecture presentation format was utilized, along with several group activities. The first activity involved asking each teacher to briefly write about a teacher who was motivating, one who was not motivating, and one who was their favorite (Niemiec, 2013). Based on their responses, themes of autonomy, competence, and relatedness were drawn. It was explained to the GTAs that they could have just as strong of an influence on the students they were about to teach by drawing on the more positive aspects of their own experiences with motivating teachers. The primary researcher then explained what need support is, how teachers can provide it as well as the most recent research evidence to support it. To further highlight exactly how the GTAs could be need supportive, a collection of videos was presented that demonstrated common autonomy supportive behaviors: nurturing inner motivational resources, relying on informational, non-controlling language, communicating value and providing rationales, acknowledging and accepting students' expressions of negative affect, and patience. Video clips showing controlling behaviors were also presented. These example clips were taken from the baseline videos that were recorded in the spring semester. To conclude the first session, a discussion about structure was given to help GTAs understand that autonomy support was not simply allowing students to do whatever they wanted in classes. The ideas of clarity of expectations along with freedom of choice were emphasized.

The second 2-h training session focused on lesson planning and how to integrate the specific need supportive behaviors into every aspect of the course. For this, a brief review of what to plan for was given, including writing learning objectives, taking attendance, activity warm-ups, individual learning tasks, game-play (where applicable), management routines, and class closure. GTAs were then split into groups by type of course taught: team sport, individual sport, and fitness activities. Within in each group, examples of how to apply the need supportive behaviors to the various aspects of their courses were explored. Feedback was given to the participants by the primary researcher to aid in their understanding. To end the second session, the primary researcher presented information on other instructional concerns, such as use of enthusiasm and sarcasm in teaching, various physical education instructional models (Metzler, 2011) that work well with need supportive teaching, effective ways to check for understanding, as well as how to deal with the potential internal frustration of implementing the behaviors as a beginning teacher.

As mentioned above, tri-weekly meetings with each GTA were conducted to focus more specifically on each need supportive behavior. Throughout the remainder of the intervention, a three week schedule was followed, whereby GTAs would meet in small groups (2–4 GTAs at a time) with the primary researcher in week 1 and then have two classes recorded during the second and third weeks of the cycle. In this way, 5 cycles were completed. In the first

Table 1
Range of correlational strength between variables across measurement occasions, correlation means, and Cohen's Kappas of instructors' behavior measurements.

	1	2	3	4	5
1-Autonomy Support	0.88	−0.72** (−0.43; −0.83)	0.87** (0.77; 0.93)	−0.46 (−0.23; −0.67)	0.34 (−0.13; 0.72)
2-Control		0.87	−0.69* (−0.43; −0.92)	0.34 (0.01; 0.76)	−0.31 (−0.63; 0.25)
3-Relatedness Support			0.83	−0.36 (−0.08; −0.64)	0.24 (−0.14; 0.53)
4-Relatedness Thwarting				0.77	−0.53 (−0.03; −0.76)
5-Structure					0.78

Note: The Cohen's Kappas are in the diagonal, and the range of correlational strength between variables is in brackets.

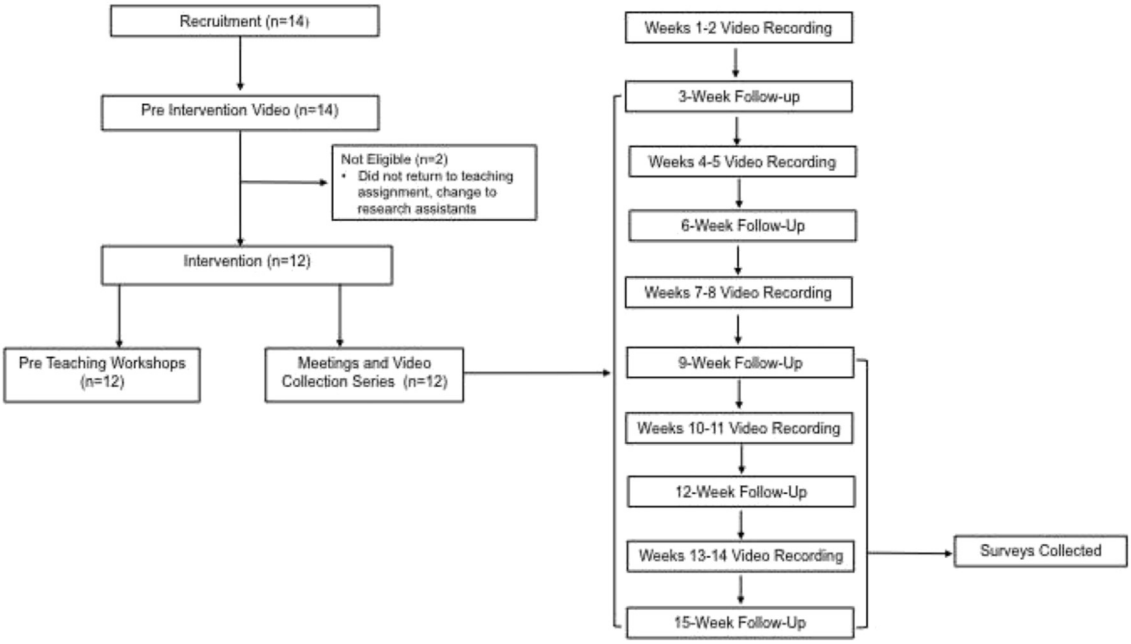

Fig. 1. Timeline of need support training.

meeting, GTAs were familiarized with a website that provided further information and self-study materials for the need supportive behaviors. Self-study materials included relevant research studies for each behavior and lesson planning activities, outlined below. GTAs were then instructed on how the behaviors have been used in several contexts, including physical education, sport, and exercise. After the first meeting, all meetings followed the same format: feedback was given to GTAs about what was observed on videos taken in the previous cycle, areas of improvement were identified, a new behavior was presented, and "homework" assigned. The last training meeting gave closure to the process as a whole and GTAs were instructed to write formal reflections on their experiences across the spring and fall semesters.

To further assist the GTAs in organizing their classes appropriately, meetings focused on implementing an autonomy supportive and structured class environment. Each meeting concentrated on the behaviors in order of presentation in the initial training session, with numbers indicating at which meeting the behavior was focused on: nurturing inner motivational resources (2), relying on informational, non-controlling language (3), communicating value and providing rationales (4), acknowledging and accepting students' expressions of negative affect (5), and patience (5). In addition, ways to incorporate these autonomy supportive behaviors within the confines of proper structure (i.e., organization, instruction for learning and guidance), was discussed. To providing further information on need supportive behaviors, individual verbal feedback was given on what was observed in the baseline videos taken in the spring semester. This feedback was given verbally. Efforts were also made to address need-undermining behaviors within these sessions. Each GTA was given 2–3 specific characteristics to focus on in their teaching before the next training meeting. Each meeting concluded with the assignment of "homework" where the GTAs would provide the primary researcher with a written plan of how they would implement the learned behavior in their teaching. It is important to note that, when needed, the GTAs were shown clips of their own previous teaching that either highlighted need supportive or need thwarting behaviors. As these meetings were done in groups, GTAs were able to view others' video clips at the same time.

6.3.2. Video analysis

A total of ten possible recordings were completed for each instructor over the course of a semester. The first two weeks of each cycle were used for recording two class sessions. Class sessions were recorded using either an iPad device or a video camera. Each participant was connected to a remote microphone in order to enhance their voice and eliminate the majority of the noise from the students and class setting. Recordings were uploaded to an encrypted external hard drive daily and securely stored in a locked cabinet of the primary investigator's office. Each recording was deleted from the iPad or video camera after it was uploaded in order to maintain a high level of security and confidentiality. GTAs were unaware of when the researchers would be coming in to record their teaching.

Four independent raters were trained to evaluate the behaviors of interest. Rater 1 was the primary researcher, who has extensive experience in using systematic observation in conducting research using self-determination theory. Raters 2 and 3 held master's degrees in physical education and public health, respectively. Rater 2 had extensive experience using systematic observation instruments. Rater 4 was a research assistant in a master's program and was heavily trained by the primary researcher in using systematic observation prior to the current study. Training took approximately 4 h and included viewing a variety of teaching episodes to allow raters to see the potential variation in use of the behaviors of interest. After training, an inter-rater reliability of 0.83 was reached. From that point, video watching was split between the 4 raters such that each video had two raters assigned.

The four independent raters were paired and the twelve participants were split into two randomly assigned groups for the paired raters to watch over the course of the semester. The two possible recordings for each cycle were watched by the raters prior to the training session of each participant during the third and final week of each cycle. Raters used the MMCOS (Smith et al., 2015) to rate each video recording. The raters were not aware of which video in the tri-weekly series came first. Means of the 4 quarters' scores

per video were used for analysis. It also important to note that each video was watched in a private office or room in order to maintain confidentiality of the video and audio components.

6.4. Data analysis

To test our hypotheses, multilevel analyses were used, as they are more appropriate than ordinary least squares models. Due to the nesting of time measurements within teachers, the possibility of dependencies in the data was raised (Bryk & Raudenbush, 1992). Even with such a small sample (n = 12), it has been recently demonstrated that multilevel analyses handle dependency (e.g., an individual's outcome scores are related to their scores at each subsequent time point) and missingness (e.g., any instance of the date is missing) in longitudinal data more efficiently than repeated measures analysis of variance (Muth et al., 2016). Thus, multilevel analyses were performed using SPSS version 21 (SPSS Inc., NY).

Linear mixed models (LMM) are commonly used to understand changes in human behavior over time. LMM suggests that the rate of growth remains constant over time. However, as it is also possible that the growth rate might not be the same over time, quadratic and cubic growth models were systematically compared to linear models. A quadratic change trajectory has no constant common slope (i.e., acceleration/deceleration over time) and consists of a single stationary point (i.e., a parabola shape). A cubic trajectory has two stationary points, with one peak and one trough (i.e., S-shaped).

Observational data were treated as a two-level hierarchical model consisting of the eleven waves of measurement (i.e., baseline plus 10 waves) at level 1, and GTAs at level 2. The effects of the training program on teachers' motivational style dimensions were examined in series of growth curve analyses. These analyses consisted of the following four steps. Step one involved using an unconditional means model – with only one intercept and no explanatory variable – to partition the variance of each dependent variable into within- and between-teachers components. Because of space constraints, only measure and teacher level variances and the score of −2 log of likelihood (i.e., labeled as reference model) of the unconditional means model are reported in the results tables. In step 2, the variable time was included in an unconditional growth model (Model 1) as a fixed parameter. This allowed for testing to determine whether treatment conditions were effective across time. In step 3, a quadratic parameter was added in the model (Model 2), which determined whether a nonlinear growth model fit the data better than the linear model. Finally, if the quadratic parameter was significant in the model 2, the cubic parameter was added in the model (Model 3). This tested whether the trajectory has a S-shaped curve. The effect size was calculated using a formula adapted from Raudenbush and Liu (2001): $d=(b_{time} + b^2_{time} + b^3_{time})/SD_{raw}$, where b_{time}, b^2_{time}, and b^3_{time} are the rates of growth across time, and SD_{raw} is the standard deviation of raw scores based on baseline data. Standard deviation of raw scores is used instead of standard deviation of change scores in order to control the confounding effect between treatment potency and the strength of the correlation of the different measurement occasions (Raudenbush & Liu, 2001).

The variable time was centered on the baseline measure so that the level-1 intercept represents individual initial status. In addition, to provide a scale for time that fit the data best, the time was clocked on the cycles. As mentioned above, each of 5 cycles was composed of 3 weeks: the first two 2 weeks for observations and the last one for the individual meetings with GTAs. Thus, the first post-training observation was coded 0.33 (i.e., 1/3 of the first cycle), the second one 0.67 (i.e., 2/3 of the first cycle), the third one – which was also the first observation of the second cycle – was coded 1.33 (i.e., 1/3 of the second cycle) and so on, until the tenth observation wave that was coded 4.67 (i.e., 2/3 of the fifth cycle). Analysis was conducted for autonomy support, control, relatedness support, relatedness thwarting, and structure.

To examine the relations between the training and the students' perceived autonomy support and motivational regulations, correlations and partial correlations were performed. First, correlations between students' perceptions and GTAs behavior scores at baseline were compared to those between students' perceptions and GTAs behaviors scores at Time 6–9 (i.e., when these students' perceptions were measured; see Fig. 1). Then, partial correlations examined whether the relations between students' perceptions and GTAs behaviors scores at Time 6–9 were still significant while controlling for baseline measurements. To do so, aggregated scores of perceptions were used; that is, individual scores of perceived autonomy support, intrinsic motivation, identified, introjected and external regulations were averaged across GTAs.

7. Results

7.1. Descriptive statistics and correlations

Table 1 presents the correlation matrix and Cohen's Kappa's of the multiple waves of instructors' behavior measurements. For all categories of behavior at each measurement occasion, results show satisfactory levels of inter-rater reliability, using the criteria of 0.70 for minimum reliability. Correlations reveal that all need-supportive dimensions were negatively correlated to all need-undermining dimensions at each measurement occasion, excepted structure at time 5.

Table 2 presents means, standard deviations, Cronbach's alphas, and correlations between the motivational regulations and perceived autonomy support for the student-participants. Results show satisfactory levels of internal consistency (above 0.70) for the MMCOS, LCQ and the SRQ-E.

Before the main analyses, we also tested for possible associations between instructors' gender and the coded behaviors. Analyses revealed that gender was not significantly associated with the 7 behaviors assessed at baseline.

7.2. Main analyses

Interclass correlation coefficients from unconditional means models were all above 5%, meaning that there was a hierarchical structure of the data and that multilevel analysis was appropriate (Bryk & Raudenbush, 1992).

As for the effect of the intervention on the GTA's behaviors, Models 1 and 2 (see Tables 3 and 4) revealed that every motivational climate dimension significantly changed over time. While autonomy support, structure, and relatedness improved over time, controlling behaviors, and relatedness thwarting were reduced. However, results of models 2 and 3 showed that the rate of change is different across behaviors. The patterns of each behavior are presented in Figs. 2 and 3. For relatedness support ($b_{time} = 0.11$, $p < 0.001$; $|d| = 0.16$) the rate of growth remained constant over time (i.e., linear). Visual inspection of the graphs[2] shows that the pattern increases progressively from about 1.5 at baseline to about 3 at the last measurement occasion. For autonomy support ($b_{time} = 0.36, p < 0.001$; $b^2_{time} = -0.05, p < 0.01$; $|d| = 0.22$), structure ($b_{time} = 0.28$, $p < 0.001$; $b^2_{time} = -0.04$, $p < 0.01$; $|d| = 0.10$), and

[2] The scores on the graphs are not the "true" scores but an estimation based on the estimates given by multilevel growth models. However, these scores are close to the "true" ones as the coding of the time has been chosen to fit the data best.

Table 2
Means, standard errors, Cronbach's alphas and correlations between the motivational regulations and perceived autonomy support.

	M	S.E.	Perceived autonomy support	Intrinsic Motivation	Identified regulation	Introjected regulation	External regulation
Perceived Autonomy Support	5.92	0.97		0.21***	0.28***	0.05	-0.05
Motivational Regulations (n = 828)			0.82				
Intrinsic Motivation	5.09	1.28		0.81	0.82***	0.42***	0.07
Identified Regulation	5.44	1.19			0.85	0.48***	0.09
Introjected Regulation	3.27	1.36				0.80	0.54***
External Regulation	1.83	0.97					0.79

Note. The Cronbach's alphas are in the diagonal.
*** p < .001.

relatedness thwarting ($b_{time} = -0.31$, $p < 0.001$; $b^2_{time} = 0.04$, $p < 0.01$; $|d| = 0.11$), the rate of growth was quadratic. The pattern of these behaviors changed (i.e., improving for need supportive behaviors and decreasing for need undermining behaviors) until the third or fourth cycle, and then leveled off. Finally, the control rate of growth was cubic ($b_{time} = -0.78$, $p < 0.001$; $b^2_{time} = 0.30$, $p < 0.01$; $b^3_{time} = -0.04$, $p < 0.05$; $|d| = 0.39$); the use of controlling behaviors decreased during the 2 first cycles, then it leveled off during the third and the fourth cycles, and it decreased again during the last cycle.

To examine change in quadratic trajectories, we used a contrast term suggested by Willett (1997) to create a "piecewise" growth function. It consisted in introducing a time-varying dichotomous predictor – named *D* – coded so that it takes on value 0 before the stationary point, and value 1 at the stationary point and beyond. This ensures that estimate of the main effect of time represents the rate of change before the stationary point; the main effect of *D* represents any sudden vertical elevation at the stationary point; and the interaction effect between time and D represents the rate change from the stationary point. On the graphs, the stationary point for autonomy support, structure, and relatedness thwarting is identical, at point 7. The results are presented in Table 5, and showed that for these three behaviors the rate of change is significant from baseline to point 6 ($b = 0.22$; 0.19; and −0.19, respectively for autonomy support, structure, and relatedness thwarting) and became non significant from point 7 ($b = -0.17$; −0.19; 0.12, respectively for autonomy support, structure, and relatedness thwarting).

To examine change in the cubic trajectory of controlling behavior, as there are two stationary points, the introduction of a time-varying dichotomous predictor was not appropriate. Thus, the cubic trajectory was split in three segments, at the two stationary points (i.e., points 3 and 8), which allowed us to examine the rates of change of these three segments separately. Results showed that from point 0 to 3 the rate of change of control was significant ($b = -0.52$, $p < 0.001$); between point 3 and point 8 the rate of change of control was not significant ($b = 0.02$, *ns*); and from point 8 to the end, the rate of change of control was significant ($b = -0.15$, $p < 0.05$).

In determining the potential influence of the intervention on student perceptions of autonomy support and motivational regulations, bivariate correlations and partial correlations were run. Correlations between GTA's behaviors and students' perceptions (motivational regulations and perceptions of autonomy support) generally increased from baseline to Time 6–9 (see Table 6). More specifically, correlations between autonomy support and identified regulation, external regulation and perception of autonomy support increased across time to become significant at Time 6–9 ($r = 0.66$; −0.53 and 0.65, respectively; $p < 0.05$). Correlations between controlling behaviors and identified, introjected and external regulations as well as perception of autonomy support increased across time, becoming significant at Time 6–9 ($r = -0.59$; 0.57; 0.53 and −0.50, respectively; $p < 0.05$). Correlations between relatedness support and perception of autonomy support increased across time, becoming significant at Time 6–9 ($r = 0.55$; $p < 0.05$). Similarly, correlations between relatedness thwarting and intrinsic motivation, identified and external regulations as well as perception of autonomy support increased across time as well, becoming significant at Time 6–9 ($r = -0.78$; −0.71, 0.60 and −0.58, respectively; $p < 0.05$). Finally, correlations between structure and intrinsic motivation, identified and external regulations as well as perception of autonomy support increased across time, showing significance at Time 6–9 ($r = 0.77$; 0.78; −0.50; and 0.70, respectively; $p < 0.05$).

Among the significant partial correlations, GTA provision of autonomy support still positively predicted identified regulation ($r = 0.50$; $p < 0.05$), while controlling for baseline score of autonomy support. GTAs' controlling behaviors still negatively predicted identified regulation ($r = -0.57$; $p < 0.05$) and perception of autonomy support ($r = -0.53$; $p < 0.01$) and positively predicted introjected ($r = 0.54$; $p < 0.05$) and external ($r = 0.45$; $p < 0.01$) regulations, while controlling for baseline score of control. For relatedness support, GTAs' behaviors positively predicted students' perception of autonomy ($r = 0.40$; $p < 0.05$), while controlling for baseline score of relatedness support. Relatedness thwarting was positively related to intrinsic motivation ($r = -0.66$; $p < 0.01$) and identified regulation ($r = -0.71$; $p < 0.01$), while controlling for baseline score of relatedness thwarting. Finally, structure was positively related to intrinsic motivation ($r = 0.67$; $p < 0.01$), identified regulation ($r = 0.70$; $p < 0.05$) and perception of autonomy support ($r = 0.65$; $p < 0.05$), while controlling for baseline score of structure.

8. Discussion

8.1. Effects of the training program on motivational climate dimensions

The main purpose of this study was to examine the effect of the training on the GTAs' behaviors across multiple waves of measurement. Within each dimension, it is clear that improvement was seen. This is in accordance with the meta-analysis of Su and Reeve (2011) who reported that short training sessions (i.e., around 3 h duration) were relatively most effective. This means that the change of teaching skills is quick; teachers do not need long sessions of training to improve their behaviors. For autonomy support, which was the major focus of the training materials, improvement was gradual, reaching its highest point at observation 7. From there,

Table 3
Results of multilevel analysis for autonomy support, structure, and relatedness support.

Parameter	Autonomy support		Structure		Relatedness support	
	Model 1 Estimate (SE)	Model 2 Estimate (SE)	Model 1 Estimate (SE)	Model 2 Estimate (SE)	Model 1 Estimate (SE)	Model 2 Estimate (SE)
Fixed effect						
Intercept	1.75 (0.19)***	1.59(0.19)***	2.32 (0.10)***	2.20(0.11)***	1.59(0.20)***	1.47(0.21)***
Time	0.12 (0.02)***	0.36(0.08)***	0.11 (0.02)***	0.28(0.07)***	0.11(0.03)***	0.28 (0.10)**
Time × Time		−0.05 (0.02)**		-0.04 (0.02)*		−0.04 (0.02)
Random effect (Unconditional means Model)						
Measure level variance	0.19 (0.03)***		0.15(0.02)***		0.26(0.03)***	
Teacher level variance	0.36 (0.15)*		0.08 (0.04)*		0.43 (0.19)*	
Random effect (Models 2 and 3)						
Measure level variance	0.16 (0.02)***	0.15(0.02)*** (0.29)***	0.12 (0.02)***	0.11(0.01)***	0.23(0.03)***	0.22(0.03)***
Teacher level variance	0.36 (0.15)*	0.36 (0.15)*	0.08 (0.04)*	0.08 (0.04)*	0.43(0.19)*	0.43 (0.18)*
Test of significance						
Reference model	190.92		142.25		227.85	
Deviance test model	168.87	160.16	114.24	108.19	213.04	210.00
χ^2 (df)	22.05(1)***	8.71()**	28.1(1)***	6.05(1)*	14.81(1)***	3.04(1)

*p < 0.05, **p < 0.01, ***p < 0.001. Model 4 is not significant.

Table 4
Results of multilevel analysis for control and relatedness thwarting.

Parameter	Control			Relatedness thwarting	
	Model 1 Estimate (SE)	Model 2 Estimate (SE)	Model 3 Estimate (SE)	Model 1 Estimate (SE)	Model 2 Estimate (SE)
Fixed effect					
Intercept	1.31 (0.16)***	1.44 (0.17)***	1.57 (0.18)***	0.72 (0.11)***	0.85 (0.13)***
Time	−0.13(0.02)***	−0.33 (0.09)***	−0.78 (0.21)***	−0.11(0.03)***	−0.31 (0.09)***
Time x Time		0.04 (0.02)*	0.30 (0.11)**		0.04 (0.02)*
Time × Time × Time			−0.04 (0.02)*		
Random effect (Unconditional means Model)					
Measure level variance	0.23 (0.03)***			0.22 (0.03)***	
Teacher level variance	0.26 (0.12)*			0.09 (0.05)*	
Random effect (Models 2 and 3)					
Measure level variance	0.18 (0.02)***	0.17 (0.02)***	0.17 (0.02)***	0.19 (0.02)***	0.18 (0.02)***
Teacher level variance	0.27 (0.12)*	0.27 (0.12)*	0.27 (0.12)*	0.09 (0.05)*	0.09 (0.05)*
Test of significance					
Reference model	205.00			193.08	
Deviance test model	179.61	174.48	169.01	174.99	170.32
χ^2 (df)	25.39(1)***	5.13(1)*	5.47(1)*	18.09(1)***	4.67(1)*

*p < 0.05, **p < 0.01, ***p < 0.001. Model 4 is not significant.

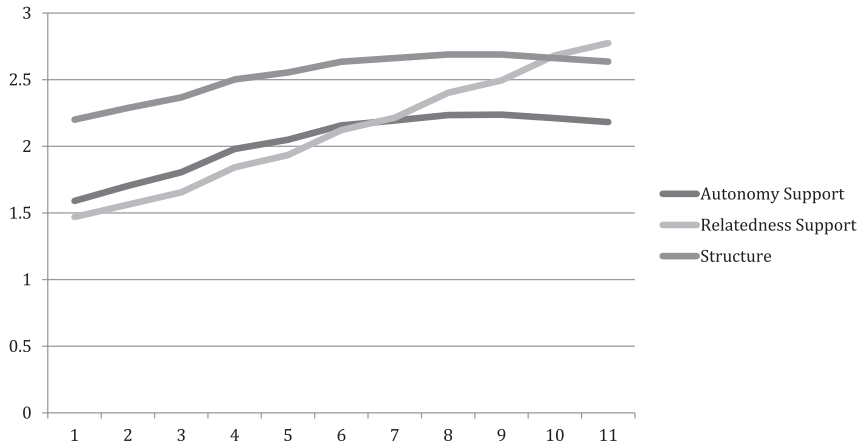

Fig. 2. Teachers' autonomy support, relatedness support, and structure behaviors across time. Numbers are mean score. Along the x-axis, 1 is the baseline measurement, and 2–11 are measurements taken during the intervention.

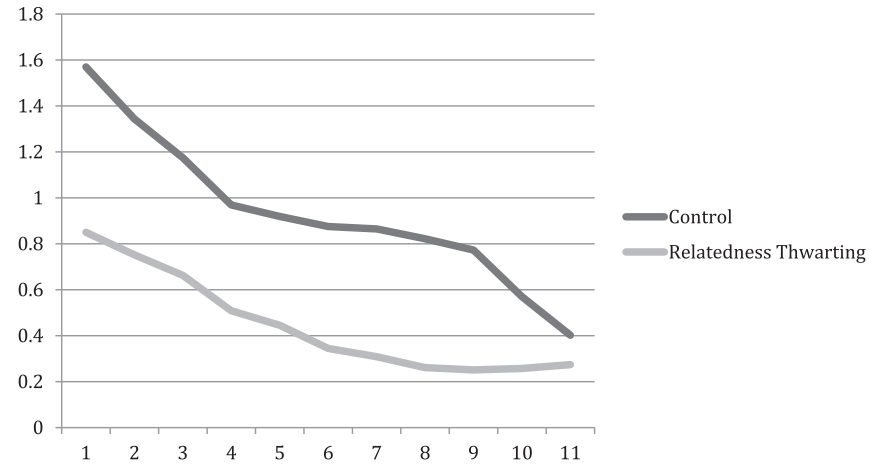

Fig. 3. Teachers' control and relatedness thwarting behaviors across time. Numbers are mean scores. Along the x-axis, 1 is the baseline measurement, and 2–11 are measurements taken during the intervention.

Table 5
Results of multilevel analysis for rate of change of quadratic trajectories.

Parameter	Autonomy support Estimate (SE)	Structure Estimate (SE)	Relatedness thwarting Estimate (SE)
Fixed effect			
Intercept	1.65 (0.19)***	2.23 (0.10)***	0.80 (0.12)***
Time	0.22 (0.04)***	0.19 (0.04)***	−0.19 (0.05)***
D	0.32 (0.45)	0.49 (0.37)	−0.19 (0.49)
Time × D	−0.17 (0.12)	−0.19 (0.10)	0.12 (0.13)
Random effect			
Measure level variance	0.15 (0.02)***	0.11 (0.01)***	0.18 (0.02)***
Teacher level variance	0.36 (0.15)*	0.08 (0.04)*	0.09 (0.04)*

$p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.
Note. D is a time-varying dichotomous predictor coded 0 before the stationary point (i.e., 7), and 1 at the stationary point and beyond. For control, complementary analysis revealed that from point 0 to point 3, b_{time} = -0.52***; from point 3 to point 8, $b_{time} = 0.02$, ns; from point 8 to point 10, $b_{time} = -0.15$*.

Table 6
Results of correlations and partial correlations for students' motivational regulations and perceived autonomy support.

	Intrinsic Motivation	Identified regulation	Introjected regulation	External regulation	Perceived autonomy support
Autonomy Support					
Baseline	0.13	0.35	0.00	−0.10	0.43
Time 6-9	0.30	0.66 *	−0.22	−0.53 *	0.65 *
Partial Correlation	0.23	0.50*	0.32	−0.48	0.33
Control					
Baseline	0.08	−0.06	0.09	0.15	−0.09
Time 6-9	−0.38	−0.59 *	0.57 *	0.55 *	−0.50 *
Partial Correlation	−0.42	−0.57*	0.54*	0.45**	−0.53**
Relatedness Support					
Baseline	0.02	0.14	−0.09	0.05	0.20
Time 6-9	0.32	0.49	−0.40	−0.43	0.55 *
Partial Correlation	0.30	0.46	−0.34	−0.44	0.40*
Relatedness Thwarting					
Baseline	−0.30	−0.40	0.01	0.27	−0.36
Time 6-9	−0.78 *	−0.71*	0.45	0.60 *	−0.58 *
Partial Correlation	−0.66**	−0.71*	0.44	0.53	−0.52
Structure					
Baseline	0.29	0.42	−0.16	−0.34	0.41
Time 6-9	0.77*	0.78 *	0.39	−0.50 *	0.70 *
Partial Correlation	0.67**	0.70*	0.49	−0.33	0.65*

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

potency of the dimension remained high, but leveled off. This indicates that GTAs were able to maintain high levels of autonomy support, lending credence to the idea that multiple meeting sessions support continued autonomy support use. In addition, there is room to consider a ceiling effect. At the end of the semester, the autonomy supportive score was close to the top of the scale. In this case, it was difficult for the GTAs to improve to perfect scores, which comprise the autonomy support dimension. The same can be said for the structure and relatedness thwarting.

Potency levels in the structure dimension remained high, which

is promising considering the general timeline of the courses. For example, in the sport skill courses, skill progressions in the beginning of the semester led to small-sided game play and tournaments in the latter parts of the semester. Although the tasks changed, the level of structure and autonomy support remained relatively steady. Further, as structure refers both to the setting of clear expectations and guidelines before the engagement in the activity, and to the provision of instructions to help overcome problems encountered during the activity (Haerens et al., 2013), the provision of structure in PE and sport domain is based on pedagogical content knowledge (PCK) related to the activity taught (Ward, 2013), and it is probable that extending PCK is a prerequisite to the change in the provision of structure.

In looking at relatedness thwarting the pattern of change indicated that GTAs use of behaviors in this dimension dropped drastically and then leveled off. This could be due to the consistent feedback being given in each cycle of the intervention. The feedback given reinforced the use of need supportive strategies while simultaneously addressing where and why relatedness thwarting and need undermining behaviors might not be effective. As mentioned in the description of the intervention, strategies for decreasing need-undermining behaviors were addressed in the tri-weekly meetings with GTAs. Using video footage, it was possible to show GTAs exactly where such behaviors were exhibited, explain the reactions of the students, and then help the GTAs to come up with potential solutions. The idea that improvements such as these could be a side effect of the training are substantiated and support results found in previous work with physical educators (Aelterman et al., 2014; Cheon et al., 2016).

The cubic trajectory of the controlling dimension is interesting to note. Potency levels of controlling behaviors tended to decrease during the two first cycles, leveled off during cycles 3 and 4, and then decreased sharply in the last cycle. A similar trend was observed in PE (Tessier et al., 2008) and in sport (Tessier et al., 2013). As noted by Reeve (2009), controlling behaviors are difficult to reduce, which supports the leveling off of behaviors in cycle 3 and 4. The subsequent sharp decrease after cycle 4 could be explained by the focus on accepting negative affect and patience in the tri-weekly meetings. At that point in the training, GTAs tended to begin accepting comments from students more positively in addition to providing more general encouragement, instead of feeling stressed and threaten by such sudden and unexpected behaviors from students. Teachers tend to rely frequently on control strategies during instruction because several forces (e.g., societal expectations, cultural norms, personality disposition and beliefs, or students disruptive behaviors) favor such behaviors to enact. GTAs occupy an inherently powerful position in the social context. To the extent that such an inherent power differential exists, students who are one-down in the power relationship are vulnerable to being controlled by teachers who are one-up in the power relationship. As this inequitable relationship cannot be changed by training, the prevalence of controlling behaviors is difficult to reduce. The fact that behaviors continued to decrease over time, with latter observations showing very little use of control, is promising.

Finally, relatedness support followed linear trajectories in a positive direction. Steady increases in the potency of these dimensions were observed, which indicates again that the individual training sessions were effective. The linear nature of the improvement could also be explained by the continued developing relationship between GTAs and their students. It is possible that the separate training sessions provided GTAs with the information to better connect with their students, although the steady nature of improvement makes it difficult to interpret exactly which portion of the training was most effective.

There were some unique features of the training program that allowed for the success of the intervention as a whole. The six key characteristics of the relatively more effective interventions mentioned by Su and Reeve (2011) were implemented. The training was delivered in multiple sessions, included a group discussion component, offered support from the researcher-instructor, emphasized not only content but also skill-based training, and addressed teachers' pre-training beliefs about motivating style. In addition, two innovative key components were added. First, the training content was delivered in a sequential and slowly-paced manner in order to favor its integration. GTAs were able to work through learning about each aspect of need supportive teaching for at least two weeks before the next concept was highlighted. Second, individualized guidance was proposed to each GTA consisting of feedback about what was observed on videos taken in the previous cycle, which helped to identify areas of improvement in a timely manner. This latter component of the training gave GTAs an opportunity to constantly reflect on their teaching, and certainly helped them to reduce the frequency of need-undermining behaviors. Further, success of the training protocol itself could be due to the fact that it was grounded in autonomy supportive teaching as well (Aelterman et al., 2013). Although high standards were given for instruction, the administrators of the program allowed GTAs to have autonomy in the choice of skills and how they were presented to students.

9. Influence on perceived autonomy support and student motivation

Although baseline data of students' perceptions was not available, we can infer from results of bivariate and partial correlations that the intervention positively influenced students' perceptions of autonomy support and motivational regulations. As the correlations between students' perceptions and GTAs' behaviors measured at Time 6–9 are stronger than those between students' perceptions and GTAs' behaviors measured at baseline, and that many partial correlations are significant, these results allow to us to deduce that students' motivation and perceptions of autonomy support improved across time, as GTAs became more need supportive and less need thwarting. Results seem to indicate that the intervention was successful in influencing students to become more autonomously motivated in their activity courses in addition to providing credible evidence of the fidelity of the training program. However, future research should confirm this inference measuring students' perceptions at baseline.

10. Limitations

A potential limitation of this study was that it included second year GTAs who only had experience teaching in the program involved in the study. This may limit generalizability to other programs that do not employ a large number of graduate students to teach courses. The intervention had a stronger focus on strategies that enhanced students' basic psychological needs, with only some focus on need undermining behaviors. The discussion of need-undermining behaviors occurred more often in the tri-weekly meetings, but still were not the main focus. Results should be interpreted with this limitation in mind. Also, although participants experienced an increase in need supportive behaviors, the lasting effects of the intervention cannot be determined by this study alone. Thus, future research should investigate the potential durability of such interventions. GTAs and raters were aware of the purpose of the study. Although every attempt was made to achieve and maintain reliability and fidelity of the data (including not making GTAs aware of exactly when they would be filmed), the

issue of demand effects cannot be ignored. Finally, the lack of a control group in this study limits the interpretation of the effectiveness of the intervention. In addition to investigating the durability of the intervention, future investigations should also include a control group to determine definitive effects.

11. Summary and conclusion

One of the major results is that the motivational climate created by the GTAs was improved across the duration of the study. By showing a significant improvement in the GTAs' ability to provide autonomy support, relatedness support, structure, and general need supportive dimensions, this study reinforces the results of the previous intervention studies grounded in SDT in the PE domain (Cheon et al., 2012; 2014, Cheon & Reeve, 2013, 2015; Aelterman et al., 2013; Tessier et al., 2008, 2010). In addition, this study supports the notion that need supportive focused training also helped teachers (i.e., GTAs) to reduce observed need-undermining behaviors (i.e., controlling behaviors and general need undermining dimensions). As the present study does not consider AGT constructs, the measure could provide further information in the future that is specific to the college and university physical activity course setting if its' full dimensions are used.

This study showed that novice GTAs reap benefits from teacher training in being able to cultivate a structured, yet supportive environment, with less reliance on controlling behaviors. An inherent strength to this study is the number of data points collected for the GTAs. Although previous work has shown the general effects of training, none have done so in a manner that shows a dynamic and consistent pattern to the level of improvement in behaviors. More specifically, results revealed that the behavioral change process could follow both linear and nonlinear patterns. This change pattern is narrowly related to the key components of the training, especially the two training sessions delivered early in the semester followed by individualized guidance, the skill-based training emphasized at least as much as content-based knowledge, and the group discussions that supported GTAs' basic psychological needs and to address their pre-training beliefs.

The lack of pre-test measure of students' perceptions does not guarantee that the intervention had an effect on students' motivation and perceived autonomy support, and thus did not inform on whether the students were sensitive to the GTAs' behavioral change. Thus, future research should focus more on the potential effects of such a training program on students by measuring the change of perceived motivational climate and motivation in multiple occasions. Although more study is needed, this investigation provides preliminary evidence that this type of training program can be helpful in preparing GTAs to teach in college and university instructional physical activity programs in a way that influences students' autonomous motivation.

Funding

This project was funded by the ADA Badminton and Tennis Company's College and University Instructional Physical Activity Program (C/UIPAP) Research Award.

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