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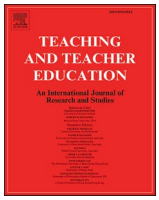

Research paper

Learning how to become an autonomy-supportive teacher begins with perspective taking: A randomized control trial and model test☆

Johnmarshall Reeve [a,*], Sung Hyeon Cheon [b,**]

[a] Institute for Positive Psychology and Education, Australian Catholic University, Australia
[b] Department of Physical Education, Korea University, Republic of Korea

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ABSTRACT

Using self-determination theory, we sought to explain how teachers learn autonomy-supportive teaching. We randomly assigned 28 teachers (35.3 years-old, grades 7–9) and their 1566 students (13.4 years-old, 50.8% female) to participate or not in an autonomy-supportive teaching workshop. Teacher participation in the workshop increased autonomy-supportive teaching. Results from a multilevel structural equation modeling analysis showed that teachers in the experimental, compared to the control, condition first learned perspective taking skill, then learned the three teaching practices of interest support, value support, and lesser teacher control, which then explained their students' year-end gains in need satisfaction and declines in need frustration.

Teachers want to provide highly motivating classroom instruction. To do this, many approaches to teaching are possible (Aelterman et al., 2019; Wubbels et al., 2006). But one approach with a strong empirical track record for promoting students' classroom motivation and engagement is autonomy-supportive teaching. For instance, empirical studies, systematic reviews, and meta-analyses collectively confirm that greater autonomy-supportive teaching enhances students' need satisfaction, intrinsic motivation, effort and engagement, learning and skill development, prosocial behavior, academic achievement, and well-being and lessens students' amotivation, need frustration, apathy and disengagement, antisocial behavior, and problematic relationships (Aelterman et al., 2019; Bureau et al., 2022; Lochbaum & Jean-Noel, 2016; Patall, 2019; Patall et al., 2013; Reeve & Cheon, 2021; Teixeira et al., 2020; Vasconcellos et al., 2020; Vasquez et al., 2016). This successful track record inspired a surge in intervention research to answer two questions: (1) Can teachers learn autonomy-supportive teaching? and (2) If yes, will their students benefit? As suggested above, most studies prioritized answering the second question, but the first question is equally important. In the present study, we addressed both questions but prioritized the first. Specifically, the purpose of the present investigation was to propose and test a hypothesized model to explain the process teachers go through to successfully learn the autonomy-supportive teaching practices that explain their students' year-end gains in need satisfaction and declines in need frustration.

1. Autonomy-supportive teaching

Autonomy-supportive teaching (AST) is the instructional effort to identify and nurture students' interests and preferences so that students become increasingly able to volitionally engage themselves in classroom learning activities (Aelterman et al., 2019). As shown in Fig. 1, AST emerges out of the two preconditions of a basic attitude to be curious about and receptive to students' emerging interests and concerns (Aelterman & Vansteenkiste, 2023; Vansteenkiste et al., 2019) and an interpersonal tone of consideration (Joussemet & Grolnick, 2023) and understanding (Vansteenkiste et al., 2019). It involves multiple teaching practices, such as perspective taking, supporting students' interests, and providing explanatory rationales (Aelterman et al., 2019; Deci et al., 1994; Mageau et al., 2015; Patall et al., 2018; Vansteenkiste et al., 2019).

Based on the conceptual model proposed by Reeve and Cheon (2021), we proposed that the practice of autonomy-supportive teaching begins with empathic perspective taking. As shown in the lower left of Fig. 1, the more teachers take the students' perspective during

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* Corresponding author. North Sydney Campus, 33 Berry Street, 9th floor, Sydney, 2060, Australia.
** Corresponding author. Anam-dong, Seongbuk-gu, Seoul, 02841, Republic of Korea.
E-mail addresses: johnmarshall.reeve@acu.edu.au (J. Reeve), cheon78@korea.ac.kr (S.H. Cheon).

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instruction, the better positioned they are to then support their students' interest and intrinsic motivation (e.g., by presenting learning activities in need-satisfying ways). Similarly, as shown in the lower right of Fig. 1, the more teachers take the students' perspective, the better positioned they are to then help their students find new value and personal usage (importance) in even monotonous and difficult activities (e.g., by providing explanatory rationales for their requests).

We suggest that the conceptual model of autonomy-supportive teaching practices displayed in Fig. 1 is comprehensive. Nevertheless, many teaching practices have been proposed as autonomy supportive acts of instruction, including all of the following: (a) asking students what they want; (b) being responsive to student-generated questions; (c) listening; (d) communicating perspective-taking statements; (e) asking students about their experience of the lesson; (f) creating opportunities for students to ask questions; (g) being open and responsive to students' opinions and questions; (h) considering students' opinions, preferences, and interests; (i) allowing student input; (j) providing choice; (k) nurturing students' interests; (l) provoking curiosity; (m) providing a variety of activities; (n) teaching in students' preferred ways; (o) encouraging students to take the initiative in their work; (p) teaching students how to set intrinsic goals; (q) allowing students to work in their own way and at their own pace; (r) fostering relevance; (s) allowing criticism and encouraging independent thinking; (t) discussing class values openly; (u) providing opportunities for students to express their concerns; (v) displaying patience; (w) using noncontrolling language; and (x) relying on informational language (Ahmadi et al., 2023; Assor et al., 2002; Deci et al., 1994; Jang et al., 2016; Kaplan & Assor, 2012; Patall et al., 2013, 2017, 2018; Reeve & Jang, 2006). While this is a long list of previously-validated autonomy-supportive instructional behaviors, we suggest that behaviors (a) to (i) all fit into the Fig. 1 category of "perspective taking," behaviors (j) to (q) all fit into the Fig. 1 category of "interest support," and behaviors (r) to (x) all fit into the Fig. 1 category of "value support."

The exception to our claim that this list of autonomy-supportive teaching practices is comprehensive is the omission of controlling instructional behaviors. Controlling teaching is the adoption of a teacher-focused authoritarian attitude and an interpersonal tone of pressure in which the teacher first prescribes what students should think, feel, and do and then applies pressure until students comply to think, feel, or do as they are told (Aelterman et al., 2019; Soenens et al., 2012). What controlling teaching practices have in common (e.g., uttering directives, commanding, yelling, pointing, shaming, introducing contingent rewards, suppressing opinions), is that they frustrate students' psychological needs. In the present investigation, we included controlling teaching in our model for two reasons. First, a self-determination theory model of teaching needs to explain not only students' greater need satisfaction but also their lesser need frustration. Second, autonomy-supportive teaching, and especially perspective taking, tends to re-orient the teacher away from need-suppressing controlling teaching practices toward, instead, need-supportive teaching practices (Levin et al., 2024; Mageau & Joussemet, 2023).

2. Explaining how teachers learn autonomy-supportive teaching

Some autonomy-supportive teaching workshops have worked better than others. That is, some produced relatively large effect sizes showing a strong intervention effect, while others produced only small effects. The least effective interventions tend to be mostly informational sessions to tell teachers what autonomy-supportive teaching is. The more effective interventions also explain the "what?" and "why?" of autonomy-supportive teaching, but they further tend to be skill-based workshops to help teachers master the take-it-to-the-classroom "how to" of autonomy-supportive teaching. To do so, these skill-based interventions used some combination of demonstrational examples (Assor et al., 2018), how-to video modeling (Escriva-Boulley et al., 2018; Huescar et al., 2019), training and practice sessions (Huescar et al., 2019; Zhang et al., 2020), lesson planning (Abula et al., 2020; Perlman, 2015), role playing exercises (Chatzisarantis & Hagger, 2009; Zhang et al., 2020),

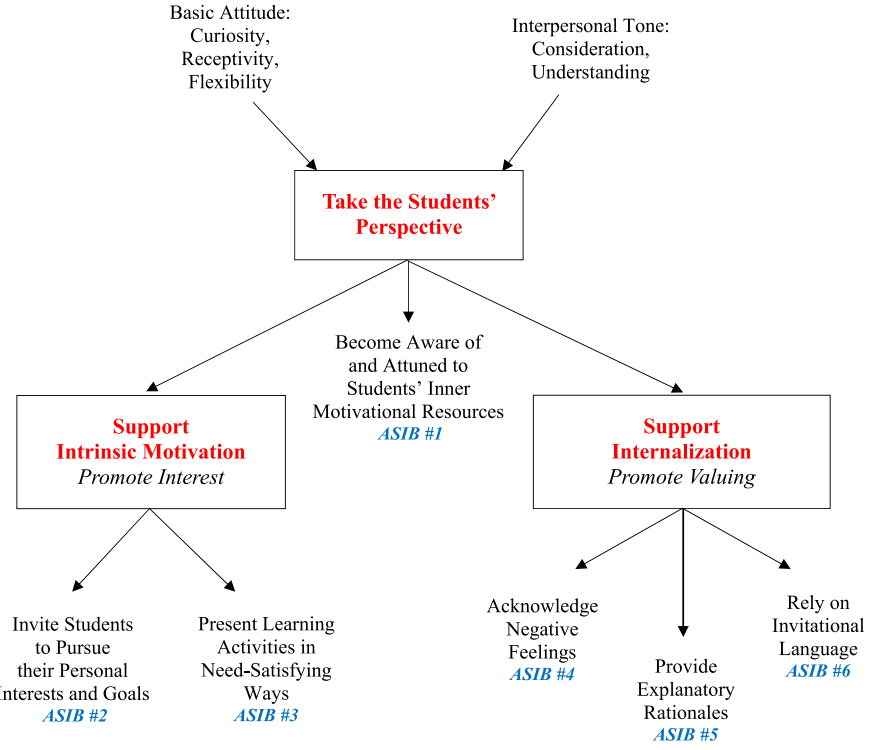

Fig. 1. Conceptual Representation of the Nature of Autonomy-Supportive Teaching: Its Three Core Teaching Practices and Six Specific Instructional Behaviors
Note. ASIB = Autonomy-supportive instructional behavior.

teaching simulations (Levin et al., 2024), problem-solving (Ulstad et al., 2018), one-on-one guidance and mentoring (Escriva-Boulley et al., 2018; Lonsdale et al., 2013), or group discussions with peer teachers (Abula et al., 2020) and with one's students (Kaplan & Assor, 2012).

Fig. 2 presents our interpretation of the ideal process teachers go through when they successfully learn how to become autonomy supportive. This hypothesized model is merely a 90-degree counterclockwise transformation of Fig. 1—with two exceptions. First, the lower part of Fig. 2 adds "minimize teacher control" as a fourth autonomy-supportive teaching practice. Second, the figure highlights the essential two-fold purpose of autonomy-supportive teaching (on the far right-hand side), which is (1) to enhance students' psychological need satisfaction and (2) to minimize students' psychological need frustration during classroom instruction.

2.1. *Autonomy-supportive teaching practice #1: Perspective taking*

The proposed starting point to autonomy-supportive teaching is perspective taking (Ryan & Deci, 2017, p. 443). Perspective taking is seeing and experiencing classroom events as if the teacher were the students. Through perspective taking, the teacher becomes aware of and attuned to the otherwise private world of students' inner motivational resources, such as their interests, goals, and preferences. Perspective taking also allows the teacher to avoid a tunnel view that may over-prioritize their own agenda, priorities, and expectations (Aelterman & Vansteenkiste, 2023). This awareness and concern for what students are thinking and feeling can fuel the teacher's sense of responsibility and desire to support their students' motivation (Joussemet & Grolnick, 2023). In practice, perspective taking typically takes the form of some type of formative assessment, such as asking open-ended questions, initiating teacher-student conversations, conducting teacher-to-whole class dialogues, and employing various forms of technology (e.g., Google forms, exit tickets, Mentimeter.com). Collectively, perspective taking teaching practices (1) ask students what they think and feel about the lesson and learning materials, (2) provide students with an opportunity to voice their preferences (e.g., to say aloud or use technology to express anonymously what they think, feel, and want), and (3) adjust the lesson accordingly to integrate those preferences into the flow of instruction (Grolnick et al., 1997; Kaplan & Assor, 2012; Levin et al., 2024; Reeve et al., 2022; Reeve & Jang, 2006). The reason why we propose that perspective taking is the starting point to autonomy-supportive teaching is because it is difficult to support students' interest and valuing without first understanding what students' baseline interests and values are in the first place.

2.2. *Autonomy-supportive teaching practice #2: Interest support*

To support students' interest and intrinsic motivation, autonomy-supportive teachers primarily do two things. First, they create an opportunity for students to pursue the interests and personal goals they already have, which we refer to as "invite students to pursue their personal interests and goals" (e.g., "What are you most interested in about this lesson?", "What would you like to accomplish in class today?"), Second, they embed within the learning activity not only new information to learn but also an opportunity to experience psychological need satisfaction, which we refer to as "present learning activities in need-satisfying ways." Teachers learn how to do this during an AST workshop by learning how to overlay the learning activity with an opportunity for (a) autonomy satisfaction (e.g., provide students with an opportunity for self-direction), (b) competence satisfaction (e.g., suggest a goal to strive for and provide progress-enabling guidance), or (c) relatedness satisfaction (e.g., have students pursue a prosocial goal together). These teaching practices do tend to support students' interest and intrinsic motivation (Jang, 2019; Jang et al., 2016; Johnson &Johnson, 2002; Koestner, 2008; Patall, 2013; Sparks et al., 2017).

2.3. *Autonomy-supportive teaching practice #3: Value support*

The third autonomy-supportive teaching practice is to support students' valuing and internalization. Internalization is the process of

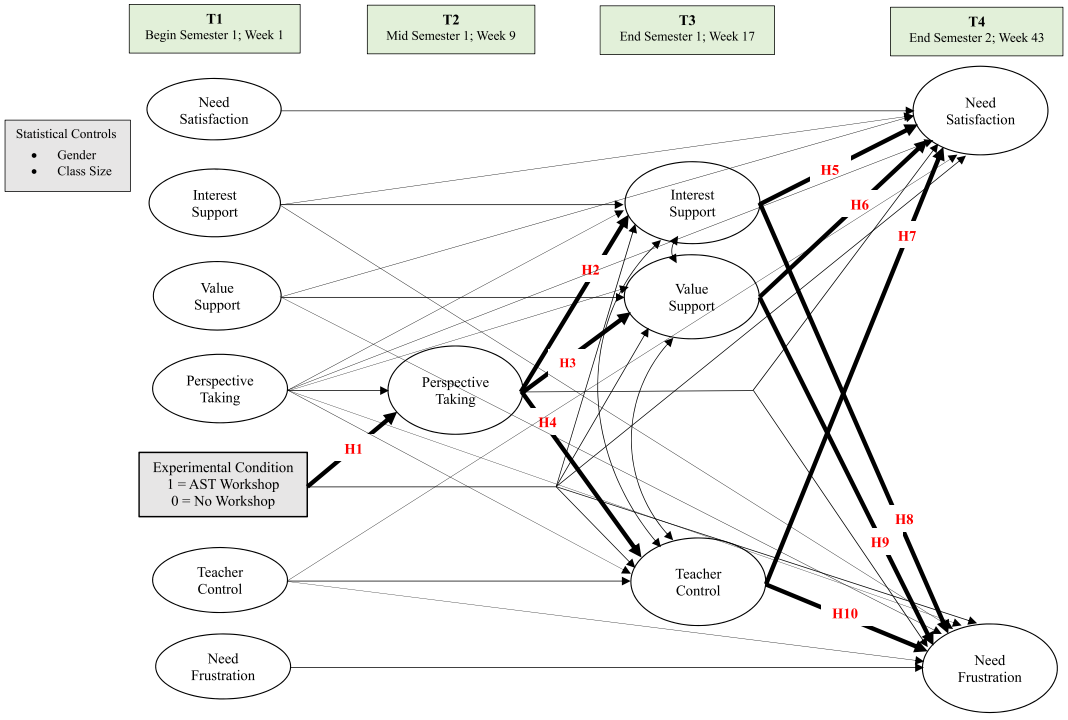

Fig. 2. *Hypothesized Model.*
Note. The 10 boldface lines with a red **H#** represent hypothesized paths, while the thin-faced lines represent auto-regressive effects and statistical controls. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

taking in values, beliefs, and ways of behaving from societal sources (e.g., the teacher) to then transform them into one's own value, belief, or way of behaving (Ryan & Deci, 2000; Vansteenkiste et al., 2018). Value internalization is a pivotal motivational issue when teachers ask students to engage in intrinsically uninteresting or difficult activities, assignments, procedures, routines, and behaviors. To promote internalization, autonomy-supportive teachers help students discover new value and hidden personal usefulness in the activity or teacher request. This process is more value developing than it is value changing (Joussemet & Grolnick, 2023; Mageau & Joussemet, 2023). Teachers learn how to do this during an AST workshop by learning how to (1) acknowledge and accept students' negative feelings (e.g., "Okay, I understand why you might feel frustrated, as this material is new, unfamiliar, and a bit more difficult than what we did last week."), (2) provide explanatory rationales for the teacher request (e.g., "This activity will be useful to you because …"), and (3) rely on invitational language to encourage volitional engagement (e.g., "You might want to …"). These teaching practices do tend to support students' valuing, internalization, and self-regulated behavior (Jang, 2008; Koestner et al., 1984, 2015; Laurin & Joussemet, 2017; Patall et al., 2013; Vansteenkiste et al., 2018).

2.4. Minimize teacher control

While interest support and value support facilitate psychological need satisfaction, teacher control fuels psychological need frustration. Controlling instructional behaviors (e.g., yelling, intimidating, demanding, bribing, punishing, shaming, and inducing guilt; Assor et al., 2005; Soenens et al., 2012) frustrate students' psychological needs, enflame negative emotionality, and damage the quality of the teacher-student relationship (De Meyer et al., 2016). What teachers learn during an AST workshop is how to transform their existing controlling instructional behaviors into autonomy-supportive alternatives or substitutes. For example, teachers learn how to replace "utter directives and commands" with "provide explanatory rationales", replace "offer an extrinsic incentive or token economy" with "invite students to pursue their personal interest", and replace "counter and try to change negative feelings" with "acknowledge and accept negative feelings." When teachers do this, students' need frustration does tend to dissipate (Cheon et al., 2019; 2020; Kaplan & Assor, 2012).

3. Hypothesized model

Built into Fig. 2's hypothesized model is a sequence of events that, over time, explains how and why teachers develop an autonomy-supportive style. Time 1 (T1) represents teachers' initial exposure to the AST workshop, which is the week before the academic year begins. To test the hypothesized model in Fig. 2, we randomly assigned teachers to participate or not in an AST workshop (i.e., experimental condition), and we asked their students to complete a questionnaire longitudinally (four waves) over the course of an academic year to report their teachers' perspective taking, interest support, value support, and teacher control as well as their own need satisfaction and need frustration. That is, students, not teachers, reported the values for all variables tested in the hypothesized model. We propose that participation in an AST workshop helps teachers develop greater perspective-taking two months into the semester. That is, we hypothesized that students of teachers who participated in an AST workshop, compared to students of teachers in a "practice as usual" control condition, would report that their teachers engaged in greater T2 perspective taking, controlling for T1 perspective taking and the statistical controls (Hypothesis 1). Because of this greater intervention-enabled T2 perspective taking, we expected teachers to then become increasingly able over time to support their students' interests and values as well as to minimize their controlling teaching at T3. That is, we hypothesized that greater T2 perspective taking would produce three effects: increased T3 interest support (Hypothesis 2); increased T3 value support (Hypothesis 3); and decreased T3 teacher control (Hypothesis 4).

Collectively, these teaching practices allow teachers to deliver highly need-satisfying and not at all need-frustrating instruction at T4, controlling for their students' T1 or baseline levels of need satisfaction and need frustration. That is, we hypothesized that students (irrespective of experimental condition) would report greater T4 need satisfaction because of their teachers' greater T3 interest support (Hypothesis 5), greater T3 value support (Hypothesis 6), and lesser T3 teacher control (Hypothesis 7). Similarly, we hypothesized that students would report lesser T4 need frustration because of their teachers' greater T3 interest support (Hypothesis 8), greater T3 value support (Hypothesis 9), and lesser T3 teacher control (Hypothesis 10). Fig. 2 adds the many statistical controls and autoregressive effects necessary to test for these hypothesized longitudinal effects.

4. Method

4.1. Openness and transparency

This study was preregistered. The preregistration document is available on the Open Science Framework (OSF) project site: https://osf.io/yr2xq/?view_only=065c7d657ac0442dbcae30ba13974a12.

Also available on this site is the study questionnaire, the dataset (in SPSS format), the Mplus syntax used in the test of the measurement and hypothesized models, and the CONSORT Checklist for a cluster randomized control trial.

4.2. Participants

Our sample featured 1566 students in 56 classes led by 28 teachers. Teachers were 28 full-time, Korean physical education (PE) teachers (16 males, 12 females) who taught in one of 28 different middle schools throughout Seoul, South Korea. On average, teachers were 35.3 years old ($SD = 6.6$; *range* = 27–48) with 8.9 years of teaching experience ($SD = 5.6$; *range* = 2–19). We recruited teachers from different schools to avoid possible cross-condition contamination concerns. To increase our L2 sample size, we collected data from two classrooms for each teacher (28 teachers who led 56 classrooms). In these 56 classrooms were 1566 ethnic Korean students in grades 7–9, including 796 (50.8%) females and 770 (49.2%) males and 762 (48.7%) in the experimental condition and 804 (51.3%) in the control condition who were, on average, 13.4 years old ($SD = 0.6$). As to *a priori* statistical power, calculating a power analysis for a multilevel longitudinal hypothesized model is a complex task (Thoemmes et al., 2010), so we used Morin, Blais, and Chénard-Poirier's (2021) guidelines to evaluate whether our sample adequately featured the statistical power needed for a multilevel hypothesized model. These guidelines recommend at least 50 L2 units with 10–15 participants per L1 unit (per classroom). Our sample of 56 classrooms with an average class size of 28.5 students/class comfortably met these recommended guidelines.

4.3. Procedure and research design

The second author's University Research Ethics Committee approved the research protocol. Our research design was an experimental, intervention-based randomized control trial with longitudinally assessed dependent measures. Fig. 3 provides the CONSORT Flowchart for the intervention's randomized control trial and year-long data collection. As shown in Fig. 3, we randomly assigned each teacher into either the experimental (intervention; $n = 14$ teachers, 28 classrooms) or control (no intervention; $n = 14$ teachers, 28 classrooms) condition, using an online computer-generated program to do so. We collected 4 waves of data in which students completed the same study questionnaire at the beginning (T1; weeks 1 and 2), middle (T2; week 9), and end (T3;

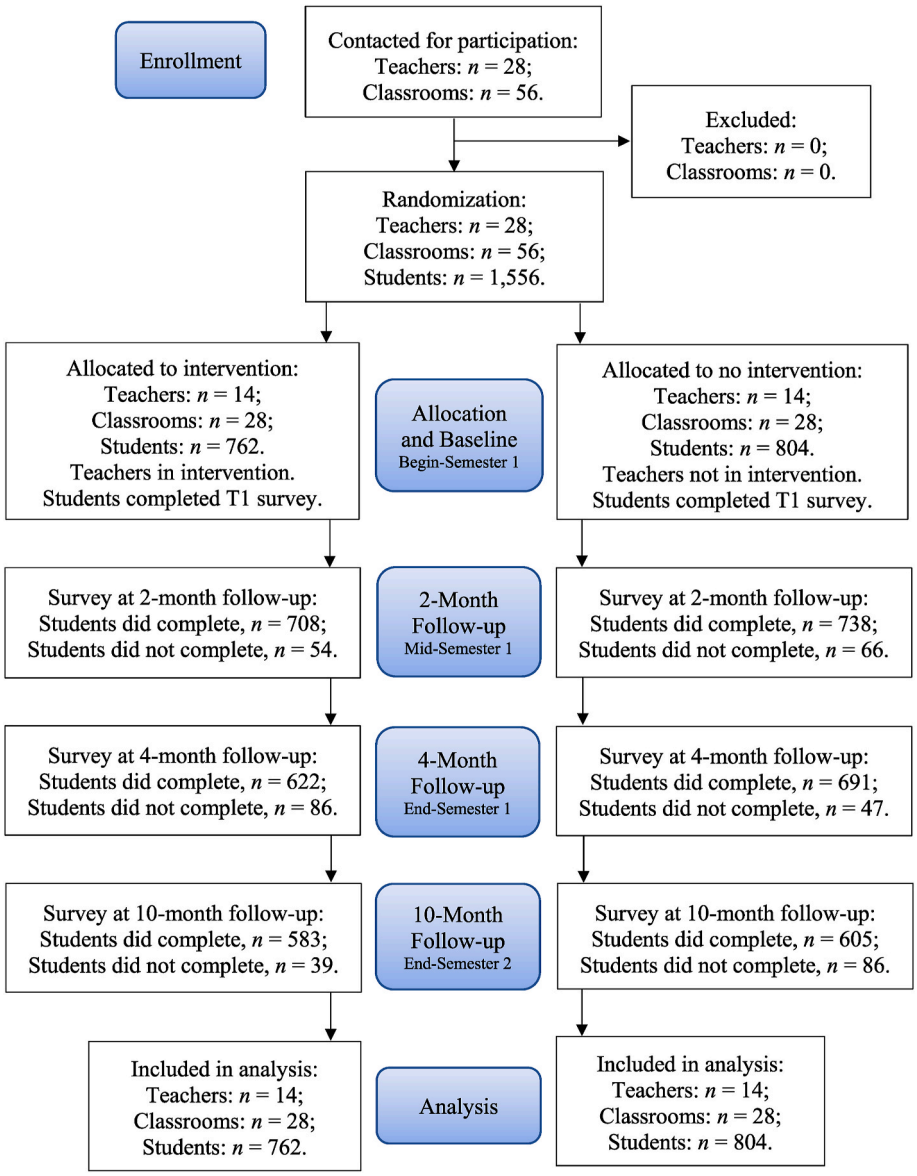

Fig. 3. Intervention and data collection flowchart (CONSORT).

week 17) of the Spring (first) semester and, again, at the end of the Fall (second) semester (T4, week 43). Missing cases (12.0%) and missing data (<0.1%) were reasonable. The questionnaire began with a consent form, and it asked students specifically about that one particular class.

4.4. Autonomy-supportive teaching workshop

The autonomy-supportive teaching (AST) workshop consisted of 3 parts with 8 h of teacher participation. Its delivery followed the contents, activities, and procedures of previously published AST workshops (e.g., Cheon et al., 2023). Part 1 was a 3-h, information-based morning presentation that took place one week before the school year began. It introduced autonomy-supportive teaching, its benefits, its empirical evidence, and the six recommended autonomy-supportive instructional behaviors featured in Fig. 1. Part 2 was a 3-h, skill-based afternoon workshop that took place on the same day as Part 1. It focused on the practical "how to" of the recommended autonomy-supportive instructional behaviors. Each recommended act of instruction was described, video modelled, and practiced using teaching simulations. Part 3 took place one month into the semester—after teachers had some actual classroom experience with autonomy-supportive teaching. It featured a 2-h peer-to-peer group discussion in which teachers shared their early-semester experiences with autonomy-supportive teaching and exchanged ideas on how they might improve and personalize its classroom application. A fuller description of the AST workshop can be found in the Supplemental Materials.

4.5. Measures

To assess the three autonomy-supportive teaching practices, we used three scales from the larger 15-scale Student Evaluation of Educational Quality (SEEQ) survey (Marsh et al., 2019, 2024), which is a questionnaire students use to self-report perceived teaching effectiveness (e.g., end-of-course teaching evaluations): the SEEQ's Group Interaction scale to assess perspective taking; the SEEQ's Choice scale to assess interest support; and the SEEQ's Relevance scale to assess value support. The SEEQ is a widely-used instrument with a strong validation record for middle- and high-school students (Marsh et al., 2024). We provide the items for these three SEEQ scales in the Appendix as well as our slightly adapted wording of these items in the descriptions of each measure below. In the present study, we did not use the most widely used scale to assess perceived autonomy-supportive teaching in the

self-determination theory literature, which is the Learning Climate Questionnaire (LCQ; Black and Deci, 2000), because this measure assesses only general, global, or overall perceived autonomy-supportive teaching rather than the specific autonomy-supportive teaching practices of interest in the present investigation. Past research that has used both the SEEQ and LCQ to assess perceived autonomy-supportive teaching in a single data set confirms that each SEEQ scale correlates very highly with the widely-used LCQ (Cheon et al., 2023): group interaction ($r = 0.85$, $p < 0.001$); choice ($r = 0.86$, $p < 0.001$); and relevance ($r = 0.79$, $p < 0.001$). To assess perceived teacher control, we used the Controlling Teaching Questionnaire (Jang et al., 2009). The CTQ is a widely used questionnaire to assess perceived controlling teaching in the self-determination theory literature (Fin et al., 2019; Jang & Reeve, 2021). Each measure used the same 7-point bipolar response scale (1 = *strongly disagree*, 7 = *strongly agree*).

Perspective Taking. For perspective taking, we used the SEEQ's 3-item Group Interaction scale. Items included the following: "My teacher listens to how students would like to do things"; "My teacher wants to know what we are feeling during class"; and "My teacher asks us what we want to do" (αs at T1, T2, T3, and T4 were 0.87, 0.91, 0.91 and 0.92, respectively; *ICC*s were 0.054, 0.110, 0.110, and 0.121).

Interest Support. For interest support, we used the SEEQ's 3-item Choice scale. Items included the following: "My teacher allows us to pursue our own interests"; "My teacher gives us lots of choices about how to do our schoolwork"; and "My teacher provides interesting in-class activities" (αs = 0.83, 0.87, 0.88 and 0.89; *ICC*s were 0.083, 0.110, 0.096, and 0.099).

Value Support. For value support, we used the SEEQ's 3-item Relevance scale. Items included the following: "My teacher explains why what we do in school is important"; "My teacher talks with us about how we can use the things we learn in school"; and "My teacher explains to us why we need to learn the materials presented in this class" (αs = 0.83, 0.87, 0.88 and 0.89; *ICC*s were 0.036, 0.038, 0.057, and 0.093).

Teacher Control. For teacher control, we used the 4-item Controlling Teacher Questionnaire. Items included the following: "My teacher tries to control everything we do"; "My teacher uses forceful language"; "My teacher puts a lot of pressure on us"; and "My teacher is inflexible (rigid, stubborn)" (αs = 0.72, 0.75, 0.78, and 0.80; *ICC*s were 0.080, 0.124, 0.111, and 0.123).

Need Satisfaction. We used three scales to assess students' need satisfaction. For autonomy satisfaction, we used the 5-item Perceived Autonomy scale (Standage et al., 2006; e.g., "In this class, I can decide which activities I want to do"; αs = 0.85, 0.91, 0.91, and 0.91). For competence satisfaction, we used the 4-item Perceived Competence scale from the Intrinsic Motivation Inventory (Ryan et al., 1983; e.g., "In this class, I feel pretty competent."; αs = 0.86, 0.89, 0.89, and 0.88). For relatedness satisfaction, we used the 5-item Relatedness Need Satisfaction Scale (Ng et al., 2011; e.g., "In this class, I feel close to my classmates."; αs = 0.83, 0.86, 0.87, and 0.87). *ICC*s for overall need satisfaction were 0.060, 0.078, 0.090, and 0.094.

Need Frustration. We assessed students' autonomy, competence, and relatedness frustration with the three need frustration scales from the Psychological Need States in Sport-Scale (PNSS–S; Bhavsar et al., 2020). The PNSS-S includes three 5-item scales to assess autonomy frustration (e.g., "In this class, I feel too much pressure"; αs = 0.77, 0.80, 0.80, and 0.79), competence frustration (e.g., "In this class, I feel like a failure"; αs = 0.89, 0.91, 0.91, and 0.92), and relatedness frustration (e.g., "In this class, I feel disliked by the people in this class"; (αs = 0.87, 0.90, 0.90, and 0.90). *ICC*s for overall need frustration were 0.125, 0.049, 0.052, and 0.080.

4.6. Data analyses

The data had a two-level longitudinal structure with repeated measures (4 waves) nested within students (Level 1, $N = 1566$) nested within classrooms (Level 2, $k = 56$). Given this data structure, we used a multilevel structural equation modeling analysis to test the measurement and hypothesized models. We used Mplus 8.7 (Muthén & Muthén, 2019), the "type = complex" model command to handle the nested structure of the data, the maximum likelihood-robust estimator (MLR), the FIML estimation procedure to handle missing data, and standard goodness-of-fit statistics to evaluate model fit: *RMSEA*, *SRMR*, *CFI*, and *TLI*. First, we tested the fit of the 38-item, 12-latent variables measurement model (see Table 1). Second, we tested the hypothesized model by adding experimental condition as an uncentered predictor (control = 0, experimental = 1), the 10 hypothesized paths shown in Fig. 2, and gender (male = 0, female = 1) and class size ($M = 28.0$ students/class) as two grand mean-centered covariates. The hypothesized model proposes a mediation effect, so we tested T2 perspective taking, T3 interest support, T3 value support, and T3 teacher control as hypothesized mediators of the direct effect of experimental condition on both T4 need satisfaction (mediation analysis #1) and T4 need frustration (mediation analysis #2). To perform these mediation analyses, we used the "model indirect" command in Mplus.

5. Results

5.1. Test of the measurement model

Table 1 shows the descriptive statistics, unstandardized, and standardized beta weights for the 38 indicators in the measurement model. The measurement model fit the data reasonably well, $X^2(580) = 2081.02$, $p < 0.001$, $RMSEA = 0.041$, $SRMR = 0.041$, $CFI = 0.937$, and $TLI = 0.924$. Given the acceptable fit of the measurement model, we next tested for the fit of the hypothesized model.

5.2. Test of the hypothesized model

Table 2 shows the correlation matrix for the variables in the hypothesized model. The preregistered hypothesized model fit the data reasonably well, $\chi^2(695) = 2262.54$, $p < 0.001$, $RMSEA = 0.038$, $SRMR = 0.046$, $CFI = 0.934$, and $TLI = 0.922$. Fig. 4 shows the unstandardized beta weights (with standard errors) for all 10 hypothesized paths and the autoregressive effects.

Table 3 provides the results from the test of the 10 hypothesized paths embedded within the hypothesized model (see boldfaced numbers). As shown in column 1, experimental condition predicted T2 perspective taking ($B = 0.37$, $p < 0.001$), confirming H1. As shown in columns 2, 3, and 4, intervention-enabled gains in T2 perspective taking increased T3 interest support ($B = 0.50$, $p < 0.001$), increased T3 value support ($B = 0.51$, $p < 0.001$), and decreased T3 teacher control ($B = -0.32$, $p < 0.001$), confirming H2, H3, and H4. As shown in column 5, in the prediction of T4 need satisfaction, T3 interest support ($B = 0.40$, $p < 0.001$) and T3 value support ($B = 0.13$, $p = 0.006$) but not T3 teacher control ($B = -0.01$, $p = 0.682$) were individually significant predictors, confirming H5 and H6 but disconfirming H7. As shown in column 6, in the prediction of T4 need frustration, T3 teacher control was an individually significant predictor ($B = 0.50$, $p < 0.001$) while T3 interest support ($B = -0.10$, $p = 0.230$) and T3 value support ($B = -0.03$, $p = 0.606$) were not, disconfirming H8 and H9 but confirming H10.

5.3. Mediation analyses

In the test for mediation to explain gains in T4 need satisfaction, the omnibus indirect effect was significant: $B = 0.19$, $SE = 0.05$, $t = 3.82$, $p < 0.001$. Individual indirect effects emerged for T3 interest support ($B = 0.06$, $p = 0.045$), T2 perspective taking via T3 interest support ($B = 0.07$, $p = 0.008$), and T2 perspective taking via T3 value support ($B = 0.03$, $p = 0.005$). In the test for mediation to explain declines in T4 need frustration, the omnibus indirect effect was significant: $B = -0.16$, $SE = 0.06$, $t = 2.49$, $p = 0.013$. An individual indirect effect emerged only for T2 perspective taking via T3 teacher control ($B = -0.06$, $p = 0.002$).

Table 1
Descriptive Statistics with Unstandardized and Standardized Beta Weights for All 38 indicators in the Measurement Model.

Observed Variable	Time 1					Time 2					Time 3					Time 4				
	M	(*SD*)	*B*	*SE*	*β*	*M*	(*SD*)	*B*	*SE*	*β*	*M*	(*SD*)	*B*	*SE*	*β*	*M*	(*SD*)	*B*	*SE*	*β*
Perspective Taking Indicators																				
1. My teacher wants to know …	5.16	(1.24)	1.00	–	0.83	5.38	(1.33)	1.00	–	0.89										
2. My teacher listens to how …	5.40	(1.21)	1.00	0.02	0.85	5.60	(1.26)	0.96	0.02	0.90										
3. My teacher asks us what we …	5.24	(1.22)	0.98	0.03	0.83	5.41	(1.28)	0.93	0.02	0.86										
Interest Support Indicators																				
1. My teacher gives us lots of …	5.18	(1.22)	1.00	–	0.81						5.52	(1.31)	1.00	–	0.85					
2. My teacher allows us to pursue …	5.18	(1.29)	0.91	0.03	0.79						5.48	(1.27)	0.92	0.03	0.81					
3. My teacher provides interesting …	5.36	(1.30)	0.97	0.02	0.78						5.57	(1.32)	0.99	0.03	0.85					
Value Support Indicators																				
1.My teacher talks with us about …	5.04	(1.25)	1.00	–	0.83						5.29	(1.40)	1.00	–	0.87					
2. My teacher explains why what …	5.28	(1.24)	0.93	0.03	0.78						5.49	(1.31)	0.94	0.02	0.87					
3. My teacher explains to us why …	5.05	(1.26)	0.91	0.02	0.75						5.28	(1.42)	0.91	0.02	0.79					
Teacher Control Indicators																				
1. My teacher is inflexible.	2.08	(1.34)	1.00	–	0.78						1.88	(1.25)	1.00	–	0.83					
2. My teacher tries to control …	2.97	(1.59)	0.64	0.05	0.42						2.30	(1.47)	0.75	0.04	0.53					
3. My teacher uses forceful language	1.71	(1.20)	0.78	0.05	0.68						1.58	(1.07)	0.79	0.05	0.77					
4. My teacher puts a lot of pressure.	2.21	(1.40)	0.91	0.04	0.68						2.14	(1.40)	0.94	0.03	0.71					
Need Satisfaction Indicators																				
1. Autonomy satisfaction	4.97	(1.11)	1.00	–	0.91											5.42	(1.19)	1.00	–	0.91
2. Competence satisfaction	4.74	(1.22)	0.83	0.05	0.69											5.05	(1.30)	0.95	0.03	0.80
3. Relatedness satisfaction	4.86	(1.08)	0.84	0.03	0.78											5.38	(1.11)	0.92	0.02	0.89
Need Frustration Indicators																				
1. Autonomy frustration	2.51	(1.07)	1.00	–	0.79											2.31	(1.11)	1.00	–	0.79
2. Competence frustration	2.28	(1.20)	0.85	0.05	0.60											2.11	(1.21)	0.94	0.05	0.68
3. Relatedness frustration	1.86	(1.02)	0.96	0.06	0.79											1.75	(0.97)	0.97	0.04	0.87

Note. Possible range for each variable was 1–7. *M* = mean; (*SD*) = standard deviation; *B* = unstandardized beta weight; *SE* = standard error; *β* = standardized beta weight.

Table 2
Intercorrelations and descriptive statistics for all latent variables and statistical controls included in the hypothesized model.

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Experimental Condition	–	0.01	0.01	−0.01	−0.02	−0.02	−0.01	0.19	0.18	0.10	−0.14	0.18	−0.19	0.12	−0.21
Time 1 Baseline															
2. Perspective Taking		–	0.93	0.71	−0.36	0.73	−0.38	0.50	0.47	0.42	−0.23	0.46	−0.33	−0.03	−0.07
3. Interest Support			–	0.75	−0.43	0.75	−0.44	0.51	0.51	0.46	−0.25	0.50	−0.36	−0.04	−0.08
4. Value Support				–	−0.30	0.63	−0.35	0.41	0.36	0.43	−0.17	0.34	−0.21	−0.01	0.00
5. Teacher Control					–	−0.29	0.66	−0.25	−0.24	−0.20	0.43	−0.22	0.32	0.09	0.05
6. Need Satisfaction						–	−0.60	0.48	0.41	0.42	−0.21	0.55	−0.31	0.08	−0.11
7. Need Frustration							–	−0.29	−0.25	−0.27	0.34	−0.32	0.36	0.02	0.01
Time 2															
8. Perspective Taking								–	0.66	0.60	−0.43	0.58	−0.43	0.04	−0.19
Time 3															
9. Interest Support									–	0.82	−0.55	0.71	−0.56	0.04	−0.16
10. Value Support										–	−0.45	0.64	−0.47	0.03	−0.11
11. Teacher Control											–	−0.41	0.72	0.05	0.15
Time 4															
12. Need Satisfaction												–	−0.69	0.03	−0.15
13. Need Frustration													–	0.04	0.11
Statistical Controls															
14. Gender														–	−0.06
15. Class Size															–
Descriptive Statistics															
Mean	0.49	5.26	5.24	5.12	2.24	4.85	2.22	5.46	5.52	5.37	1.97	5.28	2.05	0.49	28.5
Standard Deviation	0.50	1.09	1.09	1.08	1.02	0.99	0.90	1.19	1.16	1.23	1.01	1.09	0.93	0.50	3.8

$N = 1566$ students. Any $r > 0.06$, $p < 0.05$; any $r > 0.08$, $p < 0.01$; and any $r > 0.10$, $p < 0.001$.

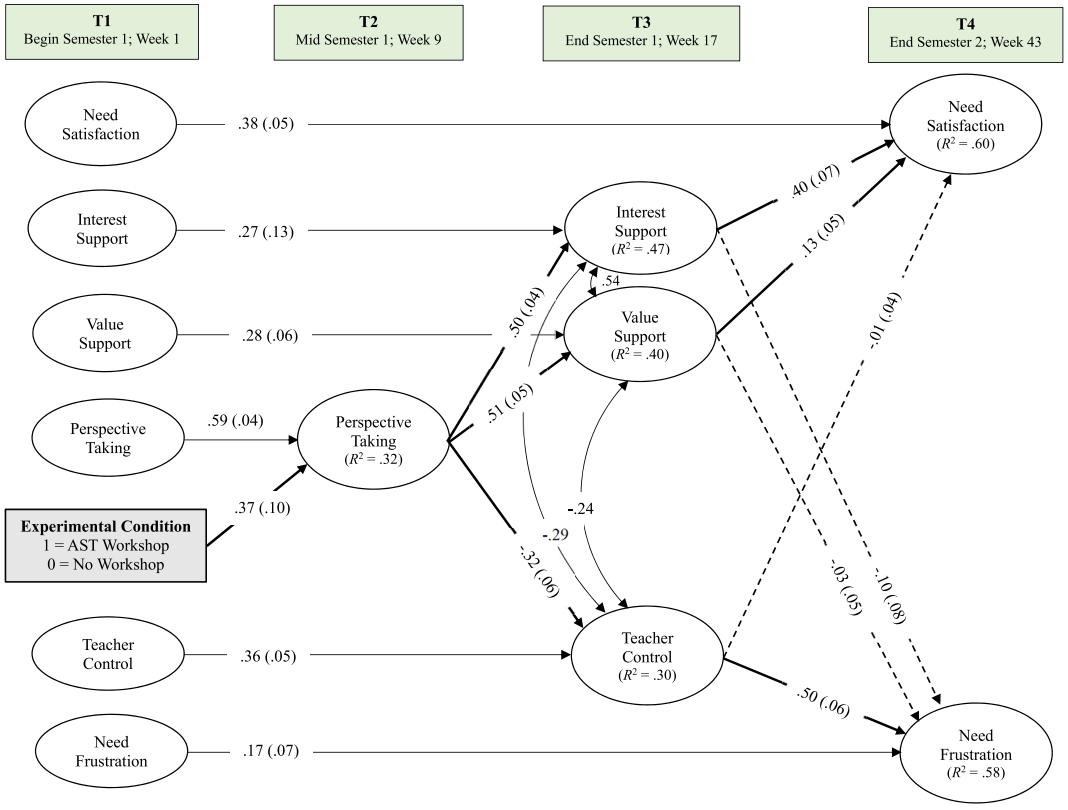

Fig. 4. *Test of the Hypothesized Model.*
Note. Thick boldface slopped lines represent hypothesized paths, thin-faced horizontal lines represent auto-regressive effects. Solid lines represent statistically significant paths, $p < 0.05$, while dashed lines represent non-significant paths. The numbers overlaying each path are unstandardized beta weights (β) with standard errors in parentheses. R^2 = Amount of explained variance in the dependent measure. T = Time. Overall model fit: X^2 (695) = 2262.54, *RMSEA* = 0.038, *SRMR* = 0.046, *CFI* = 0.934, *TLI* = 0.922. For additional results, see Table 3.

5.4. Evaluating possible alternative models

We preregistered our hypothesized model, but it is still possible that the optimal starting point to autonomy-supportive teaching might be T2 interest support, T2 value support, or T2 teacher control, rather than T2 perspective taking. So, we tested the statistical fit of these three alternative models versus the fit of the hypothesized model. To do so, we simply replaced T2 perspective taking with each of the other three teaching practices assessed at T2, one-by-one. That is, in the hypothesized model, experimental condition predicted T2 perspective taking.

Table 3
Results from test of the 10 hypothesized paths embedded within the hypothesized model depicted in Fig. 4.

	Hypothesis 1			Hypothesis 2			Hypothesis 3			Hypothesis 4			Hypotheses 5, 6, 7			Hypotheses 8, 9, 10		
	T2 Perspective Taking			T3 Interest Support			T3 Value Support			T3 Teacher Control			T4 Need Satisfaction			T4 Need Frustration		
Predictor Variable	*B*	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*
Experimental Condition	**0.37**	**0.10**	**0.001**	0.15	0.08	0.063	0.00	0.08	0.972	−0.13	0.10	0.184	0.14	0.07	0.052	−0.15	0.07	0.032
T1 Perspective Taking	0.59	0.04	0.001	−0.03	0.14	0.820	0.01	0.07	0.858	0.10	0.07	0.136	−0.18	0.12	0.127	−0.03	0.10	0.777
T2 Perspective Taking				**0.50**	**0.04**	**0.001**	**0.51**	**0.05**	**0.001**	**−0.32**	**0.06**	**0.001**	0.07	0.04	0.085	0.01	0.03	0.659
T1 Interest Support				0.27	0.13	0.038							0.20	0.16	0.225	−0.14	0.13	0.290
T3 Interest Support													**0.40**	**0.07**	**0.001**	**−0.10**	**0.08**	**0.230**
T1 Value Support							0.28	0.06	0.001				−0.15	0.05	0.001	0.10	0.06	0.074
T3 Value Support													**0.13**	**0.04**	**0.006**	**−0.03**	**0.05**	**0.606**
T1 Teacher Control										0.36	0.05	0.001	0.01	0.04	0.838	−0.10	0.04	0.013
T3 Teacher Control													**−0.01**	**0.04**	**0.682**	**0.50**	**0.06**	**0.001**
T1 Need Satisfaction													0.38	0.05	0.001			
T1 Need Frustration																0.17	0.07	0.011
Student Gender	0.03	0.07	0.682	0.02	0.05	0.705	0.01	0.07	0.808	0.15	0.07	0.035	−0.01	0.07	0.052	0.04	0.04	0.376
Class Size	−0.05	0.02	0.001	−0.01	0.01	0.187	−0.01	0.01	0.545	0.02	0.01	0.155	−0.01	0.01	0.336	−0.01	0.01	0.601

Note. B = Unstandardized beta weight; *SE* = Standard Error of *B*; *p* = p-value from the associated *t* ratio. For gender, 1 = female, 0 = male. Class size average was 28.5. Statistics in boldface represent the hypothesized predictor for that dependent measure.

But experimental condition predicted T2 interest support in alternative model #1, T2 value support in alternative model #2, and T2 teacher control in alternative model #3. Results from all four model tests appear in Table 4. The hypothesized model fit the data better than did each of the three possible alternative models, as judged by the hypothesized model's lower χ^2, *AIC*, and *BIC* values. A full display of the results from the three alternative models (e.g., unstandardized beta weights with standard errors) can be seen in full in Supplemental Figs. S1, S2, and S3.

The hypothesized model fit the data significantly better than the three alternative models, but the interest support and value support alternative models still fit the data relatively well. The reason the hypothesized model fit better than the interest support model was because experimental condition predicted T2 perspective taking better than it predicted T2 interest support (*B*s = 0.37 vs 0.28; compare Fig. 1 vs. Fig. S1) while T3 interest support better predicted T4 need satisfaction than did T3 perspective taking (*B*s = 0.40 vs 0.33). Similarly, the reason the hypothesized model fit better than the value support model was largely because experimental condition predicted T2 perspective taking better than it predicted T2 value support (*B*s = 0.37 vs 0.19; compare Fig. 1 vs. Fig. S2).

6. Discussion

We used self-determination theory and the now extensive empirical findings from autonomy-supportive interventions to propose and test a process model of how teachers learn autonomy-supportive teaching (see Fig. 4). Different teachers personalize and practice autonomy-supportive teaching in different ways, but we suggest that there still remains an essential core set of autonomy-supportive teaching practices—namely, perspective taking, interest support, value support, and minimize teacher control. The present findings provided support for this hypothesized model, and they further support the following six propositions built into the hypothesized model.

(1) The starting point to greater autonomy-supportive teaching is perspective taking.
(2) Greater perspective taking then catalyzes greater interest support, greater value support, and lesser teacher control.
(3) Interest support best predicts higher need satisfaction, though value support supplements this primary effect.
(4) Teacher control best predicts need frustration.
(5) Together, these teaching practices increase students' need satisfaction ($R^2 = 0.60$).
(6) Together, these teaching practices decrease students' need frustration ($R^2 = 0.58$).

Teacher participation in the workshop did increase autonomy-supportive teaching. These findings are important because the model depicted in Fig. 4 can provide a blueprint to guide teachers' effort to learn how to become autonomy supportive. For instance, the model confirmed that an ideal starting point would be to learn how to solicit students' input and suggestions (i.e., perspective taking). Once teachers become aware of and concerned about students' interests, preferences, and concerns, it becomes almost easy for them to learn how to support those expressed interests, values, and concerns. We say "easy" because the effect sizes observed (*B*s, R^2 values) in the present study connecting T2 perspective taking to each of these three T3 teaching practices were so large (*B*s = 0.50 for interest support, 0.51 for value support, and −0.32 for teacher control; see Fig. 4). Perspective taking is a strong catalyst to these teaching practices because it is very helpful to first know what students' baseline interests, values, and concerns are before trying to support them.

The supplemental analyses (Table 4, Figs. S1–S3) showed that the hypothesized model was the best fitting model, but also that the interest support model fit the data relatively well. While perspective taking enables greater interest support, the reciprocal effect that interest support

Table 4
Comparative Model Fit Statistics for the Hypothesized Model vs. Three Possible Alternative Models.

Name of Explanatory Model	X^2 (df = 695)	p-value	*RMSEA*	*SRMR*	*CFI*	*TLI*	*AIC*	*BIC*
Perspective Taking at T2 (Hypothesized Model)	2262.54	0.001	0.038	0.046	0.934	0.922	144,897.05	145,957.59
Interest Support at T2	2271.48	0.001	0.038	0.044	0.934	0.922	145,032.65	146,093.19
Value Support at T2	2410.06	0.001	0.040	0.048	0.928	0.915	144,602.62	145,663.16
Teacher Control at T2	2430.35	0.001	0.040	0.053	0.929	0.916	145,467.20	146,527.75

Note. X^2 = chi-square statistic, *df* = degrees of freedom, *RMSEA* = root mean square error of approximation.
SRMR = standardized root mean square residual, *CFI* = *comparative fit index, TLI* = *Tucker Lewis index.*
AIC = Akaike information criterion, BIC = Bayesian information criteria.

might enable greater perspective taking is also viable. That is, as teachers vitalize students' interest, students publicly display their interest and preferences, which allows teachers to become increasingly aware of and attuned to students' inner motivations. Accordingly, a potentially fruitful area for future research may be to test the reciprocal relations that unfold among the four teaching practices embedded within autonomy-supportive teaching (but especially between perspective taking and interest support).

The largest independent predictor of students' need satisfaction was interest support ($B = 0.40$, $p < 0.001$). This is an important practical finding. Yet, for most teachers, it is intuitively unclear what specifically they might do during instruction to support their students' interest. What teachers most often do to piqué interest is to change the presentation of the learning activity in some way. That is, teachers try to trigger situational interest by introducing novelty, suspense, videos, technology, seductive details, humor, music, puzzles, or a curiosity-inducing question (Renninger & Hidi, 2016). These are attention-getting—but not need-satisfying—strategies. These attention-getting strategies represent good practice, but autonomy-supportive teachers support students' interest and intrinsic motivation in additional (and highly effective) ways. They do this by becoming aware of and by attuning their instruction to the inner motivational resources that students bring with them into the classroom (e.g., psychological needs, personal interests, and personal goals; see Fig. 1). And they do this in three ways: (1) by inviting their students to pursue a personal interest, (2) by presenting the learning activity in a way that can generate an experience of autonomy satisfaction (e.g., offer choice to give students more say in how they will interact with the learning activity), competence satisfaction (e.g., introduce an optimal challenge that is then followed by progress-enabling guidance), or relatedness satisfaction (e.g., invite students to pursue a prosocial goal together), and (3) by encouraging students to use the learning activity as an opportunity to pursue an intrinsic goal (e.g., develop a skill, deepen a relationship). These teaching practices do support students' interest, and intervention research shows that teachers can learn how to apply these teaching practices in their own classrooms with their own students (Reeve et al., 2022).

The most surprising finding was that not all four teaching practices independently increased students' need satisfaction and not all four teaching practices independently decreased students' need frustration (which were our preregistered hypotheses). Instead, the results rather clearly showed that interest support and value support facilitated need satisfaction while lesser teacher control reduced need frustration. The role played by perspective taking seemed to be to empower the teacher toward a better implementation of these other three teaching practices. Such an overall set of findings suggests that our hypothesized model (Fig. 2) needs to be revised into a more specialized model. A more specialized model would move away from the general idea that all four teaching practices increase need satisfaction and decrease need frustration to move toward the more differentiated ideas that (1) some teaching practices enable other teaching practices (i.e., perspective taking), (2) some teaching practices best promote students' need satisfactions (i.e., interest support, value support), and (3) some teaching practices best alleviate students' need frustration (i.e., lesser teacher control). We encourage future research to test this more specialized model, and to do so with a preregistered hypothesized model that uses rigorous methodology (i.e., randomized control trial, longitudinally assessed dependent measures).

6.1. Limitations

Three features of our investigation potentially limit the conclusions that may be drawn. First, students, rather than the teachers themselves, provided the data to test the hypothesized model. We actually considered the use of students' perceptions to be a methodological strength of the study, because we delivered the intervention to teachers while we assessed its effects by asking students (a sort of dual-informant approach). Nevertheless, we understand the appeal of using either teachers' own reports of these teaching practices or objective ratings from trained classroom observers as the data utilized to test the hypothesized model.

Second, our sample featured Korean middle school students taking the PE course. This raises the question of how generalizable our findings are. In future research, we encourage the test of our hypothesized model (Fig. 4) using samples from different nations, different grade levels, and different subject matters.

Third, we adopted the student and an L1 unit of analysis to test our hypothesized model. We acknowledge that it makes just as much sense to test the hypothesized model by adopting the teacher and an L2 unit of analysis. However, a test of the hypothesized model using this alternative unit of analysis would require a much larger sample size of teachers than the one employed in the present investigation.

7. Conclusion

AST enables important student benefits. Recognizing this, many educators have proposed, implemented, and evaluated AST workshops to help teachers become autonomy supportive. The contribution of the present study was to propose and confirm an explanatory model of the process teachers go through to successfully learn how to provide classroom instruction in highly need-satisfying and in not-at-all need-frustrating ways. Our findings suggest that perspective taking makes for an excellent starting point. Once incorporated, perspective-taking teachers are then well-positioned to learn how to provide their students with highly need satisfying instruction via greater interest support and value support, and also with not-at-all need frustrating instruction via lesser teacher control.

CRediT authorship contribution statement

Johnmarshall Reeve: Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Sung Hyeon Cheon:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

All authors declare that they have no conflicts of interest.

Data availability

The dataset and Mplus syntax files to test the hypothesized model are available on the study's Open Science Framework project site, https://osf.io/g5wn8/?view_only=c79af500b7354f59bbc4d35849e41925.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tate.2024.104702.

Appendix

SEEQ's 3-item Group Interaction Scale

1. The teacher listened to how students would like to do things.
2. Students were invited to share their ideas and knowledge.
3. Students were encouraged to openly express ideas.

SEEQ's 3-item Choice Scale

1. The teacher allowed us to pursue our own interests.
2. The teacher gave us a lot of choices about how to do our schoolwork.
3. The teacher provided interesting in-class activities.

SEEQ's 3-item Relevance Scale

1. The teacher explained why what we do in school is important.
2. The teacher talked with us about how we can use the things we learn in school.
3. The teacher explained to us why we need to learn the materials presented in this class.

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