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Differential Effects of Perceptions of Equal, Favourable and Unfavourable Autonomy Support on Educational and Well-Being Outcomes

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Highlights

- Perceptions of equal autonomy support yield optimal levels of need satisfaction
- Equal autonomy support predicts enjoyment and course grades indirectly via autonomous motives and needs
- Self-determination theory is sufficient in explaining effects observed for equal autonomy support

Abstract

In this study, we examined whether high-school students experienced optimal educational and well-being outcomes when they perceived that they and their classmates received an equal, rather than unequal, and high amount of autonomy support from teachers. In a prospective study that aimed to predict academic grades and well-being outcomes, surface analyses of polynomial regression equations pointed that perceptions of equal autonomy support were the most optimal in terms of yielding highest levels of need satisfaction, autonomous forms of motivation and happiness with math courses. Additionally, in accordance with tenets of self-determination theory, we demonstrated that effects associated with perceptions of equal autonomy support were mediated by autonomous forms of motivation and psychological needs. Findings suggest that researchers and practitioners may be able to facilitate optimal educational and well-being outcomes by encouraging teachers to distribute autonomy support equally across students.

Keywords: Equality in autonomy support, differential treatment, need satisfaction, academic achievement.

Differential Effects of Perceptions of Equal, Favourable and Unfavourable Autonomy Support on Educational and Well-Being Outcomes

Over the past four decades, research drawing from Deci and Ryan's (1985) self-determination theory has documented that teachers who adopt autonomy supportive styles of communication during lessons have positive and lasting effects on students' levels of engagement, enjoyment, and happiness in class activities as well as academic achievement including overall grades (Guay & Vallerand, 1996; Ng, Ntoumanis & Thøgersen-Ntoumani et al., 2012; Su & Reeve, 2011). According to self-determination theory, students are likely to perceive teachers and the classroom climate as autonomy supportive when teachers provide choices and opportunities for self-expression, and explain, in a meaningful way, why performance of an activity is important (Deci & Ryan, 1985). Self-determination theory also posits that the positive effects of perceptions of autonomy support on educational and well-being outcomes result from students experiencing greater satisfaction of three basic psychological needs (see Deci et al., 1994; Sheldon & Filak, 2009). These are the needs for autonomy (the need to feel volitional and responsible for one's own behaviour; deCharms 1968; Deci & Ryan, 1990), competence (the need to produce outcomes and understand the instrumentalities leading to these outcomes; Deci & Ryan, 1990; White 1959), and relatedness (the need to experience satisfactory relationships with others or with the social order in general; Deci & Ryan, 1990).

In addition, according to self-determination theory and research that has tested this theory in various settings, satisfaction of the three basic psychological needs predicts educational and well-being outcomes by affecting students' motivation (Early et al., 2016; Guay & Vallerand, 1996; Ryan & Deci, 2001; Tian et al., 2014; Yu et al., 2016). Accordingly, self-determination theory makes the distinction between autonomous and controlled forms of motivation that reflect the reasons why individuals engage in activities in

a given context (Deci & Ryan, 1985). Autonomous forms of motivation are experienced when students engage in classroom activities for reasons of enjoyment (intrinsic motivation) or because they believe that the classroom activities are instrumental in the attainment of important and valued outcomes (identification) (Ryan & Connell, 1989). These forms of motivation are considered optimal because they are developed in autonomous contexts that support the three basic psychological needs (Ng et al., 2012; Su & Reeve, 2011). Controlling forms of motivation are experienced when students engage in classroom activities to avoid punishment (external regulation) or to not feel guilty and disapproval if they do not engage in classroom activities (introjection) (Ryan & Connell, 1989). Controlling forms of motivation are sub-optimal because they are likely to be engendered in autonomy-poor contexts that, by definition, do not support, or even thwart, basic psychological needs (Ng et al., 2012). In accordance with the proposition that psychological needs and autonomous forms of motivation constitute the mechanism through which perception of autonomy support predict educational and well-being outcomes, a considerable number of studies have shown that perceptions of autonomy support predict educational and well-being outcome indirectly via psychological needs and autonomous forms of motivation (Ng et al., 2012; Yu et al., 2016).

One issue that previous research has not yet addressed is the effect of perceptions of differential treatment with respect to the provision of autonomy by teachers on motivational, psychological, and behavioral outcomes. Differential treatment is a structural characteristic of classroom environments. It describes students' perceptions of how teachers distribute resources such as time and attention across students (Daniels & Plomin, 1985; Good, 1987). Accordingly, students are said to believe that their teachers' 'treat' them favourably or unfavourably in classrooms when they perceive that they receive a larger or smaller amount of support, respectively, from their teachers than their classmates (Rubie-Davies, 2015). Further, students are likely to form perceptions of equal treatment when they perceive that

teachers provide them and their classmates with ample attention or social support (Papaioanou, 1995).

The construct of differential treatment has been studied extensively in classroom and family settings (i.e., Buist, Dekovic, & Prinzie, 2013; Kuklinski & Weinstein, 2000; McKown & Weinstein, 2008; Weinstein, Marshall, Brattesani, & Middlestadt, 1982), but less so in relation to contexts that are deemed autonomy supportive. Nevertheless, a number of studies have documented that teachers do not distribute autonomy support in an equal way across students (Pelletier et al., 2002; Pelletier & Vallerand, 1996; Sarrazin et al., 2006). Additionally, in an experimental study, Lee and Chatzisarantis (2017) demonstrated that students reported lower levels of autonomy and happiness with task engagement when they were led to believe that they received less, rather than more, opportunities for choice and self-expression relative to others. However, studies have not yet examined effects associated with perceptions of equal autonomy support. Hence, it is not currently known whether perceptions of equal treatment are optimal in autonomy supportive contexts. In the present study, we address this gap in knowledge to better understand the processes underpinning need satisfaction, and the associated motivational, psychological, and behavioral outcomes in educational contexts.

Perceptions of Equal Autonomy Support, Need Satisfaction, and Psychological Well-Being

The hypothesis that perceptions of equal autonomy support will yield optimal levels of need satisfaction is based on research that links satisfaction of psychological needs to empathic processes (Pavey, Greitemayer, & Sparks, 2012; Wesselmann, Bagg, & Williams, 2009). Empathy refers to ability to take into consideration and experience the beliefs and feelings of others (Feshback, 1975). Empathic responses can be positive when for example individuals derive joy in the happiness and success of others (Morelli, Lieberman, & Zaki,

2015; Wallace & Shapiro, 2006). Empathic processes may also lead individuals to experience negative feelings and emotions when they see somebody else being socially excluded and distressed (Williams, 2009). Broadly speaking, empathic processes can be triggered by observing others (e.g., seeing an athlete breaking a world record on television), interacting with others (e.g., hearing someone's good news in person), or creating a positive or negative experience for somebody else (e.g., making a donation).

To date, research has consistently shown that negative and positive empathetic responses are triggered by knowledge about amount of autonomy support that others receive in a context (Legate, DeHaan, & Ryan, 2015; Legate, DeHaan, Weinstein, & Ryan, 2013; Wesselmann, Bagg, & Williams, 2009). For example, a series of studies that examined peer relationships revealed that individuals who received a large amount of autonomy support from a friend reported relatively low levels of need satisfaction when they believed that their friends experienced low levels of autonomy support in a relationship (Deci, La Guardia, Moller, Scheiner, & Ryan, 2006). In contrast, individuals reported optimal levels of need satisfaction when autonomy support was mutual such as when friends provided and received relatively high and equal levels of autonomy support (see also Weinstein & Ryan, 2010).

Research that links empathy to need satisfaction has important implications for understanding effects associated with perceptions of equal, unfavourable and favourable autonomy support. In classroom settings, students observe, and hence know, how teachers are treating their classmates during a lesson (Lee & Chatzisarantis, 2017; Sarrazin et al., 2006). Therefore, they should empathise with the levels of need satisfaction that their classmates experience in autonomy supportive classrooms if empathic processes are triggered by simply knowing how much support other individuals receive in autonomy supportive contexts (Wesselmann et al., 2009). For example, favourably 'treated' students who receive a much larger amount of autonomy support relative to their classmates know that their classmates

receive few opportunities for choice and self-expression. Hence, 'favourably treated' students should experience sub-optimal levels of need satisfaction if individuals empathise with the diminished levels of need satisfaction that other individuals experience as a result of receiving a low amount of autonomy support (Deci et al., 2006; Wesselmann et al., 2009).

In contrast, 'equally treated' students should experience more optimal levels of need satisfaction when they perceive to receive a large amount of support that is also similar to amount of support that their classmates receive in a classroom. This is because the 'equally treated' students know that their classmates are also enjoying high levels of autonomy support. Such knowledge therefore should enhance their levels of need satisfaction if 'equally treated' people empathise with the enhanced levels of need satisfaction that other individuals experience as a result of receiving a large amount of autonomy support in a context (Morelli, Lieberman, & Zaki, 2015; Wallace & Shapiro, 2006). However, 'unfavourably treated' students who perceive to receive a lower amount of autonomy support relative to their classmates should report low levels of need satisfaction. This is because according to Twenge, Baumeister, DeWall, Ciarocco and Bartels (2007) individuals do not emphasise with positive feelings and emotions of others when they are treated unfavourably such as when they receive a much lower amount of support or attention relative to others.

Finally, if perceptions of equal autonomy support yield optimal levels of need satisfaction, then they should predict educational and well-being outcomes indirectly via satisfaction of psychological needs and autonomous forms of motivation. This is because according to self-determination theory psychological needs and autonomous forms of motivation constitute the mechanism through which perception of autonomy support predict educational and well-being outcomes (Ng et al., 2012; Yu et al., 2016).

Overview of the Study and Hypotheses

The purpose of the present study was twofold. First, we examined effects of perceptions of favourable, unfavourable, and equal autonomy support on motivational, educational, and well-being outcomes in a sample of high school students who attended mathematics courses over a semester. We measured two well-being outcomes that aimed to capture satisfaction of the three psychological needs and happiness with math courses. The motivational outcomes captured autonomous and controlling forms of motivation. We also measured educational outcomes related to final grades that students achieved at the end of the semester. Based on previous research (Deci et al., 2006; Lee & Chatzisarantis, 2017; Sarrazin et al., 2006), we hypothesised that in comparison to perceptions of favourable and unfavourable autonomy support, perceptions of equal autonomy support would yield much higher levels of need satisfaction, autonomous motivation, happiness with the maths courses and academic achievement.

The second purpose of the current study was to examine the process by which perceptions of equal autonomy support predicted educational and well-being outcomes. According to self-determination theory and research testing the theory, effects associated with perceptions of autonomy support are mediated by basic psychological needs and autonomous forms of motivation (Deci et al., 2006; Early et al., 2016; Guay & Vallerand, 1996; Tian et al., 2014; Yu et al., 2016). Given this evidence, we hypothesised that perceptions of equal autonomy support would predict academic achievement and happiness with mathematics courses indirectly via satisfaction of psychological needs and autonomous forms of motivation. We did not expect controlling forms of motivation to mediate effects associated with perceptions of equal autonomy support because evidence suggests that controlling forms of motivation do not always undermine well-being outcomes (Ng et al., 2012).

Finally, we measured a number of variables in order to identify effects associated with perceptions of equal autonomy support or statistically control for their effects on educational and well-being outcomes. In particular, we assessed perceptions of equal, favourable and unfavourable autonomy support by measuring two distinct variables (see also Deci et al., 2006). These variables pertained to: (i) amount of autonomy support that students perceived themselves to receive from teachers (perceptions of personal autonomy support; Su & Reeve, 2011) and (ii) amount of autonomy support the students perceived that their classmates received from teachers in a classroom (perceptions of classmates' autonomy support). These two measures capture perceptions of favourable, unfavourable and equal autonomy support through the different response patterns that they elicit during responding (Edwards, 2001). For example, measures of personal and classmates' autonomy support indicate perceptions of equal autonomy support if they both elicit high scores during responding (i.e., +7). Importantly, at the analytic level, effects of perceptions of equal autonomy support on educational and well-being outcomes can be ascertained by estimating, in a linear or polynomial regression analysis, combined effects associated with the two separate measures of autonomy support (Edwards, 1994; Edwards & Parry, 1993).

We also statistically controlled for the effects of past grades on need satisfaction, motivation, psychological well-being and academic achievement. This is an important covariate because there is evidence that teachers tend to provide more autonomy support to high-achieving students who show interest in a subject than low-achieving students who show less interest (Daniels & Plomin, 1985; Good, 1987; Rubie-Davies, 2015; Sarrazin et al., 2006). Hence, the relationships between perceptions of equal autonomy support with educational and well-being outcomes may be spurious reflecting effects that are due to past grades. However, we did not expect past grades to completely attenuate effects associated with perceptions of equal autonomy support. This is because there is evidence that

perceptions of autonomy support predict future academic achievement independent of past grades or academic ability (Black & Deci, 2000; Early et al., 2016). Given that students attended different grades, we also controlled for grade levels in statistical analysis.

Method

Participants and Design

Participants were 359 high school students (M age = 16.10, SD = 0.81, Male = 219, Female = 140) in school years 9 (M age = 15.28, SD = 0.52, Male = 69, Female = 49), 10 (M age = 16.17, SD = 0.50, Male = 86, Female = 45), and 11 (M age = 16.90, SD = 0.45, Male = 64, Female = 46). Students were recruited from two co-educational schools and 13 classrooms in a European country. The average number of students per classroom was 27.6 students. The content of the math course differed across students in different year groups for the semester. The year 9 course covered estimation of perimeters, areas, volumes, and conversions, the year 10 covered linear equations, logarithmic, exponential, and polynomial functions, and the year 11 covered concepts and techniques in trigonometry, real and complex numbers, and matrices. Students engaged in coursework and took a final exam at the end of the semester.

We adopted a partially lagged design in which we measured psychological variables and grades at the same point in time (see Figure 1). In particular, during the second week of the semester, we measured grades that students achieved the previous semester in math, need satisfaction, autonomous and controlling forms of motivation as well as perceptions of personal and classmates' autonomy support. This design allowed us to directly compare our findings with previous studies that tested effects of perceptions of equal autonomy support in the context of peer relationships (Deci et al., 2006). This is because previous studies also measured perceived autonomy support and need satisfaction at the same point in time

(Weinstein & Ryan, 2010). In addition, during the twelfth week of the semester, we measured happiness with the mathematics course. Teachers also provided us with the final grades that students achieved at the end of the semester. Psychological measures were completed in classroom settings of no more than 35 students. Prospective measures were matched with baseline measures by using dates of birth and gender as criteria.

Measures

Past grades. Teachers provided us with the overall grades that students achieved at math the previous semester. Past grades could range from 0% to 100%. This measure was obtained during the second week of the semester.

Grade level. We used a simple contrast-code to model effects associated with grade levels. Specifically, we assigned the value of minus one (-1) to students who attended the year 9 course and the value of one (+1) to students who attended the year 11 course. Students who attended the year 10 course were assigned the value of zero.

Perceptions related to autonomy support. We used six items from Black and Deci's (2000) learning climate questionnaire to measure perceptions of classmates' autonomy support (Deci et al., 2006). However, the questions were phrased specifically to capture students' perceptions of amount of autonomy support that their classmates received during lessons. An example item was: "My math teacher encourages my classmates to ask questions during the class". We also measured perceptions of personal autonomy support by using the same six items from the learning climate questionnaire. These questions were phrased specifically to capture students' perceptions of amount of autonomy support that they received during lessons. An example item was: "My math teacher provides me with choices and options". Perceptions of personal and classmates' autonomy support were measured on the same seven-point scales ranging from *strongly disagree* (1) to *strongly agree* (7) (Black

& Deci, 2000). The alpha reliabilities for perceptions related to personal ($\alpha = .91$) and classmates' ($\alpha = .88$) autonomy support were satisfactory. Perceptions of personal and classmates' autonomy support were measured during the second week of the semester.

It is important to report that in the current study we measured perceptions of personal autonomy support by using Black and Deci's (2000) original instrument that includes fifteen items. However, we represented perceptions of classmates' autonomy support through six items because some of the items that are included in Black and Deci's (2000) questionnaire do not capture teacher's autonomy-supportive behaviours but the impact that these behaviours may have on participants' experiences of autonomy support. These items were not included in our measures because students are more likely to have access to, and hence encounter fewer difficulties in reporting, teachers' behaviours than classmates' experiences of autonomy support. In addition, we represented perceptions of personal autonomy support through the same six items that we used to measure perceptions of classmates' autonomy support because our analysis requires perceptions of personal and classmates' autonomy support to be measured through exactly the same items (Edwards & Parry, 1993). We provide a list of items used to measure perceptions related to personal and classmates' autonomy support in the supplementary materials.

Need satisfaction. We used the basic psychological need satisfaction scale to measure experiences associated with satisfaction of psychological needs (Deci & Ryan et al., 2001). This instrument contains 21 questions that captures satisfaction of the needs for autonomy (e.g., I feel free to express my ideas and opinions during the math class), competence (e.g., Most days I feel a sense of accomplishment during the math class) and relatedness (e.g., I get along with people in the math class). All items were measured on seven-point scales ranging from *not at all true* (1) to *very true* (7). Following Deci et al. (2006), responses to items were averaged to formulate a global need satisfaction scale that measured satisfaction of all three

basic psychological needs. The alpha reliability of this scale was satisfactory ($\alpha = .84$). Need satisfaction was measured during the second week of the semester. It is important to note that separate regression analyses that aimed to predict the three psychological needs for competence, autonomy or relatedness revealed similar results.

Autonomous and controlling forms of motivation. Autonomous and controlling forms of motivation were measured through an approach introduced by Ryan and Connell (1989). Pupils were presented with a stem: "I participate in math classes" followed by four items representing autonomous forms of motivation (identified regulation or intrinsic motivation) and four items capturing controlling forms of motivation (external regulation or introjection). An example item for identification was: "because I want to understand math". An example for introjection was: "because I will feel bad about myself if I do not". An example, for external regulation was: "because I will get in trouble if I do not". An example for intrinsic motivation was: "because I enjoy math". Autonomous forms of motivation were captured by averaging responses to items measuring identification and intrinsic motivation. Analogously, controlling forms of motivation were determined by averaging responses to items measuring external regulation and introjection. All items were measured on 4-point scales ranging from *not at all true* (1) to *very true* (4). The internal consistency reliability for autonomous motivation was satisfactory ($\alpha = .83$). However, the reliability for controlling forms of motivation was low ($\alpha = .53$). Forms of motivation were measured during the second week of the semester.

Happiness with the math courses. We employed Hsee and Zhang's (2004) instrument to measure happiness with the math courses. The instrument contained three items that measured happiness, satisfaction or enjoyment with the math courses. An example item was: "I enjoyed the math course during the last semester". Responses to this item were measured on a 19-point scale ranging from *not at all* (-9) to *very much* (9). Another example

item was: "How happy are you with your performance at the math course the last semester?" This item was measured on a 19-point semantic differential scale ranging from *very unhappy* (-9) to *very happy* (9). The alpha reliability of this measure was satisfactory ($\alpha = .92$). Happiness with math courses were measured during the twelfth week of the semester.

Academic achievement. Academic achievement was measured by students' final grades on their math courses. These grades reflected students' overall performance on the course and it was function of coursework and a grade achieved on a final exam taken at the end of the semester. Grades could range from 0% to 100%. Teachers provided to us the final grades at the end of the semester.

Analysis

We initially calculated descriptive statistics and Pearson's correlations for all variables. For the main analysis, we conducted five hierarchical regression analyses that estimated combined effects of measures of personal and classmates' autonomy support on need satisfaction, autonomous or controlling forms of motivation, happiness with math courses and final grades. In particular, in all hierarchical regression analyses we estimated main effects of personal autonomy support, classmates' autonomy support, grade level and past grades in the first step of the analysis. In the second step of the analysis, we estimated effects of the interaction between perceptions of personal and classmates' autonomous support on dependent variables. In the third step of the analysis, we estimated non-linear (quadratic) effects of personal and classmates' autonomous support on dependent variables.

In the current study, we employed non-linear analyses because linear analyses can distort conclusions about sign and magnitude of regression coefficients when quadratic terms that estimate non-linear relationships between independent and depended variables are not included in the analysis (Aiken & West, 1991; Cortina, 1993; Ganzach, 1977; Lubinski &

Humphrey, 1990). In addition, Deci et al. (1994) noted that effects associated with the construct of autonomy support are consistent with a kind of non-linear (concave) model. This conclusion was supported by findings showing that contexts that supported at least two of the three factors that make up autonomy-supportive contexts (i.e., choice and opportunities for self-expression) facilitated more task interest, overt behavioural persistence and psychological well-being than autonomy-poor contexts that supported only one of the three factors that make up autonomous contexts (e.g., choice, rationale, or perspective taking). However, contexts that supported two factors that make up autonomous contexts did not yield more task interest or overt behavioural persistence than contexts that supported three factors (i.e., choice, rationale and perspective taking). Hence, we chose a quadratic model instead of a linear regression model because the quadratic model expresses findings observed in previous research as well as it reduces the risk of drawing erroneous conclusions about effects associated with perceptions of personal and classmates' autonomy support (Ganzach, 1997). It is important to note that our analysis did not control for the impact that between-classroom or between-school variability may have on participants' responses, through multilevel modelling, because such an analysis would require a large sample of approximately 50 classrooms or schools (Hox & Maas, 2002; O'Dwyer & Parker, 2014).

Following Edwards' (1994) recommendations, we estimated combined effects associated with personal and classmates' autonomy support by analysing regression coefficients of the following five regression equations that were estimated in the third step of the hierarchical regression analyses:

$$NS = b_{10} + b_{11}PA + b_{12}CA + b_{13}PA^2 + b_{14}PAxCA + b_{15}CA^2 + b_{16}PG + b_{17}GL + e_{10} \quad (1)$$

$$CM = b_{20} + b_{21}PA + b_{22}CA + b_{23}PA^2 + b_{24}PAxCA + b_{25}CA^2 + b_{26}PG + b_{27}GL + e_{20} \quad (2)$$

$$AM = b_{30} + b_{31}PA + b_{32}CA + b_{33}PA^2 + b_{34}PAxCA + b_{35}CA^2 + b_{36}PG + b_{37}GL + e_{30} \quad (3)$$

$$HM = b_{40} + b_{41}PA + b_{42}CA + b_{43}PA^2 + b_{44}PAxCA + b_{45}CA^2 + b_{46}PG + b_{47}GL + e_{40} \quad (4)$$

$$FG = b_{50} + b_{51}PA + b_{52}CA + b_{53}PA^2 + b_{54}PAxCA + b_{55}CA^2 + b_{56}PG + b_{57}GL + e_{50} \quad (5)$$

In Equations 1 to 5, the terms NS, AM, CM, HM, and FG represent the five dependent variables that aim to capture need satisfaction (NS), autonomous (AM) and controlled (CM) forms of motivation, happiness with the math courses (HM), and final grades (FG). The terms PA and CA represent participants' responses (ratings) to the instruments that measure perceptions of personal (PA) or classmates (CA) autonomy support respectively. PAxCA is a product term that captures the synergistic (interactive) effects of perceptions of personal and classmates' autonomy support on the dependent variables. The terms PA^2 and CA^2 are quadratic terms. The term PG represents past grades. The term GL is the contrast-coded variable that represented membership in the different grade levels. The *b* coefficients are standardized regression coefficients that capture the intercepts (i.e., b_{10}), main (i.e., b_{21}), interactive (i.e., b_{24}) and quadratic (i.e., b_{35}) effects associated with of the regression equations. The *e* coefficients capture residual variances of the equations (e.g., e_{30}). Following Edwards' (1994) recommendations, scores for past grades and measures of perceptions of personal and classmates' autonomy support were standardised by subtracting the midpoint of the measurement scale for each variable. Regression coefficients were estimated by using 10,000 bootstrap replications (Edwards & Parry, 1993).

Following estimation of regression equations in the third step of the regression analyses, we tested our first hypothesis by conducting surface analysis on regression equations that supported at least two statistically significant coefficients on terms that aimed to capture main effects of personal and classmates' autonomy support or at least one statistically significant coefficient on terms that captured interactive or quadratic effects associated with measures of personal or classmates' autonomy support (Edwards & Parry,

1993). This is consistent with the typical practice in surface analysis to pay less emphasis on the significance of specific regression coefficients than on the variance explained by the set of predictor variables and the response surface pattern yielded by the regression equations (Edwards, 1994). In addition, following Edwards and Parry's (1993) recommendations, we estimated locations of the principal axes of the response surfaces. These axes address our hypothesis because they capture perceptions of autonomy support that yield highest scores on the dependent variables (Edwards, 1994). In surface analysis, the location of the first principal axis is identified by estimating the slope and the intercept of the first principal axis. In addition, we evaluated the location of the first principal axis in relation to congruence and discrepancy lines that capture respectively perceptions of equal and favourable (or unfavourable) autonomy support (Cohen, Nahum-Shani, & Doveh, 2010; Edwards, 1994). The congruence and discrepancy lines have slopes of one and minus one respectively.

In the current study, the surface analysis would support our first hypothesis if the slopes of the first principal axes were statistically different from minus one (-1). In this case, the analysis rules out the possibility that perceptions of favourable and unfavourable autonomy support, captured by the discrepancy lines, are optimal. In addition, the surface analysis would support our first hypothesis if the first principal axes intersected the congruence lines at points that indicated receipt of large amounts of autonomy support by respondents. This finding provides some additional support to our first hypothesis because it means that the first principal axes, that capture optimal perceptions of autonomy support, capture perceptions of equal autonomy support as they intersect the first principal axes at points that indicate receipt of large amounts of autonomy support by respondents and their classmates (see also Edwards & Cable, 2009). Finally, the surface analyses would support our first hypothesis if the slopes of the surfaces that corresponded to the first principal axes were positive and statistically significantly different from zero. Positive slopes mean that

perceptions of equal autonomy support yield highest levels of need satisfaction, autonomous forms of motivation, happiness with math courses and academic grades than other perceptions of equal autonomy support that are captured by the first principal axes (Edwards & Cable, 2009). We provide a detailed explanation of response surface analysis in supplementary materials.

In the present study, we also employed Hayes (2015) process or index analysis to examine our second hypothesis concerning indirect effects of perceptions of equal autonomy support on academic achievement and happiness with math courses (model 6; Hayes & Preacher, 2010). In particular, we used unstandardized regression coefficients from Equation 1 to calculate a block variable that represented effects of perceptions of equal autonomy support on need satisfaction (Edwards & Cable, 2009; Igra, 1979). This block variable was used as an independent variable in two separate regression analyses that aimed to predict academic achievement or happiness with math courses via need satisfaction and autonomous and controlling forms of motivation (Edwards & Lambert, 2007). In addition, in the process analysis, we controlled for effects that past grades and grade level may exert on academic achievement or measures of happiness. At the analytic level, our second hypothesis was supported if the indirect effects of the block variable that captured equal forms of autonomy support on happiness with math courses and academic achievement via need satisfaction and autonomous forms of motivation were statistically significant.

Results

Preliminary Analysis

Table 1 presents descriptive statistics and correlations between psychological variables. Past grades were positively associated with all variables including the grades that students achieved at the end of the semester. In contrast, the negative correlations for the

contrast-coded variable that indicated membership in the different grade levels suggested that year 11 students received a much lower amount of autonomy support as well as they experienced lower levels of need satisfaction and happiness with the math classes than year 10 or year 9 students. In addition, in accordance with previous research that has tested tenets of self-determination theory, correlations supported positive relationships between measures of need satisfaction, autonomous forms of motivation, happiness with math courses, and academic achievement (Early et al., 2016; Guay & Vallerand, 1996; Tian et al., 2014; Yu et al., 2016). The positive correlations between autonomous forms of motivation, academic achievement, and happiness with math courses were also larger than corresponding correlations for controlling forms of motivation. Moreover, correlations supported positive relationships between perceptions of personal or classmates' autonomy support with satisfaction of psychological needs of autonomy, competence, relatedness, happiness with math classes but not with academic achievement.

Main Analysis

Tables 2 and 3 present results of the hierarchical regression analyses. We found statistically significant interactive or non-linear effects for equations representing effects of measures of personal or classmates' autonomy support on need satisfaction, happiness with math courses and autonomous forms of motivation. However, the regression analyses did not detect interactive or non-linear effects of personal or classmates' autonomy support on controlling forms of motivation or final grades. Hence, at this stage, the analysis rules out the hypothesis that perceptions of equal autonomy support predict controlling forms of motivation or academic achievement (Edwards & Parry, 1993). For this reason, we analysed the response surfaces of regression equations that aimed to predict need satisfaction, autonomous forms of motivation and happiness with math courses (Edwards, 1994).

Table 4 and Figures 2a to 2c present surface parameters and surface plots respectively. As shown in Figures 2a to 2c, all response surfaces resembled the shape of a 'mountain' with a rising ridge. This is because the negative coefficients on the quadratic terms induced concave relationships between dependent variables with measures of personal or classmates' autonomy support (see also Deci et al., 1994). In addition, the surface analysis rules out the possibility that favourable or unfavourable forms of autonomy support were optimal because the confidence intervals of the slopes of the first principal axes did not include the value of minus one (Edwards & Parry, 1993). Moreover, in accordance with our expectations, all first principal axes captured perceptions of equal autonomy support as they intersected the congruence lines at points that indicated receipt of large and equal amounts of autonomy support by participants and their classmates. Most critical, the slopes of the surfaces that corresponded to the first principal axes were positive and statistically significant because the confidence intervals of these slopes did not include the value of zero (see Table 4). This final finding corroborates our first hypothesis because it shows that perceptions of equal autonomy support yielded higher levels of need satisfaction, happiness with different math courses and autonomous motivation than other perceptions of unequal autonomy support captured by the first principal axes (Edwards, 1994).

As an example, based on the response surfaces that correspond to the non-linear regression equations, we predict that students who perceive that they receive large and equal amounts of autonomy support experience much higher levels of need satisfaction (equal, M = 5.17; favourably treated, M = 2.77; unfavourably treated, M = 3.55), autonomous forms of motivation (equal, M = 3.51; favourably treated, M = 1.29; unfavourably treated, M = 1.47), and happiness in math classes (equal, M = 3.52; favourably treated, M = -6.37; unfavourably treated, M = -8.41) than favourably treated or unfavourably treated students. Interestingly, the

predicted decline in the levels of need satisfaction when changing perceptions of autonomy support from equal to favourable or unfavourable were 2.40 and 1.62, respectively.

Turning now into the process analyses, it can be seen in Table 5 that the analysis supported positive and statistically significant direct effects of perceptions of equal autonomy support on happiness with math courses. Nevertheless, the analysis also detected positive indirect effects of perceptions of equal autonomy support on both happiness and academic achievement via need satisfaction and autonomous forms of motivation. Hence, in accordance with our second hypothesis and tenets of self-determination theory, this analysis indicates that the equally treated students attained a higher grade at the end of the semester and experienced higher levels of enjoyment in math courses compared with favourably treated or unfavourably treated students. This is because the equally treated students experienced higher levels of need satisfaction and adopted more autonomous forms of motivation during the semester.

Interestingly, the process analysis also detected a statistically non-significant and negative direct effect of equal autonomy support on academic achievement. This unexpected effect is interesting because it means that the null findings observed in the surface analysis for perceptions of equal autonomy support on academic achievement may be due to the fact that perceptions of equal autonomy support exerted direct and indirect effects of opposite sign (Edwards & Lambert, 2007; Hayes & Preacher, 2010). This is illustrated in Table 5 that shows that whereas the indirect effect of perceptions of equal autonomy support on academic achievement was .19, the corresponding direct effect was -.11. These direct and indirect effects explain null findings observed in the surface analysis because the surface analysis captures total effects that are additive function of direct plus indirect effects. Hence, our findings also suggest that equal forms of autonomy support yield higher levels of academic

achievement provided that students who are treated equally in autonomous contexts adopt autonomous forms of motivation (Hayes & Preacher, 2010). The process analysis did not detect any other statistically significant indirect effects on the two dependent variables.

Discussion

The present study employed measures of personal and classmates' autonomy support to examine effects of perceptions of equal autonomy support on educational and well-being outcomes. In accordance with our first and second hypotheses, results indicated that perceptions of equal autonomy support, captured by measures of personal and classmates' autonomy support, were optimal as they yielded much higher educational and well-being outcomes than perceptions of favourable or unfavourable autonomy support. In addition, our analysis showed that the optimal effects observed for perceptions of equal autonomy support were not attenuated by grade level or past grades. This is because we controlled for the effects of these variables on educational and well-being outcomes in our analyses. Hence, at an empirical level, the current study compares favourably with previous research that demonstrated effects of equal and differential autonomy support on well-being outcomes (Deci et al., 2006; Lee & Chatzisarantis, 2017; Sarrazin et al., 2006). However, the present study adds to this literature because it identified for the first time equal autonomy support as the most optimal type of treatment in classroom settings. Broadly speaking, results from the current study suggest that students are more likely to adopt autonomous forms of motivation as well as experience higher levels of need satisfaction, academic achievement and happiness with math courses when they perceive that they and their classmates receive an equally large amount of autonomy support from their teachers. In contrast, students are less likely to adopt autonomous forms of motivation and experience high levels of need satisfaction, academic

achievement, and happiness with math courses when they perceive to receive a much lower or larger amount of autonomy support relative to their classmates.

Implications for Previous Research and Tenets of Self-Determination Theory

The effects observed for perceptions of equal autonomy support in the present study have important implications for previous research that tested tenets of self-determination theory in classroom settings. Specifically, previous primary and meta-analytic studies have documented that autonomy-supportive intervention strategies engender small-to-medium sized increases in students' levels of need satisfaction and psychological well-being (Deci et al., 1994; Ng et al., 2010; Su & Reeve, 2011). However, the experimental and intervention protocols adopted by previous interventions do not inform teachers of the deleterious effects that inequalities in the provision of autonomy support may have on students' levels of need satisfaction and psychological well-being (i.e., Chatzisarantis & Hagger, 2009). As a consequence, it is plausible that previous studies may have underestimated the effectiveness of autonomy-supportive intervention strategies on need satisfaction, educational, and well-being outcomes. This is a possibility given that previous research conducted in real-life classroom settings indicated teachers do tend to distribute autonomy support in an unequal way across students (Pelletier & Vallerand, 1996; Sarrazin et al., 2006). In addition, our analysis shows that perceptions of favourable and unfavourable autonomy support yielded much lower levels of need satisfaction than perceptions of equal autonomy support. Hence, at an empirical level, we advise researchers to interpret effect sizes of autonomy supportive interventions on educational, motivational, and well-being outcomes reported in previous primary and meta-analytic studies with caution. These effect sizes may not necessarily capture optimal effects of autonomy-supportive intervention strategies on outcomes because they did not control for teachers' tendencies to distribute autonomy support in an unequal way across students. Our results also suggest that effects associated with autonomy-

supportive intervention programs can be further maximized by encouraging teachers to provide choice, rationale, and opportunities for self-expression in more equal or consistent way across students.

It is also important to emphasise that results of the current study should not be taken to mean that the theoretical framework provided by self-determination theory is not adequate in predicting or explaining need satisfaction or psychological well-being. As we have already mentioned in the introduction, research stemming from self-determination theory has already recognised that perceptions of equal autonomy support yield optimal levels of need satisfaction in the context of peer relationships (Deci, La Guardia, Moller, Scheiner, & Ryan, 2006). The present study adds to this literature because it shows that effects of equal autonomy support on need satisfaction are more general than previously thought as they extend from peer relationships to classroom settings.

In addition, in accordance with our second hypothesis, the process analysis revealed that effects of perceptions of equal autonomy support on educational and well-being outcomes were mediated by measures of need satisfaction and autonomous forms of motivation (see Table 5). In fact, the mediation analysis showed that we would not be able to detect effects of equal autonomy support on academic grades if we did not include measures to captured need satisfaction or autonomous forms of motivation in our analysis. These findings are particularly noteworthy because they suggest that even though earlier tenets of self-determination theory did not predict effects associated with perceptions of equal autonomy, the theory is sufficient in explaining effects of equal autonomy support on educational and well-being outcomes. Given these findings, we advise researchers to not treat effects observed for equal autonomy support as a limitation of self-determination theory, but as effects that explain need satisfaction in group settings. We also advise researchers to

continue employing measures that aim to capture need satisfaction and different forms of motivation in their attempts to predict and explain educational and well-being outcomes.

Limitations and Conclusions

Finally, it would be remiss to not mention some limitations of the current study and provide directions for future research. Results of the current study should not be used to draw inferences about causal relationships between perceptions of equal autonomy support with need satisfaction, autonomous forms of motivation or happiness with math courses because its design is correlational using self-report questionnaires. In addition, the sample of the current study comprised Year 9, 10 and 11 students. Although our statistical analysis controlled for effects associated with different grade levels, the design of our study does not allow us to examine whether effects observed for perceptions of equal and favourable autonomy support are moderated by third variables such as subject areas. In the current study, we also predicted that perceptions of equal forms autonomy support would be optimal on the basis of evidence showing that individuals empathise with feelings and emotions that others experience in autonomy supportive contexts (Deci et al., 2006; Legate et al., 2013). Although a considerable number of studies have already confirmed a link between contextual autonomy support and empathic processes (Legate et al., 2015; Pavey et al., 2012), the current study did not examine whether empathic processes explain effects observed for perceptions of equal autonomy support on need satisfaction and well-being outcomes in classroom settings. Therefore, it may be important to examine in the future whether empathic processes moderate effects of perceptions of equal autonomy support on educational and well-being outcomes.

In addition, the present study cannot explain the negative direct effects of perceptions of equal autonomy support on academic grades. Although these effects were not statistically significant, it is imperative that they are addressed in future research. This is because they imply that perceptions of equal autonomy support may actually undermine academic

achievement if students do not adopt autonomous forms of motivation (Edwards & Lambert, 2007). Future studies should attempt to further explain when perceptions of equal autonomy support instigate adoption of autonomous forms of motivation, and when they do not, in classroom settings. For example, some recent studies stemming from theories of distributive justice suggest that perceptions of fairness moderate effects favourable and equal treatment on well-being outcomes (Singer, Seymours & O'Doherty et al., 2009). Broadly speaking, evidence suggests that individuals report optimal levels of happiness and psychological well-being when they believe that the amount of support or attention received by oneself and others is fair (Loeser, Whiteman, & McHalle, 2016). Given this evidence, it is plausible that equally treated students may be more likely to adopt autonomous forms of motivation when they believe that the amount of autonomy support received by oneself and others is fair, rather than unfair.

The current study did not measure other important dimensions of the classroom environment such as structure and involvement (Skinner & Belmont, 1993). The construct of structure aims to capture the amount and the clarity of information given to students about how to satisfy teachers' expectations and achieve desired educational outcomes (Jang, Reeve & Deci, 2010). Perceptions related to structure constitute an important component of the classroom environment as they predict well-being and educational outcomes over and above perceptions of autonomy support (Hospel & Galand, 2016). Hence, future studies should examine whether perceptions of equal autonomy support predict educational and well-being outcomes after controlling for effects of structure and involvement.

In conclusion, the present study extends previous research that observed effects of differential treatment in autonomy supportive contexts by showing for the first time that perceptions of equal autonomy support are most optimal in terms of yielding highest levels of need satisfaction, autonomous forms of motivation, happiness with math courses and

academic achievement. In addition, in accordance with tenets of self-determination theory (Deci et al., 2006), we demonstrated that effects associated with perceptions of equal autonomy support were mediated by autonomous forms of motivation and psychological needs. Broadly speaking, current findings suggest that students are more likely to adopt autonomous forms of motivation, achieve higher grades, and experience high levels of need satisfaction and psychological well-being when they perceive that they and their classmates receive an equally large amount of autonomy support from their teachers. In contrast, students are less likely to experience optimal educational and well-being outcomes when they know that they are treated favourably or unfavourably by their teachers, such as when they believe that they receive a much larger or lower amount of autonomy support relative to their classmates. The implication of these findings is that educational policymakers may be able to maximise effectiveness of autonomy-supportive interventions strategies by advising teachers to distribute autonomy support in a more equal way across students. By measuring and facilitating perceptions of equal autonomy support, researchers and practitioners can gain a better understanding of the processes underpinning satisfaction of basic psychological needs as well as they may be able to facilitate optimal educational and well-being outcomes in classroom settings.

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Table 1. Descriptive Statistics and Correlations Between Variables

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Past grades	57.87	19.26	1.00											
2. Membership in math courses (contrast-coded)	-	-	.19	1.00										
3. Perceptions of personal autonomy support	4.97	1.75	.14	-.38	1.00									
4. Perceptions of classmates' autonomy support	5.05	1.51	.11	-.44	.76	1.00								
5. Need satisfaction	4.45	0.97	.29	-.14	.48	.49	1.00							
6. Controlling motivation	2.92	0.62	.11	-.18	.20	.20	.25	1.00						
7. Autonomous motivation	3.14	0.77	.42	-.10	.37	.34	.45	.37	1.00					
8. Happiness with math	1.08	5.59	.37	-.16	.44	.45	.50	.23	.53	1.00				
9. Academic achievement	51.89	24.31	.55	.20	.09	.08	.36	.11	.41	.52	1.00			
10. Autonomy	4.47	1.17	.21	-.19	.50	.49	.80	.22	.37	.43	.25	1.0		
11. Competence	4.01	1.38	.38	-.05	.35	.35	.80	.22	.49	.48	.45	.55	1.0	
12. Relatedness	4.72	1.10	.14	-.12	.35	.37	.83	.17	.25	.31	.20	.49	.41	1.0

Note. Correlations greater than .10 are statistically significant at the $p < .05$ level.

Table 2. Regression Analyses Predicting Need Satisfaction, Autonomous Motivation and Happiness with Math

		Need satisfaction			Autonomous motivation			Happiness with math courses		
		ΔF	R^2	beta	ΔF	R^2	b	ΔF	R^2	b
1step		40.94*	.32		34.92*	.29		31.91*	.29	
	Personal autonomy support			.26*			.24*			.28*
	Classmates' autonomy support			.28*			.09			.12
	Grade level			.04*			-.05			-.04
	Past grades			.22*			.38*			.32*
2nd step		6.18*	.33		1.03	.29		.33	.29	
	Personal autonomy support			.23*			.22*			.29*
	Classmates' autonomy support			.26*			.08			.13
	Grade level			.04			-.05			-.05
	Past grades			.20			.38			.33*
	Personal x classmates' autonomy support			.13*			.05			-.03
3rd step		1.68	.34		6.85*	.31		3.17*	.31	
	Personal autonomy support			.18*			.18*			.29*
	Classmates' autonomy support			.33*			.16*			.13
	Grade level			.04			-.05			-.05
	Past grades			.20*			.37*			.31*
	Personal x classmates' autonomy support			.21*			.38*			.18
	Personal autonomy support^2			.04			-.13			-.16*
	Classmates autonomy support^2			-.16			-.28*			-.12

Note. The term ΔF refers to increment F test. The term R^2 refers to proportion of variance explained by independent variables. The terms 'Personal autonomy support^2' and 'Classmates autonomy support^2' are quadratic terms for variables that capture personal and classmates' autonomy support. The b coefficients are standardised regression coefficients. Parameters with an asterisk are statistically significant at $p < .05$ level.

Table 3. Regression Analyses Predicting Controlling Forms of Motivation and Final Grades

		Controlling motivation			Final grades		
Steps		ΔF	R^2	b	ΔF	R^2	b
1st		6.32*	.07		34.53*	.32	
	Personal autonomy support			.09			.04
	Classmates' autonomy support			.06			.03
	Grade level			-.14*			.15*
	Past grades			.12*			.51*
2nd		.42	.07		.05	.32	
	Personal autonomy support			.08			.04
	Classmates' autonomy support			.05			.03
	Grade level			-.14*			.15*
	Past grades			.11*			.51*
	Personal x classmates' autonomy support			.04			.01
3rd		.87	.07		.66	.32	
	Personal autonomy support			.05			.01
	Classmates' autonomy support			.10			.08
	Grade level			-.14*			.15*
	Past grades			.11*			.51*
	Personal x classmates' autonomy support			.16			.08
	Personal autonomy support^2			-.02			.02
	Classmates autonomy support^2			-.14			-.11

Note. The term ΔF refers to increment F test. The term R^2 refers to proportion of variance explained by independent variables. The terms 'Personal autonomy support^2' and 'Classmates autonomy support^2' are quadratic terms for variables that capture personal and classmates' autonomy support. The b coefficients are standardised regression coefficients. Parameters with an asterisk are statistically significant at $p < .05$ level.

Table 4. Surface Parameters of Models Predicting Need Satisfaction, Autonomous Motivation and Happiness with Math

	1st principal axes		
	Slopes	Intercepts	Slopes of surfaces
Need satisfaction	.41 [.15, .96]	1.35 [.50, 6.01]	.21* [.13, .32]
Autonomous motivation	.65 [.34, 1.79]	.14 [-1.97, .91]	.13* [.08, .22]
Happiness with math	1.07 [-.33, 10.56]	-.58 [-36.21, .89]	1.60* [1.01, 56.65]

Note. Parameters of the 1st principal axes are unstandardized regression coefficients or intercepts. Parameters in brackets are 95% biased corrected confidence intervals. Parameters with asterisks are statistically significant at $p < .05$ level.

Table 5. Indirect and Direct Effects of Perceptions of Equal Autonomy Support on Academic Grades and Happiness with Math

Dependent variable	Type of Effect	b	CI_{95}
Happiness with math	Total indirect	.21	[.13, .29]
	Indirect via need satisfaction	.11	[.05, .18]
	Indirect via autonomous motivation	.06	[.02, .11]
	Indirect via need satisfaction and autonomous motivation	.04	[.02, .07]
	Direct	.15	[.03, .15]
Academic achievement	Total indirect	.19	[.12, .28]
	Indirect via need satisfaction	.12	[.06, .20]
	Indirect via autonomous motivation	.04	[.01, .08]
	Indirect via need satisfaction and autonomous motivation	.03	[.02, .06]
	Direct	-.11	[-.23, .01]

Note. The b coefficients are standardized regression coefficients. The term CI_{95} denotes 95% biased corrected confidence intervals. The b coefficients are statistically significant if the respective confidence intervals do not include the value of zero.

Figure 1. Participant flow diagram

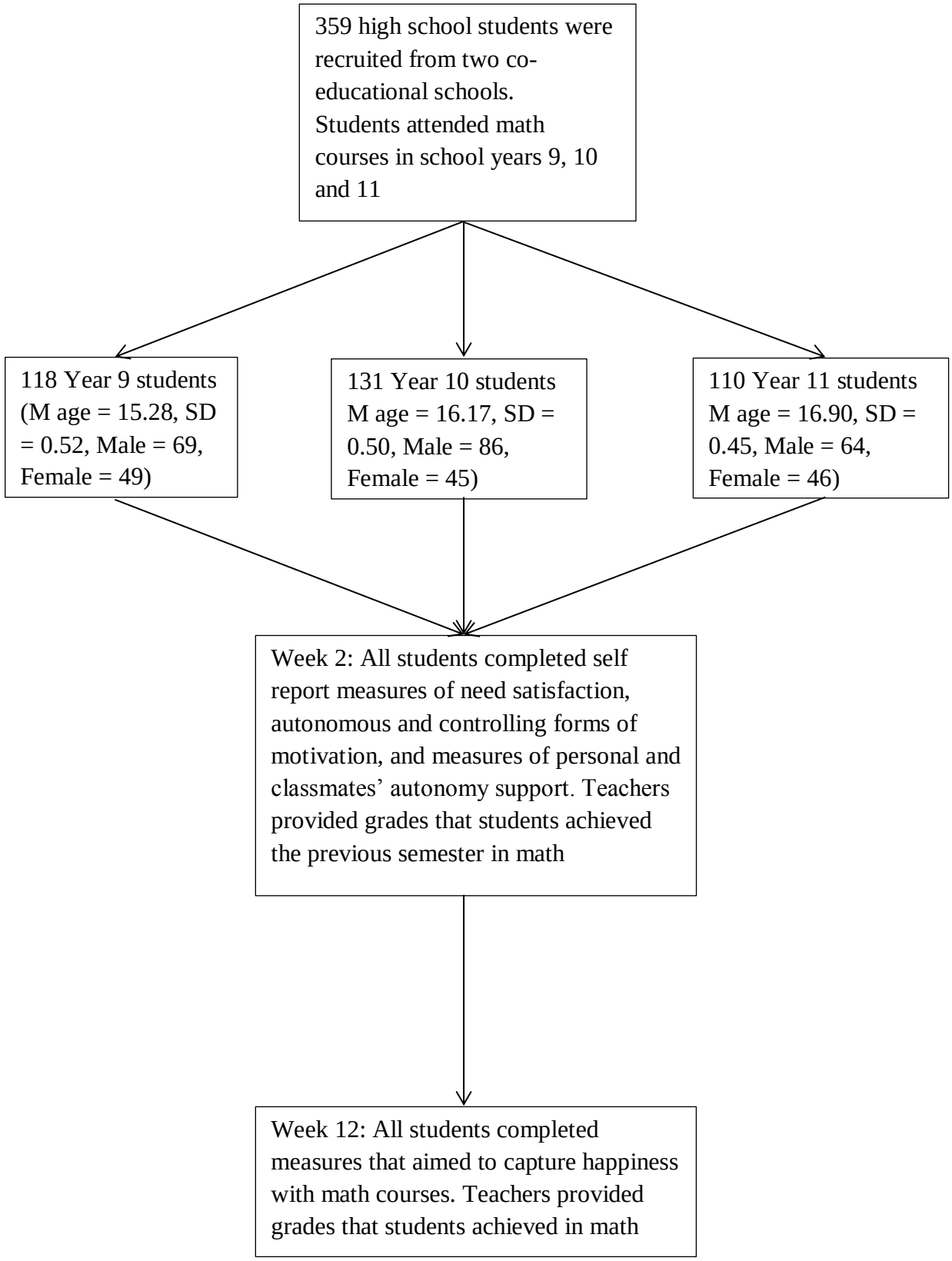
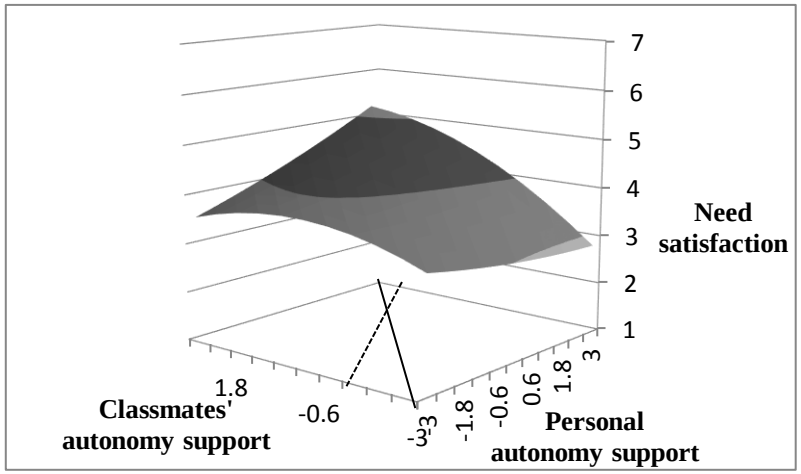
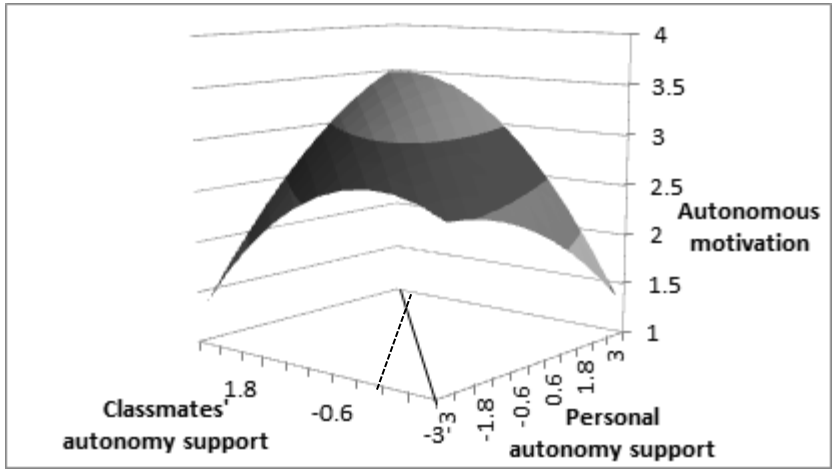


Figure 2. Response surfaces describing effects of different forms of autonomy support on (a) need satisfaction (b), autonomous forms of motivation (c), and happiness with math courses

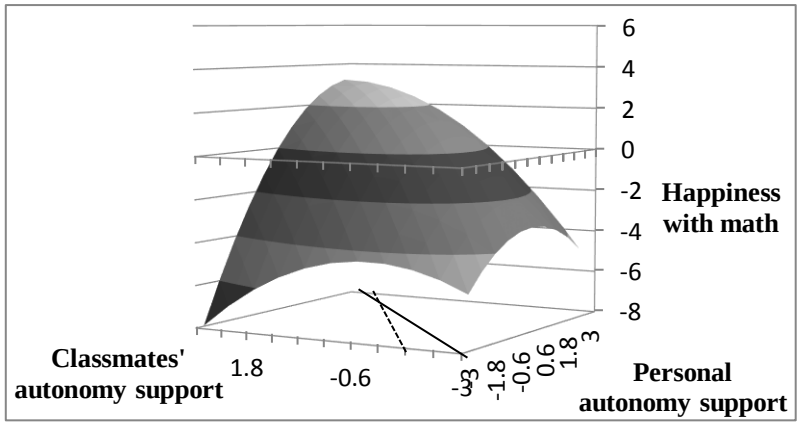
(a)



(b)



(c)

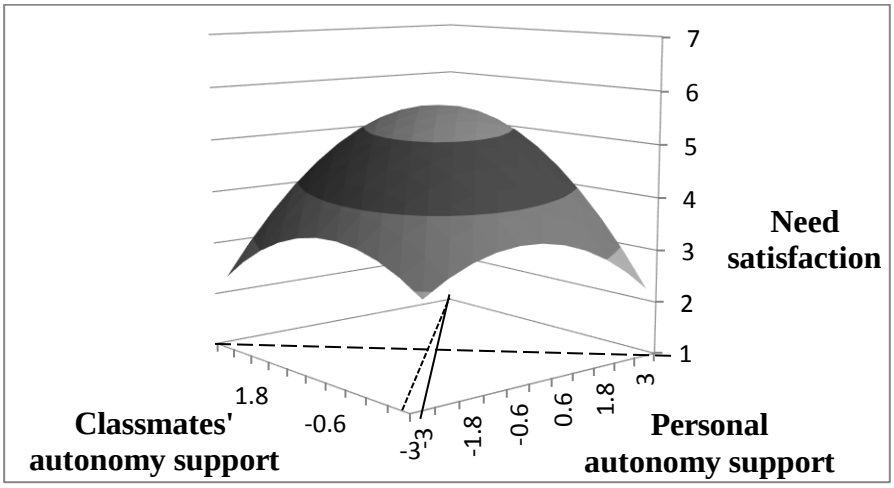


Note. The dashed line represents the 1st principal axis. The solid line is the congruence line. Values for personal and classmates' autonomy support range from -3 to 3 because these measures were standardised by subtracting the midpoint of the scale.

Supplementary Materials

Surface analysis and parameters. In this section, we discuss surface analysis and surface parameters in the context of the present study. Figure 3 presents a hypothetical response surface that is consistent with part of our first hypothesis that predicts that perceptions of equal autonomy support will yield highest levels of need satisfaction. In this plot, perceptions of personal and classmates' autonomy support are represented on perpendicular axes and levels of need satisfaction are represented on the vertical axis. In the context of surface analysis, response surfaces can be plotted by utilising the unstandardized regression coefficients from statistically significant equations.

Figure 3. A hypothetical response surface that describes effects of personal and classmates' autonomy support on need satisfaction.



In Figure 3, the hypothetical response surface displays the expected levels of need satisfaction at all possible combinations of perceptions of personal and classmates' autonomy support. In the current study, we represent different combination of perceptions related to personal and classmates' autonomy support through certain reference lines or vectors (Cohen, Nahum-Shani, & Doveh, 2010; Edwards, 1994). For example, on the floor of Figure 3, there is a congruence line (solid line) and a discrepancy line (heavily dashed line) that represent,

respectively, perfect positive and perfect negative relationships between perceptions of personal and classmates' autonomy support. Because of this, points on these lines (or line segments) capture perceptions of equal, favourable and unfavourable autonomy support. For instance, a point on the far end of the congruence line (solid line) captures perceptions of equal autonomy support. This is because this point is defined by a response pattern that indicates receipt of large amounts of autonomy support by students (i.e., PA = 3) and their classmates (i.e., CA = 3). In contrast, a point on the far end of the discrepancy line represents favourable forms of autonomy support because the corresponding response pattern indicates receipt of a larger amount of autonomy support by students (i.e., PA = 3) than their classmates (i.e., CA = -3). In surface analysis, the locations of various reference lines are represented through their slopes and intercepts (Edwards & Parry, 1993). For example, the discrepancy line has by definition a slope of minus one and an intercept of zero because it represents a perfect negative relationship between perceptions of personal and classmates' autonomy support. In contrast, the congruence line has by definition a slope of one and an intercept of zero because it represents a perfect positive relationship between perceptions of personal and classmates' autonomy support.

In Figure 3, there is also a line (lightly dashed line) that represents the first principal axis of the response surface. This axis addresses our hypothesis because it captures combinations of perceptions related to personal and classmates' autonomy support that yield optimal levels of need satisfaction (Edwards & Parry, 1993). The slope and intercept of the first principal axis are estimated by the using regression coefficients that are estimated through the regression analysis (Edwards, 1994). In the current study, we tested our first hypothesis by examining the locations of the first principal axes that corresponded to the five regression equations in relation to the congruence and discrepancy lines.

In particular, in the present study the surface analysis shows that perceptions of equal autonomy support are optimal if the locations of the first principal axes differed from the locations of the discrepancy lines (Edwards, 1994). In this case, the analysis rules out the possibility that perceptions favourable and unfavourable autonomy support, captured by the discrepancy lines, are optimal. At analytic level, this can be formally tested by examining whether the slopes of the first principal axes are statistically different from minus one (-1) (Edwards & Parry, 1993). Additionally, the surface analysis would support our first hypothesis if the first principal axes intersected the congruence lines at points that indicated receipt of large amounts of autonomy support by respondents (i.e., PA > 0) and their classmates (CA > 0) (see Figure 3). This finding provides some additional support to our first hypothesis because it means that the first principal axes, that capture optimal perceptions of autonomy support, capture perceptions of equal autonomy support as they intersect the first principal axes at points that indicate receipt of large amounts of autonomy support by respondents and their classmates (see also Edwards & Cable, 2009).

Finally, we estimated the slopes of the surfaces that corresponded to the first principal axes. In Figure 3, this slope refers to the gradient of the surface that corresponds to the first principal axis (Edwards, 1994). The surface analyses supports our first hypothesis if the slopes of the surfaces that corresponded to the first principal axes were positive and statistically different from zero. Positive slopes mean that perceptions of equal autonomy support yield highest levels of need satisfaction when they indicate receipt of large, rather than small, amount of autonomy support by respondents and their classmates (Edwards & Cable, 2009).

Perceptions of personal and classmates' autonomy support. Below we present the items that were used to measure perceptions related to personal and classmates' autonomy support.

Perceptions related to personal autonomy support:

My math teacher provides me with choices and options in the maths class.

My math teacher accepts me as they I am.

My math teacher encourages me to ask questions during the class.

My math teacher listens to me in the math class.

My math teacher answers my questions in the math class.

My math teacher cares about me in the math class.

Perceptions related to classmates' autonomy support:

My math teacher provides my classmates with choices and options in the maths class.

My math teacher accepts my classmates as they are.

My math teacher encourages my classmates to ask questions during the class.

My math teacher listens to my classmates in the math class.

My math teacher answers my classmates' questions in the math class.

My math teacher cares about my classmates in the math class.