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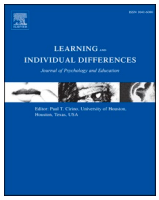

Predicting students' basic psychological need profiles through motivational appeals: Relations with grit and well-being

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ABSTRACT

The aim of the present study was to examine the predictive relation between teachers' motivational appeals (i.e., messages that appeal to a certain kind of motivation) and students' basic psychological need profiles and how the different profiles relate with students' well-being and grit. A total of 655 secondary students participated in the study. To determine the number of profiles a person-centered approach was followed. Results of the latent profile analysis revealed four profiles regarding student's need experiences: *thwarted*, *fulfilled*, *low fulfilment* and *neutral* profiles. Students whose teacher relied on autonomous motivational appeals were more likely to belong to the most adaptive profile (i.e., fulfilled), whereas students whose teacher relied on amotivational appeals were more likely to belong to the most non-adaptive profile (i.e., thwarted). Moreover, students belonging to the adaptive profiles reported higher levels of well-being and grit. The present findings highlight a resource for teachers to satisfy students' needs, well-being, and grit.

1. Introduction

Teacher's behavior often plays a role in initiating and regulating students' behavior (Jang, Reeve, & Deci, 2010), and thus, has become a focal point of research in the educational field. Accumulating evidence has proven the capability of teaching practices to boost students' potential in a wide variety of life domains (Bartholomew et al., 2018; Blazar & Kraft, 2017; Breeman et al., 2015; Codina, Valenzuela, Pestana, & Gonzalez-Conde, 2018; Collie, Granziera, & Martin, 2019; Lazarides, Gaspard, & Dicke, 2019). Among these practices, need-supportive teaching has been established as a key factor related to several student outcomes, such as motivation, engagement, and adjustment (Deci, Ryan, Vallerand, & Pelletier, 1991; Haerens et al., 2018; Jang et al., 2010, 2016; Reeve, 2009, 2016; Vansteenkiste, Zhou, Lens, & Soenens, 2005). Some examples of these behaviours include offering choice, providing informative support/feedback, and showing care and attention to students' concerns, among others (Reeve, 2009). Despite the evidence, studies examining new ways in which teachers can be need-supportive is scarce. Research on this topic rather focuses on adding knowledge on variables related to the already stablished behaviours and often follow cross-sectional designs. Moreover, whereas there is extent research linking student need profiles with several outcomes, there is still a need for research focusing on the antecedents of such profiles (Martinent, Gareau, Guillet-Descas, Lienhart, & Nicaise, 2021). The present study adds on the literature by exploring the predictive value of a teaching behavior that has not been explored before: teachers' motivational appeals. These are teacher messages that try to engage their students in school tasks by appealing to a certain type of motivation. For instance, teachers could advise their students to work hard in order to have more free time when they arrive home, and thus, they will be appealing to an extrinsic type of motivation. Specifically, following a prospective design and a person-centered approach, the current study examines how teachers' motivational appeals relate with profiles of students' basic psychological needs, both their thwarting and satisfaction, and how the different profiles relate with students' well-being and grit.

1.1. Self-determination theory

1.1.1. Basic psychological needs and need-supportive teaching

Under the umbrella of the self-determination theory (Ryan & Deci, 2000, 2017, 2020), the basic psychological needs mini-theory describes three innate basic psychological needs that, when satisfied, result essential for the correct functioning of individuals (Deci & Ryan, 2000a; Ryan, Huta, & Deci, 2008). These needs include the need for autonomy, the need for competence, and the need for relatedness (Vansteenkiste, Ryan, & Soenens, 2020). When students' need for autonomy is satisfied,

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they feel their teacher supports their ideas and actions, take under consideration their points of views, and meaningfully justify the reasons for their demands. Students engage in an activity willingly and because they want to (Vansteenkiste & Ryan, 2013). When students' feel their need for competence is satisfied, they feel capable of successfully dealing with their academic demands. Finally, a student whose need for relatedness is satisfied would feel supported and bonded with their peers and teachers (Behzadnia, Adachi, Deci, & Mohammadzadeh, 2018; Ryan & Deci, 2020).

Previous research on basic needs has provided evidence on the numerous positive outcomes related with student need fulfilment, as well as the negative outcomes related to the thwarting of these (Liu, Bartholomew, & Chung, 2017; Ryan & Deci, 2020; Skinner, Saxton, Currie, & Shusterman, 2017). For instance, need satisfaction has been related with subjective well-being (Jiang et al., 2020), several indicators of school adjustment (Raižiene, Gabrialaviciute, & Garckija, 2017), achievement (Marshik, Ashton, & Algina, 2017), and motivation (Haerens, Aelterman, Vansteenkiste, Soenens, & Van Petegem, 2015). Although it may seem similar, it is important to state that the poor satisfaction of needs is not the same as the thwarting of these (Ebersold, Rahm, & Heise, 2019; Sheldon & Hilpert, 2012; Vansteenkiste & Ryan, 2013). Researchers commonly refer to this phenomena as the "dark" and "bright" pathways of human development (Deci & Ryan, 2000a) which describes that when needs are poorly satisfied students thriving and growth attenuates, but when these are thwarted, it develops into ill-being and non-adaptive outcomes (Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011; Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011; Chen et al., 2015). Thus, it is necessary to explore both the thwarting and the fulfilment of these needs simultaneously to illustrate an accurate picture of the actual relations among variables, similar to previous research (Martinek et al., 2021). This approach would contribute to previous research that has not been comprehensive in this way (Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011; Cuevas, Sánchez-Oliva, Bartholomew, Ntoumanis, & García-Calvo, 2015; Ebersold et al., 2019). Given the differential implications of both need experiences, the present study addresses the relation among students' need thwarting and satisfaction profiles, and their outcomes on grit and well-being.

Teachers, as social agent as they are, need to serve as gateways to nurture students' needs (Gehlbach, 2010). Among the available resources for teachers to regulate the experience of need fulfilment, researchers have described a set of teaching practices under the so-called need-supportive teaching (Collie et al., 2019; Haerens et al., 2018; Ryan & Deci, 2020; Vansteenkiste et al., 2012). These practices involve teachers' support and fulfilment of students' needs for autonomy, relatedness, and competence (Ryan & Deci, 2020). Whereas autonomy supportive practices have been related with students' motivation, learning and behavior (Haerens et al., 2015; Vansteenkiste et al., 2012), controlling teaching practices have been related with students' disengagement and lower academic achievement (Collie et al., 2019) as well as need thwarting (Jang, Kim, & Reeve, 2016). Contrastingly, autonomy supportive practices have also found to increase students' need satisfaction experiences and in turn, their motivation and academic performance (Ahn, Chiu, & Patrick, 2021; Collie et al., 2019).

Among these need-supportive practices, teachers' forms of communications have been approached as a way of displaying an informative or a controlling language (i.e., "*you could/may*" vs. "*you must/have to*"; Cheon, Reeve, & Vansteenkiste, 2020; Haerens et al., 2015; Jang et al., 2016; Weinstein, Vansteenkiste, & Paulmann, 2020). However, this approach does not contemplate the motivations appealed to in the message. Say for example a teacher appeals to an autonomous motivational appeal by telling students to do their homework in order to learn interesting facts. If we focus on the previous approach the relation examined would be whether the teacher says: "you must do your homework to learn interesting facts" or whether they say, "you may do your homework to learn interesting facts". Both messages have the exact same literal meaning and what changes is the choice frame. Nonetheless, by examining messages in such way the relation of the motivation appealed to is lost when in fact it could be also important. Following the example, it could be that appealing to an autonomous motivational appeal (i.e., learn interesting facts) has a different relation that appealing to a controlled motivational appeal (i.e., have more free time at home). Now messages would have quite different literal meanings whereas the choice frame is remained constant. Thus, the present approach examines teachers' forms of communications from a new perspective. Specifically, it explores motivational appeals hold within teacher messages as it could bring insight into their relation with students' outcomes. This approach could also help us separate the contribution of a specific message from the contribution of the language used to accompany such message. From an applied point of view, teachers might benefit more from this approach as it addresses the specific messages teachers can use (i.e., "*My teacher tells me that if I work hard, I will enjoy this subject*").

1.1.2. Motivational appeals

Motivational appeals can be defined as teacher advice messages that rely on a certain type of motivation to endorse students to become involved in school-related activities (Santana-Monagas, Putwain, Núñez, Loro, & León, 2022). In such messages, teachers highlight the possible consequences derived from exhibiting (or not) certain behaviours. These consequences can be framed in terms of autonomous or controlling motivations (Deci & Ryan, 2016; Ryan & Deci, 2000, 2017, 2020). When teachers appeal to autonomous forms of motivation (i.e., intrinsic motivation), the consequences of the behavior are framed towards the pleasure and gratification of the activity itself (interest). Contrastingly, controlled motivational appeals (i.e., extrinsic motivation) frame the consequences of the behavior on external sources such as rewards or punishments (Behzadnia et al., 2018; Ryan & Deci, 2020). In some cases, teachers cannot appeal to any kind of motivation at all, instead their messages might be highlighting the absence of relation among student's behavior and the expected repercussions to such behavior. These kinds of messages can be classified as amotivation appeals. Students who feel amotivated commonly experience a sense of lack of control (Núñez & León, 2015).

Whereas both autonomous and controlled motivations activate students' behavior, they aren't equally important for optimal functioning and accomplishment. Focusing on the achievement of more autonomous goals fulfils students' needs and strongly connects with their thriving and growth (Ryan & Martela, 2016). In such way, students who feel autonomously motivated achieve self-regulated and deep learning (León, Núñez, & Liew, 2015), exert greater effort, knowledge, and performance (Behzadnia et al., 2018; Kusurkar, Ten Cate, Vos, Westers, & Croiset, 2013), report higher levels of well-being (Haerens et al., 2018), and experience goals towards learning and higher engagement (Froiland & Worrell, 2016; Ryan & Deci, 2020). Disparately, when students feel motivated in a controlled manner they tend to procrastinate more (Codina et al., 2018), confront psychological ill-being, this is, experiencing negative affect (Liu et al., 2017), and experience fear of failure, contingent self-worth, and challenge avoidance (Bartholomew et al., 2018). Accordingly, cultivating environments where students' needs can be satisfied is essential for students' positive emotions, engagement, and autonomous motivations (Deci et al., 1991; Deci & Ryan, 2016; Deci & Vansteenkiste, 2004; Hafen et al., 2012; Núñez & León, 2015). A way teachers can achieve such environments is by relying on motivational appeals. In other words, encouraging students to perform certain activities moved by autonomous forms of motivations might relate with their need experiences.

1.2. Students' outcomes: grit and well-being

Over the past ten years, research on grit has experienced an exponential growth as it has been related to numerous positive academic

outcomes (Fernández-Martín, Arco-Tirado, & Hervás-Torres, 2020). Grit refers to the perseverance and passion for long-term goals (Kwon, 2021). This combination (i.e., perseverance and passion) in conjunction with a higher-order goal-seeking approach distinguishes grit from similar constructs such as self-efficacy or self-concept (Arco-Tirado, Fernández-Martín, & Hoyle, 2018). People who are gritty tend to exert oneself towards the consecution of goals that result of interest to themselves and remain focused on this over time, regardless of setbacks, difficulties, or boredom (Duckworth, Peterson, Matthews, & Kelly, 2007; Verner-Filion, Schellenberg, Holding, & Koestner, 2020). When applied to educational contexts, it has been shown to be a strong predictor of students' achievement (Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014; Park, Yu, Baelen, Tsukayama, & Duckworth, 2018; Wolters & Hussain, 2015). Although grit has been conceived as a personality trait and thus, been studied as a predictor (Jiang et al., 2020; Park, Tsukayama, Yu, & Duckworth, 2020), it has also been found to be a malleable construct that can be modified under certain environments and that increases over lifetime (Alan, Boneva, & Ertac, 2019; Park et al., 2018). Therefore, it can also be studied as an educational outcome (Duckworth et al., 2007). However, there is still little knowledge on the educational factors that foster grit (Park et al., 2020). As Fernández-Martín et al. (2020) stated, examining grit as an outcome is as important and necessary as examining grit as a predictor. Nevertheless, this has not been the common trend followed by researchers as evidenced by the small number of studies conceiving grit as an outcome. As grit encounters a motivational force that drives behavior towards ones' self-realisation and flourishment (Duckworth et al., 2007; Vainio & Daukantaitė, 2016; Verner-Filion et al., 2020), and given grit's capacity to be alterable, teachers can assume a leading role in the development of grit.

Teachers can also promote students' well-being through their teaching practices. From a eudaimonic perspective, well-being is not understood as a state or kind of happiness. Instead, it is conceived as a product of feeling fulfilled and satisfied with ones' life (Ryan & Martela, 2016). It involves processes of self-realisation and personal growth related to a healthy functioning (Ryan & Deci, 2001). Among the literature, it has been common to rely on subjective vitality and self-esteem as indicators of eudaimonic well-being (León & Liew, 2017; León & Núñez, 2013; Liu et al., 2017; Ryan et al., 2008; Ryan & Martela, 2016). Subjective vitality refers to feeling energetic and alive (Ryan & Frederick, 1997). From the self-determination theory point of view, events that cherish ourselves through the satisfaction of basic psychological needs, would imply a sense of augmented vitality (Ryan & Deci, 2008). Moreover, self-esteem is defined as a perception or attitude, either positive or negative, towards oneself (Rosenberg, 1965) formed through the feedback we receive in social contexts (González-Pienda, Pérez, González, & García, 1997).

Integrated within the self-determination theory, researchers have identified the satisfaction of basic psychological needs, namely feeling autonomous, competent and related with others, as a predictor of well-being (Deci & Ryan, 2000b; León & Núñez, 2013; Ryan & Deci, 2001). Thus, teachers that adopt a need-supportive teaching style are more likely to foster students' well-being. In such way, supportive schools, classroom climates, and teachers have proven to be an important factor in determining students' well-being (Behzadnia, 2020; Chatzisarantis et al., 2019; Khalkhali & Golestaneh, 2011; Steinmayr, Heyder, Naumburg, Michels, & Wirthwein, 2018). For instance, quality teacher-student interactions have been found to foster numerous positive student outcomes such as higher well-being, social and emotional adjustment, engagement, and academic performance (Dubois & Silverthorn, 2005; León & Liew, 2017; LoCasale-Crouch, Jamil, Pianta, Rudasill, & DeCoster, 2018). Given its important repercussion, well-being has brought the attention of researchers that examine school variables that relate to it (Newland, Mourlam, Strouse, DeCino, & Hanson, 2019; Putwain, Loderer, Gallard, & Beaumont, 2020) as well as identifying actions that teachers and schools can endure for its promotion (Mackenzie & Williams, 2018).

1.3. The present study

Framed within the self-determination theory, the present study follows a person-centered approach. Contrary to variable-centered approaches, which inform about the existent relations between variables in the same population of students, person-centered approaches help us establish different subpopulations of students within a same population that share a common need experience (Collie, Malmberg, Martin, Sammons, & Morin, 2020). This approach results relevant to tackle the necessities displayed by each kind of profile of students, instead of addressing need fulfilment and thwarting as a shared experienced among all students in a class (Lanza & Rhoades, 2013). Thus, it could help professionals to shape future interventions based on student necessities instead of focusing on variables that may be the subject of wider interventions (Lanza & Rhoades, 2013). For example, variable-centered approach interventions would target students equally, and thus, teachers might be told what messages they should be relying on to enhance student's need experiences, regardless of their actual experiences. On the contrary, person-centered approaches would adapt the intervention towards students need experiences, therefore, teachers would be informed of the kind of messages they should be relying for each student need profile. If messages have a different predictive value regarding student needs, then future interventions can benefit from such findings. It could be that a certain kind of message that has been proven to be beneficial, such as gain-framed messages (Santana-Monagas, Núñez, Loro, Huéscar, & León, 2022) might not be effective under certain student need experiences. This can only be identified when relying on person-centered approaches.

Moreover, because we are interested on the predictive relation among teachers' motivational appeals and student outcomes, a prospective two-wave design was followed. By adopting a prospective design, besides not inferring causality, we can reach a more proximate approach to the predictive value (rather than an associative value) of teaching practices on student outcomes (Vallerand & Bissonnette, 1992). In such way, teachers' motivational appeals were measured at point A and student outcomes (basic psychological needs, grit and well-being) were measured later at point B. Talking all together, the present study purposes were (a) to examine the different profiles of students based on their experiences of need fulfilment and need thwarting; (b) to examine if teachers' motivational appeals predict students' membership to the need profiles; and (c) and explore whether there are any differences regarding student outcomes on grit and well-being among the profiles. Based on previous works highlighting the distinctive nature of need thwarting and need satisfaction, and regarding our first purpose, we hypothesize to find more than two profiles. Besides, at least two of these profiles will be characterized by opposed need experiences resulting in two kinds of profiles: adaptive and non-adaptive profiles (low fulfilment-high thwarting/high fulfilment-low thwarting). Concerning our second aim, we expect that teachers' motivational appeals would predict students' membership to the more adaptive profiles whereas amotivation appeals would predict students' membership to the least adaptive profiles. Finally, regarding our last purpose, we expect to find higher levels of grit and well-being on students belonging to the more adaptive profiles. Contrastingly, students belonging to the non-adaptive profiles would report lower levels of well-being and grit.

2. Method

2.1. Participants and procedure

The sample comprise a total of 655 students (47.6% women; Mean age = 16.37, *SD* = 1.22) distributed in forty classes (Mean students per classroom = 16.55; *SD* = 5.96; range = 5–28) from grades 8th to 12th. Participants were drawn from ten public secondary schools from both

rural and urban environments that presented no potential ethnic differences as most of the students were from [masked for peer review]. Students came mostly from middle-class families.

To lower potential bias questions were made specific to mathematics, thus, questions referring to teacher's motivational appeals referred to the teacher shared by students in the same class. Given that all students attended the same subject, they received an equal number of hours of classes per week. Questionnaires were administered during a teaching period by researchers where participants' assessed teacher was not present. Returned questionnaires were interpreted as informed consent. Participants were explained their right to withdraw from the survey at any time and for any reason. Students were asked to answer items regarding motivational appeals with reference to their current mathematics teacher.

The first wave of data collection (T1; n = 781) took place during the second trimester of the school year (February 2019) and the second wave (T2; n = 655) took place approximately three months later in the final trimester (May 2019). At T1 data on teacher motivational appeals was collected, whereas at T2 the data collected was related to student outcomes. Throughout the two time points, 16.1% of data were missing. The full information maximum likelihood estimator was used to handle missing data. This estimation method retrieves bias even when data are not missed at random (Little, Jorgensen, Lang, & Moore, 2014). Because we are aware that teacher practices likely change over time and, thus, collecting data at the beginning of the school might not be a good approach (Usher, 2021), we decided to collect data with the school year well advanced. We believe that at this time teachers and students know each other well and thus, teacher practices are more likely to be stabilised.

2.2. Instruments

All items were rated according to a 7-point Likert scale ranging from *does not correspond at all* (1) to *fully corresponds to me* (7). In order to assess reliability of the instruments used, McDonald's Omega was used as it assumes same factor loadings (Hancock & An, 2020) and has proven better accuracy in comparison with Cronbach's alpha (McNeish, 2018). Omega values are displayed in Table 1.

2.2.1. Teacher's motivational appeals

Teacher's motivational appeals were assessed using 12 items from the Spanish Teachers' Engaging Messages Scale (Santana-Monagas, Putwain et al., 2022). The items answer the following statement: "My teacher tells me that...". Items were grouped by four into three factors, one for each motivation: autonomous (e.g., "If I work hard, I will enjoy this subject"), controlled (e.g., "If I work hard, I will receive compliments"), and amotivation messages (e.g., "It does not matter if I work hard, I will fail anyway"). The reliability and validity of this scale have been previously established (Santana-Monagas, Núñez et al., 2022). Model fit indices for the CFA were as follows: χ^2 (66) = 2072.781, $p <$ 0.001, RMSEA = 0.04, CFI = 0.97.

2.2.2. Basic psychological needs

To assess perceived fulfilment of basic psychological needs, students completed the Spanish version of the *Échelle de Satisfacción des Besoins Psychologiques* validated in the educational context (León, Domínguez, Núñez, Pérez, & Martín-Albo, 2011). The scale comprises a total of 20 items preceded by the phrase "*In Maths class…*". Items are divided into four factors of five items one for each need, taking into account that the need for relatedness is divided into relatedness with teachers and relatedness with peers: autonomy (e.g., "*I feel my choices express who I really am*"), competence (e.g., "*I often feel very competent*") relatedness with teachers (e.g., "*I feel comfortable with my teacher*") and relatedness with peers (e.g., "*I get along well with my peers*"). Previous works have provided evidence of reliability and validity of the scale (Moreno-Murcia, Pintado, Huéscar, & Marzo, 2018). Model fit indices for the CFA

Table 1
Means, standard deviations, McDonald's Omega and correlations among student variables.

	Mean	SD	ω	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Autonomous motivational appeals	3.63	3.31	0.83	–													
2 Controlled motivational appeals	3.92	2.19	0.74	0.61*	–												
3 Amotivation appeals	1.41	4.50	0.97	−0.06	−0.07	–											
4 Autonomy satisfied	4.52	4.55	0.91	0.32*	0.25*	−0.20*	–										
5 Competence satisfied	4.59	2.70	0.91	0.22*	0.18*	−0.17*	0.74*	–									
6 RP satisfied	5.18	4.59	0.91	0.18*	0.14*	−0.02	0.53*	0.52*	–								
7 RT satisfied	4.55	5.18	0.94	0.28*	0.23*	−0.24*	0.74*	0.64*	0.41*	–							
8 Autonomy thwarted	2.70	1.86	0.85	0.01	0.10*	0.20*	−0.28*	−0.17*	−0.11*	−0.19*	–						
9 Competence thwarted	2.79	4.66	0.87	−0.06	0.03	0.28*	−0.31*	−0.33*	−0.16*	−0.24*	0.73*	–					
10 Relatedness thwarted	1.86	2.79	0.88	−0.03	0.04	0.19*	−0.14*	−0.10*	−0.26*	−0.12*	0.61*	0.63*	–				
11 Positive self-esteem	4.66	3.08	0.89	0.21*	0.18*	−0.18*	0.57*	0.74*	0.38*	0.49*	−0.23*	−0.40*	−0.17*	–			
12 Negative self esteem	3.08	2.80	0.94	−0.05	0.01	0.22*	−0.27*	−0.38*	−0.15*	−0.20*	0.47*	0.63*	0.40*	−0.53*	–		
13 Subjective vitality	2.80	1.78	0.96	0.39*	0.26*	−0.10*	0.47*	0.47*	0.23*	0.48*	−0.07	−0.15*	0.02	0.46*	−0.23*	–	
14 Negative Grit	4.50	3.32	0.84	−0.03	0.05	0.07	−0.07	−0.09*	0.00	−0.09*	0.40*	0.38*	0.23*	−0.16*	0.37*	−0.06*	–
15 Positive Grit	3.32	4.52	0.85	0.14*	0.08	−0.14*	0.54*	0.61*	0.32*	0.47*	−0.20*	−0.23*	−0.08*	0.53*	−0.29*	0.41*	−0.22*

Note. RT = relatedness with teachers; RP = relatedness with peers; ω = McDonald's Omega.
* $p < 0.05$.

were as follows: χ^2 (190) = 5232.978, $p < 0.001$, RMSEA = 0.06, CFI = 0.95.

To assess perceived thwarting of the basic psychological needs, students completed the Spanish version of the Psychological Need Thwarting Scale (Cuevas et al., 2015). The scale comprises a total of 12 items preceded by the phrase "*In Maths class…*". Items are divided into three factors, one for each need: autonomy (e.g., "*I feel that I cannot make decisions about how to study*"), competence (e.g., "*There are times when I feel incompetent*") and relatedness (e.g., "*I feel rejected*"). Previous works have provided evidence of reliability and validity of the scale (Warburton, Wang, Bartholomew, Tuff, & Bishop, 2020). Model fit indices for the CFA were as follows: χ^2 (66) = 1839.880, $p < 0.001$, RMSEA = 0.08, CFI = 0.89.

2.2.3. Grit

To assess grit, students completed 8 items of the Spanish version of the Grit Scale (Barriopedro, Quintana, & Ruiz, 2018) preceded by the sentence "*In Maths class…*". Four items were formulated positively (e.g., "*I never give up*") and four were formulated negatively (e.g., "*I often set a goal but later choose to pursue a different one*"). This scale has proved reliable and valid in previous studies (Park et al., 2020). Model fit indices for the CFA were as follows: χ^2 (28) = 987.358, $p < 0.001$, RMSEA = 0.07, CFI = 0.95.

2.2.4. Self-esteem

To assess self-esteem, students completed the Spanish version of the Rosenberg's Self-Esteem Scale (Martín-Albo, Núñez, Navarro, & Grijalvo, 2007). The items were preceded by the phrase "*In Math class…*". The scale is composed of ten items, five items formulated positively (e.g., "*I have a positive attitude towards myself*") and five items formulated negatively (e.g., "*Sometimes I think I am not good at anything*"). Previous studies have proven the validity and reliability of the scale (León & Liew, 2017). Model fit indices for the CFA were as follows: χ^2 (45) = 1763.734, $p < 0.001$, RMSEA = 0.07, CFI = 0.94.

2.2.5. Subjective vitality

Subjective vitality was measured using the Spanish version of the Subjective Vitality Scale (Castillo, Tomás, & Balaguer, 2017). The scale comprises a total of seven items and is headed by the statement "*In Math class*" (e.g., "*I feel very energetic*"). Previous studies have proven the validity and reliability of the scale (León & Liew, 2017). Model fit indices for the CFA were as follows: χ^2 (21) = 1506.994, $p < 0.001$, RMSEA = 0.08, CFI = 0.97.

2.3. Data analyses

2.3.1. Latent profile analysis: a person-centered approach

Researchers rely on latent profile analyses to explain the variability within a population (Korpipää et al., 2019). This approach allocates participants into profiles according to the probability of membership to that profile. Opposite to traditional cluster analysis, it relies on a set of fit indices to estimate the number of profiles more appropriate (Morin & Marsh, 2015; Stanley, Kellermanns, & Zellweger, 2017): Log-Likelihood (LL), Akaike Information Criteria (AIC), Sample Size Adjusted Bayesian Information Criteria (SSA-BIC), and Likelihood Ratio Test (LRT). Low values of LL, AIC, and SSA-BIC are indicators of better fit in comparison with higher values. LRT informs if the fit of a model with k latent profile is better than the fit of a model with k-1 profile. A low *p*-value indicates that a model with k groups fits better than a model with k-1 groups (Lo et al., 2001). The percentage of participants in the smallest latent subgroup of each model was also taken into consideration, given that solutions with a small number of participants may not represent a unique latent profile (Marsh, Lüdtke, Trautwein, & Morin, 2009). Elbow plots were created to reveal the flattening of these indices. A distinct elbow is an indicator of a good solution (Morin, Meyer, Creusier, & Biétry, 2016).

To conduct the latent profile analyses, a three-step procedure was followed as Marsh et al. (2009) and Morin and Marsh (2015) recommend. First, a latent profile analysis was estimated to decide the number of profiles for students based on their basic psychological need experiences, both thwarted and satisfied, (i.e., autonomy, competence, relatedness with teachers, and relatedness with peers). A total of 8 solutions were tested. To estimate the variable scores and lower the effect of measurement errors (Justice, Petscher, Schatschneider, & Mashburn, 2011), factor scores were calculated. Factor scores were saved and standardised with mean = 0 and SD = 1. Then, once the number of profiles were decided, differences among profiles in student's grit and psychological well-being was examined using the BCH method. This method differs from the classic ANOVA as it considers the probability of belonging to each profile instead of assuming that subjects belong to just one profile (Asparouhov and Muthén, 2014; Bolck, Croon, & Hagenaars, 2004).

Finally, to estimate the likelihood of belonging to a latent profile based on teachers' usage of motivational appeals, a logistic regression analysis was performed. This was calculated relying on the 3-step method under the *M*plus option R3STEP (Asparouhov and Muthén, 2014). The correct interpretation of a logistic regression implies the understanding of the difference between probability, odds ratio, and logit. Probability informs about the likelihood that something will happen, for example if 100 out of 1000 women study a STEM degree at a certain university, we could say that women have a probability of 0.1 $\left(\frac{100}{1000}\right)$ to study a STEM degree. Similarly, if 300 out of 2000 men study a STEM degree, we could say that men have a probability of 0.15 $\left(\frac{300}{2000}\right)$. An odds ratio informs of the probability of one group compared to another group and is the ratio of two probabilities. Following this example, to estimate the odds ratio and calculate how much more likely are men than women to study a STEM degree, we can perform the following operation $\frac{0.15}{0.1}$ (OR = 1.5). We would say that men are 50% more likely than women to study a STEM degree. We can also divide the probability of women by the probability of men (OR = $\left(\frac{0.1}{0.15}\right)$ = 0.67), and we would say that women are 33% less likely than men to study a STEM degree. However, to ease comparability we interpret results when the odds ratio is higher than 1 and inverse it when it is less than 1. The further away the odd ratio is from 1, the stronger the relation among variables. Finally, the logit provides the same information of the odds ratio but in another scale and is the b regression coefficient. The logit is the logarithm of the odds ratio, in our example it would be Log (1.5) = 0.18 (Wooldridge, 2020).

In the above example the predictor (gender) is a categorical variable, however, in our study the predictor (teacher's motivational appeals) is a continuous variable, thus, the interpretation for odds ratio is different. In our study, the interpretation would be: For every unit (i.e., standard deviation) increase in the predictor, the likelihood of pertaining to one group when compared to the other group increases or decreases an X percentage. All data analyses were conducted with *M*plus 8.4 (Muthén and Muthén, 1998-2017).

3. Results

3.1. Preliminary analyses

The mean, standard deviations, McDonald's omega, and correlations for the variables are shown in Table 1.

3.2. Latent profile analysis

Table 2 displays the fit indices for the latent profile analysis. Findings indicated that five to eight profile models hold groups with a very small percentage of participants. Thus, considering that a small number of

Table 2
Fit indices for each model of the latent profile analysis.

Profiles	Parameters	LL	AIC	SSA-BIC	LRT *p*	% smallest group
1	14	−7062.058	13,415.808	13,434.143	–	–
2	22	−6281.352	12,606.705	12,635.517	0.0497	17%
3	30	−5935.561	11,931.122	11,970.411	0.0430	15%
4	38	−5678.950	11,433.901	11,483.666	0.0237	11%
5	46	−5564.058	11,220.115	11,280.358	0.5289	0.03%
6	54	−5484.260	11,076.520	11,147.240	0.3835	0.02%
7	62	−5413.773	10,951.547	11,032.744	0.4943	0.02%
8	70	−5345.968	10,831.937	10,923.611	0.7349	0.03%

participants may not represent a singular latent profile (Marsh et al., 2009) the solutions with five to eight profiles were rejected. A four-profile solution was assumed given its lower value of LL, AIC, and SS-BIC in comparison with the three, two and one profile models. The elbow plot displayed in Fig. 1 demonstrates the slope flattening for the four-profile solution. Besides, it also displayed better and statistically significant LRT value, and a reasonable percentage of participants in the smallest group.

From a theoretical perspective, the four-profile solution was also retained as it best described the distribution of students regarding their needs. For instance, a two-profile solution described opposite need experiences. Thus, this solution was rejected theoretically as it added no further information to what is already known regarding the asymmetrical relation among fulfilled and thwarted needs (Vansteenkiste & Ryan, 2013). Moreover, when comparing three and four profiles, this last solution was retained as it included another group of students with very low need satisfaction and no need thwarting. As stated previously, given that the thwarting of basic psychological needs is something quite different from the low satisfaction of these (Ebersold et al., 2019), four profiles added rich information that differed to that of the three-profile solution. Finally, a fifth profile did not add further information but instead described two remarkably similar profiles.

The four profiles identified were characterized and named as follows: Profile 1 as *low fulfilment* with a total of 74 students (11% of the sample). Students in this profile reported very low satisfaction of their needs; Profile 2, as *neutral*, included students who reported no need fulfilled nor thwarted and included a total of 331 students (51% of the sample); Profile 3 as *fulfilled* with a total of 159 students (24% of the sample) that reported having all needs fulfilled; and finally, Profile 4 as *thwarted* included a total of 91 students (14% of the sample) that reported having all their needs. Profile analysis results are displayed in Fig. 2 and Table 3.

Odd ratios between students' basic psychological needs and teachers use of the different motivational appeals are displayed in Table 4. Results show two significant relations among two of the three motivational appeals: autonomous and amotivation. Specifically, autonomous motivational appeals increased the likelihood of students pertaining to the *fulfilled* profile compared to that of the *low fulfilment*, whereas amotivation messages increased the likelihood of pertaining to the *thwarted* profile compared to that of the *fulfilled*. Precisely, when teachers relied on autonomous motivational appeals it was three times more likely for students to belong to the *fulfilled profile* in comparison to the *low fulfilment profile*. When it came to amotivation messages, these increased a 61% the chance of belonging to the *thwarted* profiles compared to that of the *fulfilled* profile.

Regarding the differences between the profiles in students' outcomes, results showed that all groups where significantly different from the rest for all variables except for positive grit and subjective vitality for which profiles *neutral* and *thwarted* did not differ significantly. Moreover, results demonstrated that the *fulfilled profile* had the highest mean for the positive variables (i.e., positive grit, positive self-esteem, and subjective vitality) when compared with the rest of the profiles and the lowest means for the negative variables (i.e., negative grit and negative self-esteem). In a similar way, the *thwarted profile* followed the inverse pattern to that of the *fulfilled profile* except for subjective vitality for which it displayed a mean proximate to 0. The lowest means for positive variables were found in the *low fulfilment profile* whereas the highest means for negative variables were found in the *thwarted profile*. Finally,

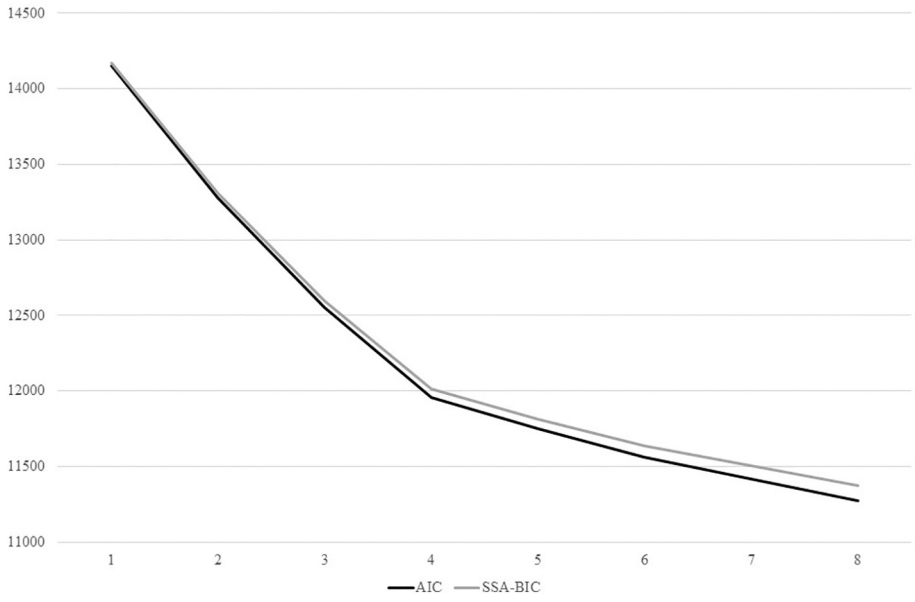

Fig. 1. Elbow plots for latent profile analysis.

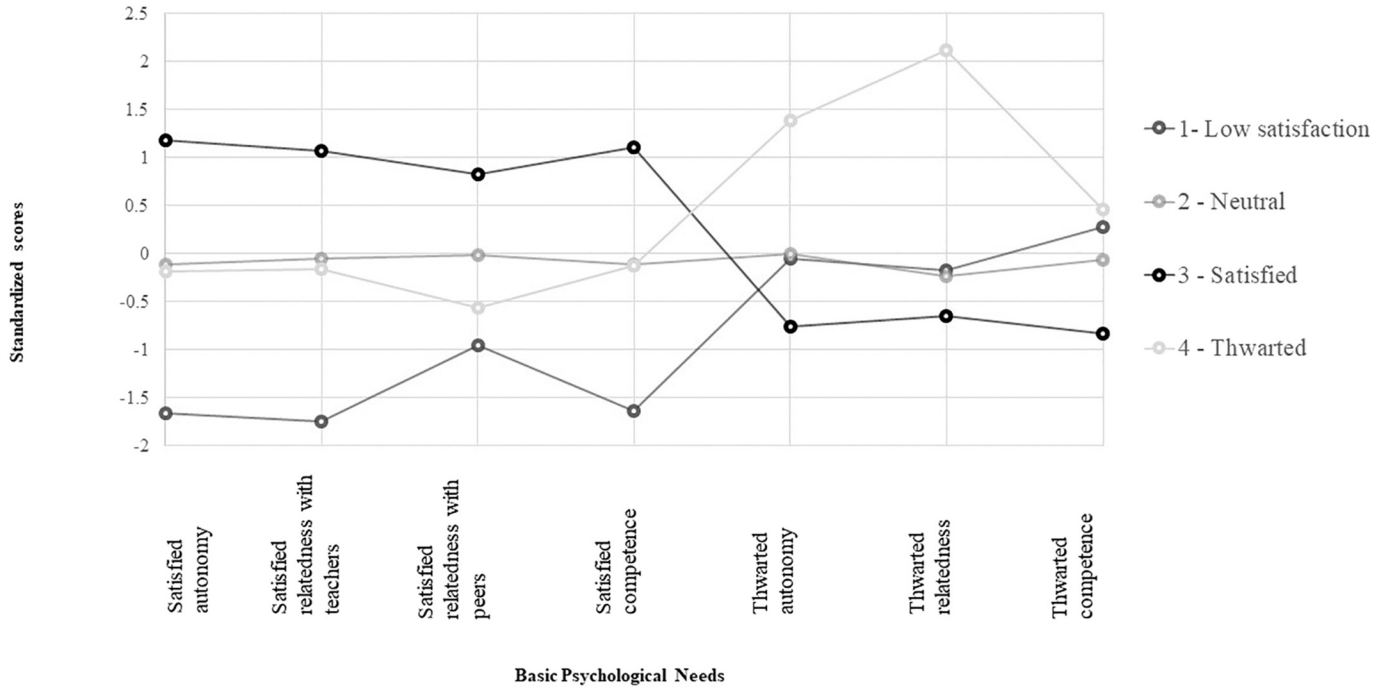

Fig. 2. Latent profile analysis results.

Table 3
Means and standard errors for the 4 latent profile analysis.

	Profiles															
	Low fulfilment				Neutral				Fulfilled				Thwarted			
	Z scores		Absolute scores		Z scores		Absolute scores		Z scores		Absolute scores		Z scores		Absolute scores	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Autonomy satisfied	−1.67	0.12	2.15	0.19	−0.12	0.05	3.99	0.13	1.17	0.05	6.06	0.09	−0.19	0.14	4.31	0.15
RT satisfied	−1.75	0.10	2.06	0.14	−0.06	0.05	4.20	0.21	1.06	0.07	5.96	0.15	−0.16	0.14	4.45	0.18
RP satisfied	−0.96	0.20	3.47	0.29	−0.01	0.04	4.90	0.10	0.83	0.08	5.94	0.11	−0.57	0.13	4.38	0.14
Competence satisfied	−1.64	0.09	2.32	0.16	−0.12	0.06	4.15	0.14	1.11	0.07	6.03	0.09	−0.12	0.10	4.51	0.11
Autonomy thwarted	−0.05	0.15	2.62	0.24	−0.01	0.07	2.59	0.17	−0.77	0.08	1.79	0.12	1.38	0.14	4.35	0.14
Relatedness thwarted	−0.174	0.15	1.80	0.13	−0.24	0.04	1.50	0.06	−0.65	0.04	1.37	0.06	2.11	0.16	4.22	0.14
Competence thwarted	0.28	0.18	3.02	0.26	−0.07	0.06	2.47	0.14	−0.84	0.06	1.65	0.1	0.46	0.14	4.50	0.13

Note. RT = relatedness with teachers; RP = relatedness with peers; SE = standard error.

the *neutral profile* displayed means really closed to 0 for almost all variables. Results are displayed in Table 5.

4. Discussion

The goals of the present study were as follows: (a) to examine profiles of students regarding their need fulfilment and thwarting experiences; (b) to examine whether motivational appeals hold within teacher messages predict student's membership to the different profiles; and (c) to examine differences among students' grit and well-being across the profiles. Three main findings can be drawn from the present work that confirm our hypothesis and report further additional findings to that of the expected. First, four profiles of students are identified according to their need satisfaction and thwarting experiences. These profiles are named as followed: Profile 1 as *low fulfilment*; Profile 2 as *neutral*; Profile 3 as *fulfilled*; and Profile 4 as *thwarted*. Second, teacher's autonomous motivational appeals predicted the membership of students to the most adaptive need profile (i.e., *fulfilled*), whereas amotivation appeals positively predict students' membership to the most non-adaptive profile (i.e., *thwarted*). Finally, the different need profiles relate distinctively with student outcomes on grit and well-being. Collectively, our findings fill in several gaps in the field by addressing three understudied concepts: need fulfilment and need thwarting measured simultaneously and addressed as independent experiences (Cuevas et al., 2015; Ebersold et al., 2019), grit assessed as an outcome (Fernández-Martín et al., 2020; Park et al., 2020), and examining a predictor (i.e., teachers' motivational appeals) of students' memberships to the distinct profiles (Martinent et al., 2021). It further adds on the existing literature on need supportive teaching by exploring a teaching resource, such as teachers' motivational appeals, teachers can rely on to enhance student need experiences and thus, make them feel grittier and happier.

4.1. Students' need profiles

The present study findings regarding students' need profiles provide evidence of the existence of four distinct profiles and thus, confirm our hypothesis. Two profiles emerge characterized by opposite experiences of need thwarting and need fulfilment (i.e., *thwarted* and *fulfilled* profiles), followed by a *neutral profile* in which no need is satisfied nor thwarted and, lastly, a profile characterized by a low satisfaction of basic needs and no need thwarting (i.e., *low fulfilment profile*). Common to all studies that have explored profiles of both need thwarting and satisfaction in students, is the fact of identifying between two and three equal profiles in relation to their need experiences (Li et al., 2021; Reed-Fitzke

Table 4
Odd ratio of the association between teacher's motivational messages and students' basic psychological needs.

Motivational messages	Profile		OR	95% CI
Autonomous	1-Low fulfilment	2-Neutral	2.50	0.69, 9.05
	1-Low fulfilment	3-Fulfilled	3.55	1.00, 12.53*
	1-Low fulfilment	4-Thwarted	1.73	0.37, 8.18
	2-Neutral	3-Fulfilled	1.42	0.48, 4.15
	2-Neutral	4-Thwarted	0.69	0.15, 3.13
	3-Fulfilled	4-Thwarted	0.49	0.13, 1.79
Controlled	1-Low fulfilment	2-Neutral	1.09	0.09, 14.01
	1-Low fulfilment	3-Fulfilled	1.97	0.14, 27.91
	1-Low fulfilment	4-Thwarted	0.44	0.02, 9.99
	2-Neutral	3-Fulfilled	1.80	0.21, 15.25
	2-Neutral	4-Thwarted	0.41	0.08, 2.10
	3-Fulfilled	4-Thwarted	0.23	0.03, 1.90
Amotivation	1-Low fulfilment	2-Neutral	0.76	0.63, 0.91
	1-Low fulfilment	3-Fulfilled	0.60	0.44, 0.81
	1-Low fulfilment	4-Thwarted	0.96	0.73, 1.26
	2-Neutral	3-Fulfilled	0.79	0.59, 1.07
	2-Neutral	4-Thwarted	1.27	0.97, 1.7
	3-Fulfilled	4-Thwarted	1.61	1.18, 2.2*

Note. OR = odd ratio; b = logistic regression coefficient; 95% CI = confidence interval.
* $p < 0.05$.

& Lucier-Greer, 2021; Warburton et al., 2020). In such way, profiles characterized by nor need fulfilment nor thwarting, all needs satisfied, and all basic needs thwarted are repeatedly found across the different studies mentioned. This trend can also be observed in research carried out with non-student samples (Rouse et al., 2020; Tóth-Király, Bőthe, Orosz, & Rigó, 2020). Therefore, these findings along with the present study results suggest the existence of three stable profiles broadly shared across contexts.

Similar to previous works and in line with the self-determination theory (Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011; Deci & Ryan, 2000b; Rouse et al., 2020; Warburton et al., 2020), the identification of more than two profiles with opposite need experiences further highlights the differential nature of the bright and dark pathways related to need experiences as these events could occur concurrently and independently from each other. Moreover, the identification of a *low fulfilment profile* with no need thwarting further confirms this idea and lines up with the premises of Vansteenkiste and Ryan (2013) regarding the asymmetrical relation between the lack of fulfilment and the thwarting of needs. In this sense, whereas the thwarting of basic psychological needs, by definition, comprise low need satisfaction, low need satisfaction those not necessarily involve need frustration. What is unique to this finding is that, to the best of our knowledge this work is the first to confirm Vansteenkiste and Ryan (2013) suggestions as no previous research conducted within the educational field has identified a *low fulfilment profile* before. For instance, the study carried out by Warburton et al. (2020) identified a student profile with low satisfaction but it also presented high frustration. Many important implications for teaching practices can be drawn from this finding as it highlights the reality faced by many students that perhaps has been previously ignored. Identifying students whose needs are poorly satisfied would result essential to foster their flourishing and prevent them from being deprived of developing their full potential, or in other words, developing their bright side.

4.2. Differences in need profiles regarding motivational appeals

Analysis of the relation between the profiles of students' needs and their teacher's usage of motivational appeals yielded important results for the two of the three kinds of messages assessed. Specifically, results show that, as expected, amotivational appeals increased the likelihood of students belonging to the *thwarted* compared to that of the *fulfilled* profile. In other words, amotivational appeals increase the probability of students belonging to the most non-adaptive profile. This finding lines up with previous works showing how need supportive practices relate negatively with students' amotivation (Jackson-Kersey & Spray, 2016) and positively with students' engagement and motivation (Collie et al., 2019; Vansteenkiste et al., 2012) remarking the well stablished link among teaching practices and student outcomes (Deci & Ryan, 2016; Jang et al., 2016; León, Medina-Garrido, & Ortega, 2018). In light of these findings, teachers should be aware of the power they have to fulfil students need, but also be aware of their power they have to thwart these needs and undermine students' growth.

Moreover, this finding provides evidence that autonomous motivational appeals have a predictive relation with students' need experiences through their fulfilment, just as need supportive behaviours do (Ahn et al., 2021; Collie et al., 2019). It could be possible that teachers who demonstrate concern on students by relying on messages such as "*If you work hard, you can learn interesting facts*", might foster students' sense of relatedness with them as they might perceive their teacher really desires the best for them (Connell & Wellborn, 1991; Taylor & Ntoumanis, 2007). It could also increase students' sense of competence as these messages reflect teachers believes on student's capability to achieve certain outcomes (Friedrich, Flunger, Nagengast, Jonkmann, & Trautwein, 2015). Finally, students' feeling of autonomy could also be enhanced as these messages express the willingness of students to engage or not in such activities suggested by teachers, highlighting the active role of students in their learning processes (Jang et al., 2016).

Table 5
Means and standard errors for student outcomes across latent groups.

	N	Positive grit		Negative grit		Positive self-esteem		Negative self-esteem		Subjective vitality	
		M	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
1-Low fulfilment	74	$-1.1^{2,3,4}$	0.17	$-.06^{2,3,4}$	0.21	$-1.33^{2,3,4}$	0.10	$.48^{2,3,4}$	0.16	$-.97^{2,3,4}$	0.11
2-Neutral	331	$-.15^{1,3}$	0.05	$.10^{1,3,4}$	0.05	$-.04^{1,3,4}$	0.05	$-.04^{1,3,4}$	0.05	$-.10^{1,3}$	0.04
3-Fulfilled	159	$.95^{1,2,4}$	0.08	$-.53^{1,2,4}$	0.09	$.93^{1,2,4}$	0.07	$-.73^{1,2,4}$	0.05	$.65^{1,2,4}$	0.12
4-Thwarted	91	$-.20^{1,3}$	0.12	$.61^{1,2,3}$	0.10	$-.32^{1,2,3}$	0.11	$1.00^{1,2,3}$	0.16	$.06^{1,3}$	0.12

Equality tests of means across classes using the bch procedure										
	χ^2	*p*	χ^2	*p*	χ^2	*p*	χ^2	*p*	χ^2	*p*
1 vs. 3	140.63	0.00	3.97	0.05	398.02	0.00	67.13	0.00	102.23	0.00
2 vs. 3	144.82	0.00	33.63	0.00	135.36	0.00	98.78	0.00	40.92	0.00
3 vs.4	60.19	0.00	94.03	0.00	87.79	0.00	110.98	0.00	13.26	0.00
1 vs. 2	27.63	0.00	0.48	0.49	142.46	0.00	10.14	0.00	45.75	0.00
1 vs. 4	28.84	0	8.89	0.00	46.60	0	4.12	0.04	35.16	0
2 vs. 4	0.12	0.73	24.24	0	5.17	0.02	39.9	0	1.51	0.22

Note. N = Percentage of sample. M = Mean. SE = Standard error. Numbers in superscript refers to groups significantly different (NC = 95%).

Therefore, the present findings present another possible autonomy supportive practice that has not been addressed before by researchers, asserting a new way teacher could enhance their students' need fulfilment experience and boost their bright side.

4.3. Relations among students' needs, grit, and well-being

Findings of the current study confirm our hypothesis. The satisfaction of students' needs relates positively with students' experiences of grit and well-being. Specifically, results show that for positive indicators of well-being (i.e., positive self-esteem and subjective vitality), students in the *fulfilled profile*, characterized by all needs satisfied, displayed the highest means. Besides, they also displayed the lowest means for the negative indicators of well-being and grit. This result is in line with previous findings that have shown how basic psychological needs positively predict students' well-being (Jiang et al., 2020; León & Liew, 2017; Reed-Fitzke & Lucier-Greer, 2021). Contrastingly, given grit has been commonly examined as a predictor and not as an outcome, to the best of our knowledge, no research has link need fulfilment with grit before. For instance, Jiang et al. (2020) examined the relation among need satisfaction and grit but placing grit as a predictor.

Moreover, the present findings further confirmed the distinction among need thwarting and need satisfaction. Our results nicely highlight how students in the *thwarted profile* displayed the highest means for negative variables (i.e., negative grit and negative self-esteem) as previous research has established (Bartholomew, Ntoumanis, Ryan, Bosch, et al., 2011; Bartholomew, Ntoumanis, Ryan, & Thøgersen-Ntoumani, 2011; Liu et al., 2017). They also showed that students in the *low fulfilment profile* displayed the lowest means for positive variables, highlighting the depletion of students' growth.

4.4. Limitations and future directions

Despite the contributions of the current study, certain limitations should be considered. First, although our study followed a prospective design and thus reached a higher predictive value that those of cross-sectional studies (Vallerand & Bissonnette, 1992), we still cannot infer relations of causality among the variables of this study. Future research could replicate the present study following longitudinal designs to observe whether changes in teacher's motivational appeals predict changes in student's need, grit, and well-being. Second, our data was self-report. Therefore, if we want to reduce possible bias, data on the present study could be complemented with observational data on teacher motivational appeals. For instance, teachers' speech during classes could be audio-recorded and then analysed for target messages and, in line with previous findings, it could also incorporate analysis on teachers' voice tone (Weinstein et al., 2020). Third, our sample correspond to students that belonged to the secondary educational stage. We endeavour future research to conduct the present study with students belonging to different educational stages to observe whether the current findings replicate. Fourth, as some authors have suggested, it may be that basic needs share a global factor (Sánchez-Oliva et al., 2017). If this was the case, then researchers could explore how this global factor could explain above and beyond each need by conducting a bi-factor ESEM (Gillet, Morin, Huart, Colombat, & Fouquereau, 2020). Fifth, the present study focused on the eudaimonic aspect of well-being rather than its hedonic conceptualization (Ryan & Deci, 2001) despite the possibility that need fulfilment could have an impact on hedonic well-being. It could be interesting to test both aspects of well-being simultaneously to observe the pattern they follow in relation to basic psychological needs and teachers' motivational appeals. Moreover, since some items from the scale used to measure need thwarting have no identification of who causes such feeling (e.g., "*In math class I feel incompetent*") this may not necessarily equate to need thwarting thus, results should be interpreted with caution. Finally, grit as an outcome was measured as a combination of its both features (perseverance of effort and consistency of interest) thus, future research could examine the effects that need satisfaction could have independently on each facet (Verner-Filion et al., 2020).

To sum up, framed within the self-determination theory, the current work contributes to the field by identifying a need-supportive practice that has not been examined before, by examining a possible predictor of students need experiences, and demonstrating that grit can be conceptualized as an educational outcome too. Specifically, it demonstrates the differential predictive value that teaching practices can have on students' need satisfaction, grit, and well-being. This confirms an important practical implication for teachers and teacher interventions targeting autonomy supportive practices, students' need fulfilment experiences as well as their well-being and grit.

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Accordance with ethical guidelines

This study was conducted in accordance with the ethical guidelines of the Declaration of Helsinki and was approved by the University Human Research Ethics Committee.

Declaration of competing interest

Authors have no competing interests to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.lindif.2022.102162.

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