Students' approach to learning and their intrinsic motivation to know – the moderating role of psychological needs

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Abstract
Students' approach to learning is associated with complex academic competencies, engagement, or achievement and is shaped by their intrinsic motivation to know, supported by the need for competence and autonomy satisfaction. The present study investigated the impact of intrinsic motivation to know on students' approach to learning (i.e., deep or surface) and whether the satisfaction of competence and autonomy needs moderates the relationships between intrinsic motivation to know and students' approach to learning. Three hundred and fourteen Romanian university students filled out three self-reported questionnaires. Findings showed that students with a high intrinsic motivation to know and a need for autonomy satisfaction probably use a deep learning approach more often. In contrast, those with a high need for competence satisfaction adopt, to a lesser extent, a surface approach to learning. These results help teachers pay more attention to motivational practices that support students' learning processes.

Keywords Intrinsic motivation to know · Autonomy and competence psychological needs satisfaction · Deep and surface learning approach

Introduction

In a rapidly changing world where people need to be flexible throughout their lives and adjust to the challenging demands of the workplace (Asikainen & Gijbels, 2017), the university's role is to prepare students to become lifelong learners and adapt to the labor market.

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Most academic competencies, such as critical and reflective thinking, problem-solving, or teamwork skills, also apply in the workplace (Asikainen & Gijbels, 2017; Tuononen et al., 2020). Therefore, fostering intrinsic motivation for a deep approach to learning, connecting theory with practice, and capitalizing on academic experiences, can be the premise of developing these competencies and transferring them to professional life (Asikainen & Gijbels, 2017).

Student learning approach and self-determination theory

The learning approach results from the interaction between the personal way in which students approach academic tasks and how they succeed in managing them (Biggs et al., 2001). When they are interested in the material and want to understand it and find its meaning, they adopt a *deep approach to learning* (Asikainen & Gijbels, 2017; Biggs et al., 2001). If the aim is to avoid failure or to memorize and reproduce the material, a *surface approach to learning* is used (Tuononen et al., 2020). Students' personal characteristics (e.g., motivation, enjoyment in studying), the learning context (e.g., teaching methods, assessment, feedback), and the way they perceive the contextual factors (e.g., workload,

supportiveness versus control) shape their learning approach (Baeten et al., 2010; Kyndt et al., 2011; Smarandache et al., 2022). Thus, motivation is one of the students' characteristics that significantly impact the learning intentions and strategies they choose in the learning process (Bengtsson & Teleman, 2019; Everaert et al., 2017; Kyndt et al., 2011). According to Self-Determination Theory (SDT), motivation is seen as a continuum, ranging from high to low levels of self-determination (Bureau et al., 2022; Ratelle et al., 2007; Ryan & Deci, 2020; Vasconcellos et al., 2020). Intrinsic motivation (IM) is the highest form of self-determination (Bureau et al., 2022; Expósito-López et al., 2021) and characterizes people who carry out an activity for its own sake, the enjoyment of that activity being the reward (Guay et al., 2015; Ryan & Deci, 2020). Consistent with the Tripartite Model of Intrinsic Motivation (Vallerand, 2000), IM is a multidimensional construct that includes three components (Burgueño et al., 2017; Carbonneau et al., 2012; Vallerand et al., 1993): *motivation to know*, *motivation toward accomplishment*, *and motivation to experience stimulation*. Related to curiosity and the desire to understand, explore, find out things, and live new learning experiences, IM-to-know is essential for learning and closely associated with intellectual curiosity, exploration, interest, and enjoyment of acquired knowledge (Carbonneau et al., 2012; Guay et al., 2015; Vallerand et al., 1992). A high level of IM-to-know makes people more willing to engage in activities that allow them to learn new and interesting things, and the pleasure felt from this learning promotes new behaviors (Burgueño et al., 2017). Students with an intrinsic interest in knowledge, understanding concepts, and connecting further information to prior experience are more engaged in the task and more likely to use a deep approach. When their interest is low, they tend to memorize and reproduce information, being more likely to use a surface approach to learning (Baeten et al., 2010; Bengtsson & Teleman, 2019; Chue & Nie, 2016).

Self-determination theory: connecting IM-to-know and psychological needs

Following the SDT framework, IM is increased by satisfying psychological needs of autonomy, competence, and relatedness (Deci & Vansteenkiste, 2004; Ryan & Deci, 2020). *The need for autonomy* indicates how self-determined people are in their actions; *the need for competence* is linked to the feeling of being efficient in performing different tasks, and *the need for relatedness* is based on the necessity for close relationships with others (Deci & Vansteenkiste, 2004; Guay, 2022; Van den Broeck et al., 2010; Vansteenkiste et al., 2020). However, results from previous studies are inconsistent in determining which needs have the most

substantial impact on IM (Conesa et al., 2022; Karimi & Sotoodeh, 2020). Some claim that *the need for autonomy* and *competence* is closely related to IM and sustain activities that are the foundation of people's learning and development (Conesa et al., 2022; Deci & Vansteenkiste, 2004; Karimi & Sotoodeh, 2020; Ryan & Deci, 2020; Holzer et al., 2021). Students with a high perception of competence satisfaction (i.e., perceptions that they are competent to fulfill learning assignments) and autonomy (i.e., perceptions that their actions are congruent with personal interests and are the result of their will) are more intrinsically motivated and perform better (Boudrias et al., 2020; Kyndt et al., 2011). These two needs are viewed more as cognitive resources involving self-assessment of the ability to carry out tasks and the possibility to choose the pace and methods of doing so (Boudrias et al., 2020). Perceptions of how needs for autonomy and competence are supported in the educational environment shape students' IM-to-know and their learning approach (Vallerand, 2000). Other research has shown that *the need for relatedness* has the weakest effect on IM (Conesa et al., 2022), having a social, emotional nature instead (Boudrias et al., 2020). Usually, people are intrinsically motivated by individual activities (Ryan & Deci, 2020), and as Vallerand (2000, p. 217) pointed out, "education is a rather individualistic type of activity, especially in the classroom". This suggests that in the context of learning, the need for relatedness may have a minor and more distal impact on IM (Conesa et al., 2022; Vallerand, 2000). However, it can play an essential instrumental role in activities and tasks with a predominantly social character (Karimi & Sotoodeh, 2020).

Most of the research in the academic environment examined the role of IM as the type of motivation with the highest self-determination level in contrast with extrinsic motivation, which has the lowest level of self-determination (e.g., Jiang & Tanaka, 2022; Pap et al., 2021; Vansteenkiste et al., 2005). Only some investigations have analyzed the distinct effects of the three dimensions of IM (i.e., motivation to know, motivation toward accomplishment, and motivation to experience stimulation) on different academic outcomes (e.g., Burgueño et al., 2017; Caleon et al., 2015), and very few on students' approach to learning (e.g., Çetin, 2015; Orsini et al., 2015). Other studies explored the role of motivation for learning, but they conceptualized it as IM (Betoret & Artiga, 2011; Kyndt et al., 2011; Olmedo-Moreno et al., 2021). Moreover, while most research has focused on the mediating role of satisfying psychological needs to understand the mechanism of various relationships (Van den Broeck et al., 2016), there is a particular lack of investigation into their facilitating, moderating role (e.g., Boudrias et al., 2020; Okros & Vîrgă, 2022), especially in the academic context (e.g., Cohen & Slobodin, 2022). Therefore,

understanding how fulfilling students' needs for autonomy and competence can buffer the relationship between IM-to-know and students' learning approach becomes essential for educational practice. As a dimension of IM, IM-to-know is directly related to students' interest and pleasure in learning and seeking opportunities to know more (Burgueño et al., 2017). This suggests that involvement in educational activities stimulates this type of motivation to a greater extent. Consequently, to fill this gap, *the present study aimed to explore the impact of IM-to-know on students' approach to learning (i.e., deep or surface) and whether the satisfaction of competence and autonomy needs moderates the relationships between IM-to-know and students' approach to learning (*Fig. 1*).*

From a theoretical point of view, this research will enrich SDT by expanding the knowledge about IM-to-know as a "higher motivational construct on the continuum" and its relationship with students' approach to learning when the educational context supports satisfying autonomy and competence psychological needs. Also, while many of the studies approach psychological needs as mediators, the present study brings their perspective as facilitating factors, respectively, as moderators of the relationship between IM-to-know and learning approach. From a practical point of view, highlighting the impact of this IM dimension contributes to understanding students' learning approach behaviors and cognitive strategies. Thus, by analyzing the effects of the two needs separately, insights are provided on how the educational environment can be structured to satisfy students' psychological needs and stimulate IM-to-know to promote deep learning, an essential feature for a lifelong learner.

Students' approach to learning and IM-to-know

Students' approach to learning arises from their intentions or motives when confronting a learning task and the strategies they use to study (Biggs et al., 2001; Diseth & Martinsen, 2003). When students intend to master the contents and connect new ideas with previous experience, a deep approach is used, and their motivation is intrinsic. When they invest less effort in understanding information because the aim is to pass the exams or cope with the assessment by reproducing that information, they use a surface approach, and their motivation is extrinsic (Cuthbert, 2005; de la Fuente et al., 2017).

Evidence regarding the relationships between students' approach to learning and IM is inconsistent, and those regarding the relationship with IM-to-know are scarce. For instance, some studies identified a positive impact of IM on the deep approach and a negative impact on the surface learning approach (Everaert et al., 2017; Kyndt et al., 2011). Other investigations found that IM positively predicted both deep and surface learning (Moneta & Spada, 2009), while others discovered positive associations only with deep learning (Bengtsson & Teleman, 2019; Chue & Nie, 2016). Only a few studies examined IM-to-know separately, highlighting the relationship with the learning approach. For example, Çetin (2015) identified significant positive associations between the IM-to-know and deep approach and negative associations with the surface approach. Orsini et al. (2015) found the same association with deep and surface motives as the motivational components of the learning approaches (Baeten et al., 2010).
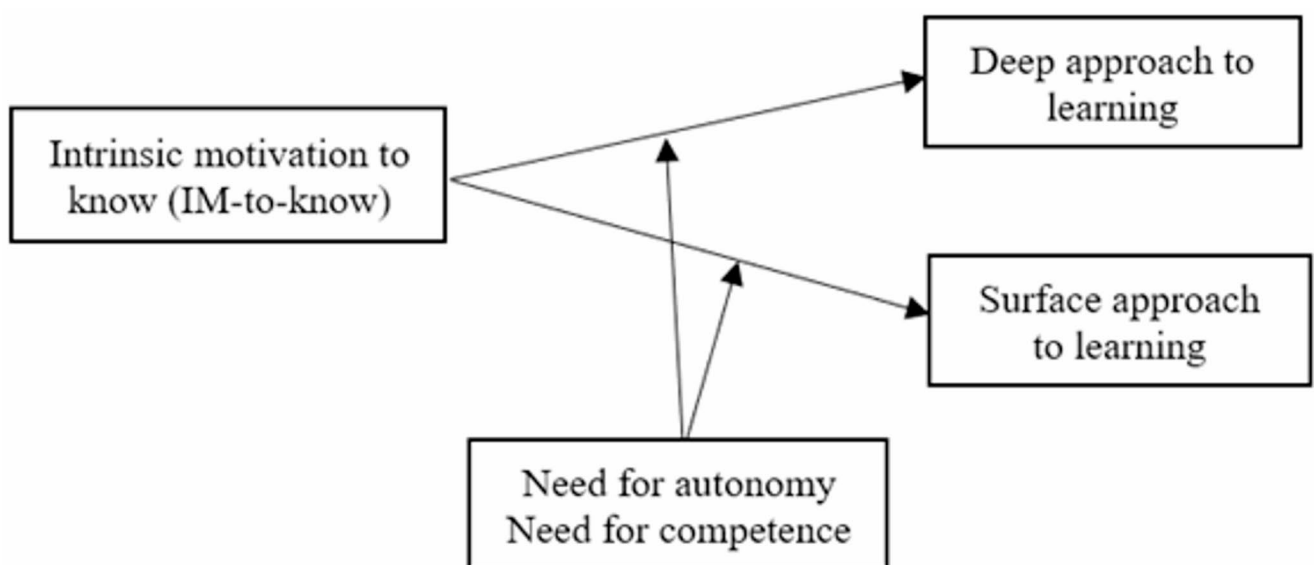

Fig. 1 Research model

Previous research has shown that the three types of IM measure different constructs, have different antecedents, and predict different consequences (Carbonneau et al., 2012; Guay et al., 2015). Assessing them separately, especially in education, would provide more critical information for comprehending the relationships between motivation and learning. Consequently, knowing that IM-to-know implies students' behavior based on how much they enjoy the learning process (Burgueño et al., 2017) and is directly related to the learning process through curiosity or motivation to learn (Orsini et al., 2015) and based on the paucity of studies on these relationships, the current research investigated IM-to-know as an essential dimension impacting the learning approach.

Psychological needs as moderators

SDT postulates that satisfying the three psychological needs is essential for IM growth (Ryan & Deci, 2020; Schweder & Raufelder, 2021). However, earlier research has found that it is mainly the satisfaction of autonomy and competence that leads to IM increase (Holzer et al., 2021; Olmedo-Moreno et al., 2021; Vansteenkiste et al., 2020) and may also stem from it (Stanley et al., 2021; Vansteenkiste & Ryan, 2013). The perception of competence and an educational environment that encourages autonomy is also associated with a high level of IM-to-know (Caleon et al., 2015; Ryan et al., 2021; Vallerand et al., 1993). Autonomy satisfaction is related to the students' need to have the freedom to choose or initiate activities in which to get involved according to their knowledge interests and to assume responsibility for their learning (Guay, 2022; Rodríguez-Meirinhos et al., 2020). Understanding the usefulness and value of what is required to be learned and establishing one's own learning pace contributes to increasing the perception of this need satisfaction (Maddens et al., 2023). Competence satisfaction involves the feeling of efficacy in the learning tasks achievement, the development of proficiency, and goals accomplishment (Sava et al., 2020; Rodríguez-Meirinhos et al., 2020; Vansteenkiste et al., 2020). Structured materials, clear feedback on tasks and progress, and explicit evaluation criteria facilitate the perception of the need for competence satisfaction (Maddens et al., 2023). Thus, both IM and IM-to-know are required to be supported by the students' volition (i.e., satisfying the need for autonomy) and their sense of effectiveness (i.e., satisfying the need for competence), which reinforce the highly autonomous motivation (Bureau et al., 2022; Maddens et al., 2023; Vansteenkiste et al., 2020). The learning approach is also related to the perception of need satisfaction. Previous studies have identified positive associations between the high level of need for

autonomy satisfaction and the deep and surface approaches to learning (Orsini et al., 2018). Fulfilling the need for competence sustains the deep approach and reduces the surface approach to learning (Betoret & Artiga, 2011; Orsini et al., 2018). On the other hand, Chue and Nie (2016) showed that when students perceive psychological support for their needs, they are more willing to be involved in deep learning.

Empirical evidence has found that highly intrinsically motivated students tend to use deep learning because of their interest and enthusiasm for learning (Bengtsson & Teleman, 2019; Chue & Nie, 2016; Everaert et al., 2017), while less motivated students adopt more surface learning (Everaert et al., 2017). The same behavioral pattern was also identified regarding IM-to-know (Çetin, 2015), assimilated in many studies with intrinsic curiosity, exploration, or motivation to learn (Carbonneau et al., 2012).

IM emerges from and is supported by the satisfaction of competence and autonomy needs (Carbonneau et al., 2012; Vallerand et al., 1992; Vansteenkiste et al., 2020) and impacts students' learning approach, which is also shaped by the satisfaction of these needs. This highlights the interdependent relationship between these constructs and their mutual reinforcement (Stanley et al., 2021; Vansteenkiste & Ryan, 2013). For instance, when students are interested in specific subjects and engage in tasks to learn more, the opportunity to choose what and how to proceed meets the need for autonomy and helps them experience a deep sense of joy and pleasure. The joy they undergo feeds their curiosity, making them deeply involved in their studies and helping them understand the subject better. As students learn and understand more in their interactions with the educational environment, they develop a sense of self-efficacy that fuels the need for competence and empowers them to persevere in improving their knowledge and skills. Hence, based on the abovementioned findings, we assumed that competence and autonomy need satisfaction would buffer the relationship between IM-to-know and students' approach to learning (deep and surface).

The present study

Each type of IM arises from different tasks, situations, or personality characteristics, leading to specific cognitive and affective outcomes and behavioral choices (Carbonneau et al., 2012). Their independent analysis can bring additional knowledge both from a theoretical and practical perspective. Depending on the goals they are pursuing, the involvement of students in learning and accomplishing academic tasks is based on specific reasons and satisfies particular needs. IM-to-know implies the student's interest in knowledge, the desire and joy of discovering and learning new things

(Carbonneau et al., 2012; Guay et al., 2015), which requires analysis, complex cognitive strategies, and increased knowledge-building effort (Tuononen et al., 2020). Suppose the educational context encourages and sustains their efforts. In that case, they get to experience the feeling of control over their actions and choices and the effectiveness determined by reaching their goals (Vansteenkiste et al., 2020), which in turn fuels IM-to-know. To our knowledge, only two studies analyzed the relationships between IM-to-know and the learning approach (Çetin, 2015; Orsini et al., 2015), and one of them only presents the relationships with the motivational and not with the cognitive dimensions of the learning approach (Orsini et al., 2015). Consequently, considering IM-to-know as an essential dimension fueling interest and desire to learn and the need for autonomy and competence as the conditions that support learning, the present study sought to identify how IM-to-know shapes students' learning approach and what role is played by satisfying the two types of needs in the learning process. Considering the arguments presented above, the following hypotheses were formulated:

H1: IM-to-know will be positively related to the deep approach (H1a) and negatively related to the surface approach to learning (H1b).

H2. The need for autonomy will moderate the relationship between IM-to-know and a deep approach (H2a) and between IM-to-know and a surface approach to learning (H2b).

H3. The need for competence will moderate the relationship between IM-to-know and a deep approach (H3a) and IM-to-know and a surface approach to learning (H3b).

Methodology

Participants

A convenience sample of three hundred fourteen Romanian university students with different specializations in social science (e.g., Psychology, Political science) voluntarily participated in this research. 13.1% were male and 86.9% female, with an average age of 20.79 years (SD = 2.04). The students come from public universities in the western part of the country and are in different years of study (e.g., first, second, or third study year).

Procedures

The third author selected the participants. The first step was to inform her fellow students about the aim of the study and the voluntary nature of their involvement. Those who wanted to get involved in the research were asked to contact other colleagues or friends who would be interested. All those who expressed their agreement received a link to a *Google Forms* document with the three questionnaires. The first part of the *Google Forms* document contained information about the aim of the research, how the study was conducted, ethical aspects (e.g., data confidentiality, anonymity), and the participation agreement. The *Google* document was set to allow the continuation of participation only if the student agreed with the stipulated conditions. The second part allowed access to the questions from the three online questionnaires. Students needed almost 25 min to give their answers. To keep the confidentiality of the data, no personal information was requested except for age and gender. The data were collected in the middle of the second semester to ensure that students had enough time to perceive the satisfaction of psychological needs and their approach to learning, and the study has a cross-sectional design. Participation was voluntary, and there was no reward for the students who engaged in the research.

The main inclusion criterion was being a social sciences faculty student, regardless of the year of study. The exclusion criteria were primarily related to the expression of consent to participate, followed by the absence of data regarding the participants' age and gender. All the procedures followed the ethical standards under the 1964 Helsinki Declaration and its later amendments or comparable ethical standards (WMA, 2013).

Instruments

Students' learning approach was assessed with the Revised Study Process Questionnaire proposed by Biggs et al. (2001). The instrument has 20 items and identifies the deep and surface learning approaches. Each scale has ten items (Leung & Kember, 2003): deep approach identifies the students' orientation toward understanding the learning material (e.g., "*I find that I have to do enough work on a topic so that I can form my own conclusions before I am satisfied*"), while surface approach identifies the students' intention to reproduce the materials for academic assessment (e.g., "*I find I can get by in most assessment by memorizing key sections rather than trying to understand them*"). Participants responded on a 5-point Likert scale (1 – *never or only rarely true of me*; 5 – *always or almost always true of me*). Cronbach's alpha for this sample was 0.81, and the McDonald's omega was 0.82 for the deep approach, while α = 0.68 and ω = 0.69 were observed for the surface approach. In terms of validity, confirmatory factor analysis using *lavaan* from RStudio Team (2015) revealed acceptable fit measures for the two-factor model ($\chi2 = 282.37$, df = 44, $p < .001$; Tucker-Lewis index [TLI] = 0.96, comparative fit index [CFI]

=0.97, root mean square error of approximation [RMSEA] =0.10 [0.08, 0.12], standardized root mean square residual [SRMR] =0.06). Also, Smarandache et al. (2022) adapted the questionnaire for the Romanian context. They showed that the two-factor model (i.e., deep and surface process) has statistical indices as good as the original 4-factor model (Biggs et al., 2001).

Intrinsic motivation to know (IM-to-know) was measured with a four-item sub-scale from the Academic Motivation Scale (Vallerand et al., 1992), one of the most used tools in the educational environment (Burgueño et al., 2017), also adapted for the Romanian context by Miulescu (2019). IM-to-know is linked to the pleasure of learning, exploration, and curiosity during the learning process (e.g., "*I go to the university for the pleasure that I experience in broadening my knowledge about subjects which appeal to me*"; Vallerand et al., 1992). The respondents rated their agreement with the statements' content on a 7-point Likert scale (1 – *does not correspond* to 7 – *corresponds exactly*). Cronbach's alpha on this sample was 0.81, and ω = 0.81.

Students' need satisfaction was assessed with the adapted school environment of the Need Satisfaction at Work Scale (Van den Broeck et al., 2010). The scale was also adapted to the Romanian context by Țânculescu and Iliescu (2014). It is an 18-item instrument with three subscales: autonomy satisfaction (6 items; "*The tasks I have to do at faculty are in line with what I really want to do*"), competence satisfaction (6 items; "*I have the feeling that I can even accomplish the most difficult tasks at faculty*"), and relatedness satisfaction (6 items; "*I don't really feel connected with other people at my faculty*"). Previous studies have shown that satisfying autonomy and competence needs mainly stimulate intrinsic motivation (Vansteenkiste et al., 2020). As a result, only these two scales were used in this study. Participants responded using a 5-point Likert scale (1 – *totally disagree*, 5 – *totally agree*). In this sample, the alpha Cronbach's coefficient was 0.70, and the McDonald's omega =0.69 for the need for autonomy scale, and α = 0.89, and ω = 0.89 for the need for competence scale.

Control variables

Previous studies have indicated that age is a demographic variable that shapes IM, psychological needs satisfaction, and learning approach. For example, IM and the perception of satisfaction of competence and autonomy needs vary according to age (Magson et al., 2022; Schweder & Raufelder, 2021; Van den Broeck et al., 2016). Age also shapes the approach to learning, correlating positively with the deep approach and negatively with the surface approach to learning (Baeten et al., 2010; Rubin et al., 2018).

The relationships between gender and motivation are inconsistent. Some research has identified stronger associations between men's need for competence satisfaction and intrinsic motivation (Bureau et al., 2022). Conversely, others have shown that psychological needs are independent of socio-demographic variables (i.e., age and gender) (Rodríguez-Meirinhos et al., 2020). Regarding the learning approach, Rubin et al. (2018) found that women use the surface approach to a lesser extent than men. Moreover, they showed that older women use a deep approach to a greater extent. Accordingly, age and gender were assessed as control variables.

Statistical approach

Four moderation analyses were conducted with IBM SPSS Statistics 25 using the PROCESS macro by Hayes (2018).

The PROCESS macro uses OLSR (ordinary least squares regression), yielding unstandardized coefficients for all effects. Bootstrapping with 5000 samples was used to calculate the confidence intervals. In all analyses, IM-to-know was added as the independent variable, and age and gender were the control variables. The need for autonomy was added as the moderator in the first two analyses. The criterion in Model 1 was the deep approach; in Model 2, it was the surface approach (see Table 2). In the other two moderation analyses, the need for competence was added as the moderator. Again, we used the deep approach as the dependent variable in model 3 and the surface approach as the criterion in model 4 (see Table 3).

Results

Descriptive statistical analysis

Table 1 presents the means, standard deviations, and correlations for the study's variables. The skewness and kurtosis of variables were below two and seven (West et al., 1995), and these parameters were deemed to display normality for each variable. We found a positive correlation between IM-to-know and the deep approach (r=.56, p<.001), as well as a negative correlation with the surface approach to learning (r= −.21, p<.01). These results offer support for *H1a* and *H1b*.

The moderating effect of the need for autonomy

First, two moderation analyses were run to determine whether the interaction between IM-to-know and the need for autonomy significantly predicts the deep and surface approaches. All relevant model coefficients can be found

Table 1 Means, standard deviations, and correlation coefficients between variables

Variable	M	SD	1	2	3	4	5	6	7
1. IM-to-know	24.61	2.99	(0.81)						
2. Need for autonomy	19.77	3.86	0.35**	(0.70)					
3. Need for competence	23.77	4.40	0.31**	0.48**	(0.89)				
4. Deep approach to learning	39.59	10.57	0.56**	0.32**	0.33**	(0.81)			
5. Surface approach to learning	29.82	7.32	−0.21**	−0.25**	−0.15*	−0.07	(0.68)		
6. Age	20.79	2.04	0.08	0.09	0.15*	0.13*	−0.33**	-	
7. Gender	-	-	0.16*	0.01	0.00	0.11*	−.07	−0.00	

Notes: $N = 314$. * $p < .01$; ** $p < .001$. Internal consistency alphas are displayed in the diagonal. IM-to-know = intrinsic motivation to know

Table 2 Bootstrap model coefficients (with 95% confidence intervals) and model parameters on the conditional impact of IM-to-know on the deep or surface approach to learning, moderated by need for autonomy

Predictors	Moderation Analysis 1	Moderation Analysis 2
	Deep approach to learning	Surface approach to learning
IM-to-know	−0.009 (-1.19; 1.17)	0.37 (-0.55; 1.31)
Need for autonomy	-2.23* (-3.88; −0.58)	0.72 (-0.58; 2.04)
IM-to-know × Need for autonomy	0.10* (0.03; 0.17)	−0.04 (-0.09; 0.00)
Gender	0.05 (-2.83; 2.94)	2.22 (-0.07; 4.51)
Age	0.08 (-0.38; 0.55)	−0.75* (-1.12; −0.37)
F	33.76***	10.72***
R^2	0.35	0.14
F interact	9.97**	2.77
ΔR^2	0.02	0.007

Note. $N = 314$. * $p < .05$; ** $p < .01$; *** $p < .001$; IM-to-know = intrinsic motivation to know

in Table 2. Regarding the need for autonomy, the overall model with the deep approach as the outcome was significant, $F(5, 308) = 33.76$, $p < .001$, predicting 35.40% of the variance. No age and no gender, as covariables, occurred as additional significant model predictors. The main effect of IM-to-know was not significant, but the effect of the need for autonomy was significant. The interaction effect was significant; results show that the need for autonomy significantly moderated the effect between IM-to-know and deep approach to learning, $\Delta R^2 = 2.09\%$, $F(1, 308) = 9.97$, $p < .001$, 95% CI[0.039, 0.171].

Figure 2 visualizes the conditional effect of IM-to-know on the deep approach. We plotted these significant interactions at +/−1 SD from the mean of IM-to-know and the need for autonomy. Thus, the data supported H2a.

The overall model with the surface approach as the outcome and need for autonomy as moderator was significant, $F(5, 308) = 10.72$, $p < .001$, predicting 14.83% of the variance. Only age but no gender, as covariables, occurred as additional significant model predictors. The main effects of IM-to-know and the need for autonomy were not significant. Also, results show that the need for autonomy did not moderate the effect between IM-to-know and surface approach,

$\Delta R^2 = 0.07\%$, $F(1, 308) = 2.77$, $p = .097$, 95% CI[−0.0004, 0.0008]. Thus, *H2b* was not supported by the data.

The moderating effect of the need for competence

Second, two moderation analyses were run to determine whether the interaction between IM-to-know and the need for competence significantly predicts deep and surface approaches to learning. All relevant model coefficients can be found in Table 3. The overall model with the deep approach as the outcome and the need for competence as moderator was significant, $F(5, 308) = 32.24$, $p < .001$, predicting 34.36% of the variance. The main effect of IM-to-know was significant, but the effect of the need for competence was not significant. No age and no gender, as covariables, occurred as additional significant model predictors. However, results show that the need for competence did not moderate the effect between IM-to-know and deep approach, $F(1, 308) = 21.99$, $p = .639$. Thus, *H3a* was not supported by the data.

Related to the need for competence, the overall model with the surface approach as the outcome was significant, $F(5, 308) = 9.01$, $p < .001$, predicting 12.77% of the variance. Both age and gender, as covariables, occurred as additional significant model predictors. The main effects of IM-to-know and the need for competence were not significant. Results show that the need for competence significantly moderated the effect between IM-to-know and surface approach, $\Delta R^2 = 1.54\%$, $F(1, 308) = 5.42$, $p = .02$, 95% CI [−0.093, −0.007]. The visualization of the conditional effect of IM-to-know on the surface approach can be found in Fig. 3. We plotted these significant interactions at +/- 1 SD from the mean of IM-to-know and the need for competence. Thus, *H3b* was supported by the data.

Discussion

This study aimed to explore the impact of IM-to-know on students' approach to learning (i.e., deep or surface) and whether the satisfaction of competence and autonomy needs
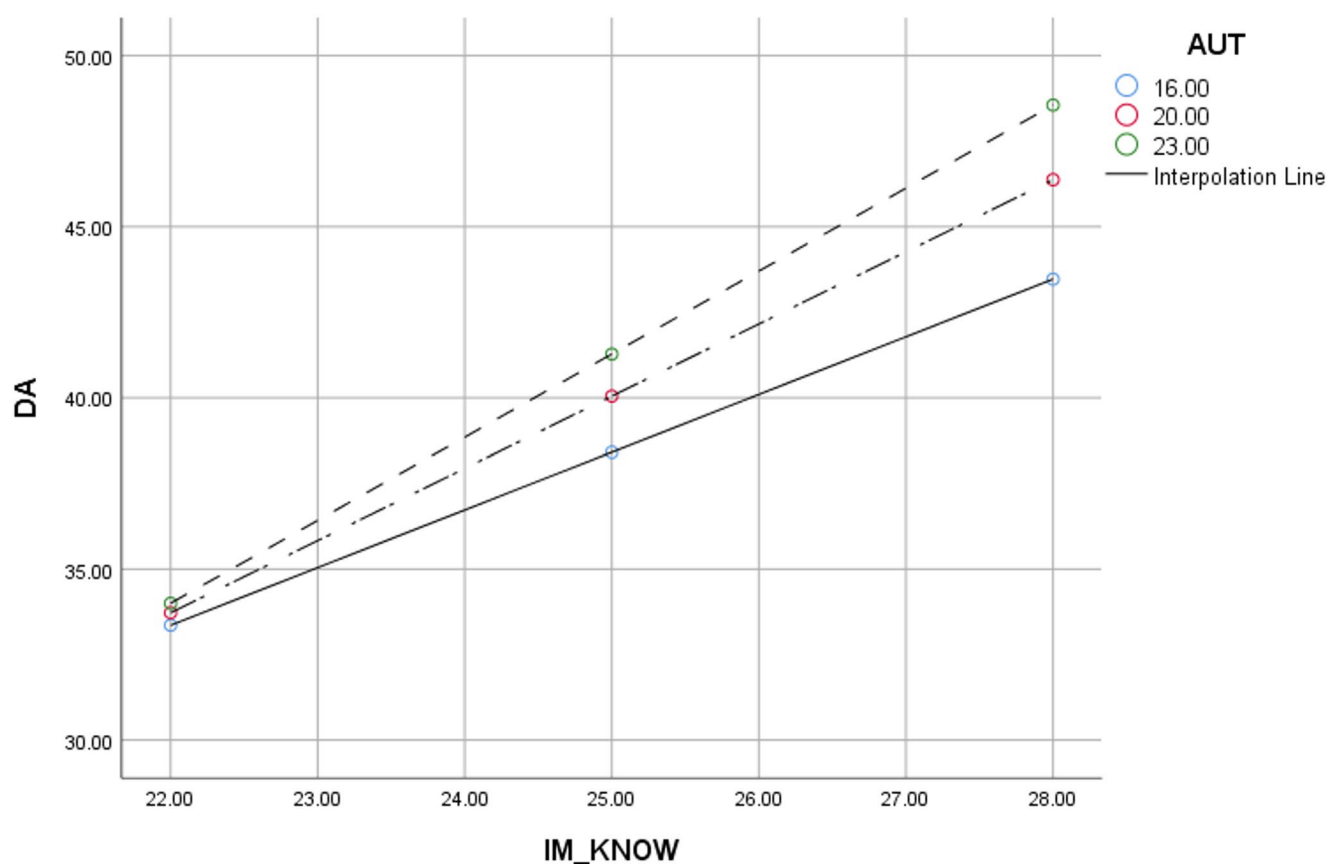
Fig. 2 Interaction effect of IM-to-know and need for autonomy in predicting deep approach to learning

Table 3 Bootstrap model coefficients (with 95% confidence intervals) and model parameters on the conditional impact of IM-to-know on the deep or surface approach to learning, moderated by need for competence

Predictors	Moderation Analysis 3	Moderation Analysis 4
	Deep approach to learning	Surface approach to learning
IM-to-know	1.50* (0.27; 2.73)	0.62 (-0.36; 1.60)
Need for competence	0.10 (-1.20; 1.41)	1.10* (0.05; 2.14)
IM-to-know × Need for competence	0.01 (-0.02; 0.07)	−0.05* (-0.09; −0.007)
Gender	0.19 (-2.71; 3.10)	2.36* (0.04; 4.68)
Age	0.06 (-0.40; 0.54)	−0.77* (-1.15; −0.39)
F	32.24***	9.01***
R^2	0.34	0.12
F interact	0.21	5.42*
ΔR^2	0.0005	0.015

Note. $N=314$. * $p<.05$; ** $p<.01$; *** $p<.001$; IM-to-know=intrinsic motivation to know

moderates the relationships between IM-to-know and students' approach to learning.

Our findings showed that IM-to-know is a positive predictor for the deep approach and a negative predictor for the surface approach to learning, which is in line with previous studies on IM (Bengtsson & Teleman, 2019; Everaert et al., 2017) and IM-to-know (Çetin, 2015; Orsini et al., 2015). Additionally, competence and autonomy needs' satisfaction moderate these relationships, but the results differ slightly from our expectations. Also, age negatively predicted surface learning when students perceived that their autonomy and competence needs were met, which is consistent with prior research that pointed out that older students use surface learning less than the youngest because they are intrinsically motivated (Baeten et al., 2010; Rubin et al., 2018). Likewise, the results indicated that men use the surface approach more than women when their competence needs are satisfied. These findings are supported by earlier investigations showing that men have less intrinsic motivation than women, being more interested in gaining qualifications than in" learning for learning's sake" (Rubin et al., 2018, p. 3).

Students with a high level of IM-to-know and need for autonomy satisfaction reported using a deep approach to a greater extent, trying to understand the tasks and improve their skills. These are in line with results that emphasized the positive impact of IM on the deep approach (Bengtsson & Teleman, 2019; Chue & Nie, 2016; Everaert et al., 2017) but are different from Betoret and Artiga's (2011)
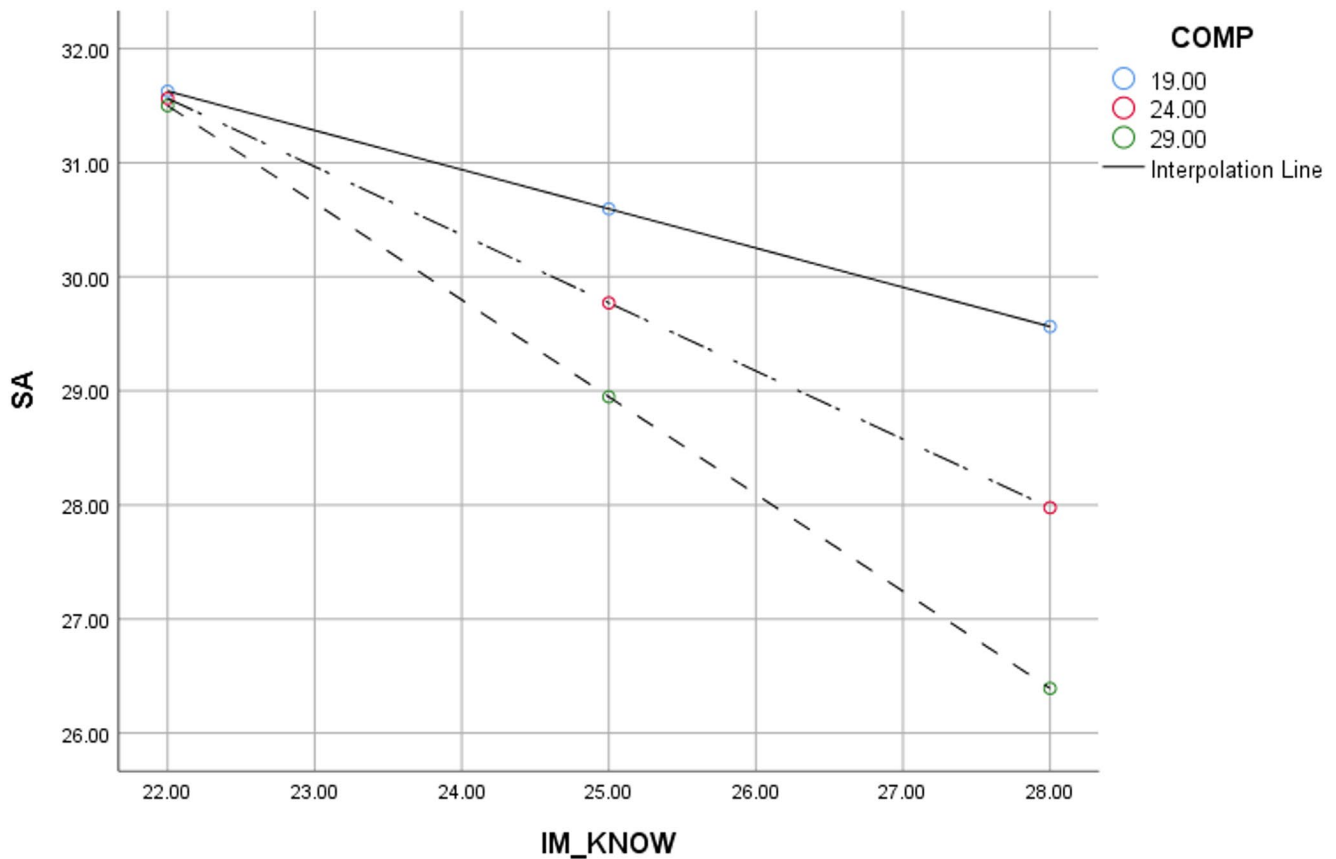
Fig. 3 Interaction effect of IM-to-know and need for competence in predicting surface approach to learning

findings, which showed that autonomy has no impact on the deep approach when IM is involved. IM-to-know sustains students' curiosity for new learning (Miulescu, 2019; Vallerand et al., 1992; Vansteenkiste et al., 2006). If the educational environment supports students' need for autonomy by creating the possibility to take the initiative, make choices, and experience freedom when carrying out different learning tasks or activities (Jiang & Tanaka, 2022; Ryan & Deci, 2020; Sava et al., 2020; Van den Broeck et al., 2010), then students become deeply involved in the learning process. They use more complex cognitive and metacognitive strategies, link their new knowledge with previous experience, and find the meaning of the learning tasks (Baeten et al., 2010; Bengtsson & Teleman, 2019). On the other hand, when IM-to-know is high but students' need for autonomy satisfaction is low, they adopt the deep approach to a lesser extent. Hence, a learning environment that does not support students' autonomy needs satisfaction is unfavorable for their deep involvement in the learning process, even if IM-to-know is heightened. It does not facilitate complex cognitive strategies or help them manage time and effort to understand learning content (Baeten et al., 2010). Therefore, fulfilling the need for autonomy is essential in the academic environment because it increases students' engagement; this

enables the deep processing of information and the use of higher-order thinking skills, and the deep learning approach thus becomes "intrinsically rewarding" (Rubin et al., 2018, p.5).

Regarding the moderating role of the need for autonomy satisfaction in the relationship between IM-to-know and surface approach to learning, our results were non-significant. Although the need for autonomy negatively correlated with students' surface approach, fulfilling the need for autonomy did not moderate the relationship between these two variables. These results make sense because when students can initiate and choose different learning activities and strategies or use teachers' feedback to solve problems (i.e., their autonomy needs are satisfied), their motivation for learning becomes intrinsic, and they use a deep approach to understanding and building knowledge.

Students with a high level of IM-to-know and need for competence satisfaction prefer a surface approach to a lesser extent. The need for competence is linked to the students' feeling that they have the necessary skills to succeed in learning tasks (Jeno et al., 2021) and can deal with requirements from the academic environment (Holzer et al., 2021). To fulfill this need and enhance IM-to-know (Olmedo-Moreno et al., 2021), they should benefit from a

well-structured environment with appropriate challenges, opportunities to develop, and constructive feedback (Ryan & Deci, 2020). On the other hand, the surface approach refers to students' intention to get only the information that helps them pass exams or rapidly solve different learning tasks (Everaert et al., 2017). Being focused on memorizing facts with minimum effort (Bengtsson & Teleman, 2019; Paloş, 2020), the knowledge built through this approach is fragmented (Tuononen et al., 2020), based on isolated factors (Bengtsson & Teleman, 2019) and valuable for short term, facilitating the achievement of the specific tasks. Hence, when students are intrinsically motivated to explore, understand things, and succeed in their academic activity showing competence, surface learning is not their preferred way to approach educational tasks. Instead, our results showed that if their need for competence satisfaction is low, although the level of IM-to-know is high, it is more probable to adopt a surface approach. A possible explanation could be linked to the students' perceived competence. They cannot focus on their progress if they do not understand the requirements and learning materials and do not feel they have the right skills to succeed (Vansteenkiste et al., 2019). In this case, students could perform the tasks only because of their instrumental value or maybe because of the possible negative consequences (e.g., low grades) (Ryan & Deci, 2000). Accordingly, a surface approach may be the solution to meet those requirements and achieve their goals.

Surprisingly, the need for competence satisfaction does not moderate the relationship between IM-to-know and the deep approach, although it is a positive predictor, as identified in previous research (Bengtsson & Teleman, 2019; Everaert et al., 2017). A potential interpretation of these results is how the needs of competence and autonomy enhance each other. Needs for competence and autonomy satisfaction increase students' IM (Ryan & Deci, 2000, 2020) and predict students' deep processing of the study materials as well (Chue & Nie, 2016). According to our findings, if teachers create appropriate circumstances to fulfill the students' autonomy needs, a deep approach will be used more often. Moreover, if the proper educational structures and practices accompany autonomy support, the need for competence is also stimulated (Ryan & Deci, 2020). So, although the need for competence does not buffer the relationships between IM-to-know and students' deep approach, we can speculate that being supported by the satisfaction of autonomy might contribute to the deep learning approach. Another possible explanation can be related to the adaptive value of the need for competence. Under a high level of IM-to-know, students' need for competence only shapes the surface approach, which will be used to a greater or lesser extent depending on how satisfied this need is. As is already known, the need for competence leads students to look for challenges

and capitalize on all opportunities that help them develop their skills, directly connecting satisfaction to performance (Guay, 2022). In this case, the effect of the need for competence on the deep approach can be mediated by other variables that ultimately lead to adaptive learning behaviors in terms of engagement and persistence (Holzer et al., 2021). In this circumstance, more research is needed to understand the mechanism behind the need for competence in a deep approach. Further, it would be necessary to study whether the students use another type of approach, namely the strategic or achieving approach (Tuononen et al., 2020), which is more related to the way they organize learning and not how they engage in learning, as is the case with deep and surface approaches (Asikainen & Gijbels, 2017; Tuononen et al., 2020).

Theoretical and practical implications

Higher education should prepare graduates to become lifelong learners capable of deeply processing information, thinking critically, and building meaningful knowledge (Asikainen & Gijbels, 2017). Our findings suggest that IM-to-know and the competence and autonomy needs' satisfaction in the educational setting are crucial in how students approach their learning.

From *the theoretical perspectives*, these results add to the SDT information related to the tripartite structure of IM, examining the relationships of the IM-to-know dimension, reflected in the enjoyment of learning and exploring (Carbonneau et al., 2012; Guay et al., 2015), with the learning approach in the academic environment. It also provides new evidence regarding the buffering role of autonomy and competence needs in encouraging students' deep or surface learning when the context supports their satisfaction.

From *a practical point of view*, the present research identifies some personal and contextual variables that can increase the efficiency of the learning process. Although previous evidence is inconsistent regarding the development of a deep approach across the studies (Asikainen & Gijbels, 2017; Baeten et al., 2010), there are some recommendations about how to work on the level of student personal characteristics (e.g., IM-to-know, psychological needs) or teaching context (e.g., teaching methods, feedback) to support this kind of learning approach (Tuononen et al., 2020). Therefore, teachers need to pay more attention to motivational practices to stimulate students to develop and use a deep approach (Vansteenkiste et al., 2019). For instance, emphasizing autonomy support and structure is essential to promoting IM-to-know (Olmedo-Moreno et al., 2021; Ryan & Deci, 2020), leading to deep learning (Bengtsson & Teleman, 2019). Suppose teachers involve students in learning decisions and are open to their interests, preferences, and values,

trying to integrate these into the classroom activities. In that case, students become aware that they "can be themselves", and their choices count (Vansteenkiste et al., 2020). Moreover, the feeling of control over the learning situation and the personal significance of the tasks will intensify the enjoyment and pleasure of learning, which, in turn, strengthens their IM-to-know (Buff, 2014). Also, when teachers build new learning starting from the student's previous experience and based on their skills and knowledge, offering clarity, guidance, and predictability, they can experience the feeling of competence (Dincer et al., 2019; Jeno et al., 2021; Vansteenkiste et al., 2019). IM-to-know can also be stimulated through participative teaching methods, which allow them to discuss complex and diverse problems (Everaert et al., 2017) or to give answers to questions that challenge them (Asikainen & Gijbels, 2017). When students can sustain their arguments, they are motivated to look for and find out more information to understand and explain things. Teachers' feedback can help them feel competent and focus on enhancing their knowledge as well (Everaert et al., 2017). The exploration of each need's contribution provides a starting point for specific interventions in the educational environment, aiming to enhance the value of learning experiences.

Limitations and future directions

This research also has some limits that need to be mentioned. First, the sample includes students from social sciences, and studies showed that the deep approach is more typical for them than for science students (Everaert et al., 2017) because the course specificity, the study materials, and the educational context impact their learning approach (Baeten et al., 2010). Also, the unbalanced structure of the sample, usually encountered in the field of humanities, education, or social sciences (a higher representation of women compared to men), could shape the present results (Kugler et al., 2021), which calls for caution in their generalization. Furthermore, caution is also needed to extrapolate the conclusions to other cultures. The satisfaction of psychological needs can be different depending on the individualistic or collectivist character of the culture (Romania being considered a collectivist culture; Hofstede et al., 2010), potentially leading to significant inter-individual differences in the degree of need for autonomy or competence capitalization (Van den Broeck et al., 2016). Likewise, future research could include all psychological needs in their cross-cultural models.

Second, only the two kinds of learning approaches (i.e., deep and surface) were analysed, without considering the motive ("intrinsic interest versus fear of failure") and the strategy components ("seeking for meaning versus selective memorization") specific for each dimension (Baeten

et al., 2010, p. 244). Although most research employs the two-factor model (i.e., deep and surface approaches), understanding the motives and strategies that underlie learning activities can be crucial for teachers and students to enhance the process and outcomes. The relationships between all these studied variables can be better emphasized if motives and strategies are investigated. Third, the original research reported an internal consistency of 0.64 for the surface approach scale (Biggs et al., 2001). Our study's alpha Cronbach for the surface approach scale was 0.68, which can be considered an acceptable value (Hulin et al., 2001). Moreover, confirmatory factor analysis revealed acceptable fit measures for the two-factor model (i.e., deep and surface). Fourth, our design is cross-sectional and does not allow for causal inferences. Further research would be interesting in longitudinally investigating how IM-to-know and learning approaches affect each other during academic studies.

It is already known that IM-to-know leads to a deep approach (Bengtsson & Teleman, 2019; Vansteenkiste et al., 2019), and the deep approach is shaped by the context, students' characteristics, or type of courses (Asikainen & Gijbels, 2017; Baeten et al., 2010). It would be helpful to explore whether changing teaching methods and re-organizing the educational environment to stimulate a deep approach could also increase the IM-to-know and be a motivational strategy for more difficult or less pleasant academic courses. IM-to-know is the dimension related to the desire and interest to know and understand new things (Lyndon et al., 2020). However, the other two dimensions of IM also require a thorough study to see if and to what extent they impact the development of various academic skills that can be transferred to professional life. Furthermore, knowing that satisfaction leads to adaptive outcomes and frustration to maladaptive outcomes (Ryan et al., 2021), another future direction could be to investigate the role of the frustration of satisfying basic psychological needs in learning and skill development (Vansteenkiste et al., 2020). Further research could also address need strength, which refers to people's importance on fulfilling particular needs (Chen et al., 2015). These individual differences in the strength of a specific need can moderate the effects of benefits or suffering resulting from the satisfaction or frustration of those needs (Chen et al., 2015). Despite the limitation, these findings can be considered a starting point for different interventions in educational practice linked to motivation and learning.

Conclusion

Our findings showed that students with a high level of IM-to-know and need for autonomy tend to use the deep learning approach more often, while those with high satisfaction

of need for competence adopt a surface approach to a lesser extent. These results align with previous research and bring new insights into the relationships between IM-to-know and the learning approach. Because the deep approach is significantly related to many academic competencies based on high cognitive abilities also needed in working life (Tuononen et al., 2020), learning more about different variables that facilitate it becomes necessary. Thus, by stimulating IM-to-know and creating a learning context that supports the need for autonomy and competence, teachers can enhance deep learning and help students grow and become more adaptable to the labour market.

Authors' contribution Conceptualization: Ramona Palos, Delia Virga; Methodology: Ramona Palos, Delia Virga, Raluca Dediu; Formal analysis and investigation: Delia Virga, Raluca Dediu; Writing - original draft preparation: Ramona Palos, Delia Virga; Writing - review and editing: Ramona Palos, Delia Virga; Resources: Raluca Dediu; Supervision: Ramona Palos.

Data availability The datasets generated and analyzed during the study are available from the corresponding author upon reasonable request.

Declarations

Ethical approval All procedures performed in studies involving human participants followed the institutional and/or national research committee's ethical standards and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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