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Personality and engagement in learning physics: the mediating effect of achievement goals

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Abstract

To achieve expected learning outcomes, students must be actively engaged in the learning process. Studies have shown that engagement consists of three components: behavioral, cognitive, and emotional (Fredrics, Blumenfeld, & Paris, 2004). Students' engagement in learning depends on their relation to the subject of teaching and the quality of the educational process, but in this study, we have focused on personal determinants of engagement. In particular, we were interested in the extent to which individual differences in the personal characteristics of students and their motivational orientations reflect the level of their engagement in learning physics. Therefore, the purpose of this study was to explore the relationship of perfectionism and reinforcement sensitivity to different components of students' engagement in learning physics, and to examine whether achievement goals have a mediational role in this relationship. The participants were 224 students in Grades 7–8 (50.5% boys) from 12 classes in three elementary schools in Croatia. The participants filled out questionnaires that measured their engagement in learning physics, achievement goals, perfectionism, and reinforcement sensitivity. The results showed different patterns of relationships of different aspects of engagement to perfectionism, reinforcement sensitivity and achievement goals. The mediational analyses showed that achievement goals have a mediational role in the relationships of adaptive perfectionism, behavioral activation system and fight-flight-freeze system to behavioral and cognitive engagement but not to emotional engagement.

Keywords: students' engagement, learning physics, perfectionism, reinforcement sensitivity, achievement goals

To achieve the expected learning outcomes, students have to be actively engaged in the learning process. Numerous studies have shown that engagement is the key factor in achieving the educational expectations (Finn & Rock, 1997; Skinner, Zimmer-Gembeck, & Connell, 1998; Appleton, Christenson, & Furlong, 2008), but also that the engagement decreases during the years of schooling (Archambault, Janosz, Morizot, & Pagani, 2009). The decrease in engagement is particularly manifested in mathematics, natural sciences and engineering (Bøe, Henriksen, Lyons, & Schreiner, 2011). Hence, it is important to determine the antecedents and mechanisms underlying various aspects of engagement. Students' engagement in learning will depend on their attitude toward a subject, the quality of educational process and various contextual factors; however, in this study, we have focused on the personal determinants of engagement. As motivational beliefs and learning strategies are specific for particular courses (Bong, 2001; Metallidou & Vlachou, 2007), we were interested in the extent to which the individual differences in students' characteristics and their motivational orientations reflect the level of their engagement in learning physics.

Engagement in learning physics

Engagement is a construct related to motivation. More precisely, motivation represents an intention while engagement refers to the component of action (Reeve, 2012). Engagement is a multidimensional construct that consists of behavioral, cognitive, and emotional component (Fredrics, Blumenfeld, & Paris, 2004). Behavioral engagement includes participation in academic, social, educational and extra-curricular activities; cognitive engagement refers to the investment of effort in terms of cognitive and metacognitive strategies, self-regulation and aspirations of mastering the material, whereas the emotional engagement refers to the positive or negative affect in interaction with teachers, peers, school activities, tasks and school in a broad sense (Fredrics et al., 2004). Numerous studies have already shown that engagement is a positive predictor of the quality of learning, school grades, test scores, school attendance, graduation, resilience and life satisfaction (Finn & Rock, 1997; Skinner et al., 1998; Fredrics et al., 2004; Appleton, et al., 2008; Salmela-Aro & Upadyaya, 2014). However, only a few studies have addressed the antecedents of subject-specific engagement. Putarek, Rovan, & Vlahović-Štetić (2016) showed that the academic contingency of self-worth predicts behavioral and cognitive engagement, but not the emotional engagement. On the other hand, when students perceive physics as useful and interesting, they are behaviorally, cognitively, and emotionally more engaged in learning physics. Further research is needed to examine the contributions of other aspects of students' personality to engagement in learning physics.

Achievement Goals

The achievement goals refer to reasons why individuals engage in activities related to achievement (Ames, 1992). The 2 x 2 taxonomy of achievement goals (Elliot & McGregor, 2001) distinguishes four goal orientations: mastery-approach; mastery-avoidance; performance-approach and performance-avoidance. The mastery-approach goals involve striving to learn as much as possible, to improve one's competencies. In contrast to this, the mastery-avoidance is motivated by a fear of not learning as much as it is possible. The performance-approach goals are motivated by a desire to demonstrate a superior competence or to outperform others, whereas the performance-avoidance is motivated by a fear of failure (Hulleman, Schrager, Bodmann, & Harackiewicz, 2010). Findings on the effects of individuals' goal orientations in the achievement settings show that the mastery-approach goals have largely positive effects, predicting a greater enjoyment and less boredom, lower levels of anxiety, a greater use of metacognitive learning strategies, lower task disengagement, and a greater use of critical thinking and cognitive elaboration as a learning strategy (for a review see Ranellucci, Hall, & Goetz, 2015). On the other hand, both avoidance goal orientations have mostly negative effects like higher levels of anxiety and surface processing (Elliot & McGregor, 2001; Pekrun, Elliot, & Maier, 2009). When it comes to the performance-approach orientation, the findings are not consistent. This goal orientation, besides positive effects, such as deep learning strategies and achievement (Diseth & Kobbeltvedt, 2010; Pekrun et al., 2009), also predicts anxiety and surface processing (Daniels et al., 2009; Fenollar, Román, & Cuestas, 2007). When it comes to the engagement in learning physics, Putarek et al. (2016) showed that when students are less concerned whether they will learn all they possibly could, or whether they will outperform others, they invest more cognitive and behavioral effort and enjoy learning.

Perfectionism

Perfectionism is a multidimensional personality trait characterized by striving for flawlessness and by the setting of exceedingly high standards of performance accompanied by tendencies for overly critical evaluations of one's own behaviors and striving for order (Flett & Hewitt, 2002; Slaney, Ashby, &

Trippi, 1995). Most authors make a distinction between adaptive and maladaptive perfectionism (Stoeber & Otto, 2006). The adaptive perfectionism, also described as positive, normal or healthy perfectionism, is characterized by strivings to high standards of performance and can be related to a higher motivation and a higher achievement (Bieling, Israeli, & Anthony, 2004; Einstein, Lovibond, & Gaston, 2000; Stoeber & Rambow, 2007; Zhang, Gam, & Cham, 2007). The maladaptive perfectionism, also known as an unhealthy or neurotic perfectionism, refers to feelings of discrepancy between performance and expectations, negative attitudes towards mistakes, and a harsh self-criticism (Stoeber & Rambow, 2007).

Reinforcement Sensitivity Theory

The Reinforcement Sensitivity Theory (Gray & McNaughton, 2000) is a neuropsychological theory of personality which explains the role of individual differences in fear and anxiety related behaviors, as well as behaviors of approach and avoidance (Stoeber & Corr, 2015). The theory postulates three emotional-motivational systems: behavioral activation system (BAS), fight–flight–freeze system (FFFS), and a behavioral inhibition system (BIS). The BAS is an approach system related to a positive affect which mediates reactions to appetitive stimuli (Corr, 2008). The FFFS is responsible for avoidance and escape behaviors related to the emotion of fear, which mediates reactions to all aversive stimuli. The BIS is also an avoidance system responsible for resolving a goal conflict in general. A goal conflict could occur between the BAS (approach) and FFFS (avoidance), and this process is related to the state of anxiety (Corr, 2004). In other words, the BAS, FFFS and BIS systems are mechanisms underlying the approach and avoidance behaviors. The approach and avoidance represent one of the two key dimensions in the achievement goals model. Several studies have shown that the behavioral inhibition system is related to achievement avoidance goals, while the system of behavioral activation is related to achievement approach goals (Bjørnebekk, 2007; Bjørnebekk & Diseth, 2010), which provides the basis for the assumption on the relationship between these constructs.

The present study

The aim of this study was to explore the relationship between perfectionism and sensitivity to reinforcement with different components of students' engagement in learning physics and to examine whether the achievement goals have a mediational role in this relationship. In his hierarchical model of achievement goals, Elliot (1999) defines the achievement goals as mid-level constructs, situated between global motivational dispositions and specific behaviors (e.g. engagement). Thus, in our research, we assumed that the achievement goals would be significant predictors of students' engagement in learning physics and that perfectionism and sensitivity to reinforcement would be important determinants of students' motivation and engagement in learning physics. More precisely, the perfectionism would be associated with the level of standards set by individuals for their accomplishments, while the sensitivity of reinforcement affects the tendency of individuals toward the achieving success and avoiding failure.

Hypothesis 1: **Perfectionism and Engagement.** Recent studies have shown that students who set high standards are more motivated and engaged than students who do not strive for perfection (Einstein, et al., 2000; Zhang, et al., 2007). Thus, it was expected that high standards would be positively related to all three aspects of engagement. On the other hand, as previous studies showed that maladaptive perfectionism is related to stress, anxiety, and depression (Chang, Watkins, & Banks, 2004; Einstein, et al., 2000; Stoeber & Rambow, 2007), it was primarily expected that the discrepancy between expectations and performance would be negatively related to emotional engagement. It was also expected that maladaptive perfectionism will be unrelated to cognitive and behavioral engagement (Damian, Stoeber, Negru-Subtirica & Băban, 2017; Shim, Rubenstein & Drapeau, 2016).

Hypothesis 2: **Sensitivity to reinforcement and Engagement**. According to the Reinforcement Sensitivity Theory (Gray and McNaughton, 2000), the BAS approach system is associated with emotions of 'anticipatory pleasure', hope, positive affect, the emotion to explore and to approach the interesting stimuli, so it was expected that the BAS would be positively related to all three aspects of engagement in learning physics. On the other hand, the two avoidance systems, FFFS and BIS, are related to fear and anxiety, so it was expected that these systems will be negatively related to emotional engagement. As we assume that learning physics does not represent a major threat to the FFFS and BIS prone students, we did not expect that it would trigger a strong avoidance reaction. Also, it is required of students to achieve learning outcomes in physics to get a satisfying grade, so the cost of cognitive or behavioral disengagement might be very high. Therefore, we expected that FFFS and BIS would be unrelated to behavioral and cognitive engagement in learning physics.

Hypothesis 3: **Achievement goals and Engagement.** Since previous studies showed that mastery-approach predicts greater enjoyment, less boredom, lower anxiety, greater use of metacognitive learning strategies, critical thinking and lower task disengagement (for review see Ranellucci et al., 2015), it was expected that mastery-approach orientation would be positively related to behavioral, cognitive, and emotional engagement. On the other hand, students with performance-approach goals, are motivated by the desire to demonstrate a superior competence or to outperform others (Hulleman et al., 2010). Therefore, we expected that this goal orientation would be positively related to behavioral engagement in learning physics. As for the relationship between performance-approach orientation and emotions, the research results are inconsistent. On the one hand, some studies showed that performance-approach orientation predicts anxiety (Daniels et al., 2009), while other studies showed that performance-approach goal orientation is positively related to emotional engagement in learning physics (Putarek et al., 2016). Therefore, no specific hypotheses were proposed regarding the emotional engagement. Likewise, due to mixed results related to the depth of processing which showed that the performance-approach orientation predicts both surface processing (Fenollar et al., 2007) and deep learning strategies (Diseth & Kobbeltvedt, 2010), no specific hypotheses were proposed regarding the cognitive engagement. Furthermore, as the avoidance goal orientations underlie negative emotions such as fear, it was anticipated that the two avoidance goal orientations would be negatively related to emotional engagement. Also, as the performance-avoidance goals are related to surface processing and disorganization (Moller & Elliot, 2006), it was expected that performance-avoidance goal would also be negatively related to cognitive and behavioral engagement. However, as the mastery goal orientation is characterized by striving to learn as much as possible to improve one's own competencies (Elliot & McGregor, 2001), it was also expected that the mastery-avoidance goal orientation would be positively related to behavioral and cognitive engagement in learning physics.

Hypothesis 4: **Achievement goals as a mediator between personal characteristics and engagement**. In accordance with Elliot's hierarchical model of achievement goals (1999), it was expected that achievement goals would mediate the relationship between students' personal characteristics and engagement. More specifically, it was anticipated that students who set high standards would endorse approach goal orientations and therefore invest more effort in terms of behavioral, cognitive, and positive emotional engagement to achieve these goals. Furthermore, it was expected that students who set high standards that could not be achieved (maladaptive perfectionism), would endorse the avoidance goal orientations and therefore invest less effort in terms of behavioral and cognitive engagement followed by negative emotions, such as fear or anxiety. When it comes to reinforcement sensitivity, as the BAS is an approach system related to positive affect, it was expected that approach goals would mediate the relationship between BAS system and behavioral, cognitive, and emotional engagement. On the other hand, as the FFFS and BIS are avoidance systems and related to negative affect, it was expected that avoidance goal orientations would mediate the relationship between the FFFS and BIS system and engagement.

Method

Participants and Procedure

The participants were 224 students in Grades 7–8 (50.5% boys) from 12 classes in three elementary schools in Croatia. The average age was 13.3 years (*SD* = 0.67). Students completed the questionnaires during two sessions that lasted about 20 min each. To link the questionnaires from the two sessions and to assure the anonymity, the respondents were asked to mark them with a code. The instruments were applied during the regularly-scheduled classes and students were given the information on the purpose and procedure of the study. The participation was voluntary. The necessary permissions by the Croatian Ministry of Science and Education, Ethics Committee, school principals and parents had been obtained before the research began. The students whose parents refused the permission for their children's participation in the research did not take part in the study.

Measures

Perfectionism. The Almost Perfect Scale - Revised (Slaney, Mobley, Trippi, Ashby, & Johnson, 1996) consists of 23 items and three subscales: High standards (e.g. "If you don't expect much out of yourself, you will never succeed."), Discrepancy between expectations and performance ("I often feel frustrated because I can't meet my goals.") and Order ("I am an orderly person."). High standards refer to the adaptive, and Discrepancy to maladaptive perfectionism. Order items were not analyzed in this study.

APS-R demonstrated good reliability and validity in several studies (Rice & Ashby, 2007; Rice, Ashby, & Gilman, 2011). The participants were asked to state how much they agreed with each statement and they responded on a scale from 1 (I disagree) to 5 (I agree).

Reinforcement sensitivity. The Reinforcement Sensitivity Theory Personality Questionnaire comprising of 64 items (RST-PQ; Corr & Cooper, 2015) was used for measuring the Behavioral activation system – BAS (e.g. „I am very persistent in achieving my goals "), FFFS („I often wake up overwhelmed with different thoughts ") and the BIS („I often think about the same things over and over again "). The RST-PQ demonstrated good reliability and validity (Corr & Cooper, 2015). The participants responded on a scale from 1 (not at all) to 4 (highly).

Achievement goals. The students' achievement goals were measured by the Achievement goal Questionnaire (Rovan, 2011) adapted from Elliot & McGregor's (2001) Achievement Goal Questionnaire (AGQ), using three items per each scale: the Mastery-approach (e.g. „It is important for me to understand the content of this course as thoroughly as possible"), the Mastery-avoidance („I am often concerned that I may not learn all there is to learn in this class"), the Performance-approach („It is important for me to do better than other students"), and the Performance-avoidance („I just want to avoid doing poorly in this class"). The Achievement Goal Questionnaire demonstrated very good reliability and validity (Rovan, 2011). The participants responded on the 5-point Likert scale ranging from 1 (disagree) to 5 (agree).

Engagement. The 18-item Engagement in learning physics scale was used in measuring the Behavioral (e.g. „I attentively follow lectures in class"), the Cognitive („I ask myself questions from physics to be sure that I understand the material"), and the Emotional engagement („I'm nervous while I study physics"). The Engagement in learning physics scales demonstrated a good reliability and validity (Pavlin-Bernardić, Rovan, Putarek, Petričević, & Vlahović-Štetić, 2016). The participants responded on a scale ranging from 1 (I disagree) to 5 (I agree).

Results

Descriptive statistics and correlation analysis

The descriptive statistics and correlation matrix are reported in Table 1. As expected, the high standards were positively correlated with behavioral and cognitive engagement, but the correlation between the high standards and emotional engagement, contrary to our expectations, was not significant. As for the discrepancy between expectations and performance, it was positively correlated with the behavioral engagement, negatively with the emotional engagement, and no significant correlation was found with the cognitive engagement. Thus hypothesis 1 was partially confirmed. The correlational analyses also showed that the behavioral activation system was positively correlated with behavioral and cognitive engagement as expected, whereas the correlation with the emotional engagement was not significant. As expected, the two avoidance systems, BIS and FFFS, showed a significant negative correlation with the emotional engagement. Thus, hypothesis 2 was confirmed partially. Furthermore, the FFFS showed a positive correlation with the cognitive engagement in learning physics, whereas the correlation with behavioral engagement was not significant.

As anticipated, the mastery-approach orientation was positively correlated with all three aspects of engagement. The performance-approach goal orientation was positively correlated with behavioral and cognitive engagement, whereas the correlation with emotional engagement was not significant. On the other hand, the mastery-avoidance goal orientation was positively correlated with cognitive engagement, but no significant correlation was found with behavioral and emotional engagement. The performance-avoidance goal orientation was, as expected, followed by negative emotions, whereas no correlation was found with behavioral and cognitive engagement. Therefore, hypothesis 3 was also confirmed partially.

Table 1

Means, Standard Deviations, and Correlations between the Perfectionism, Reinforcement sensitivity, Achievement goals and Engagement (N = 224)

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
High standards (1)	(.70)	.17*	.54**	.27**	.30**	.45**	.25**	.51**	.28**	.28**	.35**	.08
Discrepancy (2)		(.86)	.21**	.49**	.16*	-.05	.28**	.14	.31**	.19**	.00	-.42**
BAS (3)			(.85)	.48**	.36**	.30**	.25**	.30**	.22**	.16*	.36**	-.05
BIS (4)				(.90)	.51**	.05	.28**	.16*	.34**	-.10	.05	-.36**
FFFS (5)					(.74)	.26**	.18**	.17*	.23**	.13	.26**	-.19**
Mastery-approach (6)						(.70)	.29**	.36**	.08	.54**	.58**	.24**
Mastery-avoidance (7)							(.67)	.23**	.53**	.05	.24**	-.13
Performance-approach (8)								(.67)	.46**	.19**	.33**	.03
Performance-avoidance (9)									(.80)	-.12	.06	-.20**
Behavioral engagement (10)										(.90)	.56**	.36**
Cognitive engagement (11)											(.70)	.15*
Emotional engagement (12)												(.73)
M	3.70	2.87	3.04	2.65	2.71	4.22	3.68	3.68	3.21	3.80	3.87	3.40
SD	0.72	0.83	0.46	0.58	0.56	0.81	0.99	1.01	1.23	0.92	0.80	1.01
Expected range	1-5	1-5	1-4	1-4	1-4	1-5	1-5	1-5	1-5	1-5	1-5	1-5
Actual range	1-5	1-5	1-4	1-4	1-4	1-5	1-5	1-5	1-5	1-5	1-5	1-5
Skewness (St. Error: 0.16)	-.04	.23	-.68	-.24	-.19	-1.10	-.63	-.52	-.30	-.71	-.94	-.32
Kurtosis (St. Error:0.32)	.04	-.29	2.09	-.36	-.41	1.03	.09	-.35	-.97	-.14	.79	-.77

Note. Internal reliability coefficients (α) appear in parentheses along the main diagonal. * $p < .05$, ** $p < .01$ (two-tailed tests)

Mediation analyses

The mediation hypotheses (Hypothesis 4) were tested by using the SPSS macro, PROCESS (Hayes, 2012). The significance of each indirect effect was tested with 95% confidence-interval bootstrapping. All direct and indirect effects are specified in Tables 2 and 3. The mediation analyses showed that a direct effect of high standards on behavioral and cognitive engagement was not significant. However, an indirect effect of high standards on behavioral and cognitive engagement through mastery-approach occurred. Also, the results showed an indirect effect of high standards on the behavioral engagement through the performance-avoidance goal, and on the cognitive engagement through the performance-approach and the mastery-avoidance goal. As for the effect of the reinforcement sensitivity on behavioral engagement, the mediation analyses showed a significant indirect effect through the mastery-approach and performance-avoidance goal for BAS and FFFS. Also, there was a significant indirect effect of BAS and FFFS on the cognitive engagement through the mastery-approach goal and performance-approach goal. Furthermore, there was an indirect effect of FFFS on the cognitive engagement through the mastery-avoidance and performance-avoidance goals. As for the emotional engagement, the mediation analyses showed a significant direct effect of maladaptive perfectionism, BIS and FFFS, but no indirect effects through the achievement goals. Finally, we can conclude that achievement goals do not mediate the relationship between perfectionism and reinforcement sensitivity on the one hand (predictors) and emotional engagement on the other (criterion). Thus, hypothesis 4 was also confirmed partially.

Table 2

Mediation analyses: summary of total, direct and indirect effects in the relationship between aspects of perfectionism and engagement

Predictors	Adaptive perfectionism						Maladaptive perfectionism					
Criterion	Behavioral engagement		Cognitive engagement		Emotional engagement		Behavioral engagement		Cognitive engagement		Emotional engagement	
	Effect	SE	Effect	SE	Effect	SE	Effect	SE	Effect	SE	Effect	SE
Total effect	**.36****	**.09**	**.40****	**.07**	.11	.10	**-.19***	**.08**	.01	.07	**-.50****	**.08**
Direct effect	.10	.09	.07	.08	.07	.12	-.13	.07	.01	.06	**-.43****	**.08**
Indirect effect												
Total	**.26***	**.08**	**.32***	**.07**	.04	.09	-.06	.05	-.00	.05	-.07	.04
MAP	**.27***	**.06**	**.24***	**.06**	**.15***	**.06**	-.03	.04	-.02	.03	-.01	.02
MAV	.00	.03	**.03***	**.02**	-.04	.04	.01	.02	**.03***	**.02**	-.01	.03
PAP	.06	.05	**.09***	**.04**	.01	.06	.02	.02	**.02***	**.02**	.01	.01
PAV	**-.08***	**.04**	-.03	.03	**-.09***	**.05**	**-.07***	**.03**	-.03	.02	-.06	.04

Note. SE - Standard error; MAP - Mastery approach; MAV - Mastery avoidance; PAP - Performance approach, PAV - Performance avoidance; * $p < .05$; ** $p < .01$

Table 3

Mediation analyses: summary of total, direct and indirect effects in the relationship between the reinforcement sensitivity and aspects of engagement

Predictors	Behavioral activation system (BAS)						Fight-flight-freeze system (FFFS)						Behavioral inhibition system (BIS)					
Criterion	Behavioral engagement		Cognitive engagement		Emotional engagement		Behavioral engagement		Cognitive engagement		Emotional engagement		Behavioral engagement		Cognitive engagement		Emotional engagement	
	Effect	SE	Effect	SE	Effect	SE	Effect	SE	Effect	SE	Effect	SE	Effect	SE	Effect	SE	Effect	SE
Total effect	**.36****	**.13**	**.63****	**.11**	-.09	.15	**.24***	**.12**	**.39****	**.10**	**-.32***	**.13**	-.14	.11	.08	.10	**-.62****	**.11**
Direct effect	.09	.12	**.32****	**.10**	-.15	.16	.08	.10	**.18***	**.09**	**-.37****	**.13**	-.12	.10	.01	.08	**-.55 ****	**.12**
Indirect effect																		
Total	**.27***	**.11**	**.31***	**.10**	.06	.10	**.16***	**.08**	**.21***	**.07**	.05	.07	-.02	.07	.07	.06	-.07	.06
MAP	**.29***	**.10**	**.24***	**.08**	**.17***	**.08**	**.21***	**.07**	**.18***	**.05**	**.15***	**.05**	.04	.05	.04	.05	.02	.03
MAV	.00	.04	.04	.03	-.05	.05	.00	.03	**.03***	**.02**	-.03	.03	.01	.04	**.05***	**.03**	-.03	.04
PAP	.06	.05	**.07***	**.04**	.03	.06	.03	.03	**.04***	**.03**	.01	.03	.03	.03	**.03***	**.02**	.01	.03
PAV	**-.09***	**.05**	-.04	.03	**-.10***	**.06**	**-.09***	**.05**	**-.05***	**.03**	-.08	.05	**-.10***	**.05**	-.05	.04	-.08	.07

Note. SE - Standard error; MAP - Mastery approach; MAV - Mastery avoidance; PAP - Performance approach, PAV - Performance avoidance; * $p < .05$; ** $p < .01$

Discussion and Conclusion

The present study suggests that students' personality and motivational orientations are reflected in their engagement in learning physics. The results suggest mechanisms through which the students' perfectionism, sensitivity to reinforcement and achievement goals affect student engagement. Consistent with the prior research (Chang, Watkins, & Banks, 2004; Einstein, et al., 2000; Stoeber & Rambow, 2007; Zhang, et al., 2007), the students with high adaptive perfectionism tend to be more cognitively and behaviorally engaged in learning physics, while students with high maladaptive perfectionism tend to show a negative emotion towards learning physics. Contrary to expectations, maladaptive perfectionism was also positively related to behavioral engagement. This finding suggests that feelings of the discrepancy between performance and expectations may encourage students to engage behaviorally in learning physics. The results also support the hypothesis that students high in the BAS would be actively engaged in learning, both behaviorally and cognitively, while students high in the BIS and FFFS would be negatively emotionally engaged. We can conclude that different patterns of associations are related to different aspects of engagement. The behavioral and cognitive engagement is primarily related to positive dispositions – high standards and BAS. In contrast to this, the emotional engagement is related to characteristics important for dealing with conflicts – maladaptive perfectionism, BIS and FFFS.

The achievement goals mediate relationships of adaptive perfectionism, BAS and FFFS to cognitive and behavioral engagement. The mastery-approach goal has proven to be the key mediator strongly related to both types of engagement. In addition to this, the performance-approach goal showed an important mediational role in the relationship between personal characteristics and cognitive engagement. In other words, the students who set high standards and who are sensitive to rewards endorse the mastery-approach and performance-approach goals and invest more behavioral and cognitive effort to achieve these goals. The mediational role of the approach goals was expected for the adaptive perfectionism and BAS, but not for FFFS. Students sensitive to punishment, do not endorse avoidance goals, as expected, but strive to improve their competencies and to outperform others. They also worry that perhaps they will not learn as much as possible. Therefore, they are also engaged both behaviorally and cognitively in learning physics.

Contrary to our expectations, the achievement goals did not mediate the relationship between personal characteristics and emotional engagement. Hence, the results of mediation analyses were in accordance with the hierarchical model of achievement goals (Elliot, 1999) for behavioral and cognitive engagement, but not so for the emotional engagement. This result suggests that the personality and the emotional engagement could be related more directly, without the influence of mid-level motivational constructs.

This research has some limitations. We used the self-report instruments for the measuring of all constructs. The well- known shortcomings of self-report instruments are that students may not answer honestly under some conditions and that the answers do not reflect an actual behavior (Appleton, Christenson, Kim, & Reschly, 2006). Furthermore, one of this study's limitations is that all data were collected practically at a single time point, which restricts conclusions on possible causal relations.

However, an important contribution of this research is its focus on a specific context of learning physics, thus providing some guidelines for the educational process in this domain. According to the findings, we can expect that teaching students to set high, achievable and realistic standards while emphasizing at the same time the importance of improving one's competence, will contribute to greater behavioral engagement. Moreover, students who are sensitive to reward and punishment will invest more behavioral and cognitive effort by striving to improve their competence and focusing on superior performance.

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