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Students' engagement in learning physics: A subject-specific approach

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Abstract

Most of the existing conceptualizations of students' engagement explore the role of general engagement. However, if we are interested in understanding the process of learning specific school subjects, this approach is not suitable. The aim of the study was to explore the components of students' engagement in learning physics and to examine the differences in engagement in physics in respect of several variables: gender, grade, the expected grade in the subject at the end of the school year and the intention to choose physics as an elective subject in the national secondary general education final examination (The Croatian State Matura). The participants were 803 students from the second, third and fourth grade in five general-program grammar schools in Croatia. Confirmatory factor analyses confirmed the existence of three distinct, but related components of students' engagement in physics: cognitive, behavioral and emotional engagement, which all show satisfying to high reliability. Consistent with theoretical expectations, the results on the subscales measuring different components of engagement were positively associated, lowly or moderately, with the subjective task values and self-efficacy in physics. Our participants showed moderate engagement in physics on all three subscales. Gender differences were found only on the emotional subscale, with males having higher results than their female peers. Although students from the lower grades had higher cognitive and behavioral engagement, students from the fourth grade had higher emotional engagement. Students who expected a higher grade in physics had a higher level of engagement on each subscale, while students who did not intend to choose physics as an elective subject in the national final examination had lower levels of engagement.

Keywords: engagement, physics, secondary-school students, subjective task values, self-efficacy

Engagement is a construct linked to a broader area of motivation, wherein motivation represents intention, while engagement represents the component of action (Reeve, 2012). In the last two decades, the concept of engagement has been intensively researched because it has been proved to be the key factor in the achieving of educational expectations. Numerous studies have shown that the engagement is a positive predictor of the quality of learning, school grades, results in exams and, taking a long term-view, a positive predictor of regular school attendance, successful school graduation, resistance and life satisfaction (Appleton, Christenson, & Furlong, 2008; Finn & Rock, 1997; Fredricks, Blumenfeld, & Paris, 2004; Salmela-Aro & Upadyaya, 2014; Skinner, Zimmer-Gembeck, & Connell, 1998).

Among different authors, there is still no consensus over the definition and complexity of the construct of engagement. Researchers agree that it is a multidimensional construct that includes several components, but there is no agreement over the number of them. Constructs that comprise two, three or four components of engagement are dominant in the literature (Reschly & Christenson, 2012). Different authors agree that engagement at least consists of behavioral and emotional (or affective) components. Many researchers also add the cognitive component (Appleton, Christenson, Kim, & Reschly, 2006; Christenson & Anderson, 2002; Fredricks et al., 2004; Reeve & Lee, 2014), thus in this study, we started from the three-component conception of engagement.

Behavioral engagement can be identified in several ways (Fredericks et al., 2004): a positive conduct, as the following of rules, and as the maintaining of compliant behaviour through effort, persistence, concentration, attention and communicating, and as a school commitment. Emotional engagement is described as positive and negative emotions experienced while learning or in the classroom, such as interest, anxiety and frustration (Kong, Wong, & Lam, 2003). Cognitive engagement includes the way in which students attend to information, store it in memory, access knowledge and use it in thinking about problems and their solution. Kong et al. (2003) report several indicators of cognitive engagement: the use of surface strategies (memorization and practicing), the use of deep strategies (understanding the question, summarising learning, connecting new knowledge with the old one), and reliance (on parents and teachers).

Only a few studies have examined gender and age differences in engagement. Wang, Willett, and Eccles (2011) have found no differences between boys and girls; however, Lam et al. (2012) have found, in an international study, that girls reported higher levels of engagement in school. Amir, Saleha, Jelas, and Hutkemri (2014) have found in a sample of 12 to 16- year- old students that girls reported higher behavioural and emotional engagement, but there were no significant differences for cognitive engagement. In their study, the results for all components of engagement were lower for older age groups.

The most commonly used instruments for measuring the engagement are self-report scales (Fredricks & McColskey, 2012). Most of these questionnaires measure the general engagement, although there are some measures of specific engagement, for example in the area of mathematics (Kong, Wong, & Lam, 2003) or reading (Wigfield et al., 2008). The advantage of self-report scales is that they grasp, in the best way, a subjective perception of engagement, especially when it comes to emotional and cognitive engagement components, which are hard to observe objectivel. Thus, Appleton et al. (2006) suggest that only self-report measures should be used for the measurement of emotional and cognitive components of engagement. Of course, these scales have the same advantages and disadvantages as other self-report scales: they can be easily applied in large samples at a relatively small cost, but the honesty of participants' answers can be questionable, and we cannot know whether the participants' answers reflect their actual behaviour. In addition to this, as we have mentioned earlier, the items in most scales are formulated in such a way that they relate to general engagement in school and not to the engagement in the specific tasks and situations. In the studies which examine the engagement under the influence of contextual factors, the items relating to the general engagement are not suitable (Fredricks & McColskey, 2012). Furthermore, none of the existing measures intended to measure situational students' engagement address all three dimensions of engagement (Fredricks, McColskey, Meli, Mordica, Montrosse, & Mooney, 2011). Thus, in this study, we developed a situation specific measure for the engagement in physics.

For the assessing of the concurrent validity of the scale, we examined two measures of motivation: subjective task values and self-efficacy. Engagement is also associated with motivation as a construct included in the broader area of motivation, so we expect that task values and self-efficacy will be in low or moderate positive correlations with different components of engagement. We will shortly describe each of these variables. Subjective task values are important components in the expectancy-value model (Eccles et al., 1983; Eccles, 2005; Eccles & Wigfield, 2002), one of the most prominent contemporary theoretical frameworks of motivation in education. According to this model, motivational beliefs – expectancies of success and subjective task values – are direct predictors of achievement performance and academic choices (Wigfield, Tonks, & Klauda, 2009).

Eccles et al. (1983) have proposed four components of subjective task values: attainment value or importance, intrinsic value or interest, utility value or usefulness of the task, and cost. Attainment value is the importance of doing well on a given task. Tasks are important when individuals view them as central to their own sense of themselves, or allow them to express or confirm important aspects of self. Intrinsic value or interest is the enjoyment one gains from doing the task. Utility value or usefulness refers to how a task fits into an individual's future plans. It can be similar to extrinsic motivation in some aspects. However, it also reflects some important goals that the person holds deeply, and is also connected to personal goals and sense of self (Wigfield & Cambria, 2010). Cost refers to what the person has to give up to do a task (e. g., "Will I do homework or see my friends?"), as well as the anticipated effort needed to finish the task.

Self-efficacy is one's belief in one's ability to succeed in specific situations or to accomplish a task (Bandura, 1997). According to Bandura's social cognitive theory, people with high self-efficacy are more likely to view difficult tasks as something to be mastered rather than something to be avoided (Bandura, 1997).

The study aimed to explore components of students' engagement in learning physics by examining several aspects of construct validity (Messick, 1995). Therefore, the following research problems were formulated: a) to test the structural aspect of validity; b) to assess the external aspect of validity (i.e. concurrent validity) by measuring the relationships between the results on the subscales that measure different aspects of engagement and theoretically relevant correlates (subjective task values and self-efficacy) and outcomes (expected grade in physics at the end of the school year and the intention to choose physics as an elective subject in national secondary general education final examination) and c) to explore the generalizability aspect by examining the differences in engagement in physics in respect of gender and grade.

Method and material

Participants

The participants were 803 students (61.5% female) from five general-program grammar schools (academically oriented high schools) in Croatia. The students were from the second (n = 302), third (n = 381) and fourth (n = 120) grade. Their age ranged from 15 to 19, with a mean of 16.5 years (SD = 0.84).

Procedure

The study was carried out with the approval of the Ethics Committee of the Department of Psychology, Faculty of Humanities and Social Sciences in Zagreb, and with the permission of the Ministry of Science, Education and Sports. School principals' approvals were obtained, and participants' parents were informed that the study would be carried out. All surveys were administered during the students' regular school classes. Participants were informed that their answers would be anonymous and that nobody except the researchers would see their surveys. They were told that completing the questionnaire would be considered as their consent to participate in the study and were given the standard option of opting out at any time. The participants completed the questionnaires in 15 to 20 minutes.

Measures

Engagement in physics scale. The scale was constructed according to the three-component conception of engagement (e.g., Fredricks, Blumenfeld, & Paris, 2004). It consisted of three subscales: cognitive engagement ("I learn physics until I become sure I understood everything"), behavioral engagement ("I am trying to do my best during the lecture") and emotional engagement ("I am nervous when I study physics"). Participants responded on a Likert-type scale ranging from 1 ("I do not agree") to 5 ("I agree"). Several items need to be recoded, and higher results indicate higher engagement. For each participant, the total score on each subscale is calculated as a mean of his/her ratings.

In addition to this, cognitive interviews (Willis, 2005) were carried out with 10 high school students, who were asked to read the items and explain how they understood them, as well as to express their opinion on different aspects of engagement in learning physics. All of this was taken into account during the formulation of items. The first version of the scale consisted of 26 items (cognitive engagement was represented with 9 items, behavioral engagement with 7 items, and emotional engagement with 10 items).

Subjective task values scale for physics (Putarek, Rovan & Vlahović-Štetić, 2016). The scale consists of three subscales which measure subjective task values. Intrinsic value or interest in physics is represented with five items, e.g. “I am very interested in physics”. Utility value or usefulness of physics is also represented with five items (e.g., “Physics can be applied in everyday life”), and attainment value, or importance of physics, is represented with three items (e.g.,“It is important for me to master physics”). Participants give answers on a Likert-type scale ranging from 1 (“I do not agree”) to 5 (“I agree”), where a larger number means a greater value of physics. Although the three-factor model showed an acceptable fit for all indices, the correlations between the components of task values were high (r = .58 to r = .72), therefore the total result was used in the further analyses. For each participant, the total result was calculated as a mean of his/her ratings on all items. Cronbach’s alpha coefficient was .92.

Self-efficacy in physics scale (Rovan, 2011). The scale was originally developed for the area of mathematics, but in this study, it was adapted for the area of physics. It consists of six items which measure participants’ self-assessed competence in physics (e.g., “I am sure I can understand all topics I have to learn in physics”). Participants give their answers on a scale of 1 (“strongly disagree”) to 7 (“strongly agree”). The total result is calculated as a mean of participants’ ratings. Cronbach’s alpha reliability coefficient for the scale was .92 in this study.

The participants’ intention to choose physics as an elective subject in the national secondary general education final examination was assessed with one item (e.g.,“Will you choose physics as an elective subject in the final examination?”), and the possible answers were “yes”, “maybe” and “no”. The participants were also asked what school grade for physics they expected at the end of the school year.

Results

In order to examine the factor structure of the Engagement on physics scale, the confirmatory factor analysis was performed, using the R statistical package, version 3.3.1. More precisely, we compared the one-factor model to the three-factor model described earlier in this paper. Firstly, Mardia Test was calculated to test multivariate normality and it showed nonnormality of our data (skewness = 6841.36, p< .001; kurtosis = 32.02, p< .001). Consequently, CFA was conducted with 775 participants using the robust maximum-likelihood estimation method with the Yuan–Bentler correction. Several goodness-of-fit measures were used in this study: (a) χ^2 test (value should not be statistically significant in order to confirm a good fit between model and data) (Brown, 2006); (b) χ^2/df (cutoff criterion of good fit: values less than 5) (West, Taylor, & Wu, 2012); (c) comparative fit index (CFI) (values greater than 0.95 showing a good fit) (Hu & Bentler, 1999); (d) a root mean square error of approximation (RMSEA) (values of less than .06 showing good fit) (Hu & Bentler, 1999); (e) a standardized root mean square residual (SRMR) (values of less than 0.08 showing a good fit) (West et al., 2012).

Three-factor model yielded better fit indices (χ^2 = 1995.713, p < .001; χ^2/df = 6.742; CFI = .784; RMSEA = .086, 90% CI = [.083, .089]; SRMR = .120) than one-factor model (χ^2 = 2863.705, p < .001; χ^2/df = 9.578; CFI = .675; RMSEA = .105, 90% CI = [.102, .109]; SRMR = .106), which was confirmed by the chi-square difference test ($\Delta\chi^2$ = 320.47, Δdf = 3, p < .001).

According to the results of CFA, the three-factor model was superior to the one-factor model, so this model was modified in the further analysis to obtain a better fit between our data and model. Modification indices (i.e., an approximation of how much the overall χ^2 would decrease if the fixed or constrained parameter had been freely estimated; Brown, 2006) were taken into account in order to estimate which cross-loadings between an item and different factors would yield to the drop of overall χ^2. Indices of 3.84 or greater indicate that the overall model fit could be significantly improved if the fixed or constrained parameter was freely estimated (Brown, 2006). In our model, items 5 and 12 (behavioral dimension), 6 (cognitive dimension), 3, 11, 16, 18, and 20 (emotional dimension) were deleted, because their cross-loadings with two or three factors would decrease the overall χ^2 and these cross-loadings were not theoretically valid.

Furthermore, the correlations between items errors (shown in Figure 1) were included into the model because some items had similar wording, which could result in associations between them. The final model fit indices are following: χ^2 = 367.348, p < .001; χ^2/df = 2.893; CFI = .954; RMSEA = .049, 90% CI = (.044, .055); SRMR = .063. Referring to West et al. (2012), all model fit indices, except the chi-square, had acceptable values. Thus, our modified three-factor model indicated that behavioral, cognitive and emotional dimensions are the underlying structure of the engagement in physics. Regarding significant chi-square, these statistics are influenced by the sample size, and with large N, like in our study, the results are rejected on the basis of the chi-square even when differences between data and the model are negligible (Brown, 2006). The behavioral dimension has eight items, while cognitive and emotional factor have five items each. Factor loadings, residual variances and correlations are shown in Figure 1.

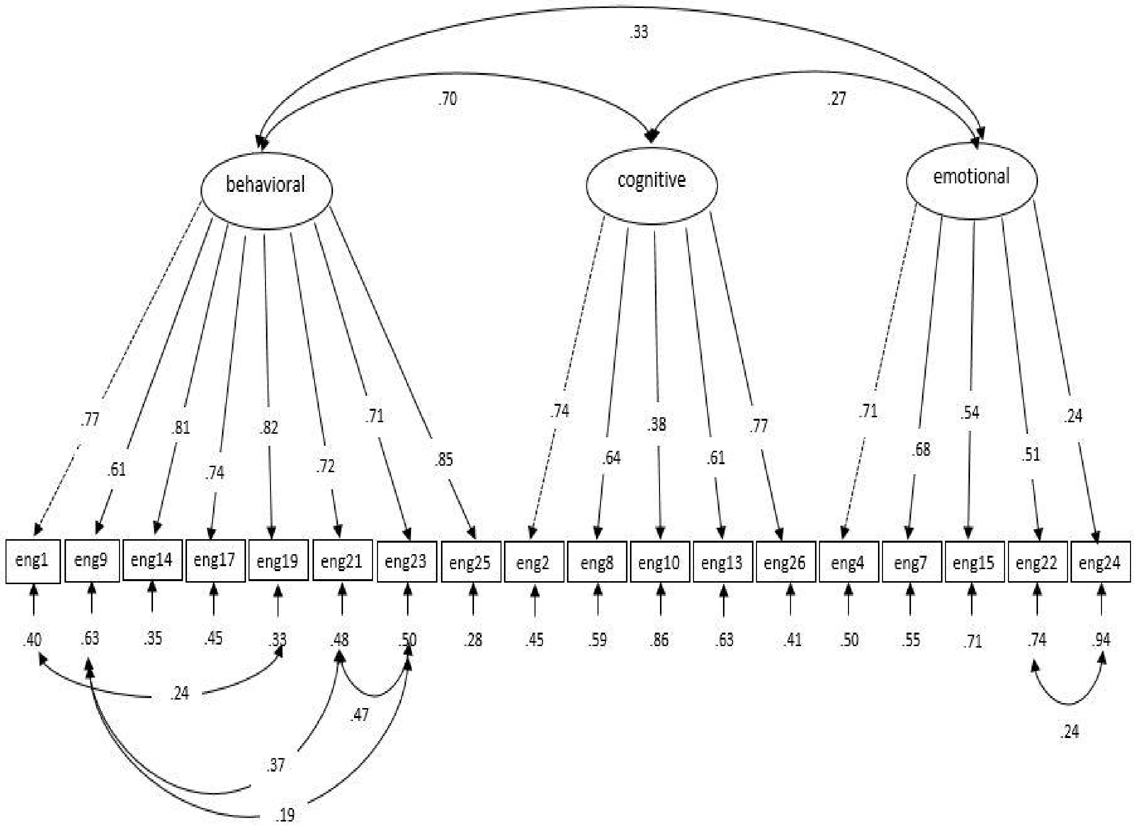

Figure 1. The results of CFA (robust maximum-likelihood estimation method) of the Engagement in physics scale: standardized path coefficients, residual variances and correlations (all statistically significant at $p< .001$).

As Figure 1 shows, almost all items have saturations higher than .30, which is usually the cut-off criterion for the interpretability of factor saturations (Brown, 2006). Item 24 ("I am frustrated when I'm unable to answer the question") has lower saturation than the previously mentioned cut-off criterion, which can be the consequence of the item's content that can be perceived not only as emotional (i.e., frustration), but also as cognitive (i.e., knowing the answer to the question). However, having a strong emphasis on emotions and a good theoretical basis, this item was included in our scale and loaded only on the emotional dimension.

Cronbach's alpha was very good for the behavioral subscale (α = .92) and acceptable for the cognitive subscale (α = .76), but the alpha coefficient obtained for the emotional subscale (α = .65) has the value lower than .70 which is usually used as the lower bond of acceptability (de Vaus, 2002). Therefore, the results on this scale should be interpreted more cautiously.

The correlation between behavioral and cognitive subscale was .58 ($p< .001$), the correlation between behavioral and emotional subscale was .22 ($p< .001$), while the correlation between cognitive and emotional subscale was .11 ($p< .001$), indicating a relative independence between dimensions. The items from each subscale are shown in Appendix A, in the Croatian and English language (the scale was validated for the Croatian language, so the translation is just for orientation).

Table 1 shows descriptive statistics and correlations between the variables.

Table 1
Descriptive results and correlations between variables (N = 794)

Variable	*M*	*SD*	Range	1.	2.	3.	4.	5.	6.
1. Expected grade in physics	3.83	0.98	1-5	-					
2.Cognitive engagement	3.16	0.97	1-5	.32*	-				
3.Behavioral engagement	2.83	1.04	1-5	.26**	.58**	-			
4.Emotional engagement	3.14	0.94	1-5	.35**	.11**	.22**	-		
5.Subjective task values	2.92	0.95	1-5	.56**	.50**	.47**	.45**	-	
6. Self-efficacy	4.34	1.35	1-7	.45**	.43**	.33**	.40**	.62**	-

**p< .01

In the whole sample, the levels of all three components of engagement were moderate. Their correlations with self-efficacy and subjective task values in physics were low to moderate.

Table 2 shows the differences among the students, regarding the expected grade in physics at the end of the school year for each component of engagement. Because a small number of students indicated that they expected grade 2 in physics, we joined the categories for grades 2 and 3. The results of the ANOVA's for each subscale were statistically significant and Scheffé's tests show between which subgroups there are significant differences. Generally, students who expect a higher grade have a higher level of engagement on each subscale. Effect sizes are medium to large (Cohen, 1988).

Table 2
Results of ANOVAs for differences between students with different expected school grades in physics in cognitive, behavioral and emotional engagement in physics

Variable	Expected grade	*n*	*M*	*SD*	*F*	df	Scheffé	η^2
Cognitive engagement	2 or 3 4 5	275 260 232	2.76 3.26 3.51	0.92 0.80 1.04	43.87**	2,764	2 or 3 < 4 2 or 3 < 5 4 < 5	0.114
Behavioral engagement	2 or 3 4 5	271 264 231	2.52 2.86 3.18	0.95 0.93 1.13	27.09**	2,763	2 or 3 < 4 2 or 3 < 5 4 < 5	0.071
Emotional engagement	2 or 3 4 5	274 261 231	2.85 2.97 3.70	0.85 0.82 0.90	70.80**	2,763	2 or 3 < 5 4<5	0.185

**p<.001

Table 3 shows the differences among the students regarding their answers to the question "Will you choose physics as an elective subject in the final examination?" The results show that students who did not intend to choose physics as an elective subject in the national final examination had lower levels of engagement than the students who chose answers "yes" or "maybe". Effect sizes are medium to large (Cohen, 1988).

Table 3

Results of ANOVAs for differences between students regarding their intention to choose physics as an elective subject on exit examinations, for cognitive, behavioral and emotional engagement in physics

Variable	Elective subject	*n*	*M*	*SD*	*F*	df	Scheffé	η^2
Cognitive engagement	Yes	119	3.61	0.90	20.45**	2,792	No < Yes No < Maybe	0.140
	Maybe	225	3.52	0.86				
	No	451	2.86	0.95				
Behavioral engagement	Yes	120	3.28	1.10	21.77**	2,791	No < Yes No < Maybe	0.102
	Maybe	224	3.15	0.97				
	No	450	2.56	0.97				
Emotional engagement	Yes	120	3.51	0.91	12.90**	2,792	No < Yes No < Maybe	0.056
	Maybe	223	3.29	0.87				
	No	452	2.96	0.93				

**p<.001

We examined whether there are any gender differences in different components of engagement. There were no significant differences in cognitive engagement (M_{male} = 3.16, SD = 0.92; M_{female} = 3.16; SD = 1.01; $t(792)$ = 0.01; p = .990) and in behavioral engagement (M_{male} = 2.82, SD = 1.04; M_{female} = 2.85; SD = 1.04; $t(791)$ = 0.46; p = .646), while the difference in emotional engagement was statistically significant (M_{male} = 3.25, SD = 0.89; M_{female} = 3.06; SD = 0.95; $t(792)$ = 2.85; p = .004; d = 0.21).

We also examined for each component of engagement whether there were any differences between students from 2nd, 3rd and 4th grade. Table 4 shows the results of ANOVAs. Generally, students from higher grades show lower cognitive and behavioural engagement in physics, but a higher emotional engagement. Effect sizes are low to medium (Cohen, 1988).

Table 4

Results of ANOVAs for differences between students of different grades in cognitive, behavioral and emotional engagement in physics

Variable	Grade	*n*	*M*	*SD*	*F*	df	Scheffé	η^2
Cognitive engagement	2	300	3.34	0.97	20.45**	2,792	2 < 4 3 < 4	0.057
	3	377	3.18	0.92				
	4	118	2.65	0.98				
Behavioral engagement	2	299	3.12	1.02	21.77**	2,791	2 < 3 2 < 4	0.053
	3	378	2.72	0.99				
	4	117	2.48	1.05				
Emotional engagement	2	298	3.04	0.99	12.90**	2,792	2 < 4 3 < 4	0.038
	3	380	3.08	0.88				
	4	117	3.56	0.84				

**p<.001

Discussion

The aim of the study was to explore the components of students' engagement in learning physics and to examine the differences in engagement in physics in respect of several variables: gender, grade, expected grade in physics at the end of the school year and the intention to choose physics as an elective subject in national secondary general education final examination. Our results indicate that the Engagement in physics scale showed an adequate structural validity and reliability. In particular, the results revealed a significantly better fit for the three-factor model (where cognitive, behavioural, and emotional engagement are factorially distinct) compared with the one-factor model. This finding is in accordance with the models which suggest that engagement is a multidimensional construct; in this study, we started from the three-component conception (Appleton et al., 2006; Christenson & Anderson, 2002; Fredricks et al., 2004; Reeve & Lee, 2014), which was confirmed.

Concerning the concurrent validity, our findings indicate that, as expected theoretically, the subscales of the Engagement in physics scale are in positive, low to moderate correlations with subjective task values and self-efficacy in physics. All three constructs were measured at the specific subject level (i.e., physics), not as the general motivation measures and engagement. Moreover, as mentioned earlier, engagement is part of a broader motivation area, and subjective task values and self-efficacy are measures of motivation. Therefore, the obtained positive correlations between these variables are not surprising. However, the correlations were not high, which can be explained by the nature of the engagement on the one hand, and subjective task values and self-efficacy on the other. More specifically, subjective task values and self-efficacy are intentions that are not necessarily transferred to behavior, while engagement has a behavioral component.

Overall, the levels of all three components of engagement were moderate in our sample, which can be expected given that the participants were students from general-program grammar schools; the results would probably be different for students in mathematical-program grammar schools.

Results regarding the expected school grades in physics show that the students who expect a higher grade have a higher level of engagement on each subscale. The nature of our data does not allow any causal conclusions, so it is possible that more engaged students expect a higher grade, but also that the students who already have higher grades in physics (and therefore expect higher grades at the end of the year) are more engaged for that very reason.

Regarding the choice of physics in the final examinations, results on all subscales show that the students who do not intend to choose physics as an elective subject in the national final examination have lower levels of engagement. Here also the causation can go both ways. It should be also noted that the majority of students indicated that they did not intend to choose physics as an elective subject, which is not surprising having in mind that they are in general-program grammar schools; the results would probably be different for students in mathematical-program grammar schools. Of course, for students in the lower grades, it was probably more difficult to answer this question than for students in the fourth grade, who were much closer to the final examination; also, the expressed intention might not reflect the real choice. However, our results show that engagement in physics is related to some important outcomes such as school grade and choosing physics as an elective subject in the final examination (which can also be related to the choice of university).

Gender differences were found only for the emotional engagement, with female students being less emotionally engaged. This result is not in accordance with the results from Amir et al. (2014), whose study shows that female students report higher emotional and behavioral engagement than male students do. However, as the emotional engagement includes positive and negative emotions experienced while learning or when in the classroom (such as feeling well, relief, anxiety and frustration), our finding is in accordance with the studies which show that females generally report higher levels of anxiety about science learning than males (e.g., Udo, Ramsey, Reynolds-Alpert, & Mallow, 2001; Udo, Ramsey, & Mallow, 2004), although this finding might be due to biases of self-report measures (Moeller, Salmela-Aro, Lavonen, & Schneider, 2015). Specifically for physics, Gläser-Zikuda and Fuss (2003) have shown that girls experience more negative and less positive emotions than boys in physics classes.

Generally, our results show lower cognitive and behavioral engagement in physics in higher grades, but higher emotional engagement. Amir et al. (2014) report lower results for all three components of engagement in higher grades; however, a direct comparison is not possible because these authors measured general school engagement and the students in their sample were younger (12 to 16 years) than the students in our sample. It may be that students in higher grades of general-program high schools become less cognitively and behaviorally engaged in learning physics because most of them do not intend to choose physics as an elective subject in the final examination or to attend a college in the STEM area. However, with more experience in learning physics, or because a physics grade is not that important for the college they might choose, they may feel less anxious and more relaxed in physics classes and thus report higher emotional engagement. Of course, these results should be interpreted with caution, because the data is not longitudinal.

In addition to the already mentioned limitations of this study, there are several others. The subsamples' size was uneven, e.g. there were more than 300 students in the second and third grade, but only 120 students in the fourth grade. The participants were only general-program high-school students. Thus, future studies should examine the results of mathematical- and language-program grammar school students, as well as those of vocational secondary school students. In addition, the present study was carried out in Croatia and, thus, cautiousness should be applied in generalizing the results to school contexts in other countries, although this new instrument could be used in other countries as well.

Finally, our scale has been so far the only instrument developed within a subject-specific approach using a three-component conception of engagement. Thus, we focused on the development of the scale specific for physics, and not on the development of a better instrument based on already existing instruments. However, in future studies, it would be useful to compare our scale also to the existing measures of engagement in order to provide evidence of its convergent validity.

Conclusions

Overall, our results showed that engagement in learning physics could be regarded as a multidimensional construct. The results revealed a significantly better fit for the three-factor model (with cognitive, behavioral and emotional engagement subscales) in comparison to the one-factor model, and high to the acceptable reliability of the subscales. Along with the contribution of developing a situation specific measure for engagement, our results also have practical implications for educators. In our sample, levels of all three components of engagement, as well as the levels of measures of motivation were moderate. In order to promote students' engagement, subjective task values and self-efficacy in physics, teachers should use a more problem-based and exploratory instruction (Taylor & Parsons, 2011), for example, conducting experiments in class. In higher grades, when student engagement decreases, attention should especially be paid to meaningful learning activities. In addition to this, teachers should also show students the utility value of physics by relating the subject matter to the world outside the classroom and students' own lives.

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Appendix A

Items from the final version of the Engagement in physics scale in Croatian and English

Kognitivna uključenost/Cognitive engagement:

2. Učim fiziku dok nisam siguran/na da sve razumijem. (I learn physics until I am sure I understood everything).
8. Kad dobijem lošu ocjenu iz fizike, nastojim razumjeti gdje sam pogriješio/la. (When I receive a poor grade in physics, I try to understand where I went wrong).
10. Kad učim fiziku, trudim se gradivo formulirati svojim riječima. (When I study physics, I try to elaborate the subject-matter in my own words).
13. Postavljam sam/a sebi pitanja iz fizike kako bih bio/la siguran/na da dobro razumijem gradivo. (I'm making questions about physics for myself, to make sure I understood the subject-matter well).
26. Rješavam više različitih zadataka kako bih bila/bio sigurna/sigurna da sam shvatila/shvatio gradivo. (I solve multiple problems in order to make sure I understood the subject-matter).

Bihevioralna uključenost/Behavioral engagement:

1. Pažljivo pratim nastavu. (I follow the lectures attentively).
9. Na satu fizike razgovaram s prijateljem iz klupe o stvarima nevezanim uz nastavu. (In physics class I chat with the neighboring classmate about things unrelated to the subject-matter).
14. Na satu radim najviše što mogu. (I'm trying to do my best during a lecture).
17. Ne trudim se previše na satu fizike. (I don't put much effort during a physics lecture).
19. Obraćam pažnju na nastavu. (I pay attention to the lectures).
21. Na satu razmišljam o drugim stvarima. (During a lecture, I think about other things).
23. Moje misli često lutaju tijekom sata. (My thoughts often wonder about during a lecture).
25. Slušam vrlo pažljivo na satu. (I listen very carefully during a lecture).

Emocionalna uključenost/Emotional engagement:

4. Općenito se osjećam dobro na satu fizike. (Generally, I feel well during a physics lecture).
7. Nervozan/nervozna sam dok učim fiziku. (I'm nervous when I study physics).
15. Osjećam olakšanje nakon sata fizike. (I feel relief after the physics lecture).
22. Nervozan/nervozna sam kad započinjemo obradu novog gradiva. (I am nervous when we start working on the new subject-matter).
24. Frustriran/a sam kad ne mogu odgovoriti na pitanje. (I am frustrated when I'm unable to answer the question).