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F. Melike Uçar & Semra Sungur

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The role of perceived classroom goal structures, self-efficacy, and engagement in student science achievement

F. Melike Uçar[a] and Semra Sungur[b]

[a]Faculty of Education, Department of Primary School Teacher Education, Hasan Kalyoncu University, Gaziantep, Turkey; [b]Faculty of Education, Department of Elementary Education, Middle East Technical University, Ankara, Turkey

ABSTRACT

Background: Numerous studies have been conducted to investigate the factors related to science achievement. In these studies, the classroom goal structure perceptions, engagement, and self-efficacy of the students have emerged as important factors to be examined in relation to students' science achievement.
Purpose: This study examines the relationships between classroom goal structure perception variables (motivating tasks, autonomy support, and mastery evaluation), engagement (behavioral, emotional, cognitive, and agentic engagement), self-efficacy, and science achievement.
Sample: The study participants included 744 seventh-grade students from 9 public schools in two districts of Gaziantep in Turkey.
Design and methods: Data were collected through the administration of four instruments: Survey of Classroom Goals Structures, Engagement Questionnaire, Motivated Strategies for Learning Questionnaire, and Science Achievement Test. The obtained data were subjected to path analysis to test the proposed model.
Results: Students' perceptions of classroom goal structures (i.e. motivating tasks, autonomy support, and mastery evaluation) were found to be significant predictors of their self-efficacy. Autonomy support was observed to be positively linked to all aspects of engagement, while motivating tasks were found to be related only to cognitive engagement. In addition, mastery evaluation was shown to be positively linked to engagement variables, except for cognitive engagement, and self-efficacy and engagement (i.e. behavioral, emotional, and cognitive engagement) were observed to be significant predictors of science achievement. Finally, results revealed reciprocal relations among engagement variables, except for agentic engagement.
Conclusions: Students who perceive mastery goal structures tend to show higher levels of engagement and self-efficacy in science classes. The study found that students who have high self-efficacy and who are behaviorally, emotionally, and cognitively engaged are more successful in science classes. Accordingly, it is recommended that science teachers utilize inquiry-based and hands-on science activities in science classes and focus on the personal improvement of the students. Furthermore, it is also recommended that they provide students with opportunities to make their own choices and decisions and to control their own actions in science classes.

KEYWORDS
Classroom goal structure perceptions; engagement; self-efficacy; science achievement

CONTACT Semra Sungur ssungur@metu.edu.tr

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Introduction

To better prepare students for the science-based societies of the future, educators, policy-makers, and researchers have directed their attention toward investigating the factors affecting science achievement (Lau and Roeser 2002). It has been documented that a large majority of the OECD (Organization for Economic Cooperation and Development) countries are not successful in engaging students in science and science-related careers (OECD 2007). This failure may serve to have detrimental effects on a country's economic future, as economic and technological developments require a deep understanding and application of knowledge in science, technology, and engineering (Örnek 2015) Therefore, beginning from the very earliest stages of schooling, it is necessary that the learning mechanisms for achievement in science be improved. In order to accomplish this, an examination of the factors associated with these important student outcomes can serve as a starting point. According to the relevant literature, motivation appears to be one of these factors and thus a central focus of educational research in teaching and learning (Pintrich 2003). As a result, in recent decades, educational and psychological researchers have focused on student motivation and its effect on science achievement (Yumusak, Sungur, and Cakiroglu 2007; Zusho, Pintrich, and Coppola 2003). From a science education perspective, motivation can be achieved through the active engagement of students in science tasks and activities, which in turn shall provide them with a better understanding of science (Lee and Brophy 1996). Among the motivational variables, self-efficacy is found to be the most powerful predictor of students' science achievement (Areepattamannil, Freeman, and Klinger 2011; Yerdelen 2013). Indeed, according to Pintrich and Schunk (1996), students who have high self-efficacy in learning and in performing a given task successfully tend to engage in the task rather than avoid it, persist in the face of difficulties, and try different strategies, all of which lead to greater achievement. Students with higher levels of self-efficacy are thus likely to have higher levels of engagement in science tasks and activities. A higher level of student engagement in science is important because it is able to predict student progress, enables learning, plays an important role in developing students' critical thinking skills, problem-solving skills, and other cognitive abilities, and cultivates their diligence in science, technology, engineering, and mathematics (Tytler et al. 2008). The literature on this subject reveals that students' self-efficacy, engagement, and achievement are strongly influenced by the educational context of their learning (Anderman and Patrick 2012). Ames (1992a) defined the educational contexts that influence students' learning and their perceptions of the type of goals emphasized in the classroom as classroom goal structures. These classroom goal structures involve the achievement goal type stressed by predominant instructional practices and strategies in the learning environment, such as grading procedure and characteristics of the tasks given to students (Wolters 2004). The goals include mastery goal structures (learning or mastering the work) and performance goal structures (demonstrating ability to others either by obtaining a good grade or by obtaining a higher grade than peers) (Palmer 2005). In point of fact, the concepts of classroom mastery and performance goal structures are similar to the personal mastery and performance goal orientation concepts, respectively (Anderman and Patrick 2012). Thus, in classrooms where the mastery goal structure is dominant, students are encouraged to value the idea of learning and understanding topics for their personal improvement. On the other hand, the classroom performance goal structure encourages students to perform better relative to others (Ames 1992b).

In one study found in the related literature, students' perceptions of mastery-oriented classroom goal structures were examined in terms of their perceptions concerning autonomy support, mastery evaluation, and presence of motivating tasks in their classroom (Guo 2007). Motivating tasks pertain to students' motivation and interest level for assignments they are given. Autonomy support, on the other hand, emerges when students are supported by placing responsibility on them for their own learning. Accordingly, student participation in decision-making processes in classroom environments can be considered a part of autonomy structures. Lastly, mastery evaluation involves the evaluation of students based on their individual progress and focuses on personal improvement. In classrooms where mastery evaluation is emphasized, learning and evaluation mechanisms are considered as fair and appropriate by students (Rostami, Hejazi, and Lavasani 2011).

The following sections provide a review of the literature concerning the role of classroom goal structure perception in student engagement, self-efficacy, and achievement. Research on the relationship between student engagement, self-efficacy, and achievement is presented in subsequent sections. The relevant literature on the relationships among each aspect of student engagement is also presented. Based on the findings, hypotheses were proposed regarding these relations, specifically within the area of science.

Relationship between self-efficacy, student engagement, and science achievement

Student engagement refers to the extent to which a student is actively involved in a learning activity (Connell and Wellborn 1991). Because of its significant role in student achievement, student engagement has been studied by many researchers (Reeve 2012). Reeve (2012) stated that student engagement involves four different, but highly intercorrelated aspects (i.e. emotional, behavioral, cognitive, and agentic engagement). Specifically, *behavioral engagement* involves student participation in learning activities through effort and concentration (Skinner and Belmont 1993). Accordingly, if a student possesses high behavioral engagement, he or she will be diligent in learning activities (Skinner and Belmont 1993). *Emotional engagement* concerns the positive and negative feelings students have about learning, such as their enjoyment, curiosity, anxiety, or boredom (Connell and Wellborn 1991; Skinner and Belmont 1993). When students possess high emotional engagement, they enjoy learning and attending school (Lam et al. 2012). *Cognitive engagement* refers to the amount and types of cognitive strategies employed by students (Walker, Greene, and Mansell 2006). *Agentic engagement* has emerged as a more authentic and action-oriented form of engagement in recent research (Lawson and Lawson 2013). Reeve (2012) defined it as the active contribution of students to teaching and learning practices. Agentic engagement occurs when students manage their learning processes and express their opinions or feelings during an activity as an active participant (Ainley 2012; Reeve 2012). Moreover, it has been shown to take place when the students are collaboratively involved with others (Davis and McPartland 2012).

The related literature suggests that the self-efficacy of students is significantly linked to each aspect of student engagement, given that the self-efficacy of students influences their motivation level, persistence in the face of difficulty, (Bandura 1994), choices of tasks (Lodewyk and Winne 2005), and the effort they expend on the tasks (Pajares 1996). Students with high self-efficacy tend to study hard, show perseverance, and seek help in an efficient manner. Their efficacy beliefs can also affect their frame of mind and emotional reactions

(Pajares 1996). A person with low self-efficacy may struggle, beyond what the actual difficulty requires, to complete certain tasks, which in turn may give rise to stress and depression, and thereby diminish their problem-solving ability. In a review by Linnenbrink and Pintrich (2003), they stated that self-efficacy beliefs facilitated the use of deeper processing strategies, and that students with high self-efficacy put forth greater effort to understanding a problem and thinking deeply about it. The relevant literature, therefore, suggests positive relations between students' self-efficacy and their cognitive, behavioral, and emotional engagement. Additionally, according to Peach and Matthews (2011), agentic engagement involved the flexibility and abilities of students to handle new and challenging situations. In line with this idea, Reeve and Tseng (2011) suggested that some agency-based constructs of motivation, such as self-efficacy and interests, may contribute to the agentic engagement of students.

A substantial amount of the research conducted over the past decades has shown that self-efficacy is one of the predictors of academic achievement (Bandura 1997; Chemers, Hu, and Garcia 2001; Pajares 1996). For example, Schunk's (1981) study revealed that self-efficacy was directly related to students' achievement and persistence. Moreover, in the meta-analysis performed by Multon, Brown, and Lent (1991) examining the relation between self-efficacy beliefs and academic performance, the findings demonstrated that self-efficacy was positively linked to academic performance and persistence in a number of disciplines. For instance, a considerable number of studies have shown that self-efficacy is significantly related to science achievement (Britner and Pajares 2006; Mason et al. 2013). According to social learning theorists, one's sense of self-efficacy may affect many aspects of behavior which are considered to be significant for achievement. These aspects involve selection of activities, use of various strategies, persistence, and effort, all of which constitute major indicators of student engagement (Bandura 1994; Schunk 1989). It is, therefore, believed that self-efficacy is both directly and indirectly linked to achievement through its effect on engagement. Furthermore, many studies have demonstrated that there are strong associations between cognitive and affective engagement and academic achievement (Archambault et al. 2009; Reschly et al. 2008). For example, Mo (2008) conducted a study in order to investigate the correlation between eighth-grade students' science achievement, student engagement, and opportunity to learn. Student engagement was examined in terms of emotional, behavioral, and cognitive engagement. The results revealed that there were significant associations between each aspect of engagement and science achievement. More recently, Reeve (2013) examined college students' achievement in relation to their engagement. The findings showed that all aspects of student engagement explained 25% of the variance in achievement, and that behavioral and agentic engagement significantly and positively predicted achievement.

Consequently, based on the aforementioned literature, it was hypothesized, in the current study, that self-efficacy and engagement are positively associated with science achievement. In addition, links were proposed between self-efficacy and each aspect of engagement.

Student engagement, self-efficacy, and science achievement in relation to perceived classroom goal structures

According to the relevant research, one of the best factors for explaining student motivation and engagement in learning is the achievement goals that are communicated in their classrooms (Urdan and Maehr 1995). As stated by Anderman and Patrick (2012), in mastery-oriented classrooms, student engagement is expected to be at higher levels, from both theoretical and practical perspectives. Indeed, many studies have clearly shown that classroom goal structures have a strong effect on all aspects of student engagement (Ames 1992a; Greene et al. 2004). More specifically, according to the research, students tend to have more positive opinions about their schoolwork (Nolen and Haladyna 1990) and enjoy the class activities (Ames and Archer 1988), if they perceive their classroom as having a master goal structure. Additionally, students who are in a classroom furnished with a mastery goal structure are more likely to expend effort and show persistence when faced with difficulties (Wolters 2004), use a variety of learning strategies (i.e. cognitive and metacognitive strategies) (Ames and Archer 1988), and have greater access to interesting and personally valued learning activities (Reeve 2013).

Several studies have demonstrated that student self-efficacy is significantly linked to perceived classroom goal structures (Friedel et al. 2007). Other studies have also shown that self-efficacy mediates the relationship between classroom perceptions and achievement (Greene et al. 2004). For example, in an empirical study conducted by Sungur and Güngören (2009), it was found that the effect of classroom goal structure perceptions on science achievement was mediated through the students' motivation, including their self-efficacy in science. Similarly, in a study by Greene et al. (2004), it was concluded that the relation between students' classroom environment perceptions and their achievement was mediated by self-efficacy.

Overall, the aforementioned literature suggests that students' perceived classroom goal structures are positively associated with their engagement and self-efficacy. Accordingly, in this study, it was hypothesized that perceived classroom goal structures are directly linked to all aspects of student engagement and self-efficacy. In addition, according to the related literature, student self-efficacy appears to mediate the influence of perceived classroom environment on achievement. Thus, the current study also proposes that perceived classroom goal structures are indirectly linked to science achievement through its effect on self-efficacy (see Figure 1).

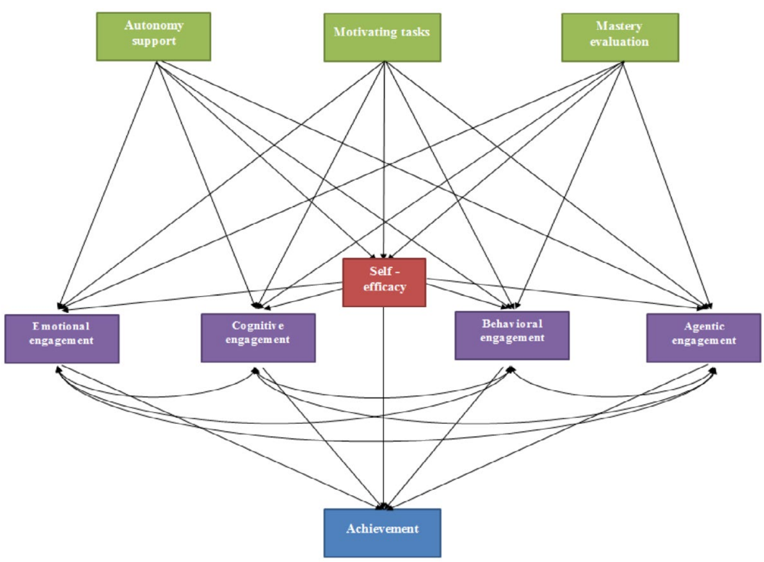

Figure 1. The conceptual model.

Relationships between each aspect of student engagement

In conceptualizing student engagement, researchers have proposed that the aspects of student engagement (behavioral, emotional, cognitive, and agentic) are all interrelated (Reeve 2012, 2013; Reeve and Tseng 2011). Nevertheless, only a limited amount of empirical research has been conducted that investigates the ways in which these aspects of engagement are related with each other (Li and Lerner 2013). For example, the longitudinal study conducted by Skinner, Kindermann, and Furrer (2008) revealed that significant links were present in terms of the impact behavioral engagement had on emotional engagement and vice versa. Additionally, Li and Lerner (2013) reported that there was a bidirectional relationship between behavioral and emotional engagement, and that behavioral engagement was significantly linked to cognitive engagement. Furthermore, various studies based on the motivational framework have proposed that emotional engagement and cognitive engagement promote active participation and lead to increased behavioral engagement (Skinner, Kindermann, and Furrer 2008). By this means, thoughts and emotions can awake or prevent action (Heckhausen 2000). Based on the empirical research findings and theoretical propositions, the current study predicts reciprocal relations between each engagement aspect.

Purpose of the study

The purpose of the present study is to explore relationships between students' perceptions of classroom goal structures, engagement, self-efficacy, and achievement in science by proposing and testing a path model (see Figure 1). As shown in the said figure, according to the model, it was hypothesized that perceptions of classroom goal structures are related to all aspects of student engagement and self-efficacy. What's more, it was proposed that self-efficacy is linked to all dimensions of student engagement and science achievement. The paths leading from each student engagement variable to science achievement are specified. It was expected that significant associations existed between the engagement variables.

This study, therefore, expands upon the studies examining the relationship between students' perception of the classroom goal structures and science achievement by exploring their self-efficacy and four engagement variables simultaneously within a single path model. With this study, as the current situation governing the related constructs of middle-grade students shall be illustrated, researches, educators, pre-service teachers, and in-service teachers will be equipped with valuable information about the relationship between classroom goal structure perception, engagement, self-efficacy, and achievement, which in turn shall potentially contribute to the formation of better classroom environments. For example, suggestions can be made to in-service teachers about creating classroom goal structures that are conducive to the science achievement of students. Additionally, based on the findings of the present study, curriculum developers can revise their curricula to improve classroom goal structures, and the student-related variables determined to enhance the students' science achievement can lead to a deeper understanding and application of the knowledge necessary for the economic and technological developments of countries.

Research questions

In line with the purpose of the current study, the main research question was 'What are the relationships between students' perceived classroom goal structures, their self-efficacy and engagement and achievement in science?' Path analysis was used to shed light on the following sub-research questions:

(1) Are self-efficacy and engagement in science directly linked to science achievement?
(2) Is self-efficacy in science indirectly linked to science achievement through its effect on engagement in science?
(3) Are students' perceived classroom goal structures indirectly linked to their science achievement through their effect on engagement and self-efficacy in science?
(4) What are the relations between each aspect of student engagement in science?

Method

Sample

A total of 744 seventh-grade students (403 girls, 337 boys, and 4 gender missing) from 9 public schools in two districts of Gaziantep in Turkey participated in the study. Participants were subjected to the same science curriculum implemented countrywide with a vision of developing scientifically literate individuals. The mean age of the participants was 13.08 (SD = 0.39). Most of the participants' mothers had a high school or lower degree (83.9%), while more than half of the students' fathers completing high school or higher educational level (58.9%). While the students' mothers were largely unemployed (75.0%), a large majority of the students' fathers were employed (87.5%). Over half of the participants had families with two or three children (58.9%). A majority of the students had their own room to study (82. 8%), a computer (84.8%), and Internet access (71.1%) in their homes.

Instruments

Perceived classroom goal structures were assessed through the Survey of Classroom Goals Structures (SCGQ, Blackburn 1998; Greene et al. 2004), which consisted of 22 items in four subscales: motivating tasks (e.g. *In this class, activities and assignments are interesting*), autonomy support (e.g. *In this class, the teacher wants us to take responsibility for our learning*), and mastery evaluation (e.g. *In this class, assignments and tests are returned in such a way as to keep individual student grades private*). Students responded on a four-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). The instrument was adapted into Turkish by Sungur and Güngören (2009). In order to validate the factor structure for the current study, confirmatory factor analysis was conducted. In addition, reliability analyses were performed. Based on the results, four items which failed to adequately contribute to the total variability were decided to be deleted. After deletion of the items, confirmatory factor analysis (CFA) revealed a good fit of the model to the data (GFI = 0.95, CFI = 0.98, RMSEA = 0.04, SRMR = 0.03). Cronbach's alpha coefficients were 0.85 for motivating tasks, 0.74 for mastery evaluation, and 0.65 for autonomy support, values of which suggest the final instrument had adequate internal consistency.

Engagement was assessed through the Engagement Questionnaire (EQ, Reeve and Tseng 2011), which consisted of 22 items in four subscales: behavioral engagement (e.g. *I listen carefully in class*), cognitive engagement (e.g. *When I study, I try to connect what I am learning with my own experiences*), emotional engagement (e.g. *When I am in class, I feel curious about what we are learning*), and agentic engagement (e.g. *I offer suggestions about how to make the class better*). Students responded on a four-point Likert scale, ranging from 1 (strongly disagree) to 4 (strongly agree). The instrument was adapted into Turkish by Author through a series of CFAs and reliability analyses. The CFA results also validated the four-factor structure of the instrument, revealing a good model fit (GFI = 0.93, CFI = 0.99, RMSEA = 0.05, SRMR = 0.04). Cronbach's alpha coefficients were 0.82 for agentic engagement, 0.88 for behavioral engagement, 0.86 for cognitive engagement, and 0.83 for emotional engagement, values of which suggest high internal consistency.

Self-efficacy was assessed through the self-efficacy for learning and performance subscale of the Motivated Strategies for Learning Questionnaire (MSLQ, Pintrich et al. 1991). The subscale consisted of eight items (e.g. *I believe I will receive an excellent grade in the science class*) on a seven-point Likert scale, ranging from 1 (not at all true of me) to 7 (very true of me). The MSLQ was adapted into Turkish by Sungur (2004). For validating the factor structure, CFA was conducted, with the results revealing a good model fit (GFI = 0.96, CFI = 0.98, RMSEA = 0.08, SRMR = 0.03). Cronbach's alpha coefficient was found to be 0.90 for the self-efficacy for learning and performance subscale, a value suggesting high internal consistency.

Science achievement was assessed through the Science Achievement Test (SAT, Yerdelen 2013), which was developed to evaluate the seventh-grade students' science achievement. The test consisted of 14 multiple-choice items, with one correct answer and three distracters. For its development, items were selected from science tests of nationwide examinations from previous years. When selecting the items, instructional objectives and the content of the seventh-grade national science curriculum were taken into consideration. With that said, the items included in the test fell under the categories of unit of force and motion (4 items), body systems (7 items), and electricity (3 items). These items were determined to be at the knowledge, comprehension, and application levels specified in Bloom's Taxonomy. To calculate the SAT scores, '1' point was given for each correct answer and '0' points for each incorrect answer, with the total number of points being added for each student. The reliability coefficient for the SAT was found to be 0.75.

Procedure

In the present study, information about the research and how to fill in the instruments was provided to the participants. Participants were given the assurance that their responses would be kept confidential and would not affect their grades in any way. All required data were collected during regular class hours.

Data analysis

Descriptive statistics and path analysis were conducted using the variables of the study. As part of conducting the descriptive statistics process, mean and standard deviation were computed using IBM SPSS Statistics 20.0. Path analysis was performed using the LISREL 8.80 program in the SIMPLIS programming language to test the proposed model.

Results

Descriptive statistics for students' perceptions of classroom goal structures

The descriptive statistics presented in Table 1 revealed that, among the perceived classroom goal structure variables, the highest mean score was obtained in the motivating tasks, while the lowest mean score was in mastery evaluation. Although the mean score was lowest for

Table 1. Descriptive statistics for students' perceptions of classroom goal structures, engagement, self-efficacy, and science achievement.

	M	SD
Motivating tasks	2.90	0.66
Autonomy support	2.87	0.64
Mastery evaluation	2.83	0.59
Agentic engagement	2.74	0.78
Behavioral engagement	3.19	0.71
Cognitive engagement	2.93	0.67
Emotional engagement	3.10	0.77
Self-efficacy	4.97	1.65
Science achievement	7.93	3.26

the mastery evaluation, it was still above the mid-point of the four-point scale ($M = 2.83$). Based on these results, students appeared to perceive their science classes as mastery goal oriented at moderate levels.

Descriptive statistics for student engagement

Examination of the mean scores for student engagement revealed that on a four-point scale, students tended to demonstrate behavioral, emotional, cognitive, and agentic engagement at moderate to high levels. The highest mean score was obtained in behavioral engagement, while the lowest mean score was obtained in agentic engagement.

Descriptive statistics for self-efficacy and science achievement

Examination of the mean score for self-efficacy on a seven-point scale suggested that seventh-grade students had a moderate level of self-efficacy in science. Concerning the descriptive statistics for students' science achievement, as shown in Table 1, the obtained mean score ($M = 7.93$) on the test reflected that students' achievement in science was also moderate.

Inferential statistics

The relationships between seventh-grade students' perceived classroom goal structures, engagement, and self-efficacy and science achievement were examined by proposing and testing a path model (see Figure 2). The results indicated that there was evidence to support adequate model-to-data fit ($\chi^2/df = 2.55$, GFI = 0.99, CFI = 0.99, RMSEA = 0.04, SRMR = 0.00)

In the model, self-efficacy and engagement (agentic engagement, behavioral engagement, cognitive engagement, and emotional engagement) explained 61% of the variance in science achievement. Standard parameter estimates showed that higher levels of self-efficacy ($\beta = 0.15$), behavioral engagement ($\beta = 0.25$), cognitive engagement ($\beta = 0.25$), and emotional engagement ($\beta = 0.29$) were positively related to students' science achievement. These results suggested that students who demonstrate behaviors such as persistence, effort, and concentration in science classes, who work hard to truly understand and organize science topics, who show positive affective reactions, such as interest and enjoyment in the science

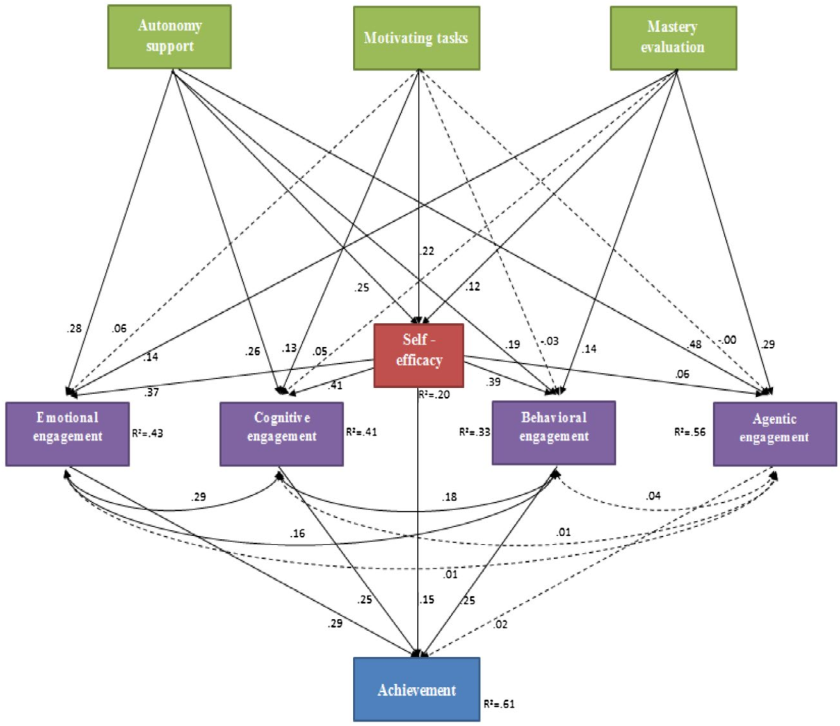

Figure 2. Path model with standardized path coefficients for direct effects. *Dashed lines show non-significant paths.

classes, and who have higher levels of self-efficacy were likely to be more successful in science (see Table 2).

Results of the path analysis also showed that seventh-grade students' perceived classroom goal structures (motivating tasks, autonomy support, and mastery evaluation) accounted for 20% of the variance in self-efficacy. As can be seen from Table 2, self-efficacy was positively linked to motivating tasks ($\beta = 0.22$), autonomy support ($\beta = 0.25$), and mastery evaluation ($\beta = 0.12$). These findings suggested that students who perceive that the tasks offered to them in science classes are meaningful, relevant, and interesting, and whose science classes are autonomy supportive and mastery oriented tended to show higher self-efficacy in science.

Furthermore, the results showed that self-efficacy and students' perceived classroom goal structures (motivating tasks, autonomy support, and mastery evaluation) accounted for 56% of the variance in agentic engagement. Standard parameter estimates indicated that the associations between self-efficacy ($\beta = 0.06$), autonomy support ($\beta = 0.48$), and mastery evaluation ($\beta = 0.29$) were statistically significant. These findings indicated that students who have high self-efficacy in science and who perceive the science classes as autonomy supportive and mastery oriented were likely to enrich the learning environment and make constructive contributions to instruction in science classes.

The results also demonstrated that self-efficacy, motivating tasks, autonomy support, and mastery evaluation accounted for 33% of the variance in behavioral engagement. The links to self-efficacy ($\beta = 0.39$), autonomy support ($\beta = 0.19$), and mastery evaluation ($\beta = 0.14$)

Table 2. Direct, indirect, and total effects of related variables.

Effect	Direct effects	Indirect effects	Total effects	Standard errors of the estimates	t	R^2
On self-efficacy						0.20
Of motivating tasks	0.22	–	0.22	0.01	6.55*	
Of autonomy support	0.25	–	0.25	0.01	4.78*	
Of mastery evaluation	0.12	–	0.12	0.01	2.37*	
On agentic engagement						0.56
Of self-efficacy	0.06	–	0.06	0.01	2.09*	
Of motivating tasks	−0.00	−0.00	−0.00	0.00	−0.06	
Of autonomy support	0.48	0.03	0.51	0.03	12.29*	
Of mastery evaluation	0.29	0.01	0.30	0.04	7.54*	
On behavioral engagement						0.33
Of self-efficacy	0.39	–	0.39	0.01	11.60*	
Of motivating tasks	−0.03	0.01	−0.02	0.00	−0.80	
Of autonomy support	0.19	0.07	0.26	0.05	3.89*	
Of mastery evaluation	0.14	0.05	0.19	0.06	2.82*	
On cognitive engagement						0.41
Of self-efficacy	0.41	–	0.41	0.01	12.87*	
Of motivating tasks	0.13	0.05	0.18	0.00	4.49*	
Of autonomy support	0.26	0.10	0.36	0.04	5.62*	
Of mastery evaluation	0.05	0.02	0.07	0.05	1.14	
On emotional engagement						0.43
Of self-efficacy	0.37	–	0.37	0.01	11.88*	
Of motivating tasks	0.06	0.22	0.28	0.00	1.91	
Of autonomy support	0.28	0.10	0.38	0.05	6.40*	
Of mastery evaluation	0.14	0.05	0.19	0.05	3.24*	
On science achievement						0.61
Of self-efficacy	0.15	–	0.15	0.01	4.93*	
Of agentic engagement	0.02	0.00	0.02	0.02	0.70	
Of behavioral engagement	0.25	0.09	0.34	0.02	8.61*	
Of cognitive engagement	0.25	0.10	0.35	0.03	7.21*	
Of emotional engagement	0.29	0.10	0.39	0.03	8.36*	

*Significant paths.

were all found to be positive. These findings implied that students' perceptions of science classes as autonomy supportive and mastery oriented and their belief that they can accomplish the tasks successfully were positively related to the manifestation of behaviors such as persistence, effort, and concentration in science classes.

Considering the paths toward cognitive engagement, all of the variables related to classroom goal structure perceptions and self-efficacy explained 41% of the variance in cognitive engagement. According to the results, self-efficacy ($\beta = 0.41$), autonomy support ($\beta = 0.26$), and motivating tasks ($\beta = 0.13$) were significantly linked to cognitive engagement. These findings indicated that students who perceive the science class as autonomy supportive, who perceive the science classroom tasks as meaningful and motivating, and who belief that they can accomplish tasks and actively participate in science classes tended to use learning strategies to remember, organize, and understand the materials at higher levels.

With respect to emotional engagement, self-efficacy, motivating tasks, autonomy support, and mastery evaluation accounted for 43% of the variance in emotional engagement. Among these variables, self-efficacy ($\beta = 0.37$), autonomy support ($\beta = 0.28$), and mastery evaluation ($\beta = 0.14$) were positively associated with emotional engagement. These results suggested that students' level of self-efficacy and the extent to which students find the science class as autonomy supportive and the evaluation practices as fair and focused on learning were positively related to the extent to which students show positive affective reactions, such as interest and enjoyment in the science classes.

In addition to one-way paths, as can be seen in Figure 2, relations were proposed among the engagement variables. The two-way arrows on the model indicate that some of the measurement errors are correlated. Path analysis results revealed that error covariance between cognitive engagement and emotional engagement, between behavioral engagement and emotional engagement, and between behavioral engagement and cognitive engagement was significant. These findings indicated that all engagement variables, except agentic engagement, were statistically correlated with each other.

Discussion

Relationships between self-efficacy, student engagement, and science achievement

The path model used in this study revealed significant links between seventh-grade students' self-efficacy beliefs and their emotional, behavioral, cognitive, and agentic engagement. This result implies that students who have confidence in learning science topics are likely to react to science learning positively (emotional engagement), exert effort toward learning and persist in the face of difficulties (behavioral engagement), try to link what they learn to their own experiences and what they already know (cognitive engagement), and creatively contribute to instruction, such as telling the teacher what they like, dislike, or are interested in offering opinions and making choices in science class (agentic engagement). These results are in agreement with the related literature (Linnenbrink and Pintrich 2003; Reeve and Lee 2014). Indeed, similar studies have shown that students with high self-efficacy are likely to actively engage in a task, use effective learning strategies, and exert effort to accomplish tasks, even if it is very hard, while on the other hand, students with low self-efficacy tend to avoid such tasks (Schunk and Mullen 2012).

The results concerning the relationship between self-efficacy and science achievement revealed that students with high self-efficacy tend to be more successful in science. This finding is consistent with the findings in the relevant literature (Areepattamannil, Freeman, and Klinger 2011; Mason et al. 2013). For instance, Areepattamannil et al. reported that students with higher levels of confidence in performing science-related tasks and with better perceptions of their ability to learn science were more likely to have higher science achievement. Students who have high self-efficacy, even under difficulties, apply different effective strategies, persist in the face of difficulties, and make an effort until they achieve success (Schunk and Zimmerman 2006).

In the current study, the path model suggested that student engagement was an important factor in science achievement. According to the findings, students who were cognitively, behaviorally, and emotionally active in their science classes, who used a variety of strategies, who persisted in the face of difficulties, and who showed interest in what they were learning tended to have higher scores on the science achievement test. These findings were in line with the study's expectations, which assumed that if students possess high emotional engagement, they will then be motivated, enjoy learning, and actively participate in classroom activities, all of which will in turn bring success. Moreover, students' use of learning strategies makes learning more interiorized and meaningful for them, which likewise also results in their success. Similarly, students' behavioral engagement reflects the extent to which they exert effort and pay attention. Students who exhibit behavioral engagement will put forth effort, concentrate, and pay attention to learning, and thereby actually accomplish the task of learning. In fact, consistent with the current findings, a number of studies in the literature have demonstrated a positive relation between student engagement and achievement (Patrick, Skinner, and Connell 1993; Reschly et al., 2008).

In contrast to other studies, the present study found the link proposed between agentic engagement and achievement to be non-significant. Reeve and Tseng (2011), for example, demonstrated that student achievement was able to be predicted by agentic engagement. And in a more recent study, Reeve (2013) also determined that agentic engagement was significantly linked to achievement and went on to conclude that agentic engagement acted as a proactive, intentional, collaborative, and constructive student-initiated pathway to higher academic achievement and motivational support. At this point, it is worth mentioning that the participants in the study of Reeve and Tseng (2011) were high school students from Taiwan, and that in the study of Reeve (2013), the participants were college students from South Korea. The sample characteristics and context of the studies were therefore different from those of the current study, the focus of which was science classes conducted at the middle school level. In Turkey, all middle school science teachers administer instruction using the same textbook and the same national science curriculum implemented countrywide. Although the curriculum is student-centered, with the aim of developing scientifically literate individuals, the implemented curriculum is different from the written curriculum (Dindar and Yangın 2007). Science teachers tend to use the suggested activities to justify the given content rather than to encourage students to contribute to the learning process (Gökçe 2006). Thus, seventh-grade students are not expected to be active agents in science classes at higher levels in Turkey. In situations when students may wish to offer suggestions in order to contribute to instruction and to inform their science teachers about what they prefer to learn in science classes and what they are interested in, but the science learning environment offers little room for such student contributions to the teaching and learning process, the expected positive link between agentic engagement and achievement can be hindered. As a reflection of this situation, in the current study, upon examination of the mean scores, the lowest mean scores were found to belong to the agentic engagement subscale, indicating that students' agentic engagement was at the lowest level compared to other student engagement variables (i.e. cognitive, behavioral, and emotional engagement). Therefore, in order to increase the generalizability of the findings, the relation between agentic engagement and achievement should be investigated using different samples in different domains.

Student engagement, self-efficacy, and science achievement in relation to perceived classroom goal structures

Based on previous studies, the current study proposed that classroom goal structures can be used as an effective empirical tool to investigate the influence of classroom contexts on student engagement and motivation. Three classroom structures (autonomy support, motivating tasks, and mastery evaluation) were identified for this purpose. The results demonstrated that while autonomy support was linked to each of the engagement variables, motivating tasks were linked only to cognitive engagement. Additionally, mastery evaluation was shown to be linked to all aspects of engagement, except for cognitive engagement.

The finding concerning the relation between autonomy support and engagement variables was as expected and confirms the results of previous research (e.g. Reeve 2013; Reeve and Tseng 2011). As emphasized in these studies, in autonomy-supportive classrooms, students are provided with the freedom of opportunity to ask questions, share their opinions, and choose tasks and activities in line with their interests. Such classroom structures have been reported to give rise to better student engagement. That is, when teachers consider their students' feelings, thoughts, and behaviors, students tend to show greater effort, attention, and concentration on tasks (behavioral engagement), exhibit interest, curiosity, and enthusiasm (emotional engagement), offer proactive and constructive contributions to the instructional process (agentic engagement), and employ deep, self- regulated, and personalized learning strategies (cognitive engagement) (Reeve et al. 2004).

Concerning the relationship between motivating tasks and student engagement, the results revealed that motivating tasks were significantly linked only to cognitive engagement. This finding implies that students who perceive the materials and tasks in the science class as challenging, meaningful, and useful are likely to use learning strategies at higher levels. This result is in accordance with the findings in the literature demonstrating that student cognitive engagement is related to their classroom environment perceptions (Sungur and Güngören 2009; Lau and Lee 2008; Reeve 2013).

Finally, the results concerning mastery evaluation revealed that it was related to each aspect of student engagement, except for cognitive engagement. In other words, if students perceive the evaluation practices in the science class to be consistent with what they learned and to be meaningful, fair, and based on their effort, then they tend to exhibit behaviors such as persistence, effort, concentration, and attention at higher levels in the science classes, (behavioral engagement), demonstrate higher levels of interest, curiosity, and enjoyment in the science classes (emotional engagement), and ask questions, explain their choices, needs, and interests, and make suggestions to improve the science class (agentic engagement). These findings are similar to those found in the related literature (Reeve and Lee, 2014). For example, Ames (1992c) proposed that in the evaluation process, if teachers emphasize individual improvement, consider the students' efforts, and show them how mistakes are part of the learning process, their students will likely show high interest, attention, and effort in learning activities, apply effective learning strategies, feel a sense of belongingness, and engage in learning actively.

Regarding the relationships between student perceptions of classroom goal structures and self-efficacy, the results showed that motivating tasks, autonomy support, and mastery evaluation were significantly related to the students' self-efficacy beliefs in science classes. In addition, the results found self-efficacy to be significantly linked to students' science achievement. According to these findings, if students perceive that science tasks are interesting and relevant to their daily lives, they tend to believe that they can learn science successfully. In fact, when the tasks are associated with their daily lives, students will concretize abstract science concepts, and thus it will be more meaningful and easier for students to learn these concepts (Pintrich and Schunk 1996). In this way, their levels of confidence in their abilities to comprehend and learn science concepts can improve. Furthermore, according to the results, if students perceive that they are evaluated in science classes based on their own effort, individual progress, and mastery level, a higher degree of self-efficacy in science emerges in them. Teachers in such learning environments give students opportunities to improve their work and use different evaluation methods, and they make the evaluation private. These practices are likely to make students more motivated in science classes and to try harder to improve in the class (Ames 1992c). Lastly, the results suggest that when students perceive that their science teachers provide them with opportunities to feel a sense of responsibility and select science tasks congruent with their interests, they tend to have higher levels of science self-efficacy. In essence, when students are allowed to participate in learning and decision processes and are supported with a certain degree of choice, autonomy, and control, these opportunities improve their responsibility, independence, and leadership skills. Thus, they become more motivated in their learning environment and feel greater confidence to accomplish given tasks (Ames 1992c; Pintrich and Schunk 1996). Overall, findings from the current study concerning the relationships between classroom goal structures, self-efficacy, and science achievement were as expected, both theoretically and empirically, and highlighted the importance of classroom goal structure perceptions on students' self-efficacy and achievement.

Relationships between each aspect of student engagement

In the proposed model, significant associations were expected among the engagement variables. Findings derived from the path model demonstrated that all aspects of student engagement, except for agentic engagement, were in a reciprocal relation with each other. For example, students who reported behaviors such as persistence, effort, and concentration in science classes put in more effort to truly understand and organize science topics and showed more positive affective reactions, such as interest and enjoyment in the science classes. In the same manner, students who reported to exert more effort to understanding a subject deeply had more positive emotions for science classes, as well as paid more attention, had greater concentration, and showed more persistence in science classes. These findings are consistent with the related literature (Avenilla 2003; Mo 2008). However, although the studies in the literature show that agentic engagement had a positive significant association with the other three aspects of engagement (behavioral, cognitive, and emotional), in the current study, agentic engagement was found to not be related with any other student engagement variable.

Implications of the study

The purpose of this study was to investigate the relationships between seventh-grade students' perceptions of classroom goal structures, in terms of motivating tasks, autonomy support, mastery evaluation, engagement (i.e. behavioral, emotional, cognitive, and agentic engagement), self-efficacy, and achievement in the domain of science. Path analysis results reveal that the science achievement of seventh-grade students is directly and positively linked to their self-efficacy and their emotional, behavioral, and cognitive engagement.

In light of these findings, the enhancement of students' engagement appears to be a very important condition for strengthening the science achievement of seventh-grade students.

Moreover, according to the results of the current study, to facilitate the emotional, behavioral, and cognitive engagement of students, classroom environments that serve to support students' self-efficacy and autonomy, and that emphasize mastery evaluation should be established. To accomplish this, it is suggested that teachers provide students with opportunities to make their own choices and decisions, to take responsibility for their own learning, and to control their own actions in science classes. The Ministry of Education plays a particularly critical role insofar as it relates to teachers being equipped with the necessary knowledge and skills to facilitate these opportunities. In effect, in-service trainings should be organized by the Ministry of Education in order to improve science teachers' autonomy-supportive style of teaching. Here, it is important to briefly point out certain features of the Turkish education system. Due to the fact that the Turkish education system has a centralized management design, student autonomy does not heavily factor into education programs (Ergür 2010). As a result of this system, students are unable to choose to take responsibility for principal components of the education program, such as targeting and building the content of lessons, selecting material, and determining instructional methods and techniques. In this respect, it is suggested that curriculum developers design courses that give students the right to speak in different phases of the education program, create classroom activities that allow students to take more responsibility in the teaching–learning process, support the improvement of students' autonomous behaviors through non-class activities and homework, and finally take students' opinions about the teaching process into consideration. In the current study, autonomy support is shown to be significantly linked to students' self-efficacy.

In addition to autonomy support, mastery evaluation also has an impact on all aspects of the students' engagement, except for cognitive engagement, and their self-efficacy. Teachers, therefore, should focus on students' personal improvement rather than conduct normative evaluations. To do this, teachers should avoid announcing the students' grades and displaying only selected papers in public spaces, as the public nature of the evaluation practices encourages the students to compare themselves according to their relative ability and performance. Additionally, teachers should use a variety of assessment strategies, considering that not all students are able to show their best work in the same format. It is also suggested that science teachers provide feedback, making sure in this feedback to stress that making mistakes and putting forth effort are important for learning, and that they provide students with opportunities to improve their work by allowing them to revise their homework for a higher grade (Ames 1992c).

Apart from autonomy support and mastery evaluation, motivating tasks were shown to be significantly related to students' self-efficacy and cognitive engagement. Based on this finding, it is suggested that science teachers make tasks, activities, and materials interesting, relevant, and useful to students. Inquiry-based and hands-on science activities and tasks should be utilized in order to enhance students' science self-efficacy, as such activities and tasks allow students to engage in the learning process actively. With the appropriate guidance of teachers, students may accomplish the tasks better, with their self-efficacy eventually increasing through these successful practices. Additionally, the challenge level of these learning activities should be set at an optimum level since students should be able to experience the joy of success in learning to improve their self-efficacy (Kıran and Sungur 2012).

Limitations and suggestions for further research

Although the present study has shed light on the predictors of students' science achievement, some limitations need to be noted for the consideration of future studies. First, because the present study included only seventh-grade students in two districts of a city in Turkey, the generalizability of the findings is diminished. In future studies, the sample can be expanded to involve students at other grade levels and in other districts and provinces. The second limitation concerns the measurement of the constructs. That is, the results of the study were strictly derived from self-report methods. To gain a deeper understanding of the issues, from the perspectives of both students and teachers, and to validate the data obtained from the self-report methods, observations or interviews may also be used as meaningful qualitative data collection methods. In this way, an in-depth understanding of students' perceptions of classroom goal structures, self-efficacy beliefs, engagement, and achievement can be provided. The third limitation concerns the research design. Because a cross-sectional design was used in the current study, the results of the path model do not reflect cause–effect relationships. A longitudinal design, therefore, can be used in future studies to determine how the observed relations change according to time and environment. The last limitation involves the way in which achievement was measured. The Content of the Science Achievement Test (SAT), which was used to measure participants' science achievement, was limited to the first semester of the seventh-grade science curriculum. Thus, more comprehensive tests, together with other indicators of student achievement, such as science grades, can be used to assess students' science achievement in future research.

Disclosure statement

No potential conflict of interest was reported by the authors.

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