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MODELLING THE EFFECTS OF SELECTED AFFECTIVE FACTORS ON LEARNING STRATEGIES AND CLASSROOM ACTIVITIES IN SCIENCE EDUCATION

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Abstract. *It is well known affective, cognitive and psychomotor factors have positive effects on science learning process. All these factors have interaction between themselves. So it is important to research what is the size and direction of these interactions. The aim of this research is to analyze the effects of value, attitude and self-efficacy on active learning strategies and classroom activities using Structural Equation Model. The research was conducted by the analysis of students' answers to questionnaires data using Structural Equation Modelling. Initially KMO and Bartlett's tests were done to test appropriateness of scale to factor analysis. Then theoretical structural model was tested using LISREL. At the end of the SEM test, it was found that there are positive effects of selected affective factors on learning strategies and classroom activities.*

Keywords: *science learning value, attitude towards science, self-efficacy, learning strategies, classroom activities, structural equation model (SEM).*

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Introduction

Since the 1980s, the main purpose of science programs of the America and many European countries has been to educate each student to be a "science-literate" and equip them with scientific thinking skills rather than only transmitting scientific information through science education (AAAS, 1993). These science-literate individuals can inquire, question, make effective decisions, solve problems, communicate effectively and acquire skills for lifelong learning with enhanced awareness of sustainable development; they are self-confident and open to cooperation, and have knowledge, skills, positive attitudes, perceptions and values concerning sciences and possess the understanding and psychomotor skills related to the relationship between sciences and technology, society, and the environment (MEB, 2015).

To this respect, the conceptual structure and mental interpretation of knowledge, affective variables operating in these mental processes during learning, and learning and teaching processes in a classroom environment play an important role in science teaching. Studies in this area lay emphasis on affective factors in students' concept learning (Duit & Treagust 1998; Lee & Brophy 1996; Pintrich et al. 1993; Strike & Posner 1992). Similarly some studies on affective factors show that attitude, value, and self-efficacy are critical determinants of students' learning, achievement in science, and development of critical thinking and of scientific process skills (Wolters & Rosenthal, 2000; Ozkan, 2003; Lee & Brophy 1996; Kuyper et al. 1999; Tuan, Chin & Sheh, 2005).

Many other studies suggest that affective domain skills are also a significant factor in students' achievement (Alsop & Watts, 2000; Duit & Treagust, 1998; Duit & Treagust, 2003; Lee & Brophy, 1996; Meredith, Fortner & Mullins, 1997; Thompson & Mintzes, 2002; Weaver, 1998). Affective skills consist of many factors such as interest, attitude, motivation, value, belief and self-efficacy. The identification of these factors will be of critical importance in enhancing the knowledge of students and will make a significant contribution to the discovery of their skills.

As well as affective factors, learning strategies and learning activities in a classroom environment also support students' achievement and develop-

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ment of skills. When constructivist learning and affective factors combined, students' self-efficacy, the value they place on science learning, learning strategies they implement, learning goals they pursue to complete academic tasks and physical conditions in the learning process seem to have an effect on students' science learning. These factors were briefly explained below.

Self-Efficacy

There are many affective factors assisting students in engaging in learning activities and effectively completing tasks for a specific course. One of these affective features is students' beliefs regarding their ability to successfully finish assigned tasks (Aslan, 2012). Perceived self-efficacy includes students' beliefs about their self-competence for the completion of science-related tasks. It is about students' self-motivation.

Students' attitudes toward science have also an effect on scientific self-efficacy (Jones & Young, 1995; Talton & Simpson, 1986; Smist & Owen, 1994). There is a statistically significant correlation between the perception of chemistry self-efficacy of American secondary school students and the perception of "normality" of scientists (Smist & Owen, 1994). Some studies argue that scientific self-efficacy is associated with academic achievement, suggesting that students with better scientific self-efficacy rank higher in science and have more motivation to achieve in science (Lent et al., 1984; Rowe, 1988; Williams, 1994). It is stated that students' conceptions of learning contribute to the formation of their own learning style profiles (Vermunt & Vermetten 2004) and that it is related to their own self-efficacy (Ferla et al., 2008, 2009, Lin, & Tsai 2013a, b, Vermunt, 2005).

There are some studies investigating the effect of students' conceptions of science learning on science learning self-efficacy in science education (Chiou & Liang 2012; Lin & Tsai 2013a, b; Tsai et al. 2011). These studies indicate that students' thoughts about learning is one of the main effects of their academic self-efficacy. They state that students' interpretations of their own learning experiences make profound contributions to reinforce and maintain their own scientific learning self-efficacy.

Self-efficacy beliefs influence one's motivations, cognitive structures and behavior (Bandura, 1986, 1993). Studies show that students who feel more self-efficacious use cognitive, metacognitive and self-regulatory strategies, aspire to achieve goals requiring more knowledge and skills and, attain high levels of achievement (Anderman & Young, 1994; Kahraman & Sungur, 2011; Middleton & Midgley, 1997; Pintrich, 1999; Pintrich & De Groot, 1990; Wolters, Yu & Pintrich, 1996; Zimmerman & Martinez-Pons, 1990).

Science Learning Value

Science learning value allows students to gain problem-solving skills, experience research-based activities, think on their own, and link science to everyday life. If students can perceive these values, they will be willing to learn science. The "science learning value" is a factor pertaining to students' attaining problem-solving abilities, experiencing inquiry activities, stimulating their own thinking processes and connecting science with everyday life.

Science learning value allows students to gain problem-solving competency, experience inquiry activities, simulate their own thoughts and find the connection of science with everyday life. If students perceive these important values, they become motivated to learn science. Science learning value is associated with achievement and strategy use (Pintrich & De Groot, 1990; Sungur, 2007; Yumusak, Sungur, & Cakiroglu, 2007).

Tuan, Chin and Shieh (2005) investigate whether students perceive the value of science learning through activities focused on acquiring problem-solving competency, seeing the relevance of science to everyday life, implementing thinking processes and engaging in scientific inquiry during science learning.

They state that, in a suitable environment, students perceive the value of science learning when they acquire problem-solving competency, engage in inquiry activities, stimulate their own thinking processes and comprehend the relevance of science to everyday life in science learning (Tuan, Chin & Shieh, 2005).

Attitude towards Science

There are three important factors for students to gain effective learning experiences. These factors are improving their attitudes, improving their thinking processes and physical skills, and improving their episodic information (Martin & Sexton, Franklin & Gerlovich, 2005: Doğru & Kıyıcı, 2005). Of these three factors, attitude plays an important role in science learning.

Attitude refers to the mental tendency of individuals toward objects, subjects and events. Attitudes determine the level of readiness of individuals to a subject. For this reason, students' attitudes toward science enable them to understand and learn course materials and related activities.

Individuals with negative attitudes toward science resist participation in activities and have difficulty in understanding course materials (Doğru & Kıyıcı, 2005). An attitude is not an observable behavior, but a tendency predisposing to behavior. According to Pratkanis et al. (1988), attitudes refer to the appraisal of episodic information on some objects (Bilgin & Karaduman, 2005). Zacharias and Barton (2004) claim that attitudes are resistant to time, learnable, related to behaviors and change depending on personal beliefs.

In addition, students' attitudes toward science are an important factor affecting student motivation (Hassan, 2008), achievement (Papanastasiou & Zembylas, 2002), and course and career choice (Koballa & Glynn, 2006).

Active Learning Strategies

Learning strategies are individual learning activities which assist individuals in learning on their own. Learning strategies are each one of the approaches that facilitate self-learning.

Student achievement depends largely on students' awareness of their own learning styles and on guiding their own learning, suggesting that learning strategies should be taught to students starting from primary school. The aim of learning strategies is to act on the sensory state of students and facilitate the selection, organization and integration of new information (Harmanli 2000). Affective strategies play an important role in learning strategies (Garcia & Pintrich 1992, Kuyper et al. 2000, Wolters 1999). Active learning strategies play an active role in students making use of different strategies to construct knowledge based on prior information.

Playing a vital role in the utilization of various strategies to generate new information based on prior perceptions, "active learning strategies" pertain to the feeling of self-motivation during this process. Students actively engage in utilizing a variety of strategies to construct new knowledge on the basis of their prior understandings. Active learning strategies involve various methods such as research and exploration in which students actively participate during learning.

Tuan, Chin and Shieh (2005) identified active learning strategies in science education from a constructivist perspective. According to their definition, active learning strategies refer to students' active engagement in using various strategies to build new knowledge based on their prior understandings.

Despite the importance of learning strategies, one must motivate oneself to use these strategies (Zimmerman, 2005). Motivational variables are associated with various student outcomes such as conceptual engagement (Garcia & Pintrich, 1993), conceptual change (Pintrich, Marx & Boyle, 1993) and learning strategies (Midgley, Arunkumar, & Urdan, 1996). Studies lay emphasis on motivational components for understanding students' use of different strategies (Pintrich & De Groot, 1990; Meece, Blumenfeld & Hoyle, 1988). Pintrich (1999) regards self-efficacy, science learning value and goal orientations as important motivational beliefs about students' learning.

Classroom Learning Activities

DeWitt and Osborne (2008) state that some classroom learning activities are more effective in encouraging and motivating students to complete higher-level tasks. The most attractive and motivating classroom learning activities are those which allow more autonomy, lead to self-learning, facilitate ongoing collaboration with classmates and overseas students, and extend beyond the scope of a course.

Effective classroom teachers understand the importance of providing students with various classroom learning activities. They also understand that as the number of students in the classroom increases, they will have less problems with behavior management.

Research Focus

As mentioned above in the literature review light it can be easily said that affective, cognitive and psychomotor factors have positive effects on science learning process. All these factors have interaction between themselves. So it is important to research what is the size and direction of these interactions. In this context the research questions of this research are these:

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1. Is there any effect of science learning value on learning strategies and classroom learning activities?
2. Is there any effect of attitudes toward science on learning strategies and classroom learning activities?
3. Is there any effect of self-efficacy on learning strategies and classroom learning activities?

Methodology of Research

General Characteristics

In this research structural equation modelling (SEM) was used. SEM enables researchers to match theories in their mind with the data, to decide on the extent to which they fit each other, and to use latent variables (Simsek, 2007) and it is a comprehensive statistical approach used to test the models characterized by causal and correlational relationships between observable and latent variables, and it allows one to research the set of relationships between one or more independent variables and one or more dependent variables (Anagun, 2011).

Sample

The participants in this research included 1251 secondary school students in Turkey from two cities and eight schools in the 2015-2016 academic year. Research participants were youth aged 10-14, with 641 (51.2%) female and 610 (48.8%) male. There were 303 (24.2%) 5th grade, 333 (26.6) 6th grade, 332 (26.5%) 7th grade and lastly 283 (22.6%) 8th grade students in sample. In this research the data was collected at first hand by authors from students based on voluntariness, so for sampling "convenience sampling" was used. Because it allows to select subjects by availability (McIntyre, 2005).

Variables and Measures

Five latent variables were of particular interest in this research. Three of them were predictor variables that describes affective factors: (1) attitude, (2) value and (3) self-efficacy and two of them were outcome variables: (4) learning strategies and (5) classroom learning activities. Totally 30 items used for obtain data in this survey. A detailed list of each scale (whole scales were five-point Likert-type ranging from "1 = strongly disagree" to "5 = strongly agree" and developed in Turkish so it was no need to translate them into students' mother language) that measures variables in this research is shown below:

(1) Attitude

For measuring attitudes of students towards science lesson, the scale was used developed by Kaya & Böyük (2011). The scale consisted of 7 items that asked students to express their opinions toward learning science and the Cronbach's Alpha reliability coefficient was found 0.76.

(2) Value, (3) Self-efficacy and (4) Learning strategies

These three scales were developed by Yılmaz & Huyugüzel-Cavaş (2007). There were 5 items for "value" that concerned with the importance and the utility value of learning science. The 7 items for "self-efficacy" scale focused on students' self-appraisal of their efficacy in performing science lessons. Lastly 6 items for "learning strategies" to assessed students' use of approaches for learning and understanding science topics. They found the Cronbach's Alpha reliability coefficients in respectively 0.74, 0.71 and 0.85 in their original research.

(5) Classroom learning activities

The scale was developed by Uzun, Gelbal & Öğretmen (2010) with 5 items. The items described the activities which students participate actively in classroom like studying together on projects, textbooks or experiments. The Cronbach's Alpha reliability coefficient was 0.72.

Data Analysis

First of all, Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were conducted with SPSS to understand whether the questionnaire items are suitable for factor analysis. Then used explanatory factor analysis (EFA) to respectively clarify the factor structure of all scales and items' factor loadings. After the result of EFA, the factor loadings of items with a factor load of less than 0.40 and which were seen to be double loaded were removed from the research model. Following exploratory factor analysis, whole variables were separately included in the model and tested with LISREL. After testing measurement tools separately, the effects of attitude, value and self-efficacy on learning strategies and classroom learning activities were analysed using structural equation modelling (SEM). The strength of SEM is that it allows both confirmatory factor analysis for measurement models and path analysis for latent variable models to be processed simultaneously (Jöreskog & Sörbom, 1996; Kelloway, 1998). Path analysis further allows chains of association between latent variables to be estimated. In this research, the theoretical structural model and latent variable path models, are shown in Figure 1.

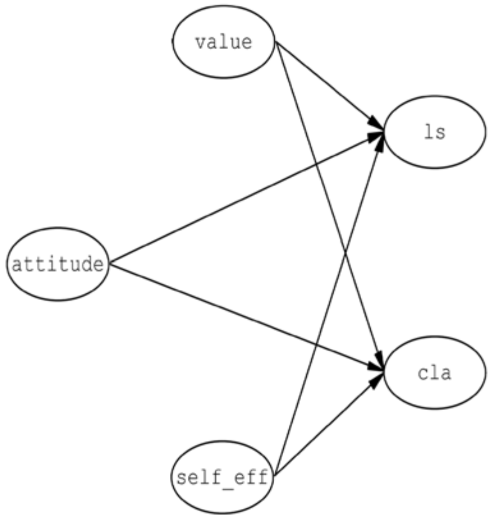

Figure 1: Theoretical structural model for effects of value, attitude and self-efficacy on learning strategies and classroom learning activities.

The fit statistics in LISREL provide a holistic assessment for the quality of the structural relationships among the variables. Following indexes were employed to inspect the fitness between the theoretical model and the empirical data. The acceptance range of the criteria which are used the most to assess suitability of SEM are as follows (Schermelleh-Engel, Moosbrugger, & Müller 2003):

Table 1. Evaluation of SEM fit.

Fit measure	**Perfect fit**	**Acceptable fit**
χ^2	$0 < \chi^2 \leq 2df$	$2df < \chi^2 \leq 3df$
p value	$.05 < p \leq 1.00$	$.01 < p \leq .05$
χ^2/df	$0 \leq \chi^2/df \leq 2$	$2 < \chi^2/df \leq 3$
RMSEA	0≤ RMSEA ≤.05	.05 < RMSEA ≤ .08
SRMR	0 ≤ SRMR ≤ .05	.05 < SRMR ≤ .10
NFI	.95 ≤ NFI ≤ 1.00	.90 ≤ NFI < .95
NNFI	.97 ≤ NNFI ≤ 1.00	.95 ≤ NNFI < .97
CFI	.97 ≤ CFI ≤ 1.00	.95 ≤ CFI < .97
GFI	.95 ≤ GFI ≤ 1.00	.90 ≤ GFI < .95
AGFI	.90 ≤ AGFI ≤ 1.00	.85 ≤ AGFI <.90

Note: AGFI=Adjusted Goodness-of-Fit-Index, CFI= Comparative Fit Index, GFI = Goodness-of-Fit Index, NFI = Normed Fit Index, NNFI=Nonnormed Fit Index, RMSEA=Root Mean Square Error of Approximation, SRMR= Standardized Root Mean Square Residual

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Results of Research

Explanatory Factor Analyses (EFA) for Scale

Before EFA, Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were conducted to understand whether the questionnaire items are suitable for factor analyses and results are given in Table 2:

Table 2. The results of suitability examination of scale for factor analysis.

KMO test	Bartlett's test		
	χ^2	SD	p
0.857	6152.573	253	< .001

As seen in Table 2, KMO test value found as 0.857. The results of Bartlett's test found as significant ($\chi^2 = 6152.573$; SD = 253; $p < .001$). As KMO ensued greater than 0.60 and Bartlett's test ensued as significant, this indicates the suitability of the data for factor analysis (Çokluk, Şekercioğlu, & Büyüköztürk, 2010). Table 3 shows the results of EFA for scale. The component analysis was utilized as the extraction method, with the "rotation method of varimax" with Kaiser normalization. For finalizing the scale factor loadings should weigh greater than 0.40 and should not be double loaded. Finally 23 items were remained in the final version of scale which was used in research model. The alpha coefficients for scales from the sample of this research were between 0.67 – 0.79 for each scale and the total variance explained was 47.90%.

Table 3. Rotated factor loadings and Cronbach's alpha values for factors.

	Factor 1: Value	Factor 2: Attitude	Factor 3: **Self-efficacy**	Factor 4: Learning strategies	Factor 5: Classroom learning activities
Factor 1: value (coded as "val" for LISREL), α = 0.67, mean = 14.22, *SD* = 1.836					
i14_val	0.684				
i6_val	0.667				
i4_val	0.589				
i19_val	0.492				
Factor 2: attitude (coded as "att" for LISREL), α = 0.77, mean = 11.82, *SD* = 2.594					
i26_att		0.798			
i25_att		0.748			
i15_att		0.634			
i13_att		0.568			
Factor 3: self-efficacy (coded as "se" for LISREL), α = 0.77, mean = 15.17, *SD* = 3.430					
i24_se			0.675		
i20_se			0.661		
i21_se			0.645		
i30_se			0.618		
i7_se			0.529		
Factor 4: learning strategies (coded as "ls" for LISREL), α = 0.79, mean = 20.55, *SD* = 2.675					
i3_ls				0.692	
i29_ls				0.613	
i1_ls				0.591	
i2_ls				0.589	
i28_ls				0.494	
i9_ls				0.482	
Factor 5: classroom learning act. (coded as "cla" for LISREL), α = 0.71, mean = 12.00, SD = 2.306					
i17_cla					0.686
i16_cla					0.649
i23_cla					0.540
i10_cla					0.432
Overall alpha: 0.824; total variance explained: 47.896%					

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Testing the Measurement Models

Following EFA, all factors were included in the model and tested with LISREL. However, in the model studies to be conducted using latent variables, each measurement tool should be individually tested before starting the analysis (Şimşek, 2007; Byrne, 2009). Testing measurement tools should be similar to confirmatory factor analysis and a measurement model which hasn't been confirmed shouldn't be included in the structural model (Çokluk, Şekercioğlu & Büyüköztürk, 2012). Therefore, each factor used in the research should be individually tested and demonstrated to be compatible with the structural model. Goodness of fit values obtained for each factor are given in Table 4.

Table 4. Goodness-of-fit values of factors.

Factors	AGFI	GFI	NNFI	NFI	CFI	RMSEA
Value	1.00	1.00	1.00	1.00	1.00	0.008
Attitude	1.00	1.00	1.00	1.00	1.00	0.000
Self-efficacy	0.98	1.00	0.98	0.99	0.99	0.045
Learning strategies	0.98	0.99	0.97	0.98	0.99	0.044
Classroom learning activities	0.95	0.99	0.91	0.97	0.97	0.049

Table 4 shows that goodness-of-fit values for factors intended to be use in the SEM were within the limits of perfect fit according to the criteria in Table 1. Also all variables' values for chi-square per degree of freedom ($\chi 2/df$) were between 0 – 2 (1.09 for value, 0.04 for attitude, 1.72 for self-efficacy, 1.63 for learning strategies and 1.93 for classroom learning activities). So the dataset of all scales were seen to be suitable for SEM analyses.

Results of the Model Testing

After testing measurement tools, the theoretical structural model (figure 1) defined in order to reveal the effects of attitude, value and self-efficacy on learning strategies and classroom learning activities were analysed using structural equation modelling (SEM). The explanatory power of model was assessed by calculating the coefficient of determination (R^2) of items. Velayutham & Aldridge (2013) supposed that the minimum R^2 should be 0.10. They also cited from Hair et al. that significant paths showing hypothesized direction empirically support the purposed causal relationship. Table 5 shows the coefficient of determination (R^2) and *t* values of items:

Table 5. Parameter estimations, R^2 and *t*-values of items.

	Parameter estimation	R^2	*t*
i4_val	0.29	0.16	12.91
i6_val	0.36	0.25	16.32
i14_val	0.24	0.12	11.11
i19_val	0.40	0.37	20.17
i13_att	0.33	0.11	10.60
i15_att	0.65	0.67	27.73
i25_att	0.62	0.41	21.55
i26_att	0.45	0.28	17.16
i7_se	0.37	0.11	11.26
i20_se	0.82	0.64	23.75
i21_se	0.53	0.26	17.37
i24_se	0.75	0.56	21.54

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	Parameter estimation	R^2	*t*
i30_se	0.44	0.18	14.42
i1_ls	0.34	0.33	-
i2_ls	0.36	0.26	14.03
i3_ls	0.35	0.17	11.95
i9_ls	0.32	0.24	13.16
i28_ls	0.44	0.46	16.71
i29_ls	0.41	0.28	14.42
i10_cla	0.56	0.62	-
i16_cla	0.52	0.35	13.59
i17_cla	0.40	0.19	11.03
i23_cla	0.43	0.46	6.44

Table 5 shows that all the R^2 values were higher than requirement (> 0.10) and *t*-values of items were statistically significant ($p < 0.05$). Table 6 shows the goodness-of-fit values of research model.

Table 6. Goodness-of-fit values of research model.

χ^2 /df	AGFI	GFI	NNFI	NFI	CFI	RMSEA
1.88	0.94	0.96	0.97	0.96	0.96	0.048

According to the goodness-of-fit values presented in table 6, the research model has in within the perfect ranges for evaluation of SEM fit (Table 1). In addition, the standardized RMR value was found 0.043, a value acknowledged in many studies notably good fit (Keskin, & Başbuğ, 2014). These values all show that the research model had perfect fit and it was valid for the whole dataset. Lastly figure 2 presents the standardized values of research model.

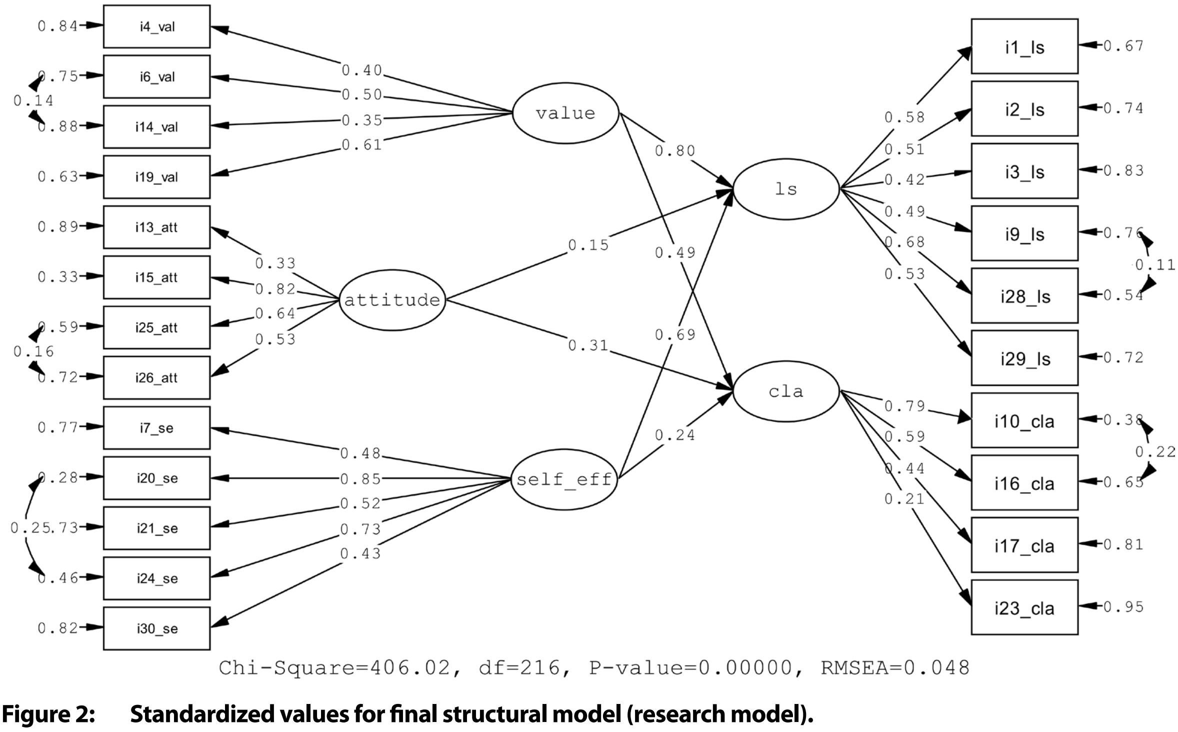

Figure 2: Standardized values for final structural model (research model).

According to figure 2 value, attitude and self-efficacy have positive effects on learning strategies and classroom learning activities. The correlation coefficients show that "value" (*r*=0.80 and *t* value = 11.16) and "self-efficacy" (*r*=0.69 and *t* value = 16.65) have high, but "attitude" (*r*=0.15 and *t* value = 2.89) has small effects on learning strategies. When the correlation coefficients on classroom learning activities examined it is seen that "value" (*r*=0.49 and *t* value = 9.19), "attitude" (*r*=0.31 and *t* value = 6.78) and "self-efficacy" (*r*=0.24 and *t* value = 6.34) have moderate effects.

Discussion

This research examined the effect of self-efficacy, science learning value and attitudes toward science learning on learning strategies and on classroom learning activities. The results indicate that science learning value has positive effects on learning strategies. Similarly, Tas and Cakir (2014) report a positive relationship between science learning value and use of active learning strategies. Students think that science learning is important in terms of its applicability to real life, satisfying their curiosity, improving their own ideas, facilitating their ability to make connections between the concepts they learn, and developing skills to research into science concepts they initially do not understand. To this respect, students who value science learning are more likely to use active learning strategies. Similarly, Pintrich and De Groot (1990) state that primary school students who value science learning use more cognitive and self-regulatory strategies. Sungur (2007) also points to the presence of a positive relationship between high school students' science learning value and their metacognitive strategy use.

There are numerous studies carried out on the relationship between learning strategies and self-efficacy, and between beliefs regarding science learning value and motivational factors and goal orientations. For example, in their correlation study conducted on seventh grade students (n = 173), Pintrich and De Groot (1990) report that students who have the ability to complete academic tasks (high self-efficacy) and believe that those tasks are important and interesting use more cognitive strategies and self-regulatory strategies than those with low self-efficacy.

Kahraman and Sungur (2011) carried out a study in Turkey with seventh grade students (n = 115) on the use of metacognitive strategies; planning, monitoring and evaluation. The results of the regression analysis indicate that self-efficacy has a statistically significant and positive effect on students' metacognitive strategy use. In her study with 391 high school students, Sungur (2007) states that there is a positive relationship between motivational beliefs and cognitive strategy use.

This research shows that attitudes have a positive effect on learning strategies. Similarly, Tuan et al. (2005) report a statistically significant correlation between attitudes toward science and learning strategies, which is also similar to the result of the study conducted by Friedel et al. (2007). This study also indicates that the students' goals are positively correlated with personal goal orientations, self-efficacy and positive coping strategies. When students interpret their interaction with their parents by laying emphasis on their goals, they use active learning strategies more. The results also demonstrate that personal goal orientations positively and significantly affect the students' active learning strategy use. In other words, students who work on improving their skills and competencies are more likely to use active learning strategies.

Another result of this research is that there is a positive correlation between self-efficacy and active learning strategies. This result emphasizes that students who believe that they can perform well in science learning tasks use higher levels of active learning strategies. In other words, students who are confident of their ability to perform well in science make associations between new scientific concepts and their prior knowledge, find further resources to understand science concepts, and conduct discussions with teachers and other students to clarify their own understanding. Previous studies show that students who are extremely impressive in terms of their abilities use more cognitive, metacognitive and self-regulatory strategies (Kahraman & Sungur, 2011; Pajares, 2002, Pintrich & De Groot, 1990). Similarly, Yilmaz and Huyugüzel-Çavaş (2007) point to a positive relationship between self-efficacy and active learning strategy use. Andressa et al. (2015) also demonstrate a significant correlation between active learning strategies and self-efficacy ($p < .05$). In addition, Baser (2007) states that active learning strategies are positively correlated with self-efficacy ($r = .606$, $p = .0001$).

When students perceive the importance of science learning value, they actively engage in learning tasks by using active learning strategies to integrate prior knowledge with new information. On the other hand, when students do not perceive the importance of science learning value, they use superficial learning strategies (such as memorization) for learning (Pintrich & Schunk, 1996).

Another result of this study is the positive correlation between self-efficacy and classroom learning activities, which is in accordance with the result of the study carried out by İlhan, Yıldırım and Yılmaz (2012).

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The results indicate that attitudes toward science have positive effects on classroom learning activities. Similarly, Owen et al suggest that different learning activities affect students' attitudes toward science. Hampden-Thompson and Bennett (2013) report that there is a relationship between students' attitudes toward science and learning activities. The results of their study indicate that teaching and learning activities are related to students' interaction with science. Frequently used in science education, hands-on activities are claimed to have more effect on students' motivation, enjoyment and future orientations toward science. The result of the regression analysis shows that there is a positive relationship between classroom student investigations and students' science motivation.

There are numerous studies in the literature which address the relationship between self-efficacy and science learning (Pintrich & De Groot, 1990; Yılmaz & Huyugüzel-Çavaş, 2007; Cho & Heron, 2015; Baser, 2007; Yetişir & Ceylan, 2015), between attitudes and science learning value (Tuan, Chin & Sheh, 2005; Ceylan & Berberoğlu, 2007) and between self-efficacy and attitudes toward science (Tuan, Chin & Sheh, 2005; Yetişir & Ceylan, 2015).

The analysis of the constructivist learning model and affective factors together indicate that students' self-efficacy, science learning value, learning strategies, learning goals and the learning environment are important factors affecting students' science learning.

Conclusions

This research indicates that science learning value, attitudes toward science and level of self-efficacy have positive effects on classroom learning activities and active learning strategies. It shows that students with high self-efficacy believe that they are capable of performing their learning tasks regardless of their difficulty. Science learning value helps students understand whether it is valuable to learn science in which they are engaged.

The classroom learning activities and active learning strategies are important in science education. They both influence academic achievement and motivation in science education. There may be many factors that affect classroom learning activities and active learning strategies. Some of the factors are science learning value, attitudes toward science and level of self-efficacy. It shows that students with high self-efficacy believe that they are capable of performing their learning tasks regardless of their difficulty. Science learning value helps students understand whether it is valuable to learn science in which they are engaged. Students' attitudes toward science enable them to understand and learn course materials and related activities. As several researchers mentioned, science learning value, attitude towards science and self-efficacy have a significant correlation with learning strategies and classroom learning activities. This research has proved such a theoretical position and also revealed that self-efficacy, science learning value and attitude towards science have correlation with learning strategies and with classroom learning activities. It would be interesting to study with other possible variables that would be the effect on classroom learning activities and active learning strategies. Education curriculum can be organized taking these variables into account. If it were known which factors would be the effect on classroom learning activities and active learning strategies, effective learning could be realized. In this context, it is thought that this research, in which the effects of different variables on classroom learning activities and active learning strategies are investigated, will contribute to the researches about science education.

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References

AAAS, American Association for the Advancement of Science (1993). *Benchmarks for scientific literacy.* New York: Oxford University Press.

Alsop, S., & Watts, M. (2000). Facts and feelings: Exploring the affective domain in the learning of physics. *Physics Education, 35*, 132-138.

Anagün, Ş. S. (2011). The impact of teaching-learning process variables to the students' scientific literacy levels based on PISA 2006 results. *Education and Science, 36* (162), 84-102.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Anderman, E. R., & Young A. J. (1994). Motivation and strategy use in science: Individual differences and classroom effects. *Journal of Research in Science Teaching, 31*, 811-831.

Andressa, H., Mavrikaki, E., & Dermitzaki, I. (2015). Adaptation of the students' motivation towards science learning questionnaire to measure Greek students' motivation towards biology learning, *International Journal of Biology Education, 4* (2), 78-93.

Aslan, A. (2012). Predictive power of the sources of primary school students' self-efficacy beliefs on their self-efficacy beliefs for learning and performance. *Educational Sciences: Theory & Practice, 12* (3), 1907-1920.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*, 191–215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, New Jersey: Prentice-Hall.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28* (2), 117-148.

Bandura, A. (1997). *Self-efficacy: the exercise of control.* New York: W. H. Freeman.

Baser, M. (2007). *The contribution of learning motivation, reasoning ability and learning orientation to ninth grade international baccalaureate and national program students' understanding of mitosis and meiosis* (Unpublished master's thesis). Middle East Technical University, Ankara, Turkey.

Byrne, B. M. (2009). *Structural Equation Modeling with AMOS: Basic Concepts, applications and programming* (2nd Ed.). New York: Routledge.

Ceylan, E., & Berberoğlu, G. (2007). Factors related with students' science achievement: A modeling study. *Education and Science, 32* (144), 36-48.

Chiou, G. -L., & Liang, J. -C. (2012). Exploring the structure of science self-efficacy: A model built on high school students' conceptions of learning and approaches to learning in science. *The Asia-Pacific Education Researcher, 21*, 83–91.

Cho, M. H., & Heron, M. L. (2015) Self-regulated learning: The role of motivation, emotion, and use of learning strategies in students' learning experiences in a self-paced online mathematics course. *Distance Education, 36* (1), 80-99. doi:10.1080/01587919.2015.1019963.

Çokluk, Ö., Şekercioğlu, G., & Büyüköztürk, Ş. (2012). *Sosyal Bilimler İçin Çok Değişkenli İstatistik, SPSS ve LISREL Uygulamaları* [SPSS and LISREL applications of multivariate statistics for social sciences]. Ankara: Pegem Akademi Yayıncılık.

DeWitt, J., & Osborne, J. (2008). Engaging students with science: In their own words. *School Science Review, 30* (331), 109–116.

Doğru, M., & Kıyıcı, F. B. (2005). Fen Eğitiminin Zorunluluğu. In M. Aydoğdu & T. Kesercioğlu (Eds.), *İlköğretimde Fen ve Teknoloji Öğretimi* [Teaching science and technology in elementary education] (pp.1-8). Ankara: Anı Yayıncılık.

Duit, R., & Treagust, D. (2003). Conceptual change: A powerful framework for improving science teaching and learning. *International Journal of Science Education, 25* (6), 671-688.

Duit, R., & Treagust, D. (1998). Learning in science: From behaviourism towards social constructivism and beyond. In B. Fraser, & K. Tobin (Eds.), *International handbook of science education* (pp. 3-26). Kluwer Academic, UK: Dordrecht.

Ferla, J., Valcke, M., & Schuyten, G. (2008). Relationships between student cognitions and their effects on study strategies. *Learning and Individual Differences, 18,* 271–278.

Ferla, J., Valcke, M., & Schuyten, G. (2009). Student models of learning and their impact on study strategies. *Studies in Higher Education, 34,*185–202.

Friedel, J. M., Cortina, K. S., Turner, J. C., & Midgley, C. (2007). Achievement goals, efficacy beliefs and coping strategies in mathematics: The roles of perceived parent and teacher goal emphases. *Contemporary Educational Psychology, 32* (3), 434-458.

Garcia, T., & Pintrich, P. R. (1992). *Critical thinking and its relationship to motivation, learning strategies, and classroom experience.* Paper presented at the Annual Meeting of the American Psychological Association, Washington DC.

Hampden-Thompson, G., & Bennett, J. (2013). Science teaching and learning activities and students' engagement in science. *International Journal of Science Education, 35* (8), 1325-1343, doi: 10.1080/09500693.2011.608093.

Harmanlı, Z. (2000). *Öğrenme Stratejileri (Etkili Öğrenme Eğitimi)* [Learning strategies (Effective learning education)]. İzmir: DEÜ, Buca Eğitim Fakültesi.

Hassan, G. (2008). Attitudes toward science among Australian tertiary and secondary school students. *Research in Science & Technological Education, 26* (2), 129–147.

Hofstetter, C, R., Zuniga, S., & Dozier, D. M. (2001). Media self-efficacy: validation of a new concept. *Mass Communication & Society, 4*(1), 61–76.

Ilhan, N., Yıldırım, A., & Yılmaz, S. S. (2012). Chemistry motivation questionnaire: The study of validity and reliability. *Mustafa Kemal University Journal of Social Sciences Institute, 9* (18), 297-310.

Kaya, H., & Böyük, U. (2011). İlköğretim II. kademe öğrencilerinin fen ve teknoloji dersine ve fen deneylerine karşı tutumları [Attitudes towards science and technology course and science experiments of the elementary school's 2nd grade students]. *Türk Bilim Araştırma Vakfı Dergisi, 4* (2), 120-130.

Jones, J., & Young, D. (1995). Perceptions of the relevance of mathematics and science: An Australian study. *Research in Science Education*, *25* (1), 3–18.

Jöreskog, K. G., & Sörbom, D. (1996). *Lisrel 8: User's reference guide. Scientific Software International.* USA:Lincolnwood.

Kahraman, N., & Sungur, S. (2011). The contribution of motivational beliefs to students' metacognitive strategy use. *Education and Science, 36* (160), 3-10.

Kelloway, E. K. (1998). *Using LISREL for structural equation modeling: A researcher's guide*. Newbury Park, CA: Sage.

Keskin, H. K., & Baştuğ, M. (2014). A study of the correlations among reading frequency, participation in reading environments and reading attitude. *International Journal of Social Sciences & Education, 4* (3), 560-568.

Koballa, T. R. (1995). Learning science in the schools: Research reforming practice. In S. M. Glynn & R. Duit (Eds.), *Children's attitudes toward learning science* (pp. 59–84). Mahwah, NJ: Erlbaum.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Koballa, T. R., & Glynn, S. M. (2006). Attitudinal and motivational constructs in science learning. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 75–102). Mahwah, NJ: Erlbaum.

Kuyper, H., van der Werf, M. P. C., & Lubbers, M. J. (2000). Motivation, meta-cognition and self-regulation as predictors of long term educational attainment. *Educational Research and Evaluation, 6* (3), 181–201.

Lavasani, M. G., Mirhosseini, F. S., Hejazi, E., & Davoodi, M. (2011). *The effect of self-regulation learning strategies training on the academic motivation and self-efficacy*. International Conference on Education and Educational Psychology (ICEEPSY 2011). *Procedia - Social and Behavioral Sciences, 29,* 627–632

Lee, O., & Brophy, J. (1996). Motivational patterns observed in sixth-grade science classrooms. *Journal of Research in Science Teaching, 33* (3), 585-610.

Lent, R. W., Larkin, K. C. & Brown, S. D. (1984). Relation of self-efficacy expectations to academic achievement and persistence. *Journal of Counselling Psychology, 31* (3), 356–362.

Lent, R. W., Larkin, K. C., & Brown, S. D. (1986). Self-efficacy in the prediction of academic performance and perceived career options. *Journal of Counselling Psychology, 33* (3), 265–269.

Lin, T. -J., & Tsai, C. -C. (2013a). A multi-dimensional instrument for evaluating Taiwan high school students' learning self-efficacy in relation to their approaches to learning science. *International Journal of Science and Mathematics Education, 11*, 1275–1301.

Lin, T. -J., & Tsai, C. -C. (2013b). An investigation of Taiwanese high school students' science learning self-efficacy in relation to their conceptions of learning science. *Research in Science and Technological Education, 31* (3), 308–323.

Martin, R., Sexton, C., Franklin, T., & Gerlovich, J. (2005). *Teaching science for all children: An inquiry approach*. Boston: Allyn & Bacon.

Matseke, P. M. (2011). *The influence of learning strategies learners' self-efficacy and academic achievement*, (Unpublished master's thesis). Universıty Of South Africa.

McIntyre, L. J. (2005). *Need to know: Social science research methods* (1st ed.). Boston, MA: McGraw-Hill.

Meece, J. L., Blumenfeld, P. C., & Hoyle, R. H. (1988). Students' goal orientations, and cognitive engagement in classroom activities. *Journal of Educational Psychology, 80*, 514-523.

Meredith, J. E., Fortner, R. W., & Mullins, G. W. (1997). Model of affective learning for nonformal science education facilities. *Journal of Research in Science Teaching, 34* (8), 805-818.

Middleton, M., & Midgley, C. (1997). *Avoiding the demonstration of lack of ability: An underexplored aspect of goal orientation.* Paper presented at the Annual Meeting of the American Educational Research Association. Chicago, IL.

Midgley, C., Arunkumar, R., & Urdan, T. C. (1996). "If I don't do well tomorrow, there's a reason." Predictors of adolescents' use of academic self-handicapping strategies. *Journal of Educational Psychology, 88*, 423-434.

MEB, (2005). *İlköğretim Fen ve Teknoloji Dersi (6, 7, 8. Sınıflar) Öğretim Programı* [Primary science and technology course]. Ankara: M.E.B.

Owen, S., Dickson, D., Stanisstreet, M., & Boyes, E. (2008). Teaching physics: Students' attitudes towards different learning activities. *Research in Science & Technological Education, 26* (2), 113-128, doi: 10.1080/02635140802036734.

Özkan, S. (2003). *The roles of motivational beliefs and learning styles on tenth grade students' biology achievement* (Unpublished doctoral dissertation). Middle East Technical University, Ankara, Turkey.

Pajares, F. (2002). Gender and perceived self-efficacy in self-regulated learning. *Theory into Practice, 41* (2), 116-125.

Papanastasiou, C., & Papanastasiou, E. C. (2002). The process of science achievement. *Science Education International, 13* (2), 12–24.

Papanastasiou, E. C., & Zembylas, M. (2002). The effect of attitudes on science achievement: A study conducted among high school students in Cyprus. *International Review of Education, 48* (6), 469–484.

Pintrich, P. R. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International Journal of Educational Research, 31*, 459-470.

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and applications (2nd Ed.)*. Upper Saddle River, NJ: Prentice Hall.

Pintrich, P. R., & De Groot, E. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*, 33-40.

Pintrich, P. R., Marx, R. W., & Boyle, R. A. (1993). Beyond cold conceptual change: The role of motivational beliefs and classroom contextual factors in the process of conceptual change. *Review of Educational Research, 63* (2), 167–199.

Pratkanis, A. R., Breckler, S. J., & Greenwald, A. G. (1989). *Attitude structure and function*. Hillsdale, NJ: Erlbaum Associates.

Ritter, J., Boone, W., & Rubba, P. (2001). Development of an Instrument to assess prospective elementary teacher self-Efficacy beliefs about equitable science teaching and learning (SEBEST). *Journal of Science Teacher Education, 12* (3), 175-198.

Roberts, J. K., Henson, R. K., Tharp, B. Z., & Moreno, N. (2001). An examination of change in teacher self-efficacy beliefs in science education based on the duration of in-service activities. *Journal of Science Teacher Education, 12* (3), 199-213.

Rowe, K. J. (1988). Single-sex and mixed-sex classes: The effects of class type on student achievement, confidence and participation in mathematics. *Australian Journal of Education, 32* (2), 180–202.

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research Online, 8* (2), 23-74.

Şimşek, Ö. F. (2007). *Yapısal Eşitlik Modellemesine Giriş Temel İlkeler ve LISREL Uygulamaları* [Introduction to structural equation modeling basic principles and LISREL applications]. Ankara: Ekinoks Yayıncılık.

Smist, J. M., & Owen, S. V. (1994). *Explaining science self-efficacy.* Paper presented at the annual meeting of the American Educational Research Association. New Orleans, LA.

Strike, K. A., & Posner, G. J. (1992). A revisionist theory of conceptual change. In R. A. Duschl & R. J. Hamilton (Eds.), *Philosophy of Science, Cognitive Psychology, and Educational Theory and Practice* (pp. 147-176). Albany: State University of New York Press.

Sungur, S. (2007). Modeling the relationships among students' motivational beliefs, metacognitive strategy use, and effort regulation. *Scandinavian Journal of Educational Research, 51* (3), 315 – 326.

Talton, E. L., & Simpson, R. D. (1986). Relationships of attitudes toward self, family, and school with attitude-toward-science among adolescents. *Science Education, 70* (4), 365–374.

Tas, Y., & Cakir, B. (2014). An investigation of science active learning strategy use in relation to motivational beliefs. *Mevlana International Journal of Education (MIJE), 4* (1), 55-66, http://dx.doi.org/10.13054/mije.13.55.4.1

Thompson, T. L., & Mintzes, J. J. (2002). Cognitive structure and the affective domain: On knowing and feeling in biology. *International Journal of Science Education, 24* (6), 645-660.

Tsai, C. -C., Ho, H. -N., Liang, J. -C., & Lin, H. -M. (2011). Scientific epistemic beliefs, conceptions of learning science and self-efficacy of learning science among high school students. *Learning and Instruction, 21*,757–769.

Tuan , H. S., Chin, C. C., & Shieh, S. H. (2005). The development of a questionnaire to measure students' motivation towards science learning. *International Journal of Science Education, 27* (6), 639-654. doi:10.1080/0950069042000323737.

Uzun, N. B., Gelbal, S., & Öğretmen, T. (2010). Timss-r fen başarısı ve duyuşsal özellikler arasındaki ilişkinin modellenmesi ve modelin cinsiyetler bakımından karşılaştırılması [Modeling the realitionship between timss-r science achievement and affective characteristics and comparing the model according to gender]. *Kastamonu Eğitim Dergisi, 18* (2), 531-544.

Velayutham, S., & Aldridge, J. M. (2013). Influence of psychosocial classroom environment on students' motivation and self-regulation in science learning: A structural equation modeling approach. *Research in Science Education, 43* (2), 507-527. doi: 10.1007/s11165-011-9273-y.

Vermunt, J. D. (2005). Relations between student learning patterns and personal and contextual factors and academic performance. *Higher Education, 49* (3), 205–234.

Vermunt, J. D., & Vermetten, Y. (2004). Patterns in student learning: relationships between learning strategies, conceptions of learning, and learning orientations. *Educational Psychology Review, 16* (4), 359–384.

Weaver, G. C. (1998). Strategies in K-12 science instruction to promote conceptual change. *Science Education, 82* (4), 455-472.

Williams, J. E. (1994). Gender differences in high school students' efficacy expectation/performance discrepancies across four subject matter domains. *Psychology in the Schools, 31* (3), 233–237.

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