Engagement and Big-Fish-Little-Pond Effect on Self-Concept in Science: Findings from TIMSS 2011

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Abstract

Big-Fish-Little-Pond-Effect (BFLPE) suggests that students form their own self-concept by comparing their abilities to those of their peers. This study aims to examine how students' gender, socioeconomic status, science achievement, and engagement dimensions (motivational and behavioral engagement) predict students' self-concept in science by considering BFLPE. This study used TIMSS 2011 data set including 6928 eighth grade Turkish students from 239 schools. Since the data were in a nested structure (students nested in classrooms) HLM analysis was preferred to minimize the dependences of the data. HLM analyses showed that about 10% of the variance in students' self-concept in science learning was between classes while the rest of the variance was within classes. Findings suggest that students' motivational and behavioral engagements are important indicators of students' self-concept as well as science achievement. Additionally, at the class level, aggregated science achievement was found to be significant and a negative predictor of self-concept, which supported BFLPE.

Keywords: TIMMS, science education, Academic self-concept, Big-Fish-Little-Pond Effect

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Academic self-concept is one of the constructs of self-belief that attracted researchers' attention (Bong & Skaalvik, 2003). Individuals' self-perceived ability in a domain is the central element of self-concept (Bong & Skaalvik, 2003; Ferla, Valcke, & Cai, 2009). Self-concept beliefs are formed based on individuals' past experiences such as accomplishments and failures. To illustrate, individuals compare their self-perceived competence with others, thus individuals' evaluation of their competence includes some normative criteria (Bong & Skaalvik, 2003; Ferla et al., 2009; Wigfield & Eccles, 2000). Self-concept is important because "[o]ne's perceptions of himself are thought to influence the ways in which he acts, and his acts in turn influence the ways in which he perceives himself" (Shavelson, Hubner, & Stanton, 1976, p. 411). Several studies have demonstrated that self-concept is positively correlated to desirable student outcomes such as self-efficacy and interest (e.g. Ferla et al., 2009), student motivation to aspire a career in science (e.g. Jansen, Scherer, & Schroeders, 2015), and academic achievement (e.g. Suárez-Álvarez, Fernández-Alonso, & Muñiz, 2014). Examining the factors influencing students' self-concept is important to enhance quality of education and, in turn, students' learning outcomes (Bong & Skaalvik, 2003). In the present study, students' self-concept in science is explored considering the Big-Fish-Little-Pond Effect (BFLPE).

According to BFLPE, the frame of reference for students to compare their abilities is their classmates' abilities. Based on this comparison, students form their own academic self-concept (Marsh et al., 2015). The BFLPE mainly focused on the relationship between academic self-concept and achievement which revealed differential effects at different levels. Studies pointed out that student achievement and self-concept was positively related at the student level while the effect of average achievement on student self-concept was negative at the class or school level (e.g., Marsh et al., 2008a; Seaton, Marsh, & Craven, 2010). This effect is known as

BFLPE. According to BFLPE, students attending high achieving classes or schools have lower academic self-concept than students with equal achievement who are attending low or average achieving classes or schools (e.g., Marsh, 2004; Seaton et al., 2010). For instance, Marsh (2004), utilizing Australian students' responses to The Program for International Student Assessment (PISA) 2000 survey, found that individual achievement positively predicted self-concept whereas school-average achievement was a negative predictor of self-concept.

Most of the research on BFLPE was conducted with secondary school students in Western countries and there is a need to investigate this effect with younger students in different countries (Marsh et al., 2015). Some distinct findings regarding self-concept and achievement were reported by studies conducted in East Asian countries (e.g., Kung, 2009; Wilkins, 2004; Yoshino, 2012). For instance, utilizing TIMSS 2003 data Kung (2009) found that although Taiwanese students have higher mathematics achievement, they reported lower mathematics self-concepts than their Western counterparts. Similarly, Yoshino (2012) exploring TIMSS 2007 data found that Japanese students have higher achievement but lower mathematics self-concept than American students. Turkey, located in the Middle East, is a bridge between Europe and Asia. In this sense, the Turkish culture is distinct from other nations' cultures which reflect both Western and Eastern values (Yalvac, Tekkaya, Cakiroglu, & Kahyaoglu, 2007). Besides that, the education system in Turkey is competitive; students take elimination exams not only to enter high school but also to enter a college. Therefore, due to such exams, students in Turkey frequently compare themselves with their peers and make social comparisons. Furthermore, supporting these comparisons, the evaluative feedback provided to students by teachers (Odabaşi Çimer, Bütüner, & Yiğit, 2010) may also influence students' academic self-concept beliefs. Therefore, the present study is an attempt to better understand the influence of Turkish students'

perceptions of their classmates' achievement on their own self-concept beliefs and this study aims to contribute to the generalizability of BFLPE by studying it within the Turkish context. Furthermore, the present study uses The Trends in International Mathematics and Science Study (TIMSS) 2011 data set. TIMSS data were most appropriate to study BFLPE, since the unit of analysis is classroom (Marsh et al., 2015). Parallel to BFLPE assertions, we hypothesize that students' self-concept beliefs in science will be positively predicted by individual achievement and negatively predicted by class-average science achievement. In other words, students' beliefs about their competence to do well in science will be high if they have high achievement. On the other hand, students will feel less competent if their classmates have high achievement than students with the same ability level but having classmates with low achievement. Besides investigating BFLPE, this study also aims to examine the relationship between student engagement and academic self-concept in science. The role of engagement in self-concept also deserves investigation as will be discussed in the next section.

Self-concept and Engagement

Engagement attracts educational researchers' attention (Sinatra, Heddy, & Lombardi, 2015) and is shown to be closely related to students' achievement (e.g., Bae & DeBusk-Lane, 2019; Schnitzler, Holzberger, & Seidel, 2021). In the relevant literature, there are various definitions about school engagement (Jimerson, Campos, & Greif, 2003). Linnenbrink and Pintrich (2003) addressed engagement as a multifaceted construct in terms of behavioral, motivational, and cognitive engagement. Behavioral engagement is interested in students' observable behaviors like their effort for, or persistence at a task. This type of engagement can be easily observed by watching students. The second component of engagement is motivational engagement which is concerned with students' interest in and value attached to learning the

material. The last component of engagement, cognitive engagement, refers to students' investment in learning. In other words, students who are engaged cognitively think about the content and the learning process and use self-regulated strategies to understand the content. Since TIMSS 2011 only provided data related to behavioral and motivational engagement, this study is limited with only these two dimensions of engagement.

The behavioral engagement dimension is focused on students' observable behaviors, in other words, students' participation, effort and persistence in school activities (Finn, Pannozzo & Voelkl, 1995). Students who are behaviorally "engaged in" tend to do the tasks, show effort, be persistent on the task, and seek help when they need it (Fredricks et al., 2004). Connell and Wellborn (1991) proposed "context-self-action-outcome" model and suggested that students' self-beliefs, like self-concept, directly affect their engagement. In particular, students who show effort and persistence at a task are those who have high self-concept, namely who think that they can do the task. There are many researchers that confirm predictor effect of self-concept on students' engagement in the literature (e.g. Bush, 2005; Schnitzler et al., 2021). However, the relevant literature also suggests that the relation between self-beliefs and engagement may be reciprocal; engagement can also help students believe their abilities (Salanova, Llorens & Schaufeli, 2011). Supporting this idea, Badiozaman (2012) investigated the relationship between students' self-concept and engagement and indicated that not only students' self-concept affects their engagement, but students' engagement may also affect their self-concept. Moreover, Green et al. (2012) investigated the relationship between high school students' self-concept and their school engagement and suggested that students' self-concept is a significant predictor of their engagement. The researchers offered that future studies may consider engagement as a predictor of students' self-concept. However, according to the authors' knowledge, there is not much

research investigating behavioral engagement as a predictor of self-concept. Hence, the current study aims to examine how behavioral engagement predicts students' self-concept in science.

The other component of engagement, motivational engagement, refers to students' interest in the task. There are at least three aspects of motivational engagement: interest, affect, and value beliefs (Linnenbrink & Pintrich, 2003). Students' interest refers to their liking or disliking the subject; while, utility value refers to students' thoughts about the usefulness or importance of the task. Lastly, affect is concerned with students' affective or emotional experiences (Pintrich & Schunk, 1996). These aspects of motivational engagement are positively related to students' self-concept and this relation is reciprocal. In other words, students who find tasks useful or interesting tend to have high self-concept and vice versa (e.g., Eccles & Wigfield, 1995; Eccles & Wigfield 2002). Empirical evidence exists for these relationships (e.g., Bakadorova & Raufelder, 2017; Cheung, 2018; Raufelder et al., 2015). For instance, in a longitudinal study Bakadorova and Raufelder (2017) examined the relationships among German students' emotional and behavioral school engagement, self-concept, and with peers and teachers as motivators from beginning of 8th grade to the end of 9th grade. Over time, associations demonstrated that self-concept was positively related to both behavioral and emotional engagement. On the other hand, self-concept negatively predicted students' emotional engagement over time. The authors explained that this might be due to suppression effect since the correlations between the variables were positive. In another study conducted in the United States, Wang and Eccles (2013) found that middle school students' self-concept and task value beliefs mediated the relationship between perceived school environment and student engagement. More specifically, self-concepts and task value significantly and positively predicted behavioral, emotional, and cognitive engagement. In the present study, liking science

and valuing science will be examined as predictors of self-concept beliefs in science. Empirical evidence also suggests that the strength of the relationship between science self-concept and value of science may change from culture to culture (Schütte, 2015). This study also attempts to understand the associations between self-concept and motivational engagement in the Turkish culture.

The Role of Gender and SES in Self-Concept

Previous research showed that gender was associated with academic self-concept (e.g., Cooper, Krieg, & Brownell, 2018; Jansen, Schroeders, & Lüdtke, 2014). For example, Wilkins (2004) examined the gender difference in students' science self-concept for different countries based on the TIMSS data. The author found that a gender gap existed between males and females in the favor of the former. Additionally, Wilkins stated that this gap was observed at different magnitudes across the countries and, in fact, females had higher self-concept in science in few countries. In another study, Jansen et al. (2014) found that female students have lower self-concept in chemistry and physics in a sample of 10^{th} grade German students. Nevertheless, gender difference in students' science self-concept has been relatively less studied in Turkey and studies have revealed inconsistent findings. For example, Senler and Sungur (2009) examined elementary and middle school Turkish students' self-concept in science regarding gender. Their results revealed no difference between girls and boys in their science self-concept. On the other hand, in their study with high school students taking biology course, Pehlivan and Köseoğlu (2010) found that girls had higher self-concepts than boys.

Socioeconomic status is another variable that may influence academic self-concept (e.g., Easterbrook, Kuppens, & Manstead, 2020). For example, Maqsud and Rouhani (1991) found a positive correlation between socioeconomic status and self-concept of secondary school students.

Additionally, some researchers who focused on whether the BFLPE applied to all students in the same way examined if socioeconomic status influenced the magnitude of the negative association between the group self-concept and individual self-concept (e.g., Seaton, et al., 2010; Trautwein, Lüdtke, Marsh, & Nagy, 2009). Therefore, in this study, it seems that controlling for the SES variable is necessary when examining the association between engagement and self-concept.

Significance and Purpose of the Study

In line of the aforementioned studies, investigating the factors influencing students' self-concept is important since it is related to several adaptive student outcomes (e.g., Jansen et al., 2015; Suárez-Álvarez et al., 2014). In the present study, Turkish students' self-concept in science is explored from the perspective of BFLPE. Parker et al. (2021) calls for educational policy makers to consider BFLPE while making decisions. Although generalizability of negative effect of the class or school achievement on students' self-concept have been demonstrated by several studies (e.g., Guo et al., 2018), some cultural differences are also reported regarding self-concept and achievement (e.g., Yoshino, 2012). Reflecting both Western and Eastern values, Turkish culture is unique (Yalvac et al., 2007). The examination oriented and competitive Turkish education system may influence students' self-concept, as well (Senler & Sungur, 2009). Utilizing TIMSS 2011 data, this study attempts to provide empirical evidence about these relations in Turkey. Furthermore, predictive power of emotional and behavioral engagement on students' self-concept will be examined. According to our knowledge, there is limited research investigating behavioral engagement as a predictor of self-concept and this study will contribute to this issue. Additionally, due to their potential influences, gender and socioeconomic status were entered in the model to control their effects. In the light of the mentioned literature, the

present study has two major aims: first it aims to investigate the relation of middle school students' self-concept to student engagement and achievement in science. Second, considering BFLPE on students' self-concept. Utilizing Turkish 8th grade students' responses to TIMSS 2011 survey the present study aims to answer the following research questions:

1. To what extent students' science achievement and engagement dimensions (i.e., motivational and behavioral engagement) predict students' self-concept in science while controlling for gender and socioeconomic status?
2. Is there a BFLPE (class average achievement) on students' self-concept in science?

Method

Design of the Study

This study is a correlational quantitative study (Frankel & Wallen, 2006) which aims to examine the relation between engagement, achievement and self-concept of middle school students in science.

Sample

In the present study, TIMSS 2011 data set that was obtained from Turkey was used. In the data collection procedure of TIMSS, the stratified two-stage sampling design was used. Namely, in the first stage of this sampling procedure, schools were sorted by considering their sizes and important demographic variables and then systematic random sampling method was applied. In the second stage, one or two intact classes with the students at the target grade levels were selected by using systematic random sampling method (Joncas & Foy, 2012).

Sample of the present study includes 6928 (49.3% girls and 50.7 % boys) eighth grade students from 239 classrooms. Number of participants in each classroom ranged between 10 and 56. Mean age of students is 14.06 (SD= .67). Students mostly have computer at home (58.2%),

own room (52.9%) and less than 100 books at home (83.7%); but do not have internet connection (54.4%).

Instruments

Instruments used in the present study were obtained from TIMSS 2011 questionnaire. TIMSS examined the validity of the instruments and suggested both criterion- related, and comparative validity (Martin & Mullis, 2012). Characteristics of the instruments are summarized in Table 1.

Self-concept in Science

Students' self-concept scores were computed by using nine items that were included in Student Confident in Science (SCS) Scale. (e.g., "I am good at working out difficult science problems" and "Science is more difficult for me than for many of my classmates"). This scale was based on 4-point Likert response scale ranging from 1 (Agree a lot) to 4 (Disagree a lot). Cronbach's alpha internal consistency for the self-concept scale was high (.85). Principal component analysis of the items suggested that item loadings in Turkish data set varied between .58 to .76 for SCS scale (Martin & Mullis, 2012).

Students' Value Science (SVS) Scale

In TIMSS 2011, students' value science was measured by students' responses to six items including a sample item of "I need science to learn other school subjects". Students' responses ranged from 1 (Agree a lot) to 4 (Disagree a lot). Reliability (Cronbach's alpha) of this scale was found to be .82 indicating high internal consistency. Factor loadings of items varied between .59 and .84 for Turkish data (Martin & Mullis, 2012).

Students Like Learning Science (SLS) Scale

The extent to which students liked learning science was assessed by students' responses to five items. A sample item was: "I enjoy learning science". Responses were collected using a 4-point Likert scale with anchors ranging from 1 (Agree a lot) to 4 (disagree a lot). Cronbach's alpha internal consistency was calculated as .79 indicating good reliability. Factor loadings of items varied between .61 and .87 for Turkish data (Martin & Mullis, 2012).

Students' Engaged in Learning Science (SES) Scale

In TIMSS 2011, the level of students' engagement in learning science was measured by five items. A sample item was "I am interested in what my teacher says". Response options in the scale included four possibilities on a Likert scale ranging from 1 (Agree a lot) to 4 (Disagree a lot). Cronbach's alpha internal consistency of this scale was calculated as .66 indicating acceptable internal consistency (Özdamar, 1997). Factor loadings of items varied between .42 and .76 for Turkish data (Martin & Mullis, 2012).

Science Achievement Scores (SAS)

In TIMSS 2011, science achievement questions included four science domains: biology, chemistry, physics, and earth science. The general science achievement scores were transformed into five plausible values by using Item Response Theory. Besides using achievement at level-1 (student level), these 5 plausible values were also aggregated for use at second level (class level).

Socioeconomic Status

Students' socioeconomic status points were computed by using the items of Home Educational Resources (HER) scale. HER is a composite variable created based on students' responses on the 3 questions concerned with the availability of home resources. These items include the number of books at home, number of home study supports, and highest level of

education of either parent. Cronbach's Alpha was .63 indicating acceptable reliability (Özdamar, 1997). Factor loadings of items varied between .75 and .80 for Turkish data (Martin & Mullis, 2012).

Table 1

TIMSS 2011's scales that were used in this study

Measured construct	Scale of TIMSS 2011	Number of items	Sample item	Cronbach alpha	Response scale
Self-concept	Students confidence in science (SCS)	9	I usually do well in science	.85	1=agree a lot 2=agree a little 3=disagree a little 4=disagree a lot
Motivational engagement	Students Like Learning Science (SLS)	5	I enjoy learning science	.79	
	Students Value Science (SVS) Scale	6	I need science to learn other school subjects	.82	
Behavioral engagement	Students Engaged in Science Learning (ESL)	5	I am interested in what my teacher says	.66	
Socioeconomic status	Home Educational Resources (HER)	3	Number of books at home	.63	Different for each question

Procedures

The data were obtained from TIMSS 2011's official website. Source: TIMSS 2007 Assessment. Copyright © 2009 International Association for the Evaluation of Educational Achievement (IEA). Publisher: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College. This website includes an international database of data which was obtained from 45 participating countries, and anybody who is interested in examining the TIMSS data can access and download the data set. In line with the research questions, only the data collected from 8th grade students in Turkey was used in the study. Since the student sample of the present study was clustered within classes, the responses students provided cannot be regarded as independent from each other. Therefore, dependencies among student responses

should be taken into consideration to obtain more robust results from analyses. Thus, HLM analysis method was utilized with HLM 6 software (Raudenbush, Bryk, Cheong, & Congdon, 2004). Another advantage of using HLM analysis is that variables at student level and teacher/school level can be analyzed simultaneously. In this study, both student and class level variables were tested. In order to find out which variables significantly predicted students' self-concept in science, students' science achievement scores, motivational engagement (i.e., liking science and value science), behavioral engagement, student gender, and socioeconomic status were incorporated into the HLM analysis at level-1, and aggregated classroom achievement scores were incorporated as level-2 variables. We considered weighing variables while conducting the HLM analysis. All predictors (except gender) were grand mean centered. Moreover, Raudenbush, Bryk, and Congdon (2005) suggested that multilevel modeling regression analysis should be conducted for each of the plausible value and averaging coefficients obtained throughout the analyses. Considering their recommendation, we ran the HLM model five times for each plausible value and then calculated averages.

Results

Preliminary Analyses

Before performing HLM preliminary analyses were conducted. There was no missing value more than 3% which is inconsequential for the analysis (Schafer, 1999). The variables showed normal distribution. The skewness and kurtosis values of the variables were the range of between -1 to +1. Additionally, there were no violation of the assumptions of HLM. Besides, means, standard deviations and bivariate correlation coefficients are presented in Table 2. Results showed that all bivariate correlations were significant. The highest correlation was between liking science and self-concept ($r = .65$, $p < .01$). The descriptive statistics suggest that

students are at moderate level on liking science, value science, self-concept in science, and behavioral engagement. Mean science achievement score of eight grade Turkish students was 478.98 which was below the TIMSS scale average score of 500 (Oral & McGivney, 2013).

Table 2

Descriptive statistics and bivariate correlations among variables

	Min.	Max.	Mean	SD	Cut points Low- Middle - High	Bivariate correlations 2	3	4	5	6
1. Socioeconomic status	4.32	14.02	8.34	2.07	8.2-12.5	.05**	.04**	.17**	.12**	.42**
2. Liking Science	3.51	12.94	10.60	1.89	8.4-10.8		.48**	.65**	.60**	.24**
3. Value science	4.14	13.1	10.01	1.84	8.6-10.5			.48**	.49**	.15**
4. Self-concept in science	3.09	14.97	10.27	2.01	9-11.5				.60**	.40**
5. Behavioral engagement	3.56	13.83	10.38	1.85	8.4-11.2					.26**
6. Science achievement			478.98	97.17						

** p<.01

Predicting Self-Concept in Science

First, intraclass correlation coefficient (ICC) was computed by using the variance components obtained from one-way random effect ANOVA model. ICC is an indicator of expected (population) correlation between two randomly selected students within the same class (Hox, 2010). Besides, ICC can also be considered as the magnitude of random effect in multilevel models (Lorah, 2018). For student self-concept, ICC indicated that approximately 10% of the variance in students' self-concept in science learning can be explained by class level variables.

As for the prediction of self-concept, five multilevel modeling regression analyses were conducted with each of the achievement plausible values. Achievement was handled as the

achievement score of students, without group-mean centering, at level-1, and as the achievement of the classroom at level-2. Afterwards, based on these results, parameter estimates, standard errors, t values and between and within variances were calculated by averaging results obtained from results derived for each plausible value (Raudenbush et al., 2005). Results revealed that, at level-1, gender, science achievement, socioeconomic status, liking science, value science and behavioral engagement significantly predicted students' self-concept in science, while at level-2, aggregated classroom science achievement was a significant and negative predictor of self-concept in science. The regression coefficients were presented in Table 3. Furthermore, to investigate the explained variance R^2 was calculated for both level 1 and level 2 by using the equation (1) and (2) respectively:

$$R^2 \text{ at level 1} = 1-(\sigma^2\text{cond}+\tau^2\text{ cond})/(\sigma^2\text{uncond}+\tau\text{uncond}) \quad (1)$$

$$R^2 \text{ at level 2} = 1-[(\sigma^2\text{cond}/nh)+\tau^2\text{cond}]/[(\sigma^2\text{uncond}/nh)+\tau^2\text{uncond}] \quad (2)$$

All level-1 predictors accounted for approximately 57% of the student level variance in students' self-concept in science. Moreover, aggregated classroom science achievement explained approximately 7% of the between class variance of self-concept. Based on the t values, it can be argued that the best predictor of students' self-concept in learning science was liking science (t= 25.82, p< .001) which was followed by behavioral engagement (t= 17.60, p< .001). The equations (3) and (4) represent the final full model as presented below:

$$\gamma_{ij} = \beta_{oj} + \beta_{1j}(Gender) + \beta_{2j}(Science\ Achievement) + \beta_{3j}(Socioeconomic\ Status) + \beta_{4j}(Liking\ Science) + \beta_{5j}(Value\ Science) + \beta_{6j}(Behavioral\ Engagement) + r_{ij} \quad (3)$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Aggregated\ Classroom\ Science\ Achievement) + u_{0j} \quad (4)$$

Table 3

Predicting Students'Self-concept in Science

Students' Confidence in Learning Science			
Predictor	Coefficient	SE	t
Student level			
Intercept, γ_{00}	9.9225	.0745	133.26*
Gender, γ_{10}	.2286	.0443	5.17*
Science achievement$_{\text{within-class}}$**,** γ_{20}	.0046	.0003	15.37*
Socioeconomic status, γ_{30}	.0674	.0110	6.12*
Liking science, γ_{40}	.4077	.0158	25.82*
Value science, γ_{50}	.1413	.0169	8.37*
Behavioral engagement, γ_{60}	.2869	.0163	17,60*
Class level			
Aggregated science achievement$_{\text{between-class}}$**,**γ_{01}	-.0042	.0008	-5.61*
R^2 between-class	.07		
R^2 within-class	.57		

*: p<.001

The equation (5) is used to calculate the effects size of BFLPE (Marsh, Lüdtke, et al. (2009). The effect size was found to be .44 for level 1, and -.24 for level 2.

$$\text{BFLPE ES} = 2 * \beta * \frac{\sigma p}{\sigma y} \quad (5)$$

In this equation, while β represents unstandardized regression coefficient, σp and σy represent standard deviation of predictor and outcome variables, respectively.

Discussion

The present study aimed to investigate: (1) the relation of middle school students' self-concept to student engagement and achievement in science and (2) the Big Fish Little Pond Effect (BFLPE) on students' science self-concept. Additionally, gender and socioeconomic status were included in the study in order to control for their potential effects on students' self-concept. TIMSS 2011 data obtained from Turkish eight grade students were utilized for this purpose and

HLM analysis was conducted. Analysis results showed that at the student level, girls and students with higher socioeconomic status reported higher levels of science self-concept than boys and students with lower socioeconomic status respectively. These findings are consistent with previous research findings (e.g., Maqsud & Rouhani, 1991; Pehlivan & Köseoğlu, 2010). Furthermore, science achievement was a significant and positive predictor of self-concept. This finding indicates that students with high performance in science tend to have more positive beliefs about their abilities to perform well in science. The positive relationship between academic self-concept and student achievement was anticipated as previous research also linked higher self-concept with higher achievement at the student level (e.g., Marsh, 2004; Marsh et al., 2014).

Two dimensions of engagement, behavioral engagement and motivational engagement, were included in the present study. Students' attendance to the task, making an effort to complete the task or persistence on the task were treated as students' behavioral engagement. The results suggested that behavioral engagement was a significant and positive predictor of students' self-concept in science. This is an important finding because previous research generally investigated the relationship in the opposite direction; students with positive judgments about their competence (i.e., have high self-concept) tend to be more engaged in behaviorally than individuals with low levels of self-concept beliefs (e.g., Pintrich & Schunk, 2002). Although a number of researchers suggest that behavioral engagement can also affect students' self-concept (Badiozaman, 2012; Bakadorova & Raufelder, 2017), according to the authors' knowledge, there are not many studies investigating students' behavioral engagement as a predictor of self-concept beliefs. The current study suggests that students, who attend to their classes and make an effort to complete the task or persist on the task, tend to have higher levels of self-concept beliefs than

others. Actually, the predictive effect of behavioral engagement on students' self-concept is rational, since students' self-concept beliefs can occur based on their past experiences (e.g. Wigfield & Eccles, 2000). Hence, students' attendance, persistence or effort in science may support their perceptions about their ability in science. However, further studies can examine the predictive effect of students' behavioral engagement on their self-concept beliefs in detail. Besides that, student's value in science and liking science were treated as trajectories of motivational engagement in this study. The results suggested that students who had high interest in science and who had high levels of science value tend to have higher levels of self-concept beliefs. In other words, both of the dimensions of the motivational engagement had significant predictive effects on students' self-concept beliefs. This was an expected result since Salanova et al. (2011) underline the reciprocal relation between motivational engagement and self-concept. In this sense, students who have high self-concept beliefs are those who also have high interest and value, or vice versa. The findings of the present study contribute to the relevant literature; although research has generally linked behavioral engagement to self-concept, in the present study behavioral engagement predicted self-concept.

The second purpose of this study was to examine the BFLPE on Turkish students' self-concept beliefs over and above gender, socioeconomic status, science achievement, and engagement dimensions of interest. Class average science achievement was entered in the model as a class level predictor. Analysis results showed that class average science achievement was a negative and significant predictor of science self-concept. Thus, students reported lower self-concept when classmates' achievement was high, and higher self-concept were reported when classmates' achievement was low. This finding implies social comparison effects on students' perceptions of their ability to perform well in science. Students may compare their achievement

with their classmates and if other students' achievement is high, they may question their competence which may have an unfavorable effect on their self-perceived ability. This negative effect is in line with previous research which also has revealed a negative predictive effect of average class achievement on self-concept (e.g., Marsh et al., 2008; Seaton et al., 2010). Therefore, findings of the current study are consistent with previous research which was mostly conducted in Western counties. To our knowledge, no study has investigated BFLPE with Turkish sample and findings support that BFLPE also exists in the Turkish context. Our interpretation is that examination oriented Turkish education system and prevalence of evaluative feedback provided by teachers may have contributed to such findings. Students are frequently given tests and their performance on those tests is highlighted in the classrooms. Both teachers and families emphasize the importance of getting high scores on tests since eighth grade students take a national examination which determines their placement in high schools. Furthermore, teachers' provision of evaluative feedback may help students focus on their strengths and weaknesses. In Turkey, teachers mostly give evaluative oral and written feedback where, for example, they make judgements about their students' performance (Odabaşi Çimer et al., 2010). Supporting this idea, Marsh et al. (2015) investigated BFLPE for different countries and suggested that it was smaller for Middle Eastern Islamic countries than Asian and Western countries. The researchers also discussed that the students of these countries don't receive evaluative feedback as much as the students of Asians or Westerns do. Hence, in a further study, investigating the relation between BFLPE and feedback can be useful for the relevant literature.

Based on the findings of the present study, we suggest that science teachers may try to support students' motivational and behavioral engagement which in turn may increase self-concept beliefs in science. For instance, teachers can assign different roles which foster them to

engage in the task. In other words, teachers can encourage their students to engage behaviorally in science courses. Furthermore, gaining further understanding about how contextual factors (i.e., average class achievement) affect students' self-concept beliefs may be useful to create more supportive learning environments for students. Rather than making comparisons among students' achievement, which may focus students' attention to classmates' performance, self-improvement may be emphasized by educators. Rather than concentrating on performance, appreciating student effort during learning process may help the creation of more supportive learning environments. Teacher's provisioning of less evaluative feedback but more informative feedback may also encourage students to focus on their own progress.

Besides its contribution to the field, this study has several limitations too. First, the data are limited to TIMSS 2011 Turkey study. This data set is important for Turkey because, it is potential to reflect the results of the first attempts of the constructivist approach which has firstly form the basis of the science education curriculum in 2005 (Ministry of Education, 2005). Although there are several attempts of researchers to figure out the results of the new science curriculum by considering various variables since 2005, these studies are generally lack in leading or providing basis for longitudinal studies. Additionally, longitudinal investigation of engagement and BFLPE will provide new perspective about the development of students' self-concept in the classrooms. By taking attention to this starting point, this research has the potential to initiate the longitudinal investigation of the role of engagement and BFLPE in self-concept in science education by investigating the same subjects from TIMSS Turkey studies being conducted in the following years. The second limitation of this study is that although student engagement includes cognitive engagement dimension, because of the TIMSS data set content, liking science and value science were examined as predictors of self-concept beliefs in

science. Lastly, the present study limited to 8th grade students. Although TIMSS study mostly surveyed 4th and 8th graders for same variables consistently, survey of 4th graders did not include value science variable. Therefore, 4th graders data were not sufficient to represent the motivational engagement dimension. Therefore, when evaluating the findings of this study, these issues should be considered.

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