Testing the Information Distortion Model for Turkish Students' Self-Concept and Interest in Science

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Abstract

The information distortion model (IDM) explains the relationship between socioeconomic status (SES) and students' interest or self-concept by considering achievement. The purpose of the present study was to investigate the IDM of Turkish middle school students' academic interest and self-concept in science by considering the big-fish-little-pond effect (BFLPE). Trends in International Mathematics and Science Study (TIMSS) 2019 data and multilevel modeling analyses were used to achieve the aims of the current study. Three models were tested for each construct (self-concept and academic interest). The first model used a random comparison; in the second model, a comparison was made by considering the achievement of the students and in the third model, a comparison was made by considering school achievement. The findings of the students' academic interest in science confirmed the IDM for model 2 and 3; on the other hand, surprisingly, regarding self-concept, only model 1 confirmed the IDM. Furthermore, the BFLPE was noticed in both self-concept and academic interest in science.

Keywords: Self-concept, interest, big fish little pond effect, socio-economic status, science education.

Bilgi Bozulması Modelinin Türk Öğrencilerin Fendeki Akademik Benlik Kavramı ve Fen Bilimlerine İlgisi İçin Test Edilmesi
Öz

Bilgi bozulması modeli (BBM), sosyoekonomik statü (SES) ile öğrencilerin ilgisi veya akademik benlik kavramı arasındaki ilişkiyi başarıyı dikkate alarak açıklar. Bu çalışmanın amacı, büyük balık-küçük göl etkisini (BBKGE) dikkate alarak Türk ortaokul öğrencilerinin fene yönelik akademik ilgilerinin ve benlik kavramlarının BBM'sini araştırmaktır. Bu çalışmanın amaçlarına ulaşmak için Trends in International Mathematics and Science Study (TIMSS) 2019 verileri ve çok düzeyli modelleme analizleri kullanılmıştır. Her bir yapı (benlik kavramı ve akademik ilgi) için üç model test edilmiştir. İlk modelde rastgele bir karşılaştırma kullanılmış; ikinci modelde öğrencilerin başarıları dikkate alınarak bir karşılaştırma yapılmış ve üçüncü modelde ise okul başarısı da dikkate alınarak bir karşılaştırma yapılmıştır. Öğrencilerin fene yönelik akademik ilgilerine ilişkin bulgular model 2 ve 3 için BBM'yi doğrulamıştır; diğer yandan, şaşırtıcı bir şekilde, akademik benlik kavramına ilişkin olarak sadece model 1 BBM'yi doğrulamıştır. Ayrıca, BBKGE hem benlik kavramında hem de fene yönelik akademik ilgide ortaya çıkmıştır.

Anahtar kelimeler: Akademik benlik, ilgi, büyük balık-küçük göl etkisi, sosyoeknomik statü, fen eğitimi.

INTRODUCTION

The self-concept and academic interest of students are crucial concepts in education to understand students' achievement. Self-concept can be defined as the self-perceptions of individuals about their ability in a certain domain (Bong & Skaalvik, 2003). Moreover, interest can be described as a long-term tendency of students to pay attention to specific items and actions (Hidi & Ainley, 2002; Renninger, 2000). The information distortion model (IDM) suggests that socioeconomic status (SES) may influence the interest or self-concept of students through an achievement mechanism. In other words, according to the theory, once academic achievement is considered, there are no common factors, such as students with low academic self-belief coming from low-income families (Parker et al., 2018). The IDM explains the relationship between SES and the interest or self-belief of students through two mechanisms. The first one focuses on the positive relationship between SES and achievement; high SES students tend to get higher scores on standardized tests. On the other hand, the other mechanism examines the effect of SES on the interest (or self-belief) of students depending on achievement (Parker et al., 2012). It is important to emphasize that it is not only individual achievement that is important for the theory, but also school average achievement. Furthermore, there are three scenarios in IDM; firstly, if we compare high SES and low SES students randomly, it is expected that high SES students may have higher interest or self-belief than low SES students. Second, if we select students with equal achievement, low SES students are expected to have more interest or self-concept than low SES students. Lastly, if we compare students with equal achievement from equally successful schools, there would be no difference between low SES and high SES students (Parker et al., 2021b). Alternatively, people can show assimilation to the group that they are involved in. For instance, being a part of a prestigious school or organization can lead students to increase their self-concept or academic motivation, which is known as the "basking-in-reflected-glory" effect (Marsh et al., 2000). Another example of assimilation is related to identity stereotypes (Parker et al., 2017). Students with low SES backgrounds may think that science is not interesting for children with their identity. Parker and his colleagues (2021b) suggest that if the IDM pattern occurs with assimilation, Scenario 1 would have the strongest association and Scenario 2 would have the weakest association between SES and academic interest, motivation, or self-concept. Hence, the present study aims to see how IDM affects Turkish middle school students' academic interest and self-concept in science.

The Big-Fish-Little-Pond Effect (BFLPE)

The BFLPE suggests that students tend to compare themselves with their peers and build their self-concept and academic interest based on this comparison (Marsh, 2004). According to this theory, students' academic interest, self-concept, or motivation can be determined by external references such as achievement. However, not only their achievement but the average school achievement is an important reference for students, and students who are at high performing schools tend to have lower self-beliefs than their peers with equal achievement (e.g., Marsh et al., 2008; Seaton, Marsh, & Craven, 2010). Studies that investigate BFLPE mainly focus on self-concept as the dependent variable. For instance, Fang et al. (2018) conducted a meta-analysis of the BFLPE on students' self-concept. They examined studies from 1984 to 2018 and included 33 studies in the analysis. The results suggested a significantly negative effect of average school achievement on students' self-concept. In another study, Wang (2020) investigated the BFLPE on students' mathematics self-concept with TIMSS 2015 data and found a significant impact in most of the participating countries (44 of the 46) in eighth grade. In a recent study, Parker et al. (2021a) studied the BFLPE in mathematics by using four cycles of TIMSS. They conducted analyses in all Organization for Economic Co-operation and Development countries except Mexico and Turkey since they used to be members until 2003. They argued that the relationship between the BFLPE and ability stratification is significant, which means that countries that stratify schools according to the performance of students tend to have higher BFLPE than other countries. On the other hand, the BFLPE should not be limited to self-concept since it can also be observed in academic interest. To illustrate, Parker et al. (2021b) examined this impact on mathematics and reading interest and discovered similar findings: negative and significant effects on the average school achievement. Marsh and his colleagues (2015) suggested that the BFLPE was investigated mostly among high school students in Western countries so studies with younger students and in different cultures are needed. Hence, in the present study, the BFLPE was investigated in terms of both science self-concept and academic interest.

The Turkish Education System

In Turkey, students are encouraged to stay in the education system for at least 12 years: elementary school (four years), middle school (four years), and high school (four years). Although there is a transition examination from middle school to high school, middle school choice is dependent on the residential addresses of the families rather than the achievement of students (Ministry of National Education [MoNE], 2024). In the transition from

middle school to high school, the stratification degree among schools is above average. For instance, according to PISA 2022, the school differences are significantly higher than the average variance in OECD countries (OECD, 2023). Besides that, middle schools are also stratified in Turkey. School stratifications according to ability can be related to the SES of families, since high SES parents tend to register their children for higher-performing schools (Maaz et al., 2008). Supporting the validity of this idea in Turkish schools, Börkan and Bakış (2016) investigated students 'success by considering the SES of middle school students. The data of the study were collected from 184,487 middle school students. According to the results of the study, the students' characteristics explained a significant amount of the variance between schools. It is important to underline that the SES variables of the students largely explained the school differences, which supports the reason why school stratification also exists at the middle school level. While investigating the relationship between SES and achievement, it will be useful to touch on shadow education. The term shadow education is used to describe additional, private tutoring or educational activities that take place outside of the formal school system. These activities are often provided for a fee and are designed to assist students in enhancing their academic performance within the mainstream school environment (Bray, 1999). However, shadow education does not include formal educational intuitions and is mainly related to private supplementary education. Students may take extra courses from teachers out of school hours. In Turkey, participation in shadow education is at the highest rate among eighth-grade students (Gümüş, 2021).

The Current Study

This is a kind of replication study. Replication studies aim to replicate a previously conducted study. They play an important role in ensuring the reliability and reproducibility of scientific research (Asendorpt et al., 2013). There are two types of replications: exact and conceptual replication. In exact replication, researchers repeat the previous study by using the same method, same dependent variable and the same materials. On the other hand, in conceptual replications, researchers make an effort to test the idea or hypothesis of the original study (Crandall & Sherman, 2016). The purpose of the present study was to conceptually replicate Parker and his colleagues '(2021b) study. In the original study, the IDM of the mathematics and reading domains. This study aims to investigate the IDM of academic interest and self-concept in the science of middle school students in Turkey. To the best of the authors 'knowledge, no studies have investigated these patterns in Turkish culture. Furthermore, few studies have been conducted on educational inequalities in Turkey (Börkan & Bakış, 2016). Besides that, TIMSS 2019 data gathered from a representative sample were used to achieve the aim of the study. Consequently, following research questions were addressed:

1. How does the IDM theory explain the relationship between students' SES and their academic interest in science for Turkish middle school students?
2. How does the IDM theory explain the relationship between students' SES and their self-concept in science for Turkish middle school students?

Parker et al. (2021b) summarize how the IDM is applied under three circumstances: (1) for a random population, SES will be positive and significant; (2) for students with equal achievement, SES will be negative and significant, and (3) for students with equal achievement from equal performing schools, SES will not be a significant predictor of academic interest or self-concept. To test these hypotheses, three models were established and analyzed separately for science interest and self-concept. The first model includes only the SES variable as the predictor of the dependent variable. In the second model, science achievement was also included in the model, and in the third model, school achievement was also included in the model. This model also explains the BFLPE of Turkish middle school students. Lastly, gender control is also included in all three models. The proposed models were presented in Figure 1.
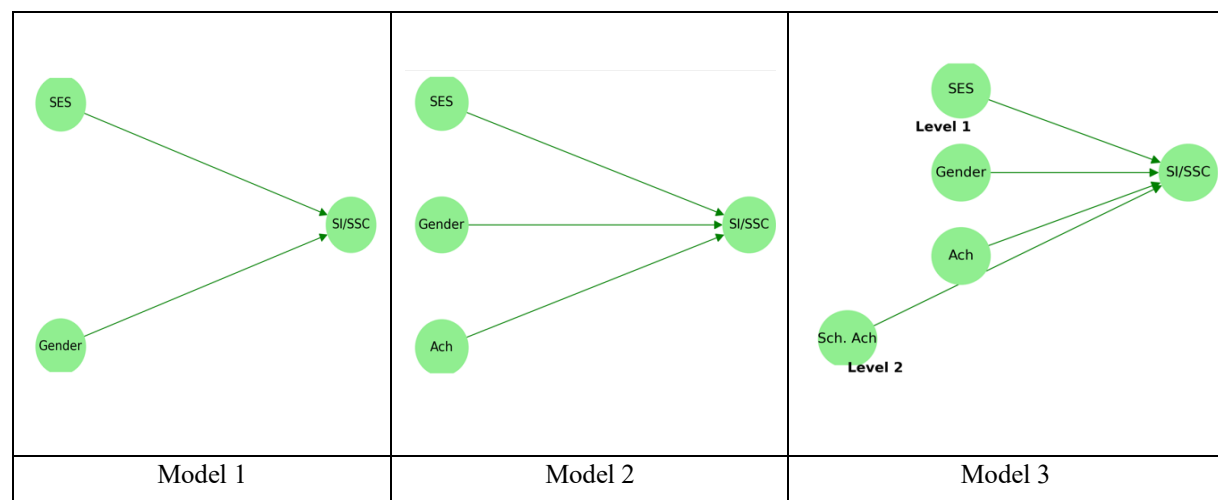
*SI: Science Interest, SSC: Science Self Concept, SES: Socioeconomic Status, Ach: Achievement, Sch. Ach: School Achievement

Figure 1. *The Proposed Models*

METHOD

Research Design

The research design of this study is correlational study. In a correlational study, the relationship between two or more variables is examined without any manipulation. Besides, the primary objective is to examine the degree of relationship between two or more variables, thereby enabling researchers to identify potential patterns, trends, or associations. Hence, the objective of this kind of research is not to establish a causal relationship. (Frankel & Wallen, 2016).

Data Collection

Achievement

Four science disciplines were covered in the TIMSS 2019 science achievement questions: biology, chemistry, physics, and earth science. Using Item Response Theory, the general science achievement scores were translated into five plausible values by TIMSS. These five plausible values were also aggregated to use at level 2, as school performance.

Interest in Science

Students like learning science scale was used to determine how much they interest in learning science in the current study. There were nine items like "I enjoy learning science" and "science is boring". Responses were gathered using a 4-point Likert scale ranging from 1 (agree a lot) to 4 (disagree a lot). The internal consistency of Cronbach's alpha was calculated to be .87, indicating good reliability. For the validity of the instrument, principal component analysis was conducted and the item loadings for the Turkish data set ranged from .57 to.84 (Yin & Fishbein, 2020).

Self-concept

Students' self-concept was measured with four items like "I usually do well in science". It is a four-point Likert scale ranging from 1 (strongly agree) to 4 (strongly disagree). The self-concept measure had a high level of Cronbach's alpha internal consistency (.85).

Data Analysis

Researchers can get TIMSS data via the TIMSS website (Fishbein, et al., 2021). The data were analyzed using the R programming language and MPLUS. While R (Edsurvey package) was used to get the data and descriptive statistics and MPLUS 8.8 was used to conduct analyses. In model 3, school achievement was present as a predictor, so achievement scores of students were aggregated for schools. Preliminary analyses were conducted before multilevel modeling. There were approximately 4% missing values. With small missing values with a large sample size, the listwise deletion method is acceptable (Kim & Curry, 1977). Flemming-Smiley (2015) investigated the performance of the dealing methods for the missing value in multilevel analysis and suggested that there are enough advantages to using listwise deletion. Hence, listwise deletion was performed for missing values in the current study. Additionally, the normality of the distribution was controlled and observed. Lastly, there were no violations of multilevel modeling assumptions.

FINDINGS

Descriptive Statistics

To investigate SES, achievement, science interest, and science self-concept of middle school students, descriptive statistics were used. For self-concept scores range from 3.25 to 14.84, with a mean of 10.81. This implies that, Turkish middle school students have self-confidents about their ability to success science (Mullis et al., 2019). It has moderate positive correlation with both achievement (r = .64) and interest (r = .47). Regarding academic interest in science, scores range from 3.85 to 13.52, with a mean of 10.71. This implies that, Turkish middle school students have high interest in science (Mullis et al., 2019). It also has small correlation with achievement (r = .24). Table 1 presents descriptive statistics for the variables.

Table 1. Descriptive Statistics

	Description				Correlation	
	Min.	Max.	Mean	Std. Dev.	Interest	Achievement
Self-concept	3.25	14.84	10.81	2.13	.64*	.47*
Interest	3.85	13.52	10.71	1.92		.24*
Achievement	199.45	787.76	511.58	93.06		

*p < .01

Inferences Statistic

To investigate the IDM hypothesis three models were tested for interest and self-concept of science separately. Moreover, to control the gender effect, it is also included in all the models. In Model 1 only SES and gender were the predictors of the dependent variables. In model 2, science achievement was added to the analysis. Lastly in model 3, aggregated achievement score was included into the model to examine the school achievement effect. According to the findings, SES was a significant and positive predictor of science interest. In model 2, the achievement was included in the models and results suggested a positive association between achievement and interest, and the relation of SES to interest was negative. Lastly, in model 3, when aggregated achievement score was included in the model, SES lost its significance while predicting science interest. Regarding self-concept, the results suggested that SES positively and significantly contributed to all the models. Table 2 presents regression coefficients for the analyses. Additionally, to calculate BFLPE size the equation (1) was used (Marsh, Lüdtke, et al., 2009).

$$BFLPEES = 2 * \beta * \frac{\sigma p}{\sigma y} \tag{1}$$

The effect size was found to -.09 for science interest, and -.16 for science self-concept.

Table 2. Models Predicting Science Interest and Self-concept

Predictors	Science interest			Science self-concept		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)	B (SE)
Level 1						
Gender (Boy)	-.10 (.03)**	-.08 (.03)**	-.10 (.04)**	-.08 (.03)**	-.05 (.03)	-.05 (.03)
SES	.03 (.02)	-.10 (.02)**	-.03 (.02)	.21 (.02)**	-.02 (.02)	.06 (.02)**
Achievement	-	.28 (.02)**	.30 (.02)**	-	.49 (.02)**	.55 (.02)**
Level 2						
School achievement (BFLPE)	-	-	-.16 (.06)**	-	-	-.28 (.05)**
AIC	11163.45	10906.34	10530.04	11053.83	10208.32	10007.09
BIC	11188.57	10937.74	10573.99	11078.94	10239.71	10051.04
Log-likelihood	-5577.73	-5448.17	-5258.01	-5522.91	-5099.16	-4996.54
R^2 within	.01	.07	.10	.05	.23	.33
R^2 between	-	-	.06	-	-	.32

B=unstandardized regression coefficient; **p < .01

DISCUSSION & CONCLUSION

The current study aimed to investigate the IDM mechanism of Turkish middle school students' academic interest and self-concept in science. To accomplish this goal, TIMSS 2019 Turkish data for eighth-grade students were used and multilevel modelling analyses were conducted separately for academic interest and self-concept. The IDM focuses on three patterns related to SES and the academic interest or self-concept of students. The first one randomly compares high SES and low SES students, and SES is expected to have a positive effect. The second one compares high SES and low SES students by considering their achievement and SES is expected to have a negative effect. The last pattern includes the school's achievement average and assumes that low and high SES students with equal achievement from equally performing schools tend to have similar academic interest or self-concept. This last pattern is also interesting when it comes to the BFLPE. Therefore, in the present study, three different models were tested for each construct. Regarding academic interest, the findings supported all the IDM mechanisms except model 1. Consistent with the theory, low SES students tend to be much more interested in science than their peers from high SES families if they have equal achievement. Besides, SES has no significant effect when students with equal achievement from equally performing schools are compared. On the other hand, while it was expected to find positive effect of SES while comparing students from low SES and high SES families randomly, the model suggested no significant relation between SES and science interest. It was surprising that low SES students were nearly as interested in science as their peers from high SES families when achievement is not considered. The reason for this result may be an assimilation effect. According to the theory, the group that the people involved in can affect their beliefs and assimilation may be occur. As noted by Parker et al. (2021b), if there is assimilation, the IDM mechanism can work differently. In this context, Turkish educational system and culture can be an underlying factor for this outcome. Turkish people across all SES levels value education and parents motivate their children to pursue a good career (e.g., Şenler & Sungur, 2009). For instance, careers related to science, technology, and engineering are popular among to people because of their financial opportunities. Hence, this may lead low SES students to be interested in science more than expected. In a further study, this can be studies in detail with a mix method study.

The findings of the students' self-concept in science were different from academic interest and behavior of SES varied in model 2 and model 3. In model 1, as expected, SES was a significant factor indicating that if we compare high SES and low SES students randomly, high SES students tend to have a higher self-concept than their peers. On the other hand, surprisingly, in model 2 SES was not a significant predictor of self-concept by considering their science achievement and comparing high SES and low SES students. Furthermore, in model 3, which examined low and high SES students with equal achievement from schools with similar performance levels, there was a significant and positive effect of SES on students' self-concept of in science. Here, we can again mention the assimilation effect. Marsh et al. (2000) suggested "basking-in-reflected-glory" effect which suggest that membership in a prestigious school or organization has the potential to enhance students' self-concept or

motivation. In other words, students may assimilate into the group and develop their self-beliefs from the group in which they are involved. As mentioned before, schools are stratified in Turkey and, generally, students from high SES families tend to enroll in higher-performing schools (Börkan & Bakış, 2016). This may affect the association between SES and the self-concept of students. Nevertheless, it is surprising that the assimilation effect manifested differently when it comes to self-concept to compared academic interest in science. The reason for this interesting finding can be the competitive educational system of Turkey. To prepare for the transition examinations, it is very common for eighth-grade students to join a shadow education activity (Gümüş, 2021). Students from high SES backgrounds may therefore have more opportunities to support their education than their peers. This may lead to high SES students adopting higher a self-concept than low SES students even though they are from equally performing schools with equal achievement. In future research, this issue can be studied in detail.

Another purpose of the study was to investigate the BFLPE on the academic interest and self-concept of students in science. In Model 3, the average school achievement was included in the model as a Level 2 predictor. In the relevant literature, studies that have investigated the BFLPE generally focus on self-concept (e.g. Marsh et al., 2015); however, the BFLPE can be applied to different psychological constructs (Marsh et al., 2020). According to the results of this study, the school average is a significantly negative predictor, not only of self-concept but also of academic interest in science. In other words, students tend to have lower self-concept and interest in science when their school achievement is high. These results confirmed the BFLPE on the self-concept and academic interest of Turkish students; the students compare themselves with their peers at school and can orient their self-belief or interest according to the results of this comparison. This finding was not surprising since the relevant literature also emphasizes the negative effect of the school average on students' self-belief. Consistent with the meta-analysis by Fang et al. (2018), the relevant literature suggests that students evaluate their own achievement not only based on their individual performance, but also in relation to the overall level of achievement in their school environment. When school averages are high, students' comparisons with their peers may lead to lower self-concept and academic interest. Comparing the effect sizes of the BFLPE for the constructs, it can be suggested that the BFLPE on self-concept (.-16) is higher than academic interest (.-09) in science. Besides that, the competitive education system of Turkey may have contributed to this effect. Competitive education refers to a system based on competition and can be expressed as one is being better than the other. For instance, since the high school transition examination is a kind of ranking examination, the place of the students in the ranking is important. Therefore, parents and teachers generally compare eighth-grade students with their peers according to their test results. This can make students compare their performance with that of their schoolmates. The underlying reasons and the consequences of the BFLPE among Turkish students can be investigated in future studies.

To sum up, the current study found that the IDM is a valid predictor of Turkish middle school students' academic interest. More specifically, when compared to equally skilled high and low SES students, students from a low SES background tend to have a higher academic interest in science than their peers from a high SES background. On the other hand, the IDM mechanism was not as accurate in predicting the self-concept of middle school students. High SES students tend to have a higher self-concept than their peers, regardless of having a similar level of achievement. Furthermore, another aim of the study was to investigate the BFLPE on both interest and self-concept. The findings confirmed that the group which students are involved in had a significant and negative impact not only on Turkish middle school students' self-concept but also on their academic interest in science.

This study has some limitations. Firstly, since the design of the study is correlational, it does not imply a cause-and-effect relationship among the variables. It should be noted that the term "effect" was used to imply a statistical effect in this study, not a causal effect. Secondly, the data are limited to a Turkish sample; in future studies, data from other countries can be gathered for analysis and cross-cultural comparisons can be conducted among countries. Besides that, the data are also limited to eighth-grade students and the findings vary according to the age of the students. Future studies can also consider applying the model to other grades.

Statements of Publication Ethics

This study used publicly available data from the TIMSS dataset, which is anonymized and does not include any identifiable personal information. Therefore, ethical approval and consent to participate were not required for this research.

Conflict of Interest

There are no any financial or non-financial conflicts of interest that could have influenced the research or its interpretation.

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