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DIFFERENCES IN SCIENTIFIC EPISTEMIC BELIEFS AMONG REGIONS AND SCHOOL TYPES IN TURKEY

A MASTER'S THESIS

BY

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THE PROGRAM OF CURRICULUM AND INSTRUCTION
İHSAN DOĞRAMACI BILKENT UNIVERSITY
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This thesis was dedicated to my family and my friends.

Differences in Scientific Epistemic Beliefs Among Regions and School Types in Turkey

The Graduate School of Education
of
İhsan Doğramacı Bilkent University

by

Fatma Çözeli

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Fatma Çözeli

September 2022

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

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I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Curriculum and Instruction.

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ABSTRACT

Differences in Scientific Epistemic Beliefs Among Regions and School Types in Turkey

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M.A. in Curriculum and Instruction

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October 2022

The purpose of this study was to reveal differences in students' scientific epistemic beliefs between geographic regions and school type in Turkey. The geographic regions were selected as 12 NUTS-1 regions and school types were general secondary schools and vocational and technical secondary schools. The reason why this study was deemed necessary was that educational inequalities in Turkey seem to be decreasing the well-being of the citizens and the full economic potential of the country. Attention is especially drawn to science education because we live in the information age where ability in producing knowledge in science and technology is highly rewarded. Moreover, science education in Turkey has rooms for development. The data was pooled from the 2015 PISA cycle (which included 6 4-point Likert scale items on scientific epistemic beliefs), and a two-way ANOVA was carried out via SPSS to examine mean differences with respect to regions and schools, and also their interactions. Concerning significant results were revealed for the Northeast Anatolia Region's vocational and technical secondary students. Significant between school differences also seem to require more attention. However, practical significance of the study was small.

Keywords: Educational inequalities in Turkey, scientific epistemic beliefs of Turkish students, egional Inequalities in Turkey, School Type Related Inequalities in Turkey

ÖZET

Türkiye'deki Okul Türleri ve Coğrafi Bölgeler Arasında Bilimsel Epistemolojik İnanç Farklılıkları

Fatma Çözeli

Yüksek Lisans, Eğitim Programları ve Öğretim

Tez Danışmanı: Dr. Öğr. Üyesi İlker Kalender

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Bu çalışmanın amacı Türkiye'deki coğrafi bölgeler ve okul türleri arasındaki bilimsel epistemolojik inançlar hakkındaki farklılıkları açıklamaktı. Türkiye'deki coğrafi bölgeler NUTS-1 bölgeleri olarak ve okul türleri ise normal Liseler ve Mesleki ve Teknik Liseleri olarak tanımlanmıştır. Bu çalışma Türkiye'deki eğitim alanındaki eşitsizliklerin kişilerin refah seviyesini etkileyebileceği ve ülkenin ekonomik gelişimini aksatabileceği için gerekli görülmüştür. Günümüz bilgi toplumlarında özellikle fen eğitimi böyle çalışmalarda ilgi odağı olmaktadır çünkü bilim ve teknoloji alanında bilgi üretmek en çok ödüllendiriliyor. Hem de Türkiye'deki fen eğitimi daha çok geliştirilmesi gereken bir durumdadır. Bu çalışmanın verisi PISA'nın 2015'teki sınavından (bu sınavda bilimsel epistemolojik inançlar hakkında 6 tane 4-puanlı Likert ölçeği tarzı soru vardır) çekilmiştir ve SPSS'te iki yönlü ANOVA ile veriler analiz edilmiştir. Kuzeydoğu Anadolu Bölgesi'ndeki (TRA) Mesleki ve Teknik Lise öğrencileri için endişe verici sonuçlar bulunmuştur. Okullar arası farklılıklar da daha çok ilgi gösterilmesi gerektiği bulunmuştur. Ama çalışmanın pratik önemi küçüktür.

Anahtar kelimeler: Türkiye'de eğitimde eşitsizlikler, Türk öğrencilerin bilimsel epistemolojik inançları, Türkiye'deki Bölgesel Eşitsizlikler, Türkiye'de Okul Türlerinden Doğan Eşitsizlikler

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CHAPTER 1: INTRODUCTION

Introduction

Scientific epistemic beliefs simply refer to "the nature of knowledge and the nature or process of knowing" (Hofer & Pintrich, 1997, p. 112). Scientific epistemic beliefs are relevant in science education as they communicate one's approach to interpret and comprehend scientific knowledge. As with the case many other aspects of education, there are beliefs which are favored over others. The idea behind this is that some epistemic positions might be detrimental to students' understanding of the topics. For example, a student who does not believe that scientific knowledge can change might find it challenging to compare the historical development of atom or planetary systems to comment on the scientific knowledge that we deem true today. That is the student's belief in certain knowledge might give them the idea that our ancestors were simply wrong, but we are now correct. Instead of evaluating a claim based on the argument presented with it, they might simply compare it with what they think is certain knowledge. Such behavior is often deemed problematic as ideal education should foster citizens who are capable of thinking for themselves without relying on an external source.

Background

William G. Perry is the pioneer researcher who investigated epistemic beliefs in an educational context. Perry (1968) postulated a developmental scheme comprising nine positions that explains the intellectual and moral development of college students. The students in the first positions viewed knowledge as being either right or wrong. As students attained higher positions in the scheme, they started to understand the importance of making commitments for the truth. That is the truth depended on context instead of existing on its own. However, his work was subject to criticism because the majority of the participants were male students from Harvard University (Duell & Schommer-Aikins, 2001). Perry's initial work was followed by researchers who were interested in gender differences in epistemic beliefs.

Later, Schommer-Aikins (2002) pointed out that researchers had only modeled epistemic beliefs as being unidimensional ranging from naïve/dualistic beliefs (everything is either right or wrong view) to sophisticated beliefs (pieces of knowledge are tentative). Instead, she offered a multi-dimensional model in her 1990 study which is explained in more detail in the Chapter 2. More importantly, she devised a Likert-type scale questionnaire for measuring epistemic beliefs that was more efficient compared to in-depth interviews and surveys with open-ended items – which were the only options up until then (Hofer & Pintrich, 1997). This questionnaire enabled measuring the epistemic beliefs of a wider population and exploring the relationship between the concept and other variables related to education. However, Clarebout et al. (2001) point out that there are apparent problems with factor analyses in studies using the questionnaire. They add that there are problems with the theoretical framework as well. Regardless, the instrument is still in use due to its statistical simplicity. In fact, the international benchmark examination Programme for International Students Assessment (PISA) included a similar questionnaire in its 2015 cycle, consisting of 6 items about scientific epistemic beliefs. Based on the questionnaire, Organization for Economic Cooperation and Development (OECD) states that "differences among students in their epistemic beliefs about science account for about 12% of the variation in students' science performance" (OECD, 2016, p.105). With similar findings from other studies, scientific epistemic beliefs are often treated as an important part of scientific literacy and science achievement (Chen & Pajares, 2010; Jehng et al., 1993; She et al., 2019; Tsai et al., 2011).

In the case of Turkey, Turkish students are revealed to be not as sophisticated science-believers as students from other countries. According to the 2015 PISA report, the percentage of Turkish students who hold sophisticated scientific epistemic beliefs are lower than the OECD average (OECD, 2016). To be more precise, OECD's mean index on epistemic beliefs scale is around –0.02 points, whereas Turkey's is around –0.17 points. Turkish students are the 8th least sophisticated students about science out of 56 economies. In addition, there is significant scientific epistemic beliefs mean score difference between the top performers and low performers in Turkey. Lastly, scientific epistemic beliefs scores explain about 7.4% variation in Turkish students' PISA science literacy performance (OECD, 2016). That is not only Turkish students are considered less sophisticated than other economies on scientific knowledge, but there seem to be inequalities related to their beliefs too. In addition, these inequalities seem to be affecting their science literacy as well.

In general, educational inequalities in Turkey is evident in achievement differences between school types and geographic regions. For instance, Berberoğlu and Kalender (2005) investigated the achievement differences between school types and geographic regions using the standardized university admission tests between 1999–2002 and the 2003 Programme for International Student Assessment (PISA). They concluded that there were significant differences between schools in terms of achievement. They also expressed that the achievement differences between geographic regions were lower than their expectations. To be more precise, South-Eastern Anatolia, East Anatolia and Black Sea regions in Turkey had performed relatively lower than the rest of the country, but they suggested that the differences would have been easily atoned for. Gumus and Atalmis (2012) carried out a similar study to reveal how such differences had changed over time. Their study shows that regional achievement differences indeed showed a sign of improvement from the 2003 administration of PISA to the 2009 administration. The only region that could not improve its significantly low achievement was South-Eastern Anatolia. Similar to the findings of Berberoğlu and Kalender, they highlight that the achievement differences between school types are of medium to large magnitude and they seem persistent. Without much digression, both studies also draw attention to the fact that many Turkish students have low subject-based (reading, science, and mathematics) literacy levels. Hence, policymakers and authorities should address inequalities along with the nationwide low subject-based literacy levels.

Turkish Ministry of National Education has been paying great attention to the aforementioned PISA results since Turkey first took part in the assessment in 2003. One of the driving factors of this attention is the persistent lower than the OECD average performance of Turkish students (OECD, n.d.a). For clarification, “PISA measures 15-year-olds’ ability to use their reading, mathematics and science knowledge and skills to meet real-life challenges” (OECD, n.d.b). According to the Ministry’s reports on the 2015 and the 2018 administrations of PISA, results from the studies of Berberoğlu and Kalender, and Gumus and Atalmis still persist. That is, most students have low subject-based literacy levels and there are significant differences in mean achievement scores between school types and geographic regions (Suna et al., 2019; Taş et al., 2016). According to the 2018 PISA Report published by the Ministry, the correlation coefficient between socio-economic status and achievement scores in Turkey is absolutely smaller than the OECD average which is taken as a good sign for equality in education (Suna et al., 2019). Nevertheless, there are also significant differences in mean achievement scores between different socio-economic status groups (Suna et al., 2019; Taş et al., 2016). The PISA results of Turkey implies that there is still room for improvement in Turkish education system.

Problem

Taken into account that the authorities have been trying to address and decrease educational inequalities between geographic regions and between general secondary schools and vocational and technical secondary schools, scientific epistemic beliefs can also be addressed during these processes. However, if there are any significant scientific epistemic beliefs differences between geographic regions and these two school tracks in Turkey is not yet examined. In other words, there is a gap in the literature on this issue. In addition, since there could be inequalities between two variables mentioned, there could also be inequalities between their combinations. The rationale is that since both variables seem to vary significantly in education related variables, they might have a combined effect on this study's dependent variable that is scientific epistemic beliefs. To make this clear, this study also checks if the effect Nomenclature of Territorial Units for Statistics regions at level (NUTS-1 regions) have on scientific epistemic beliefs is similar for both tracks of schooling (general secondary schools, and vocational and technical secondary schools). Similarly, it also checks if the effect of school types on scientific epistemic beliefs is the same in each region. For example, between general and vocational track differences might exist in some regions, but not in others. Hence, the literature gap on the interaction effect between these two variables with regards to scientific epistemic beliefs should also be filled.

Purpose

The purpose of this quantitative study is to fill the literature gaps that are stated in the previous paragraphs. Namely, the study describes how geographic regions and school types in Turkey differ in scientific epistemic beliefs. For its generalizability and comprehensiveness, the data was pooled from the 2015 PISA cycle. The PISA 2015 Student Questionnaire included six Likert-type scale items measuring scientific epistemic beliefs. The analysis of the data is expected to reveal the mean score differences for each item between geographic regions and school types. The twelve geographic regions in the PISA 2015 dataset were NUTS-1 regions of Turkey and schools were grouped into two as general secondary schools and vocational and technical secondary schools. Scientific epistemic beliefs scores of students were compared with respect to these geographical regions and these school types using a two-way ANOVA. Since a type of school could also be affected by the region it is located in, and each region could produce varying between-school differences, the interaction effect of the two independent variables was also analyzed.

Research Questions

This study addresses the following research questions:

1. What are the scientific epistemic beliefs score differences between geographic regions in Turkey?
2. What are the scientific epistemic beliefs score differences between general secondary schools and vocational and technical secondary schools?
3. What is the interaction effect between school types and geographic regions on mean scientific epistemic beliefs scores?

Significance

Curriculum developers and policy makers may take the results of this study into consideration to improve the quality of science education in Turkey. The results are expected to reveal how geographic regions and school types in Turkey differ in scientific epistemic beliefs. In addition, analyses will reveal the interaction effect, if exists any, of geographic regions and school types. In line with the results, curriculum developers and policymakers might adjust the curriculum and education policies in order to minimize the possible negative effects of inequalities regarding scientific epistemic beliefs. For example, groups with less sophisticated scientific epistemic believers can be offered additional courses on the nature of scientific knowledge. In addition, teachers who are allocated to regions or schools with comparatively less sophisticated scientific epistemic believers might adjust their lessons accordingly. Students can self-evaluate to compare themselves with their peers and the result of this study as well.

CHAPTER 2: REVIEW OF RELATED LITERATURE

Introduction

This chapter explains the theoretical framework of the thesis by covering the discussions and debates surrounding the scientific epistemic beliefs and educational inequalities in Turkey. Educational inequalities consist of three subheadings that are between geographic region inequalities, between school inequalities and the studies that looked for inequalities between both variables. On that account, the chapter is organized as the following: Epistemic Beliefs and Educational Inequalities in Turkey. The chapter concludes with a conclusion section.

Epistemic Beliefs

Epistemology is a branch of philosophy that studies theories of knowledge. In addition to philosophy, epistemology intrigued researchers who study intellectual development within the scope of number of different disciplines such as psychology, ethics and education. In the discipline of education, researchers often focus on a concept called epistemic beliefs. Epistemic beliefs simply refer to an individual's beliefs about the nature of knowledge and knowing (Hofer & Pintrich, 1997). Educationalist quest after the development of epistemic beliefs within educational settings, what the concept implies for learning of the students, the relationship between the concept and other educational variables, the optimal way of integrating the concept into a curriculum and so on. Despite the overwhelming number of works dealing with the concept, it is a fairly new one. Perry's work in 1968 was the first one that explored epistemic beliefs within an educational context (Moschner et al., 2008).

Historical Development of the Theoretical Frameworks

Perry (1968) postulated the first epistemic beliefs scale, modelling the intellectual and moral development of students. Initially, his research team was interested in exploring the learning experiences of voluntary undergraduate students at Harvard University. First, they devised an instrument called Checklist of Educational Views (CLEV) and they "administered CLEV to a random sample of 313 freshmen in the fall of 1954 and to the same students in the spring of 1955" (Perry, 1968, p. 9). They went on to conduct in-depth interviews at the end of each academic term with 31 participants out of 55 randomly selected students from the original sample. They initially expected the instrument to group students according to their personality types. However, as they pursued their analysis of the in-depth interviews, they came to realize patterns that could be modelled as a developmental scheme. They later repeated the study with randomly selected 366 students among which 67 students were interviewed annually. Under the lead of Perry, they devised a scheme with nine positions. The first three positions are associated with thinking that knowledge has a dualistic nature (either right or wrong). The positions from four to six are assigned to students who begin to realize the non-dualistic nature of knowledge. People grouped under these three positions vaguely understand the necessity for commitment. Lastly, positions seven to nine are used to "trace the development of commitments in person's actual experience" (Perry, 1968, pp. 13–14). Following the development of the scheme, the interviews were distributed to judges twice (once with the year of the students concealed) and they were asked to assign a position to each interviewee. The reliability of the positions which the judges assign to students were greater than .87 which suggests that the scheme was highly trustable. However, his scheme of development was criticized by Belenky et al. because the study was representing only the elite white males (Hofer & Pintrich, 1997).

Based on the work of Perry, Belenky et al. (1986) wanted to explore the intellectual and moral development of women. In accordance with their aim, they interviewed 135 women and published the results in their book titled *Women's Ways of Knowing*. In their review of studies examining epistemic beliefs, Hofer and Pintrich (1997) summarize the book as follows. Initially, Belenky et al. attempted to model the interviews using the scheme proposed by Perry, but they later decided to devise "a new classification scheme of five epistemological perspectives" (Hofer & Pintrich, 1997, p. 95). Compared to the Perry's scheme, Belenky et al. focused on a metaphor voice rather than views. That is five positions –which are silence, received knowledge, subjective knowledge, procedural knowledge, and constructed knowledge– represent the degree to which the individual sees herself as a part of knowledge construction. Subjective knowledge is the first position in which the truth unites with the identity of the individual. Hofer and Pintrich (1997) also underlines that "Perry's positions are descriptive of the nature of knowledge and truth, while Belenky et al. focus more on the source of knowledge and truth" (Hofer & Pintrich, 1997, p. 96). However, failure to compare the differences in the results due to the studies' gender-specific samples gave rise to studies interested in exploring the relationship between epistemic beliefs and gender.

Magolda (1987) ventured to compare gender differences in epistemological assumptions. She used semi-structured interviews and an instrument called Measure of Epistemological Reflection (MER) to assess the differences between two genders in six areas which they have defined based on Perry's scheme. The areas are "the role of the learner, instructor, and peers in the learning situation, the question of evaluation of learning, the nature of knowledge, and educational decision making" (pp.13–14). The written instrument MER was used to ask "the respondent to make a choice on each of the six areas and justify his/her thinking related to that choice" (p.14). Both the semi-structured interview and MER was validated before the study. The participants of the study consisted of 100 freshmen university students with half of them being females. Certified raters were asked to rate the results from MER using a manual. Both for the interview and MER, the average of ratings of each domain according to the Perry's intellectual development scale were taken for each participant. The quantitative analysis revealed that the correlation between the use of both instruments was .47. The qualitative analysis also revealed similar results for both. Their study found that there were no significant differences between the epistemological assumptions of males and females. However, it should be noted that the participants were all assigned to either the second or the third positions and the results should not be generalized to the higher positions. Nevertheless, there were some qualitative differences between males and females in their reasoning structure. For example, females were more supportive of connected learning which refers to voicing opinions and questions freely. According to females, knowledge had a certain nature at the second position and at the following position the uncertain nature of knowledge began to emerge. Males, on the other hand, preferred to be more individualistic in their learning. The uncertainty emerging in the third position motivated males to reach to truth with logic.

Perry's pioneer study did not only lead the way of studies interested in gender differences in intellectual development, but it also garnered interest in other areas related to epistemological development. For example, King and Kitchener (1994) devised their own reflective judgement model that covers the concept of epistemic cognition. Their model had seven stages among which the first three stages comprise the first level called the pre-reflective level; the next two stages comprise the second level called the quasi-reflective level and the last two comprise the third level called the reflective level. Their instrument was an interview consisting of four ill-structured problems. The aim of their study was to unveil how epistemic assumptions influence reasoning. Kuhn also made use of a similar instrument to conduct a study grouping her sample according to a simplified version of Perry's scheme (Hofer & Pintrich, 1997). Also building on the work of Perry, Schommer became one of the researchers that lead the way by devising a Likert-type scale on epistemic beliefs and hypothesizing the multi-dimensionality of epistemic beliefs.

In 1990, Schommer "reported the first major study attempting to test the conceptualization of personal epistemology as a system of more or less independent beliefs" (Shommer-Aikins, 2002, p.104). She hypothesized for her model that epistemic beliefs had five more-or-less independent dimensions which are, namely, stability of knowledge, source of knowledge, structure of knowledge, the speed of knowledge acquisition and control of knowledge acquisition. Different to the aforementioned studies, she held that people may hold sophisticated beliefs about one of the dimensions and not the others (Schommer-Aikins, 2004). In addition to the hypothesis that epistemic beliefs do not define a unidimensional structure, her development of a Likert-type scale to measure epistemic beliefs was also a revolutionary step as it eased quantification. She used the scale in one of her explanatory factor analyses to conclude that "four of the five hypothesized beliefs were generated: structure and stability of knowledge, as well as the speed and control of learning" (Shommer-Aikins, 2002, p.105). Following a number of repetitions of the study, she moved on to study the relationship between her system of epistemic beliefs and variables that are related to learning. One of the other central contributions of her was suggesting that epistemic beliefs "are better characterized as frequency distribution rather than dichotomies or continuums" (Schommer-Aikins, 2002, p.106). Even though the points raised by her are disputed due to lack of statistical and theoretical clarity, her work has been greatly influential especially for studies that focus on the relationship between epistemic beliefs and other educational variables. One of the debates surrounding Schommer's multi-dimensional scale is the definition of the epistemic beliefs, or the boundaries of the definition.

Whether to include or omit the beliefs about learning in epistemic beliefs frameworks is often contested by researchers. For example, in their literature review, Hofer and Pintrich (1997) suggests omitting them because they are not conceptually consistent with most other frameworks employed in epistemology including philosophical and psychological endeavors. They instead suggest that epistemic beliefs frameworks should solely focus on "individuals' beliefs about knowledge as well as reasoning and justification processes regarding knowledge" (Hofer & Pintrich, 1997, p. 116). They note that the dimension called fixed ability, which denotes beliefs regarding one's talents and its link with hard work, is not in theoretical harmony with Schommer's framework and it is a weak predictor of other dimensions and other educational variables. Similarly, the factor called quick learning, which denotes beliefs regarding whether learning is gradual or sudden, is conceptually distinguished from epistemic beliefs. Hofer and Pintrich (1997) also add that "the hypothesized dimension, source of knowledge, has yet to be empirically validated as a factor" (p.109). They advance that the core structure of epistemic beliefs frameworks should consist of "beliefs about the nature of knowledge and the nature or process of knowing" (p.119). The multidimensional framework that they hypothesize, instead, is two dimensions under nature of knowledge and two others under nature of knowing. The prior two are called certainty of knowledge and simplicity of knowledge and the latter two are called source of knowledge and justification for knowing.

Clarebout et al. (2001) are among researchers who strongly criticize the studies relying on Schommer's works. After their endeavor of trying to conduct two similar studies in Netherlands and Belgium, they pointed out that Schommer's studies have a problem of missing out essential information such as the size of the sample in one study or scale construction in another. They summarize the shortcomings of the studies as the following: low reliability in general, inexplicit use of factor scores and factor score coefficients and doubtful use of statistical methods to test the relationship between each hypothesized dimension. Clarebout et al. (2001) also criticized the studies that made use of Schommer's questionnaire because they left out important statistical information as well, such as validity or reliability of the instrument. One of the problems with studies replicating Schommer's studies is that the items in the epistemic beliefs scale are grouped together before any analysis is carried out. Hence, the internal consistency of the scale is not reported. To conduct a study to test the multi-dimensionality of epistemic beliefs, Clarebout et al. first translated the instrument into Dutch with the help of Schommer. The sample of the first study consisted of 250 sophomore students from Belgium and Netherlands attending 3 different universities. In the second study, their sample consisted of 450 sophomore students from Belgium attending 4 different higher education institutions. The questionnaire was administered at the end of a lecture. In the analysis step, their skepticism towards information provided by Schommer led them to initiate an exploratory factor analysis of their own. The data collected from both experiments failed to reproduce the factor structures from Schommer's studies. In the first study, only three factors with loadings higher than .50 were produced. The subsets of learning is quick and ability to learn is innate were loaded on one factor with correlation coefficients of .52 and .54 respectively. The subsets of avoid ambiguity and depend on authority were loaded on one factor with correlation coefficients of .59 and .50 respectively. The subsets of seek single answers, knowledge is certain and not criticize authority were loaded on one factor with correlation coefficients .51, .51 and .55 respectively. In the second study, only two factors with loadings higher than .50 were produced. The subset of avoid integration and avoid ambiguity were loaded on one factor with correlation coefficients .53 and .56 respectively. The subset of knowledge is certain was loaded on one factor with a correlation coefficient of .79. After failing to replicate the factor structure using groups of items, they repeated the factor analysis with using only the items from the questionnaire. The items loaded on two different factors for the first data set and three different factors for the second data set. The only common factor identified between them was produced by two items related to the scientist' knowledge of the truth. Regardless, the reliability of the models was lower than .70 which does not indicate a strong reliability. Clarebout et al. concluded that researchers should be careful with the use of Schommer's questionnaire. They assert that there are no theoretical explanations for different educational and cultural settings producing different factor structures for epistemic beliefs. They also advise researchers to be more careful with reporting reliability coefficients and other essential information.

To shed light on the current situation, Buehl (2008) reviewed 37 published studies that focus on multi-dimensional structure of epistemic beliefs. She compiled relevant studies with the help of databases with a catalog of studies in education and psychology in addition to the research conducted by well-known researchers in epistemology. She excluded conference papers, dissertations, and other unpublished papers along with the studies that focused solely on beliefs about learning or identified only one factor or used the factor structure directly from another study. Only one study was chosen from studies that made use of the same data. The compiled studies represented 42 student samples among which 32 samples represented undergraduate students or undergraduate students along with graduate students, 4 samples represented high school students, 3 samples represented middle school students, and 3 samples represented elementary school students. The samples were predominantly from the United States of America. She mentions that 24 studies used exploratory factor analysis only, 5 studies used confirmatory factor analysis only, 7 studies used exploratory factor analysis and confirmatory factor analysis both, and the one remaining study used multidimensional scaling method. Most of the explanatory factor analysis focused directly on the individual items from Schommer's Likert-type scale as opposed to Schommer's conceptual –not empirical– groups of items. She also adds that the studies using the groups of items instead of individual items tended to leave out reliability coefficients. Similarly, all of the confirmatory factor analysis studies, except three, leaved out reporting a criterion to interpret the fit of the data. Following her review, she proposed the following three-dimensional framework. The first dimension is beliefs about nature of knowledge which "include beliefs about simplicity or complexity of knowledge, the degree to which knowledge is isolated or integrated as well as beliefs about the certain or changing nature of knowledge" (Buehl, 2008, p. 100). The second dimension is beliefs about process of knowing which also includes "factors that contribute to knowing" (Buehl, 2008, p. 100). The last dimension is beliefs about controlling and influencing factors which includes "beliefs about ability or other aspects of individual's lives that may influence what they come to know" (Buehl, 2008, p. 100). Her hypothesized model merges the characteristic traits of other models. For example, Schommer's beliefs about learning is included in the last dimension. Her review suggests, in general, that there are evident problems with the statistical methods and the way in which they are being reported in studies about the factor structure of epistemic beliefs. Studies seem to suggest that epistemic beliefs get more polished as people get older and that the factor structure differ by both age and culture. However, the fact that factor structure changes with culture is often contested and some suggest that there could be a problem with the current instruments instead (Buehl, 2008).

The Relationship Between Epistemic Beliefs and Other Educational Variables

One of the reasons why the study of epistemic beliefs is admired is because of the alleged link it has with knowledge acquisition. Even in the initial work of Perry, the focus is on the influence of an educational environment, where learning occurs, on one's beliefs about knowledge. As a result, the relationship between epistemic beliefs and other variables related to learning and education has been a robust area of research. Some variables that have received attention are academic achievement, learning strategies, academic motivation, self-efficacy and culture. The following is a selection of such studies.

Trautwein and Lüdtke (2006) studied the relationship between the dimension of certain knowledge (that is the dimension associated with beliefs about the changing nature of knowledge) and two other variables –field of study and academic achievement. They drew their data "from a large, ongoing German study, Transformation of the Secondary School System and Academic Careers (TOSCA), conducted at the Max Planck Institute for Human Development, Berlin, and the Institute for Quality Enhancement in Education at the Humboldt University, Berlin, Germany" (Trautwein & Lüdtke, 2006, p.354). The data was representative of Gymnasium students which are schools designated for academically successful students. Among randomly selected 2854 students, 1094 provided valid responses for the longitudinal study. The instrument for measuring certain knowledge was a questionnaire developed based on the studies of Hofer and Schommer. In addition, data was collected for the following variables: cognitive ability, final school grade, family socio-economic status (family SES), cultural capital and fields of study. In the analysis step, the intercorrelation matrix of final school grades, certain knowledge, and five predictor variables –which are gender, age, family SES, cultural capital and cognitive abilities– revealed that certain knowledge had a significant relationship with family SES, cultural capital, cognitive abilities and final school grades. Trautwein and Lüdtke proceeded with a structural equation modelling to examine the dimension of certain knowledge as a predictor of final school grades and how it mediated the effect of other variables. Their model had a good fit which suggests that sophisticated beliefs about certain knowledge had a significantly positive relationship with final school grades. In the analysis of data related to students' fields of study, one of the aims was to explore socialization effects and selection processes regarding students' epistemic beliefs. Their analysis supported Jehng et al.'s findings that soft fields students hold more sophisticated epistemic beliefs than hard fields students. In addition, both the socialization effects and selection processes could explain such differences. In other words, students who initially held more sophisticated beliefs about the dimension of certain knowledge preferred to study in soft fields and the difference between two fields became more pronounced at the university level.

Nussbaum et al. (2008) focused on the effect of scientific epistemic beliefs and exposure to the sound scientific argumentation criteria on quality of students' arguments and their science learning. To measure students' epistemic beliefs, they used the instrument developed by Kuhn. The instrument originally had five domains that are judgements of taste, aesthetic judgements, value judgements, judgements of truth about the physical world and judgements of truth about the social world. Nussbaum et al. measured only the domain of judgements of truth about the physical world. The students were grouped into three orientations that are absolutist (the view that knowledge is immutable and certain), multiplist (the view that all pieces of knowledge are equally true), and evaluativist (the view that knowledge is a justified true belief). The original instrument was modified to incorporate three responses per item instead of two. In addition to the variable of epistemic beliefs, the variable of argumentativeness was measured with a questionnaire as well. Eighty-eight participants of the study were mostly Caucasian university juniors seeking a teaching credential. They were enrolled in three introductory educational psychology classes and five educational assessment classes. They were randomly assigned to control and treatment groups as randomly appointed pairs. "The treatment group received additional written information about constructing an effective scientific argument" (Nussbaum et al., 2008, p. 1981). The study was carried out in an online classroom in which all pairs were asked an identical physics question. The pairs were instructed to come up with a joint answer after an argumentative discussion. The transcripts of the chats were coded according to a rubric devised beforehand. The statistical significance of the data was measured with a multilevel statistical model. "Epistemic orientation (absolutist, multiplist, and evaluativist) was included in the model at the individual level" (Nussbaum et al., 2008, p. 1985). According to their analysis, 55.3% of the participants had an evaluativist orientation, 28.2% had a multiplist orientation, 11.8% had an absolutist orientation and the rest did not have any orientations. There were no significant epistemological orientation differences between the control and treatment group. The results revealed that compared to the absolutist students, evaluativist students were more likely to offer novel ideas during discussions and correctly answer the question. In addition, multiplist students were significantly less likely to engage in discussions compared to both the absolutists and evaluativists. In fact, the qualitative analysis supported that "the multiplists were not that critical of their arguments … [and they] had arguments containing inconsistencies" (Nussbaum et al., 2008, p. 1991). The multiplists tended to pick up the view of their pairs after the pair explained their stance on the issue.

Chen and Pajares (2010) examined the relationship between implicit theories of ability, epistemic beliefs, students' academic motivation and achievement in science. In addition, they also examined if these variables showed significant differences between different genders and ethnicities. The data was collected for the following five variables: implicit theories of ability, epistemic beliefs, science grade self-efficacy, science achievement goal orientations and self-efficacy for self-regulation. To measure epistemic beliefs, they devised a 26-item questionnaire based on the previous studies. Theoretically, their instrument measured the dimensions of source of knowledge, justification for knowing, certainty of knowledge and development of knowledge (which denotes beliefs regarding evolving and developing nature of science). Their "participants were 508 Grade 6 science students attending a large, suburban, public middle school in" the United States of America

(Chen & Pajares, 2010, p. 79). They conducted a path analysis which revealed that holding sophisticated beliefs about the dimensions of development of knowledge, justification of knowledge and certainty of knowledge had a significantly positive relationship with the following: the belief that science ability is incremental or evolving, self-efficacy, final grade and the focus on attaining normative competence. The dimension of source of knowledge did not have significant relationship with the variable of self-efficacy. They summarize their results as “espousing naïve views about the nature of scientific knowledge is related to maladaptive motivational beliefs and lower academic achievement” and the opposite holds for sophisticated views (Chen & Pajares, 2010, p. 82). No significant gender differences were detected for epistemic beliefs. Asian and Hispanic students were significantly more likely to hold naïve beliefs about the source of knowledge than Black and White students. Hispanic students were also more likely to hold naïve beliefs about certainty of knowledge than the rest of the students.

Tsai et al. (2011) conducted a study on the relationship between scientific epistemic beliefs, conceptions of learning science and self-efficacy of learning science. To measure scientific epistemic beliefs, they used a Likert type scale with 26-items measuring the four dimensions of Hofer and Pintrich. They relied on the structural equation model technique to test the hypothesized relationships. Their sample consisted of “377 high school (10^{th} – 12^{th} grade) students in Taiwan” (Tsai et al., 2011, p.760). Almost half of the sample were female, and the mean age was around 16. They randomly selected a class from schools that were “stratified into three demographic areas, northern, central and southern Taiwan” (Tsai et al., 2011, p. 761). The science class was mandatory in the 10^{th} grade only. For the analysis, they first conducted a confirmatory factor analysis to test the dimensions of epistemic beliefs. The analysis confirmed that all items loaded significantly to their designated dimensions. They add that the fit of the model was more than adequate. They continued with SEM path analysis to test the hypothesized relationships. The results revealed that the dimensions of source of knowledge, certainty of knowledge and development of knowledge have significantly negative relationship with lower-level conceptions of learning science. That is the science learning conceptions of naïve students about those three dimensions are significantly more likely to be of lower level than the conceptions of sophisticated students. Conversely, the dimensions of development of knowledge and justification of knowledge have a significantly positive relationship with higher level conceptions of learning science. Lastly, only the dimension of certainty of knowledge has a significant relationship with self-efficacy of learning science. As opposed to the previous studies, the relationship was negative. That is the self-efficacy of sophisticated students about certainty of knowledge is more likely to be lower than the self-efficacy of naïve students. The researchers explain this phenomenon by culture and educational values in Taiwan. They also mention about one of the criticisms against most literature on epistemic beliefs, that is Western centrism.

Hofer (2008) conducted a literature review of epistemic beliefs studies from across and within diverse cultures. They state that most common developmental scheme in studies conducted in the USA are scales ranging from naïve to sophisticated positions. The most naïve positions are assigned to individuals who view knowledge as dualistic, certain, unchanging, and absolute. The individual advances to a multiplist position where every piece of knowledge is deemed equally valid and true. Finally, the most sophisticated position occurs when individuals realize that some pieces of knowledge are better than the others owing to superior evidence, justification, and proofs. However, if the exact same scheme is replicated in other cultural environments is still not clear. For instance, in studies conducted in China, different patterns of development of epistemic beliefs were observed. A possible explanation is that social interactions in China, especially within educational contexts, pushes students to hold more absolutist beliefs, that are considered naïve from the Western perspective. Hofer (2008) underlines that one of the central concerns in interpreting these studies is related to the measurement issues. Since the instruments are usually self-reported Likert type scales, the researchers might be oversimplifying the complex reality of epistemic beliefs. Similar to the development of epistemic beliefs, dimensions of epistemic beliefs have also showed some differences across the globe. For example, in studies conducted in East Asia, the factor structure was different than the one in USA. Some researchers hold that such differences can be attributed to the differences in cultural heritage. In addition, the studies conducted in East Asia produced results that assigned East Asian students to more naïve positions, especially in the dimensions of the source of knowledge, than the students in USA. However, one of the main concerns regarding such results is that too many variables change between two cultures to be able to attribute the differences to schooling only. Similar concerns exist about the relationship between epistemic beliefs and other educational variables because they might not replicate in other cultures as well. In addition, East Asian students are not academically less successful than the students in the Western countries which raises even more questions about the underlying assumptions of the current literature about epistemic beliefs. Hofer underlines that current literature might be culturally biased. To make more trustable comparisons, she suggests conducting cross-cultural studies that relies on in-depth interviews similar to the initial work of Perry.

Educational Inequalities in Turkey

Turkey's formal education system is recognized for its radical revisions that happen in short periods of time (Karapehlivan, 2019). In Turkey, formal education is often seen as a tool for social engineering, and it is often treated as such (Yilmaz, 2018). Authorities seem to strongly support the theory of tabula rasa at both the individual and societal level to the degree of complete dismissal of people's agency and freedom. Unfortunately, radical revisions, an extreme attention given to the instrumental pledges of formal education and ignoring the public might turn the formal education system ineffective altogether. This is not surprising because mass education, in a sense, is a solution which human societies have come up with for keeping up with global developments and trends in political, social, technological, and scientific spheres. Mass education is not a soulless infrastructure which the dominant group can resort to for social control, but it is rather "produced by the social construction of the main institutions of the rationalized, universalistic worldview that developed in the modern period" (Boli et al., 1985, p.156). People naturally expect schools to function as they were intended to because formal education is still a significant part of their life in the 21st century rationalized and universalistic knowledge economies. That expectation of people is the benchmark with which the public education will be declared to be of high or low quality.

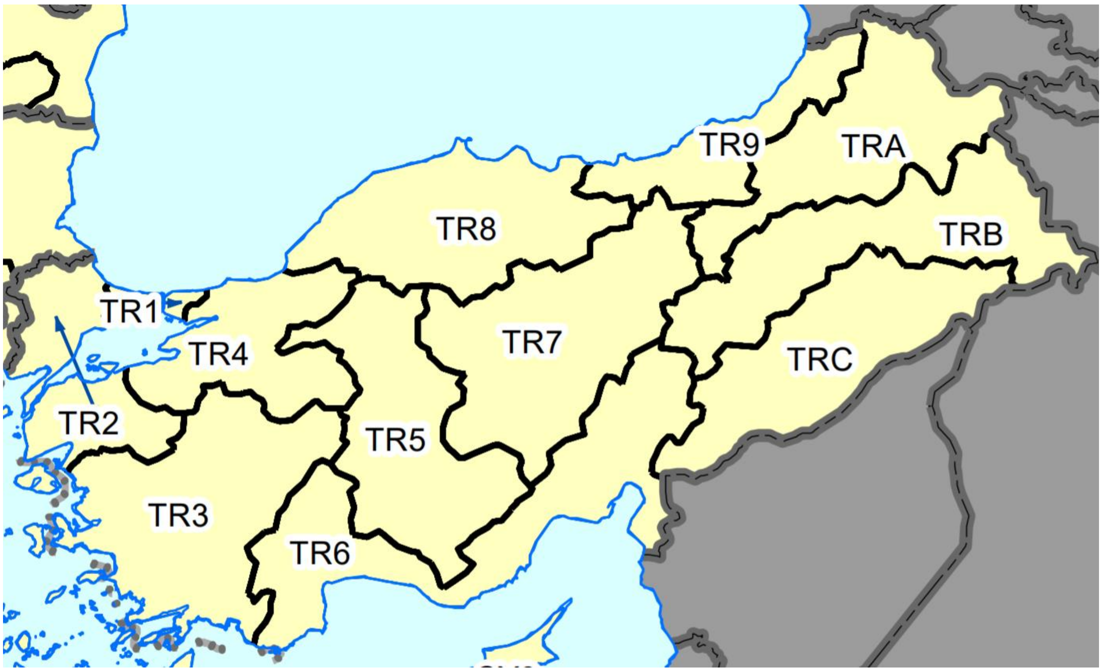
The low quality of education in Turkey is a persevering issue not only according to the perspective of the public but also according to the authorities who seem determined to increase the Turkish human capital. European Training Foundation (ETF) highlights this situation as a "serios impediment to the further development of a high-tech and knowledge-based economy" (Mereuta, 2019, p.22). They base their claim on the World Bank's report which reveals that 12 years of compulsory schooling in Turkey is only equivalent to 8.9 quality-adjusted years of schooling (Mereuta, 2019). ETF also asserts that, despite visible improvements, region of residence and income related inequalities impede further expansion of human capital. In addition to these areas mentioned by ETF, school type is also one of the areas that inequalities in education become pronounced. The following includes a selection of studies that focus on the educational inequalities in Turkey regarding differences between geographic regions and school types.

Studies Investigating Regional Inequalities

There are number of ways to geographically divide Turkey. This thesis uses the Nomenclature of Territorial Units for Statistics (NUTS) classification. The Eurostat established the NUTS "for dividing up the economic territory of the EU [which includes EU candidates, potential EU candidates, and EFTA countries] and the UK" (Eurostat, 2020a, para. 3). Eurostat (2020b) lists the twelve-regions of Turkey according to NUTS classification as follows: Istanbul Region (TR1), West Marmara Region (TR2), Aegean Region (TR3), East Marmara Region (TR4), West Anatolia Region (TR5), Mediterranean Region (TR6), Central Anatolia Region (TR7), West Black Sea Region (TR8), East Black Sea Region (TR9), Northeast Anatolia Region (TRA), Central East Anatolia Region (TRB), and Southeast Anatolia Region (TRC). Figure 1 below illustrates these regions on a map.

Figure 1

Turkey NUTS regions at level 1. 2021 NUTS and Statistical regions – level 1. From "NUTS Maps," by EuroGeographics, UN-FAO, & Turkstat, 2020



Economic development and living conditions are different especially between the provinces located in the West (TR1, TR2, TR3, TR4, TR5, TR6, TR7, TR8) and the East (TR9, TRA, TRB, TRC). The already richer West –in terms of GDP per capita– has more opportunities to increase the region's prosperity (Gezici & Hewings, 2004). The differences between prosperity might be a nuisance for equality in educational opportunities. Especially considering that the wealth of students predicts academic achievement to a certain degree (Tomul & Savasci, 2012), the differences in educational variables between geographic regions become even more challenging to interpret and repair. Nevertheless, the complex picture of the current situation also makes the study of regional inequalities more valuable.

Ataç (2019) conducted a study to explore the issues in education related to geographic and socio-economic variables in Turkey. She obtained her data from the 2012 administration of Programme for International Student Assessment (PISA), the scores from 2011 University Entrance Examination, and 2011 census dataset by TURKSTAT. She analysed the data in two phases: OLR analysis, and GWR analysis, respectively. OLR analysis revealed that family background (the most predictive), home assets, and urban effect (the least predictive) can all predict students' academic achievement. She identified the following five explanatory variables as powerful enough to describe academic achievement in Turkey: university graduation rates in a district, female illiteracy, young population rate, child to woman ratio, and the population of migrants. In the second phase, GWR analysis revealed that the relationships between these five variables and academic achievement is significantly different between regions. She reported that the relationships were more statistically significant in the Eastern Turkey. She concluded that the place of residence was a powerful predictor of academic achievement in Turkey. She also noted that educational inequalities might be growing more intense in the fullness of time.

Erberber (2010) came to a similar conclusion following her investigation of the science achievement differences between seven geographic regions of Turkey: Marmara, Aegean, Central, Mediterranean, Black Sea, South-Eastern and Eastern. She used the data from the 2007 administration of an international examination called Trends in International Mathematics and Science Study (TIMSS). The sample of this examination consisted of eighth grade students. Erberber analysed the data in two phases. In the first phase she calculated the average TIMSS science scores of each region. In the second phase she used a regression technique called hierarchical linear modelling to explore the background variables which are relevant to the science performance differences between seven regions. Erberber revealed that "the differences in student outcomes corresponded to the socioeconomic disparities between the western and eastern parts of Turkey" (2010, p.128). She stated that attending a school in Marmara region significantly increased the TIMSS science scores when compared to attending a school in Eastern or South-Eastern regions. There were no significant differences between the regions of Marmara, Aegean, Central, Mediterranean, and Black Sea regions –regions located in the west of Turkey.

Ferreira and Gignoux (2010) studied inequalities in educational opportunities in Turkey. They used the data from the 2003 – 2004 Turkey's Demographic and Health Survey (TDHS) and the 2006 administration of PISA. TDHS surveyed 10.836 households and they collected data including school enrolment rates and the region of residence. The PISA sample consisted of 15 years old students. The authors used regression analysis to analyse the PISA data. Ferreira and Gignoux concluded that the status of being enrolled in a school in Turkey depends on circumstances at birth. They posited that school enrolment in eastern regions differed significantly from other regions. Additionally, other circumstances –namely gender, educational background of parents, socioeconomic background, the type of area of residence, number of children in the household– produced even more considerable inequalities in eastern regions than they did in other regions. The analysis of PISA data also showed that students studying in the central and western regions performed significantly better than the students studying in eastern regions.

Concerned with the quantity of education, Tomul (2007) compared regions based on average years of schooling. He "obtained [the data] from the sources of Social and Economic Characteristics of Population about the cities, which was published after the Census of Population in the years 1990 and 2000" (2007, p.18). The survey was answered by people aged 24 or higher. He used the scale of average years of schooling for his analysis. He revealed that average years of schooling of males was higher than girls in all regions both in 1990 and 2000. Average years of schooling was also higher in western regions. However, the gap between males and females was higher in eastern regions than it was in western regions. The gap decreased in 2000 only in the following cities: Istanbul, Izmir, Antalya, Ankara, Aydin, and Adana –all of which are located in the west. In addition, Tomul conducted a similar study later in 2009 to investigate the educational inequalities between geographic regions and gender. He checked the relationship between the following variables: average years of schooling, changes in the average years of schooling, education Gini index, and the changes in education Gini index. He obtained his data from “the tables of the census of population pertaining to the period between 1975 and 2000” (Tomul, 2009, p. 950). The analysis revealed once again that the average years of schooling increased in all regions of Turkey for both males and females. The increase was higher in regions that initially had a lower average. In 1975, Istanbul had the highest average for both males and females with average years of schooling of 5.81 for males, 3.90 for females and 4.89 in general. The lowest average in 1975 belonged to Mardin with averages of 1.80 for males, 0.35 for females, and 1.06 in general. In 2000, Ankara had the highest average with averages of 8.45 for males, 6.43 for females, and 7.43 in general. Mardin managed to keep its low record for the average years of schooling for females and all students considered, but the region of Şanlıurfa had a lower average for boys with an average of 5.39. The increase in average years of schooling was highest in Antalya with an average increase of 3.57 years of schooling. The lowest increase was observed in Istanbul with an average increase of 1.87 years. The Gini index was lowest in Istabul in both 1975 and 2000 with an index of .42 and .33 respectively. The Gini index was highest in Mardin in both 1975 and 2000 with an index of .84 and .62 respectively. Implying that Mardin had the most unequal distribution of education while Istanbul had the most equal one. The index decreased the most in Manisa, Konya and Niğde which shows that best improvements in equality of distribution were made in these regions. Tomul also states that "there is a negative relationship between … [average years of schooling] and … [Gini index and] this negative relationship stops approximately when the … value [of average years of schooling] reaches 6 years, the decrease in [the Gini index] stops" (Tomul, 2009, p. 951). In general, this study also supports the hypothesis that the East lags behind the West on the issue of distribution of educational opportunities.

Öztürk and Kayaoğlu (2016) investigated whether such educational inequalities produce inequalities in income distribution as well. They note that, since an increase in educational attainment might have an equalizing effect on distribution of education, "it can be inferred that education inequality and income inequality do also affect each other" (Öztürk & Kayaoğlu, 2016, p. 228). The data was obtained from a panel dataset from a TURKSTAT survey on income and living conditions. The results for the educational Gini index are in support of the Tomul's findings. The index is showing a decreasing trend in all regions of Turkey which implies that equality is increasing. The index is lowest in western regions such as Marmara and Central Anatolia and it is highest in Eastern and South-Eastern Anatolia. They started their model with pooled OLS but, later, switched to dynamic models. Their initial analysis did not reveal a significant relationship between Gini index for education and income. However, the static models were not working well for the analysis, so they switched to dynamic models. Their final analysis revealed that the relationship between Gini index for education and income was significant and negative. The researchers underlined that "none of … [the models employed] perfectly eliminates the serial correlation and endogeneity problems" (Öztürk & Kayaoğlu, 2016, p. 230).

Karahasan and Uyar (2009) focused solely on the "spatial distribution of educational inequalities in Turkey" (p. 2). They wanted to also highlight the "spatial clusters for educational attainment in 3 dimensions: primary education, secondary education and university level" (Karahasan & Uyar, 2009, p. 2). They pooled their data from TURKSTAT for the following indicators between the years 1997-2006: pupils to teacher ratios in primary and secondary education, students to lecturer ratio in universities and per capita income levels. Theil index was used for analysing inequalities and Moran's I analysis was used for the distribution of educational opportunities. Theil index analysis revealed that between regional inequalities were higher than within regional inequalities for the primary and secondary education. Moran's I revealed that there were significant clusters of educational opportunities at the primary and secondary levels. They proceeded with a LISA analysis to describe the clusters. The results showed that "the socially and economically lagging regions on the South-Eastern and Eastern Anatolia constitute the worst clusters of Turkey" (Karahasan & Uyar, 2009, p. 14).

Ozoglu (2015) investigated the unequal geographic distribution of teachers in Turkey since the teacher quality might be one of the underlying reasons for academic achievement differences. He measured the quality of teachers by their experience in the field and their Turkish teacher selection exam scores. He phrased his main purpose as "to determine whether there is any kind of sorting pattern in the allocation of novice and experienced teachers to schools across regions" (Ozoglu, 2015, p. 20). He obtained his data for the years between 2010 to 2014 from "initial teacher assignment (ITA) data and inter-provincial voluntary teacher transfer (IVTT) data published on the MONE website” (Ozoglu, 2015, p. 20). He performed descriptive and correlation analyses on the data. The analysis of the ITA data showed that novice teachers were disproportionately allocated to the less developed regions in the east that are East Black Sea Region (TR9), North-East Anatolia Region (TRA), Middle East Anatolia Region (TRB) and South-East Anatolia Region (TRC). In addition, novice teachers sent to these regions, except the East Black Sea Region, have significantly lower exam scores than the novice teachers sent to other regions. Hence, he concludes that “already-disadvantaged students … are disproportionately far more likely to be exposed to novice teachers than their counterparts” (Ozoglu, 2015, p. 22) and the novice teachers allocated to them have lower exam scores as well. The analysis performed on the ITVV data supported these results too. The findings revealed that provinces with lower socio-economic development were less likely to be allocated senior teachers. Last but not least, senior teachers in eastern regions had lower levels of experience in the field than the ones in western regions.

Persistent inequalities in life opportunities naturally create a pattern of migration from east to west and from rural to urban areas in Turkey (Gökhan, 2008). Berker (2009) was interested in how such migration patterns were influencing the regional inequalities in education. In his study, he investigated the effect of migration on the “likelihood of completing middle school for the 16 – 19 age group and of completing high school for the 18 – 20 age group” (Berker, 2009, p. 740). He obtained his data from randomly drawing it from 1990 and 2000 Censuses. Based on his data, he grouped his sample into three: recent migrants, permanent natives, and old migrants. The latter two groups together defined another group called natives. For his analysis, he used a two-stage estimation method. His analysis revealed that overall educational attainment improved from 1990 to 2000 in Turkey. Their study suggests that influx of migrants significantly lowered the educational attainment of natives. The middle-school attainment rates were lowered more than the high school attainment rates. The students from high socio-economic backgrounds were able to avoid the negative impact of migration better than the students from low socio-economic backgrounds. In middle-school, boys were affected more negatively than girls, but the situation was reversed in high-school. Lastly, permanent natives were affected more negatively than old migrants.

Gumus and Chudgar (2016) investigated the “regional disparity in school access in Turkey and explore the factors contributing to this disparity” (p. 930). They pooled their data from Turkey Demographic and Health Survey in 2008. They only included children aged 8 to 17 whose mother also participated in the survey. Their independent variables were as follows: gender, age, region of residence, household poverty, household heads’ education, mothers’ Turkish speaking ability, household size and mother’s traditional gender role attitude. The dependent variable was a dichotomous variable called school participation. They used the binary logic model approach for the analysis. The chi-square tests revealed that there were significant differences in school participation for all of the independent variables. The only unexpected result was that “the country’s two well-developed regions, the West and the South, also experience relatively lower school participation” (Gumus & Chudgar, 2016, p. 939). The regions with the lowest out-of-school children were the regions of Central and the North. They also highlight that “a very high proportion of out-of-school children in the East region had a mother who could not speak Turkish” (Gumus & Chudgar, 2016, p. 942). Being a female created a disadvantage for all regions except the North and it created the largest disadvantage in the East. The mother's ability to speak Turkish was a significant predictor of school enrolment in the regions of East and South.

Studies Investigating School Type Related Inequalities

In Turkey, central examinations start as early as at the end of the 8^{th} grade. At the end of their primary education, students get tracked into the following types of school based on their exam scores: Anatolian high schools, science high schools, social sciences high schools, vocational and technical high schools, religious high schools (commonly referred to as Imam Hatip high schools) and private high schools. In addition to these types of schools, students can opt out for fine arts high schools or sports high schools for which they must pass a special talent examination. Vocational and technical high schools are further partitioned into number of different career routes. Students who do not attend vocational and technical secondary schools are referred to as general secondary students. Unfortunately, tracking students into academic (general secondary) or vocational schools has the tendency of producing and escalating academic achievement gaps between different socio-economic groups (Chmielewski, 2014). Furthermore, Turkey is one of the countries with high between-school academic performance differences. The following is a selection of studies focusing on the educational inequalities between different types of schools in Turkey.

Bölükbaş and Gür (2020) investigated inequalities stemming from tracking students at the end of the Turkish primary education. In light of their exploratory research design, the researchers conducted semi-structured "in-depth interviews with low-income students, as well as with several school principals and teachers" (2020, p. 3). The sample was purposefully chosen from socio-economically disadvantaged students with different entrance exam scores who were studying in Ankara in the

2015–2016 school year. The students were grouped into three according to their exam scores as Group A (the highest scores), Group B and Group C (the lowest scores). These groups represented four, six and three different schools respectively. The principals and teachers were also chosen from high schools with varying academic records. The interviews revealed the following findings. According to the students, teachers of the Group A have high expectations from their students. Some teachers of the Group B have high expectations from their students, while some others only have high expectations from some of their students. Students from the Group C stated that none of their teachers have positive expectations from them. In line with the views of the students, teachers and principals of the Group A stated that the competency of their students motivated them, while, on the other hand, teachers and principals of the Group C stated the opposite. In addition, the students of the Group A talked about peer influence as being positive, while the other two groups talked about it as being negative. The teachers of the Group C also talked about peer influence as being negative, while the other groups talked about it as being positive. The teachers of the Group C also mentioned that their students lacked core academic competencies in subjects which they need to be able to understand the content of the lessons. They also added that absenteeism and dropouts were serious impediments to their teachings. The students from the Group B and C also complained about discipline problems. The researchers conclude that there are serious differences in quality and quantity of education stemming from the practice of between-school tracking. They suggest that the practice of tracking might be worsening the already existing educational inequalities in Turkey.

Since socio-economic status (SES) is one of the factors that contributes to the educational inequalities in Turkey, Suna et al. (2020a) investigated the influence of school types on academic achievement along with the influence of their SES. They pooled their data from the central examination for high school entrance in the years of 2012, 2015 and 2018. The central examination for Turkish high school admission is a test measuring the knowledge of the students in main subject areas such as mathematics, science and language with around 100 multiple choice items. The students were attending one type of the following middle schools: religious middle schools, public middle schools, private middle schools and boarding middle schools. They note that most of the students were enrolled in public middle schools in these three years. The educational level of the parents and the SES of the families showed an increasing trend from 2012 to 2018 for all types of schools. Most advantaged students were from private schools and the least advantaged ones were from boarding schools. After the validity and reliability test, ANOVA and ANCOVA (with SES controlled) were carried out. ANOVA revealed that the effect of the type of middle school on exam scores was low without controlling for the SES levels. The highest effect was observed in the year of 2015. There were significant differences in mean exam scores between all types of school in all three years except the difference in 2015 between public schools and religious schools. The highest scores were obtained by private school students and the lowest were by boarding schools. After controlling for the level of SES with ANCOVA, the researchers discerned that some significant differences between schools disappeared. Namely, 2018 mean mathematics and science score differences between religious and boarding schools, 2018 mean science score differences between religious and public schools, and 2015 mean mathematics and language score differences between religious and boarding schools. Controlling for the effect of SES significantly decreased the mean score of private schools, but it significantly increased the mean score of boarding schools.

Highest effect of SES was observed in the year of 2015. Based on the results, the researchers warn the authorities against an unhealthy social reproduction that tracks students into SES clusters. The clusters result in the most socio-economically advantaged students being offered the best educational opportunities, while the least advantaged are offered the worst ones.

Suna et al. (2020b) investigated the trend of between school differences in Turkey. They focused on the literacy rate distribution by types of school based on the information provided by the PISA examinations. They focused on the distribution ratio of students at the basic proficiency level and the distribution ratio of students at the advanced proficiency level by types of secondary schools. The statistical changes in ratios were analysed with a z-test. They analysed the proficiency levels for mathematics, reading and science. They obtained the following results for the subject of mathematics. A significant increase in basic proficiency distribution was observed for Anatolian high schools and Anatolian imam hatip schools. Anatolian imam hatip schools also showed a significant increase in the ratio of students with advanced proficiency in mathematics. A significant decrease in basic proficiency distribution was observed for social sciences high schools. A significant decrease in advanced proficiency ratios was observed for science high schools (from 96.8% in 2003 to 40.2% in 2018) and vocational and technical Anatolian high schools. The basic proficiency ratios increased and decreased significantly for vocational and technical Anatolian high school and multi-program Anatolian high schools, but there was not a significant difference between the 2018 and 2003 ratios. A similar situation was observed for the advanced proficiency ratios of Anatolian high schools. The results for basic science proficiency levels were somewhat similar. Anatolian high schools and Anatolian imam hatip high schools significantly increased their ratios, while the ratios significantly varied for vocational and technical Anatolian high school and multi-program Anatolian high schools. The ratio of students with advanced science proficiency significantly increased for Anatolian imam hatip high schools and varied significantly for science high schools and Anatolian high schools. The science high schools started with a ratio of 22.8% but ended up with 19.4%. The ratios for Anatolian high schools started from 1.4% to 2.7%. The results for reading proficiency levels also revealed a significantly positive trend for Anatolian imam hatip high schools. The basic proficiency ratios varied significantly for Anatolian high schools, vocational and technical Anatolian high school and multi-program Anatolian high schools. However, in 2018, Anatolian high schools managed to reach their starting (a ratio around 70% in 2009) ratio. A concerning decrease was observed for the remaining two schools. The ratios for advanced reading proficiency varied for science high schools and Anatolian high schools, but both schools managed to increase their initial ratios over the years. A concerning decrease was observed for social sciences high schools from 17.1% in 2009 to 0.8% in 2018. Researchers add that there are statistically significant differences between types of schools. They mention that "in all three fields, almost all science high school and social science high school students have reached basic proficiency levels" whereas the ratios for Anatolian high schools were around 80% and the ratios for other school types were below 70% (Suna et al., 2020b, p. 93). The ratio distribution is even worse for advanced proficiency levels with some schools, such as fine arts high schools, failing to have even one student reaching the level. They also warn against the possibility of non-educational factors affecting the academic achievement differences between school types.

In addition to the aforementioned studies, some of the studies investigated whether other educational variables would also differ by types of schools such as learning approaches and problematic internet use. For example, Çolak and Kaya (2014) conducted a study on learning approaches (deep or surface) of students studying in technical high schools or vocational high schools. Their sample included 10^{th} and 11^{th} grade students from Istanbul. They collected their data with a background questionnaire and learning process questionnaire. They analysed their data with MANOVA. The results revealed that there were significant differences in learning approaches with respect to school types and grade level, but no significant differences occurred in the case of separate analysis. Their main finding is that "vocational high school students' surface approach scores increase as they move from tenth to eleventh grade" (Çolak & Kaya, 2014, p. 1560). On the other hand, a decrease is observed in technical high school students. They conclude that vocational high schools might be fostering an educational environment where surface level strategies are appreciated more than deep level strategies.

In a similar study, Kılıç and Sağlam (2010) compared the learning approaches of "565 secondary school students attending Anatolian high schools, vocational and technical high schools and high schools with intensive foreign language programme" (p. 3379). They used a Likert-type questionnaire called the learning approach questionnaire to collect data. MANOVA was performed for the analysis. The results revealed that students enrolled in vocational and technical high schools were significantly more likely to employ the rote learning approach. They were also significantly less likely to employ the meaningful learning approach. Even though there were not any statistically significant differences between the other two schools, students studying in high schools with intensive foreign language programme had the highest score for employing the meaningful learning approach. On the other hand, Anatolian high school students had the lowest score for employing the route learning approach. Once again, a disadvantage of vocational and technical high school students was highlighted.

Öztürk and Özmen (2016) went on to explore the relationship between problematic internet usage and school types along with number of other variables such as self-perception, personality types and gender. Their sample consisted of 771 high school students from a province in Turkey called Kars. Around 60% of the students were female and around half of them did not have a computer in their homes. Around 37% had an internet access in their homes, while the rest of the students accessed the internet from school, internet cafes or a friend's house –25%, 34% and 4% respectively. Six students did not have any internet access. They collected data with questionnaires on background information, problematic internet use, self-perception and personality. Multiple linear regressions and ANOVA were carried out for the analysis. The results revealed significant differences between school types on problematic use of the internet. "Technical high school students had a significantly higher problematic internet use score than students in all other types of schools" (Öztürk & Özmen, 2016, p. 503). The other types of schools in the study included "common high schools, vocational high schools for girls, fine arts high schools, trade vocational high schools, Anatolian high schools and science high schools" (Öztürk & Özmen, 2016, p. 504). This study also highlighted a disadvantageous set of circumstances for technical and vocational high schools that might deteriorate their educational outcomes.

Studies Investigating Both School Type and Geographic Region Related Inequalities

In addition to the studies summarized in the previous two headings, a number of studies investigated inequalities with respect to both school types and geographic regions. The following includes a selection of such studies.

Berberoglu and Kalender (2005) were interested in the trends of mean achievement scores on the central Turkish university entrance exam called OSS. (OSS consists of two branches that are the verbal branch consisting of Turkish, history, geography and philosophy and the numerical branch consisting of mathematics, physics, chemistry and biology.) In addition, they also investigated the differences between school types and geographic regions with respect to their PISA achievement scores and OSS scores. They used MANOVA to test the statistical differences, and partial effect size to test the practical implication of the differences. The results for school types revealed that a negative trend in the verbal branch of OSS was observed for religious high schools, Anatolian commerce high schools, technical high schools, Anatolian technical high schools, and Anatolian technical high schools for girls. Anatolian high schools showed a negative trend for both branches. Science high schools, on the other hand, showed a positive trend in the numerical branch. They add that schools under technical high schools, especially, showed a decreasing trend in their OSS scores. The schools that were considered above average according to OSS scores, such as science high schools, were also considered above average according to their mean PISA scores. Similarly, the below average schools, such as technical high schools, kept their positions as well. Partial effect size analysis also revealed that mean score differences between schools were of significant magnitude. The analysis of geographic regions revealed that OSS performance of all regions was below the 50% success rate for the verbal branch and below %20 for the numerical branch. This suggests that all regions performed poorly. The regions of East Anatolia and South-Eastern Anatolia performed comparatively lower than other regions in both branches. PISA scores also produced similar results. There were significant differences between regions, but the effect size was of negligible magnitude. Following the results, researchers suggest that Turkish students have low proficiency levels in basic academic subjects. In addition, educational inequalities pose a threat to Turkey as a social state. Statistical differences were lower than their expectations for geographic regions, but the issue of inequality between school types is a major issue.

In a similar study, Alacacı and Erbaş (2010) also looked into the between school types educational inequalities in Turkey regarding also the geographic regions. The main focus of the study was on school capital that was measured using "school autonomy, school management and funding, school resources, admitting, grouping and selecting [and] school program type" (p. 184). Background variables of geographic regions, family SES, school SES, gender, and school community were also included in the study to check their influence on PISA scores. They obtained their data from the 2006 PISA cycle. The data was analysed with hierarchical linear modelling. Their analysis revealed that between school capital differences accounted for around 55% of the variation between the students' scores. With respect to the types of schools, students attending vocational high schools were significantly more likely to attain lower scores than students from general secondary high schools. On the other hand, students from Anatolian high schools were significantly more likely to attain higher scores than general secondary students. However, among the background variables, only three of the variables were found to be significant that are family SES, school SES and gender. In other words, the variable of geographic regions was not a significant predictor of the scores. However, the students from the regions of Eastern Anatolia and South-Eastern Anatolia were significantly more likely to score lower than the students from the region of Marmara. Based on their findings, researchers strongly warn against the crucial effect of family and school capital related variables on academic achievement. They note that students are being grouped into SES clusters even within the system of public education which is an impediment for equality in educational opportunity.

Gumus and Atalmis (2012) also investigated achievement differences between school types and geographic regions in Turkey. They focused on the change of scores between the 2003 administration of PISA and the 2009 administration. They started their analysis with a t-test to check if there were any statistically significant changes between the student scores in math, reading and science. The test revealed a significant positive increase of small magnitude in all subject areas from 2003 to 2009. The t-test for the regions revealed that

> … students' achievements in Marmara Region had significantly increased only in reading, students' achievements in the other six regions had increased in at least two subjects from 2003 to 2009. According to Cohen-d effect size, the magnitudes of increase are small in all regions but Eastern Anatolia. … [In addition, between group analysis of math achievement scores showed that] there was a significant relationship between students' performance in PISA and their regions of residence in both 2003 and 2009. (p. 54)

However, the relationship decreased from 2003 to 2009 and it was of small magnitude. Nevertheless, similar to all the studies mentioned previously, Eastern Anatolia and South-Eastern Anatolia could not close their achievement gaps completely with other regions from 2003 to 2009. The results were similar for reading and science. The results for within school differences were as follows:

> … While students' achievement in junior high school and Anatolian Vocational high school significantly increased in only one subject (math), students' performance from general high schools, Anatolian high schools, Anatolian technical high schools and vocational high schools increased at least in two subjects. However, performances from students in science high schools significantly decreased in all three subjects, while performances from students in technical high schools decreased in two subjects and performances in Anatolian vocational high schools decreased in one subject. (p. 59)

The relationship between the reading, math and science scores and the type of school was statistically significant in both 2003 and 2009. In fact, the size of the effect increased from 2003 to 2009, suggesting a worsening situation of inequality between schools. Among secondary schools, the biggest difference between mean scores occurred between science high schools, Anatolian high schools, vocational high schools and Anatolian vocational high schools. The last two obtained significantly lower scores than the first two.

Demir et al. (2010) ventured to check if there were secondary school efficiency differences between regions that might be negatively contributing to the educational inequalities. They pooled their data from the 2003 administration of PISA. However, some schools were excluded from the original sample. They measured the effectiveness of schools based on the following variables: school size, student to teacher ratio, highest occupational status of parents, gross domestic product purchasing parity and schooling ratio as input variables and math, reading and science scores as output variables. The efficiency implied that a positive change in the input variables produces a positive change of significant magnitude in the output variables. The analysis was done via output oriented CCR model. They grouped schools into two as efficient schools and inefficient schools. Among efficient schools, the most efficient school emerged to be science high schools in Aegean and the least efficient (among efficient schools) emerged to be Anatolian high schools in Istanbul. Among inefficient schools, the most efficient school (among inefficient schools) emerged to be Anatolian vocational high schools in Western Anatolia (roughly Ankara and Konya) and the least efficient emerged to be primary schools in Middle Anatolia (roughly Kırıkkale, Kayseri and their surroundings). In addition, efficient schools were found to be only in the following regions: Istanbul (2 efficient schools), Western Anatolia (2 efficient schools), Aegean (1 efficient school), Middle Anatolia (1 efficient school), and Eastern Black Sea (1 efficient school). Among types of schools, efficient schools were found only in the following schools: science high schools (2 efficient schools), vocational high schools (2 efficient schools), Anatolian high schools (1 efficient school), private high schools (1 efficient school) and police collages (1 efficient school).

A similar study was conducted by Sulku and Abdioglu in 2015. They used the data from the 2011 administration of Trends in Mathematics and Science Study (TIMSS) to unravel the factors that were contributing to the mathematics achievement differences between primary school students. In their study “basic statistical and econometric techniques, descriptive statistics, and classical linear regression models were employed to determine pupils’ success” (Sulku & Abdioglu, 2015, p. 423). Eight regression analyses were used to determine the influence of number of variables such as school type (public or private) and geographic region on

TIMSS math scores. Significant differences were found between achievement score for both school type (in favour of private schools) and geographic region (in disfavour of Eastern Anatolia and South-Eastern Anatolia). In addition, the variables of rural/urban settlement, father's educational background and economic status, ownership of educational and training materials, gender and attitudes towards math were also found to be of significant importance.

Conclusion

To sum up, Turkey has educational inequalities between school types and geographic regions which is an issue that authorities need to fix. Based on the theoretical overview, this study aims to fill a literature gap on differences in scientific epistemic beliefs between general secondary schools and vocational and technical secondary schools and between geographic regions (NUTS regions at level 1 in Turkey). Epistemic beliefs about science should ideally be distributed equally within a country. That is because epistemic beliefs in science is a component of capability of doing science (which is an underlying assumption of this study). Furthermore, the more sophisticated scientific epistemic beliefs are assumed to result in higher capability in doing science. The only setback of this assumption is the alleged Western centrism of the construct –because the initial assumption of Schommer also assumes a correlation between higher cognitive ability and sophistication of epistemic beliefs. However, the problem with Western centrism is mostly an issue with dimensions related to the source of knowledge which the PISA questionnaire on epistemic beliefs (the instrument of this study) does not include. On the basis of this assumption, scientific epistemic beliefs can be taken as an indicator of capability of doing science. In fact, in the case of Turkey, scientific epistemic beliefs explain around 7.4% variation in PISA science scores (OECD, 2016). Implying that the assumption is not violated.

CHAPTER 3: METHOD

Introduction

This paper aspires to describe if there are any statistically significant mean score differences between NUTS-1 regions of Turkey, school types (general secondary schools and vocational and technical secondary schools) and their interaction. The study pools its data from the 2015 administration of Programme for International Student Assessment (PISA). This chapter explains in detail the research design, sampling, instrumentation, data collection and analysis methods in order.

Research Design

This study uses an explanatory study design. Two reasons for the use of this research design are stated as, first, the available information on the topic is limited and, second, the hypotheses have a causal nature (George & Merkus, 2021). This study goes along with both of them. The study aims to shed light on the between school and geographic region differences in scientific epistemic beliefs for which the literature is limited. Furthermore, the hypotheses are in line with the literature that is explained in the Chapter 2, and they are as follows. First, the students studying in the west of Turkey are significantly more sophisticated than the students studying the east. Second, the students studying in general secondary schools are significantly more sophisticated than the students studying in vocational and technical secondary schools. Third, there is an interaction effect that is the effect of two tracks of schooling in Turkey depends on the effect of geographic regions and vice versa. To put it differently, this study expects to reveal a possible causal relationship between sophisticated epistemic beliefs, geographic regions, and two tracks of schooling in Turkey.

Context

PISA is OECD's programme through which they suggest policies to improve the education system of countries and economies involved (Hanberger, 2014; Schleicher, 2019). Each of PISA's triennial administration focuses on one of the following domains: reading, mathematics, and science. PISA assesses the extent to which formal compulsory education and associated education policies equips 15-years-old students with relevant twenty-first century skills in these three domains (Schleicher, 2019). By the virtue of PISA's scale, countries compare themselves with other participant countries and determine how effective their policies have been in practice. Turkey took part in the exam regularly since 2003. Authorities in Turkey have often shown interest in increasing the Turkish students' PISA performance.

According to the PISA results, there are significant scientific literacy differences between geographic regions and school types in Turkey (Taş et al., 2016). Needless to say, Turkey, as a whole, falls behind other OECD countries in equipping its students with economically competent skills in math, reading and science as well (OECD, 2016). To elaborate on the previous point, PISA uses the Nomenclature of Territorial Units for Statistics (NUTS) at level 1 (see Figure 1) partition of Turkey. According to the results of PISA there are significant differences between these geographic regions (Suna et al., 2019; Taş et al., 2016; Yıldırım et al., 2013). Besides, between geographic region differences were reported in other studies too (Ataç, 2019; Erberber, 2010; Ferreira & Gignoux, 2010; Tomul, 2007). Without much digression, one of the reasons why differences between regions are studied by educationalists in Turkey is that the living conditions tend to significantly differ between the eastern and western regions (Gezici & Hewings, 2004; Tomul & Savasci, 2012). However, since the conditions of our times necessitates accidents of birth to not intervene in the schooling process, educationalists in Turkey need to make sure that differences between living conditions do not penetrate schools. Similar to the geographic regions, the variable of school types in Turkey is also a significant predictor of achievement (Berberoğlu & Kalender, 2005; Bölükbaş & Gür, 2020; Çolak & Kaya, 2014). To give an instance, PISA 2015 – which this study focuses on– made use of ten implicit school type variables for stratifying the sample (OECD, 2017b). These variables were later grouped into three as the following: basic education, general secondary school, vocational and technical secondary school (OECD, 2015b). Basic education included 15 years-old students who were still studying in the first 8^{th} grades at the time of the PISA 2015 cycle. General secondary schools included all the students from Anatolian high schools, science high schools, social sciences high schools, religious high schools (commonly referred to as imam hatip high schools) and private high schools. That is general secondary students are in the academic route in Turkey as opposed to vocational and technical secondary students who learn skills tailored to a specific career route. Turkish Ministry of Education noted that PISA scores differed significantly between these school types (Suna et al., 2019; Taş et al., 2016; Yıldırım et al., 2013). Surveillance of inequalities between schools is important in Turkey for the following reasons. First, schooling routes in Turkey are allegedly socio-economic clusters in disguise (Alacacı & Erbaş, 2010; Suna et al., 2020a). Second, the vocational and technical secondary schools tend to have a negative socialization effect that deteriorate students' learning approaches and academic motivation (Bölükbaş & Gür, 2020; Kılıç & Sağlam, 2010).

As has been mentioned numerous times, the educational inequalities in Turkey are damaging both for the authorities who want to increase the country's human capital (Mereuta, 2019) and individuals who wish to attain better capabilities through public schooling. Science is among disciplines which are desired by both. Science supports a country's human capital by making the working force more profitable according to the 21st century standards. Individuals also desire to increase their capabilities of doing science because of science's alleged link to better paying jobs. Even though, it is hard to pinpoint all the variables that constitute one's capability of doing science, the variable which this study focuses on –scientific epistemic beliefs– is allegedly one of such variables (Trautwein & Lüdtke, 2006).

According to the PISA 2015 cycle (which included 6 items on scientific epistemic beliefs), scientific epistemic beliefs scores explained about %7.4 variance of science scores of Turkish students (OECD, 2016). Moreover, Turkey is among the least sophisticated countries which is a result in harmony with nation-wide low scientific literacy levels (OECD, 2016). In other words, scientific epistemic beliefs seem to be related to capability of doing science in the case of Turkey. Considering that significant scientific literacy differences exist between geographic regions and between general secondary and vocational and technical secondary schools; it is possible that both variables have significant differences between their mean scientific epistemic beliefs scores as well. To put it differently, since scientific epistemic beliefs seem to be related to Turkish students' capability of doing science and the capabilities of doing science do not appear to be distributed equally within the country, it is possible that there are significant differences with regards to scientific epistemic beliefs as well. Especially between geographic regions and school types (for which there are persistent educational inequalities), scientific epistemic beliefs could be distributed unfairly.

Sampling

The sample of the PISA examinations consist of 15-year-old students studying at least in the grade 7. The sampling design used in Turkey was a "two-staged stratified sample design" (OECD, 2017b, p.66). In the first stage, 187 schools were chosen from a list of eligible schools in Turkey –hosting around 70% of all fifteen-years-old students in Turkey. The schools were located in 61 different Turkish provinces. In the second stage, 5895 students were chosen from the list of students attending a school sampled in the first stage (OECD, 2017b; Taş et al., 2016). However, in this study, 111 students from basic education were not included because their size was too small compared to the sizes of the other two groups. To be more specific, the number of valid responses for general secondary schools was around 3000 for the six items analysed and the number for vocational and technical secondary schools was around 2400. SEB index also had similar numbers for both tracks. To put it another way, the sample sizes were somewhat equal between schools. On the other hand, the valid response numbers differed numerically between NUTS-1 regions. The Istanbul Region (TR1) had the highest number among regions with approximately 1000 valid responses for all items and scientific epistemic beliefs (SEB) index. The second highest was the Mediterranean Region (TR6) with around 800 valid responses, followed by the Aegean Region (TR3) with around 700 responses for each item and SEB index. The list continued in the following order of regions: Southeast Anatolia (TRC) with around 600 responses, West Anatolia (TR5) with around 550 responses, East Marmara (TR4) with around 470 responses, Central Anatolia (TR7) with around 330 responses, West Black Sea (TR8) with around 280 responses, Central East Anatolia (TRB) with around 250 responses, West Marmara (TR2) with around 230 responses, East Black Sea (TR9) with around 190 responses and North East Anatolia (TRA) with around 170 valid responses. This could be stated as TR2, TR7, TR9, TRA and TRB had relatively similar valid responses in size; TR4, TR5 and TRC also had relatively similar responses in size; TR3 had a comparatively similar number of responses with TR6; and TR1 had disproportionately large number of responses. That is there were roughly four different sizes of valid responses for NUTS-1 regions.

Instrumentation

PISA can be conducted either with a paper or a computer-based design. In 2015, Turkey followed the computer-based design. Both designs include a cognitive assessment tool, a student questionnaire, and an optional financial literacy test. The cognitive assessment tool included items related to mathematics, science, and reading literacy (OECD, 2017b). Item types included selected response (either simple or complex) and open response. These items were used to form 66 different booklets (Taş et al., 2016). The student questionnaire focused on collecting information about variables relevant to education such as family background and scientific epistemic beliefs. Turkey did not implement the financial literacy test which was available in PISA 2015. Computer-based design also included an educational career questionnaire (optional), an ICT familiarity questionnaire (optional), and a teacher questionnaire (optional). Turkey did not implement any of these additional questionnaires. Turkish was the only available test-language. The instruments were translated to Turkish from English (OECD, 2017b).

The student questionnaire included six 4-point Likert scale items about epistemic beliefs about science. Each of the items was rated from 1, meaning strongly disagree, to 4, meaning strongly agree (OECD, 2015a). That is the students were not allowed to pick a neutral position. They had to pick a clear stance on the six statements listed on the screen. The higher scores were associated with more sophisticated beliefs about science.

The items, in order, are as listed below:

1. A good way to know if something is true is to do an experiment.
2. The ideas in <broad science> books sometimes change.
3. Good answers are based on evidence from many different experiments.
4. It is good to try experiments more than once to make sure of your findings.
5. Sometimes <broad science> scientists change their minds about what is true in science.
6. The ideas in <broad science> science books sometimes change (OECD, 2015a, p. 61).

According to the multi-dimensional models of epistemic beliefs, three of the items measured the justification dimension (items 1, 3 and 4), while the remaining three measured the certainty dimension (items 2, 5 and 6). Nevertheless, factor analysis of the PISA 2015 data for Turkish students excluding basic education students (n = 111) revealed a factor structure with a single dimension. The single factor structure was observed when the data was split with respect to NUTS-1 regions only, school types (general secondary schools and vocational and technical secondary schools) only, and both. OECD (2017a) reported the scale reliability of these six items as being equal to .92 for the PISA 2015 data from Turkey.

Method of Data Collection

For the computer-based administration, a computer was allocated to each student. Students had to start with the cognitive assessment tool. They were allowed 120 minutes to complete the cognitive assessment tool –with a break of at most 5 minutes allowed at the 60-minutes timestamp. Students were allowed 35 minutes to complete the student questionnaire. A total of 30-minutes were allocated for distributing and collecting the materials –15-minutes for each. Fifteen to 30 minutes of break time was allowed before the student questionnaire session (OECD, 2017b). After the computer-based administration, selected response type items were coded automatically by the computers. Majority of the constructed type items were coded by humans and the rest was coded automatically (OECD, 2017b).

Method of Data Analysis

Two-way factorial ANOVA was used for the analysis. The dependent variables were the 6 items about scientific epistemic beliefs (SEB) from the PISA student questionnaire in addition to an index score provided by PISA that incorporates responses to these items using Item Response Theory. SEB index score is scaled such that the mean is 0 and the standard deviation is 1. The six items were coded in their order from the list above, under the Instrumentation section. That is, the item 1 referred to the item *A good way to know if something is true is to do an experiment* and so on. The items were also considered separately in the analysis. The categorical independent variables were school types and geographic regions. School types had two categories that were general secondary schools, and vocational and technical educational secondary schools. Students from basic education were excluded from the analysis due to the small size of the participants. The geographic regions had twelve categories that were Istanbul Region (TR1), West Marmara Region (TR2), Aegean Region (TR3), East Marmara Region (TR4), West Anatolia Region (TR5), Mediterranean Region (TR6), Central Anatolia Region (TR7), West Black Sea Region (TR8), East Black Sea Region (TR9), Northeast Anatolia Region (TRA), Central East Anatolia Region (TRB), and Southeast Anatolia Region (TRC). The null hypotheses were as follows:

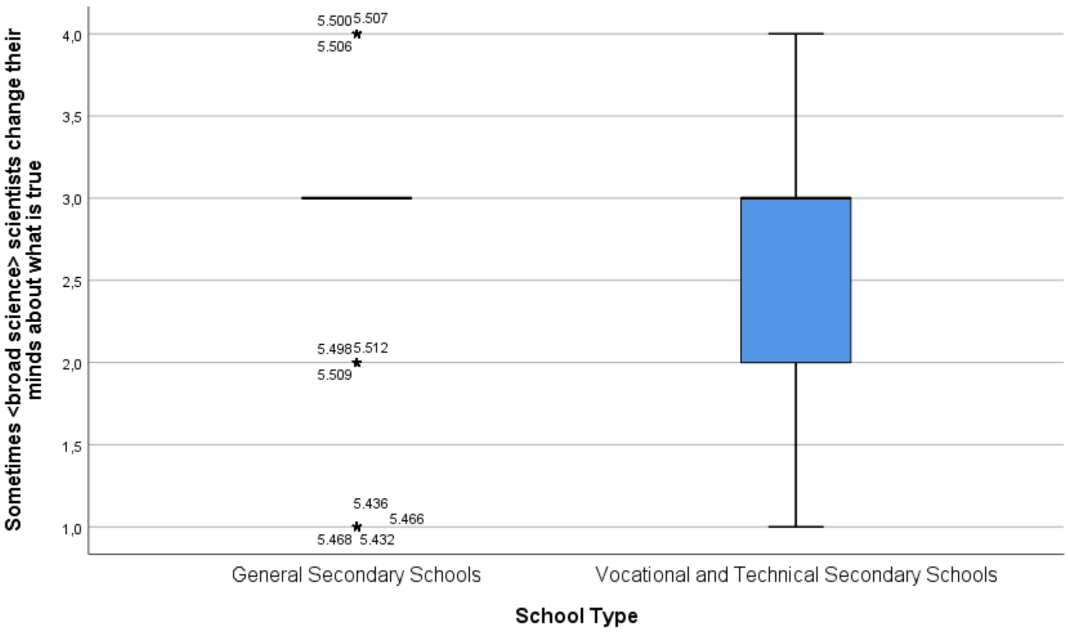
1. There are no significant mean differences in scientific epistemic beliefs scores between any pairs of NUTS-1 regions.
2. There is no significant mean difference in scientific epistemic beliefs scores between general secondary schools and vocational and technical secondary schools.
3. There is no interaction effect between school types and geographic regions on mean scientific epistemic beliefs scores.

The analysis was carried out with SPSS. The threshold value for statistical significance, alpha, was set to .05. The students were weighted according to a variable provided by the PISA dataset called W_FSTUWT. This variable provided information on the students' weights to ensure the representability of the whole population.

Before conducting analyses, the assumptions of the two-way ANOVA were checked. First and foremost, the dependent variables (six 4-point Likert scale items and SEB index score) were assumed to be continuous, and both of the independent variables (school types in Turkey and NUTS-1 regions of Turkey) had at least two categories. The assumption for the independence of observations was also fulfilled. The next step was to carry out outlier analyses on SPSS with boxplots. Since two-way ANOVA was used in the study, the outliers were first checked for each category of NUTS-1 regions and school types. Significant outliers were detected for general secondary schools for the items 2 and 5. No significant outliers were detected for vocational and technical secondary schools. The boxplots for NUTS-1 regions revealed that there were significant outliers for the following regions. Istanbul had significant outliers for the item 3; Aegean had significant outliers for items 2 and 5; East Marmara had significant outliers for the item 3; West Anatolia had significant outliers for the items 2, 5 and 6; and lastly, Central East Anatolia had significant outliers for the item 4. After that the data was split according to school types and the outliers were checked for each category of NUTS-1 regions. The purpose was to check if there are any significant outliers in the combination of two variables since the analysis would reveal the results for each school type in each region separately. Significant outliers were as follows. Regarding general secondary school students, there were significant outliers in Istanbul for items 2, 3, 5 and 6; East Marmara for items 2 and 6; West Anatolia for items 2, 5 and 6; Mediterranean for items 2 and 5; Northeast Anatolia for the item 2; and lastly Central East Anatolia for the item 4. On the other hand, significant outliers for vocational and technical secondary schools were detected in Aegean for items 3 and 4, and East Black Sea for the item 2. However, since all of the significant outliers occurred when most students picked agree (for which the numerical value was 3) with the given statement, the outliers were kept in the data. That is, since a forced Likert scale was used to measure the responses, when a trend of agreeing with a statement occurred, the students who strongly agreed, disagreed, or strongly disagreed made up the significant outliers as illustrated in the Figure 2. SEB index and item 1 did not have any significant outliers for NUTS-1 regions, the two types of school and their combinations.

Figure 2

Outliers For the Item 5 per Each Category of School Types



After the outlier analyses, Shapiro-Wilk Normality Test was run on SPSS to test if each category of school types and NUTS-1 regions were distributed normally. Null hypotheses were rejected for both school types for all items and SEB index ($p < .01$ for all). That is responses of students were not normally distributed for both schools. Similarly, null hypotheses were rejected for each category of NUTS-1 regions for all items and SEB index as well ($p < .01$ for all). That is all categories of school types and NUTS-1 regions were not normally distributed. After that, the data was split according to school types once again to check the distribution of the data for combinations of NUTS-1 region and both school tracks. All null hypotheses of Shapiro-Wilk Normality Tests were rejected once again ($p < .01$ for all). That is the data for NUTS-1 regions were not distributed normally for both general secondary schools and vocational and technical secondary schools. However, since two-way ANOVA is robust to violating the assumption of normality, the study was continued. Furthermore, skewness was absolutely smaller than 1 for all NUTS-1 regions, school types and combinations of NUTS-1 region and both tracks of schooling. Similarly, kurtosis was absolutely smaller than 1 for all data except the data of vocational and technical secondary schools (VTSS) students in West Blacks Sea, Northeast Anatolia and Southeast Anatolia for the item 1; VTSS students in Northeast Anatolia for items 3, 4, and 5; general secondary schools' students in East Marmara for item 2; and students in Northeast Anatolia for the item 1. However, all these data had kurtosis absolutely smaller than 2 which is within the acceptable range for assumption of normality (George & Mallery, 2010). Hence, normality was assumed.

The last assumption to check was the homogeneity of the variances. The Levene's Test of Homogeneity of Variances was carried out on SPSS for both tracks of schooling and NUTS-1 regions for all items and SEB index. Homogeneity of variances (based on mean) held true for SEB index between two tracks of schooling. The analysis also revealed that there were significant differences between the variances (based on mean) of both categories school types for items considered individually ($p < .01$). Similar results were obtained for NUTS-1 regions for individual items and SEB index. That is the variances (based on mean) significantly differed between the categories of NUTS-1 regions. After that, the data was split according to the school types and the Levene's Test was run for NUTS-1 regions. The null hypothesis was not rejected for general secondary students' response to the item 3 and SEB index score of vocational and technical secondary schools. That is the variances (based on mean) were homogenous between NUTS-1 regions for the item 3 regarding general secondary schools. Null hypotheses were rejected for all the other cases. Lastly, the data was split according to the NUTS-1 regions of Turkey and the Levene's Test was run for school types. Null hypotheses were not rejected for West Marmara, Aegean, Mediterranean, East Black Sea and Central East Anatolia for all individual items; East Marmara for the item 3; West Anatolia for items 1, 3, 4, 5, and 6; Central Anatolia for items 3, 4, 5, and 6; West Black Sea for items 1, 2, 4, 5, and 6; Northeast Anatolia for items 1, 2, 3, 5, 6; and lastly, for Southeast Anatolia for the item 5. That is variances of general secondary schools and vocational and technical secondary schools were homogenous for the regions and items listed. The hypotheses were rejected for all the other cases. For the case of SEB index, the between school variances was homogenous in Istanbul, West Marmara, East Marmara, West Anatolia, Central Anatolia, West Black Sea, East Black Sea, Northeast Anatolia, Central East Anatolia and Southeast Anatolia regions. However, the Levene's Test might have produced significant results due to the sample size being larger than 30 for all categories (Grace-Martin, 2018). Regardless, the sample sizes across NUTS-1 regions were not equal, so the validity for regional comparisons might be affected to a certain degree. Still, two-way ANOVA was carried out despite the violations.

CHAPTER 4: RESULTS

Introduction

This study aims to describe the differences in students' scientific epistemic beliefs scores between geographical regions and two tracks of schooling in Turkey, as defined by PISA. The tracks are general secondary schools and vocational and technical secondary schools. The data was pooled from the PISA 2015 cycle which included six 4-point Likert scale type items about scientific epistemic beliefs (SEB). PISA 2015 data also provided a SEB index score calculated with Item Response Theory –which scales responses so that the mean is 0 and standard deviation is 1. A two-way ANOVA was conducted to compare the main and interaction effects of school tracks (general secondary schools and vocational and technical secondary schools) and NUTS-1 regions of Turkey on scientific epistemic beliefs scores. The following sections present the results in the following order: between region differences, between school type differences, regional and school type differences, and lastly, the interaction effect.

Between-Geographical Regions Differences

Table 1 shows the mean scores for SEB index and each item per region. For the items, all of the means are higher than 2.5 suggesting a tendency for holding sophisticated epistemic beliefs. The highest mean score belongs to students from Western Anatolia for all items while the lowest mean score belongs to students from Northeast Anatolia. Excluding the students from the regions of East Black Sea, Central East Anatolia and Southeast Anatolia, students had the highest mean for the item 4. Students from East Black Sea had the highest mean for the item 3. Students from Southeast Anatolia had two maximum values for items 3 and 4. Students from

Central East Anatolia also had two maximum values, but for items 1 and 3 instead. The following regions had the minimum value for the item 2: Istanbul, Mediterranean, Central Anatolia, West Black Sea and Southeast Anatolia. The following regions had the minimum value for the item 6: West Marmara, East Marmara and Central East Anatolia. The regions of Aegean and Northeast Anatolia had two minimum values for items 2 and 6. Lastly, the item 5 produced the minimum mean score for the regions of West Anatolia and East Black Sea. For SEB index score, all of the regions had a mean lower than the average of all countries who attended PISA. This suggests that despite their tendency to hold sophisticated scientific epistemic beliefs, Turkish students are less sophisticated than the students from other countries. Northeast Anatolia students have especially deviated away from the mean. Among all regions, Aegean and West Anatolia are closest to the PISA 2015's attendee's average.

Table 1

The Mean Score for the SEB index and Each SEB Item With Respect To Regions

NUTS-1 Regions	SEB Index	Items					
		1	2	3	4	5	6
Istanbul (TR1)	-0.17	2.89	2.83	2.92	3.00	2.85	2.85
West Marmara (TR2)	-0.34	2.84	2.79	2.81	2.86	2.71	2.66
Aegean (TR3)	-0.08	2.91	2.87	2.99	3.04	2.89	2.87
East Marmara (TR4)	-0.19	2.89	2.84	2.89	2.93	2.83	2.79
West Anatolia (TR5)	-0.04	2.96	2.89	3.04	3.10	2.88	2.92
Mediterranean (TR6)	-0.12	2.92	2.84	2.94	2.99	2.86	2.91
Central Anatolia (TR7)	-0.31	2.81	2.70	2.79	2.84	2.78	2.78
West Black Sea (TR8)	-0.33	2.73	2.68	2.80	2.86	2.70	2.75
East Black Sea (TR9)	-0.16	2.86	2.84	2.97	2.96	2.80	2.85
Northeast Anatolia (TRA)	-0.54	2.59	2.56	2.65	2.68	2.59	2.56
Central East Anatolia (TRB)	-0.24	2.91	2.79	2.91	2.88	2.78	2.71
Southeast Anatolia (TRC)	-0.30	2.79	2.68	2.87	2.87	2.76	2.73

Table 2 shows the mean score differences for the SEB Index between NUTS-1 regions of Turkey. The effect size, as shown by partial η^2, NUTS-1 regions have on the scores for item 1 was .01 ($F(11, 5475) = 4.00$, $p < .001$). This implies that only 1% of the differences in scores for the index was explained by differences in regions. Still, there were significant mean differences between regions. The significant mean differences were as follows. Northeast Anatolia (M = -0.54, SD = 0.10) had a significantly lower mean than Aegean (M = -0.09, SD = 0.05, p = .007), West Anatolia (M = -0.07, SD = 0.05, p = .002) and Mediterranean (M = -0.15, SD = 0.04, p = .023). In addition, West Anatolia had a significantly higher mean than West Black Sea (M = -0.33, SD = 0.07, p = .043) and Southeast Anatolia (M = -0.30, SD = 0.05, p = .014). In the following, the two-way ANOVA results are presented item by item and these results are in line with the result for the SEB index score. That is Northeast Anatolia will appear as the pair with the significantly lower mean score for each item compared to the regions mentioned here. In addition, West Anatolia will have significantly higher mean than number of other regions. Lastly, the effect sizes are of small magnitude for all items.

Table 3 shows the mean score differences for the item 1 (*A good way to know if something is true is to do an experiment*) between NUTS-1 regions of Turkey. The effect size, as shown by partial η^2, NUTS-1 regions have on the scores for item 1 was .01 ($F(11, 5472) = 2.96$, $p = .001$). In other words, only 1% of the differences in scores for this item was explained by differences in regions. Despite the very small practical effects, there appeared to be significant mean differences between regions. Namely, three pairs yielded significant mean differences. To be more precise, the mean score of Northeast Anatolia (M = 2.59, SD = 0.09) was statistically significantly lower than the mean scores of Aegean (M = 2.91, SD = 0.04, p = .035), West Anatolia (M = 2.96, SD = 0.04, p = .006) and Mediterranean (M = 2.92, SD = 0.03, p = .017). There were numerical differences between the other pairs, but the differences were not statistically significant.

Table 4 shows the mean score differences for the item 2 (*The ideas in <broad science> books sometimes change*) between NUTS-1 regions of Turkey. For this item, the effect size was the same as before. Only 1% of the variations of scores for item 2 was explained by the twelve regions (F(11, 5429) = 4.15, p < .001). Nevertheless, six pairs of regions yielded statistically significant results. The region of Northeast Anatolia (M = 2.56, SD = 0.08) performed significantly below Aegean (M = 2.87, SD = 0.03, p = .017) and West Anatolia (M = 2.89, SD = 0.04, p = .011). However, the numerical difference between Northeast Anatolia and Mediterranean was not significant for the second item, as opposed to the first one. The mean score of West Anatolia was significantly higher than the mean scores of West Black Sea (M = 2.68, SD = 0.05, p = .041) and Southeast Anatolia (M = 2.68, SD = 0.04, p = .004) as well. In addition, the mean scores of Aegean (p = .006) and Mediterranean (M = 2.84, SD = 0.03, p = .037) were significantly higher than Southeast Anatolia. Based on the results of the first two items, a pattern seemed to have emerged that was in favor of regions of Aegean, West Anatolia and Mediterranean and in disfavor of Northeast Anatolia and Southeast Anatolia. Once again, there were numerical differences between the other pairs, but the differences were not statistically significant.

Table 2

The Mean Score Differences for SEB index between NUTS-1 Regions of Turkey

NUTS regions	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC
Istanbul (TR1)	–											
West Marmara (TR2)	0.17	–										
Aegean (TR3)	-0.09	-0.26	–									
East Marmara (TR4)	0.02	-0.15	0.11	–								
West Anatolia (TR5)	-0.13	-0.30	–0.04	–0.15	–							
Mediterranean (TR6)	-0.05	-0.21	0.04	–0.07	0.08	–						
Central Anatolia (TR7)	0.14	-0.03	0.23	0.12	0.27	0.18	–					
West Black Sea (TR8)	0.16	0	0.25	0.14	0.29*	0.21	0.03	–				
East Black Sea (TR9)	-0.01	-0.18	0.08	-0.03	0.12	0.04	-0.15	-0.17	–			
Northeast Anatolia (TRA)	0.38	0.20	0.46*	0.35	0.50**	0.42*	0.23	0.21	0.38	–		
Central East Anatolia (TRB)	0.07	-0.10	0.16	0.05	0.20	0.12	-0.07	-0.09	0.08	-0.30	–	
Southeast Anatolia (TRC)	0.13	-0.03	0.22	0.11	0.26*	0.18	0	-0.03	0.14	-0.24	0.06	–

Note. * $p < .05$. ** $p < .01$.

Table 3

The Mean Score Differences for the Item 1 between NUTS-1 Regions of Turkey

NUTS regions	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC
Istanbul (TR1)	–											
West Marmara (TR2)	0.04	–										
Aegean (TR3)	-0.03	-0.07	–									
East Marmara (TR4)	0	-0.05	0.02	–								
West Anatolia (TR5)	-0.08	-0.12	–0.05	–0.08	–							
Mediterranean (TR6)	-0.04	-0.08	–0.01	–0.04	0.04	–						
Central Anatolia (TR7)	0.08	0.04	0.11	0.08	0.16	0.12	–					
West Black Sea (TR8)	0.15	0.11	0.18	0.16	0.23	0.19	0.07	–				
East Black Sea (TR9)	0.03	-0.02	0.05	0.03	0.11	0.07	–0.05	–0.13	–			
Northeast Anatolia (TRA)	0.30	0.26	0.33*	0.30	0.38*	0.34*	0.22	0.15	0.27	–		
Central East Anatolia (TRB)	-0.03	-0.07	0	–0.03	0.05	0.01	–0.11	–0.18	–0.06	–0.33	–	
Southeast Anatolia (TRC)	0.09	0.05	0.12	0.10	0.17	0.13	0.01	–0.06	0.07	–0.21	0.10	–

Note. * $p < .05$. ** $p < .01$.

Table 4

The Mean Score Differences for the Item 2 between NUTS-1 Regions in Turkey

NUTS regions	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC
Istanbul (TR1)	–											
West Marmara (TR2)	0.04	–										
Aegean (TR3)	-0.04	-0.08	–									
East Marmara (TR4)	-0.01	-0.05	0.03	–								
West Anatolia (TR5)	-0.06	-0.10	–0.02	–0.05	–							
Mediterranean (TR6)	-0.01	-0.05	0.03	0	0.05	–						
Central Anatolia (TR7)	0.13	0.09	0.17	0.14	0.19	0.14	–					
West Black Sea (TR8)	0.15	0.11	0.19	0.16	0.21*	0.16	0.02	–				
East Black Sea (TR9)	-0.01	-0.05	0.03	0	0.05	0	–0.14	–0.16	–			
Northeast Anatolia (TRA)	0.26	0.23	0.31*	0.27	0.32*	0.27	0.14	0.11	0.30	–		
Central East Anatolia (TRB)	0.04	0	0.08	0.05	0.10	0.05	–0.09	–0.11	0.10	–0.22	–	
Southeast Anatolia (TRC)	0.14	0.11	0.19*	0.15	0.20**	0.16*	0.02	–0.01	0.20	–0.12	0.1.	–

Note. * *p* < .05. ** *p* < .01.

Table 5 shows the mean score difference for the item 3 (G*ood answers are based on evidence from many different experiments)* between NUTS-1 regions of Turkey. The pattern from previous two items remained for the regions of Aegean, West Anatolia and Northeast Anatolia. That is both Aegean (M = 2.99, SD = 0.04, p = .011) and West Anatolia (M = 3.04, SD = 0.04, p = .002) significantly outperformed Northeast Anatolia (M = 2.65, SD = 0.08). West Anatolia also realized a significantly higher mean score than the regions of Central Anatolia (M = 2.79, SD = 0.05, p = .006) and West Black Sea (M = 2.80, SD = 0.05, p = .013). On that account, West Anatolia managed to maintain its favorable results for this item as well. The other pairs did not generate statistically significant mean differences. Still and all, the effect of NUTS-1 regions on the scores for the item 3 was, once again, equal to .01 (F(11, 5411) = 3.85, p < .001).

Table 6 shows the mean score difference for the item 4 (*It is good to try experiments more than once to make sure of your findings)* between NUTS-1 regions of Turkey. In line with the above results, the effect size was equal to .01 (F(11, 5432) = 4.80, p < .001) Still, this item yielded one of the highest numbers for pairs with significant mean differences with eight pairs in total. West Anatolia (M = 3.10, SD = 0.04) proved itself to be capable of performing significantly above the regions of Central Anatolia (M = 2.84, SD = 0.05, p = .005), West Black Sea (M = 2.86, SD = 0.05, p = .014), Northeast Anatolia (M = 2.68, SD = 0.08, p < .001) and Southeast Anatolia (M = 2.87, SD = 0.04, p = .001). Aegean (M = 3.04, SD = 0.04) also sustained its significantly higher mean score compared to Northeast Anatolia (p = .004) and Southeast Anatolia (p = .034). For this item, the mean score of Northeast Anatolia was significantly lower than the mean scores of Istanbul (M = 3.00, SD = 0.03, p = .018) and Mediterranean (M = 2.99, SD = 0.03, p = .028) as well.

Table 5

The Mean Score Differences for the Item 3 between NUTS-1 Regions in Turkey

NUTS regions	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC
Istanbul (TR1)	–											
West Marmara (TR2)	0.11	–										
Aegean (TR3)	-0.07	-0.17	–									
East Marmara (TR4)	0.03	-0.08	0.09	–								
West Anatolia (TR5)	-0.11	-0.22	–0.05	–0.14	–							
Mediterranean (TR6)	-0.02	-0.13	0.05	–0.05	0.10	–						
Central Anatolia (TR7)	0.14	0.03	0.20	0.11	0.25*	0.15	–					
West Black Sea (TR8)	0.13	0.02	0.19	0.10	0.24*	0.14	–0.01	–				
East Black Sea (TR9)	-0.04	-0.15	0.02	–0.07	0.07	–0.02	–0.18	–0.17	–			
Northeast Anatolia (TRA)	0.27	0.16	0.34*	0.24	0.38**	0.29	0.14	0.15	0.31	–		
Central East Anatolia (TRB)	0.02	-0.09	0.08	–0.01	0.13	0.03	–0.12	–0.11	0.06	–0.26	–	
Southeast Anatolia (TRC)	0.06	-0.05	0.12	0.03	0.17	0.07	–0.08	–0.07	0.10	–0.22	0.04	–

Note. * $p < .05$. ** $p < .01$.

Table 6

The Mean Score Differences for the Item 4 between NUTS-1 Regions in Turkey

NUTS regions	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC
Istanbul (TR1)	–											
West Marmara (TR2)	0.14	–										
Aegean (TR3)	–0.04	–0.18	–									
East Marmara (TR4)	0.08	–0.07	0.12	–								
West Anatolia (TR5)	–0.09	–0.24	–0.05	–0.17	–							
Mediterranean (TR6)	0.01	–0.13	0.05	–0.07	0.10	–						
Central Anatolia (TR7)	0.16	0.02	0.20	0.08	0.25*	0.15	–					
West Black Sea (TR8)	0.15	0.00	0.19	0.07	0.24*	0.14	–0.01	–				
East Black Sea (TR9)	0.04	–0.10	0.08	–0.04	0.13	0.03	–0.12	–0.11	–			
Northeast Anatolia (TRA)	0.32*	0.18	0.36**	0.25	0.42**	0.31*	0.16	0.18	0.28	–		
Central East Anatolia (TRB)	0.12	–0.02	0.16	0.05	0.21	0.11	–0.04	–0.03	0.08	–0.20	–	
Southeast Anatolia (TRC)	0.14	–0.01	0.18*	0.05	0.23**	0.13	–0.02	–0.01	0.10	–0.19	0.02	–

Note. * $p < .05$. ** $p < .01$.

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Table 7 shows the mean score difference for the item 5 (*Sometimes <broad science> scientists change their minds about what is true in science*) between NUTS-1 regions of Turkey. Once more, the effect size was .01 (F(11, 5441) = 2.93, p = .001). In addition to a very small practical effect, this item yielded only one pair with a statistically significant mean difference as well. Aegean Region (M = 2.89, SD = 0.03) had a significantly higher mean than the region of Northeast Anatolia (M = 2.59, SD = 0.08, p = .04). The numerical differences between the other pairs were not significant.

Table 8 shows the mean score difference for the last item (*The ideas in <broad science> science books sometimes change*) between NUTS-1 regions of Turkey. Similar to all items before, the effect size was .01 (F(11, 5411) = 4.54, p < .001). Regardless, along with the item 4, this item generated the highest number of pairs with significant mean differences. There were eight such pairs in total. In line with the previous results, the mean score of Northeast Anatolia (M = 2.56, SD = 0.08) was significantly lower than the mean scores of Istanbul (M = 2.85, SD = 0.03, p = .036), Aegean (M = 2.87, SD = 0.03, p = .026), West Anatolia (M = 2.92, SD = 0.04, p = .003) and Mediterranean (M = 2.91, SD = 0.03, p = .003). The mean score of Southeast Anatolia (M = 2.73, SD = 0.04) was significantly lower than the mean scores of West Anatolia (p = .025) and Mediterranean (p = .012) in line with the previous results as well. Lastly, the mean score of the region of West Marmara (M = 2.66, SD = 0.06) was significantly lower than the mean scores of West Anatolia (p = .011) and Mediterranean (p = .009). The pattern of Aegean, West Anatolia and Mediterranean being significantly more sophisticated than Northeast Anatolia and Southeast Anatolia emerged for this item as well.

Table 7

The Mean Score Differences for the Item 5 between NUTS-1 Regions in Turkey

NUTS regions	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC
Istanbul (TR1)	–											
West Marmara (TR2)	0.14	–										
Aegean (TR3)	–0.04	–0.18	–									
East Marmara (TR4)	0.03	–0.11	0.06	–								
West Anatolia (TR5)	–0.03	–0.17	0.01	–0.05	–							
Mediterranean (TR6)	–0.01	–0.15	0.03	–0.04	0.02	–						
Central Anatolia (TR7)	0.08	–0.07	0.11	0.05	0.10	0.09	–					
West Black Sea (TR8)	0.16	0.02	0.20	0.13	0.18	0.17	0.08	–				
East Black Sea (TR9)	0.05	–0.09	0.09	0.02	0.08	0.06	–0.03	–0.11	–			
Northeast Anatolia (TRA)	0.26	0.12	0.30*	0.23	0.29	0.27	0.19	0.10	0.21	–		
Central East Anatolia (TRB)	0.08	–0.06	0.11	0.05	0.10	0.09	0.00	–0.08	0.03	–0.18	–	
Southeast Anatolia (TRC)	0.09	–0.05	0.13	0.07	0.12	0.10	0.02	–0.07	0.04	–0.17	0.02	–

Note. * $p < .05$. ** $p < .01$.

Table 8

The Mean Score Differences for the Item 6 between NUTS-1 Regions in Turkey

NUTS regions	TR1	TR2	TR3	TR4	TR5	TR6	TR7	TR8	TR9	TRA	TRB	TRC
Istanbul (TR1)	–											
West Marmara (TR2)	0.20	–										
Aegean (TR3)	–0.02	–0.21	–									
East Marmara (TR4)	0.06	–0.14	0.07	–								
West Anatolia (TR5)	–0.07	–0.27*	–0.05	–0.13	–							
Mediterranean (TR6)	–0.06	–0.25*	–0.04	–0.12	0.01	–						
Central Anatolia (TR7)	0.08	–0.12	0.09	0.02	0.15	0.13	–					
West Black Sea (TR8)	0.10	–0.09	0.12	0.05	0.17	0.16	0.03	–				
East Black Sea (TR9)	0.01	–0.19	0.02	–0.05	0.08	0.06	–0.07	–0.10	–			
Northeast Anatolia (TRA)	0.30*	0.10	0.31*	0.24	0.36**	0.35**	0.22	0.19	0.29	–		
Central East Anatolia (TRB)	0.15	–0.05	0.16	0.09	0.21	0.20	0.07	0.04	0.14	–0.15	–	
Southeast Anatolia (TRC)	0.12	–0.08	0.14	0.06	0.19*	0.18*	0.04	0.02	0.11	–0.18	–0.03	–

Note. * $p < .05$. ** $p < .01$.

To sum up, students from all regions tended to agree with statements corresponding to sophisticated epistemic beliefs. However, all of the regions were below the overall mean for PISA attendee countries. Even though there were numerical scientific epistemic beliefs mean-score differences between NUTS-1 regions of Turkey, most of the differences were not significant. The least number of pairs with significant score differences was observed for the item 5 with only one pair. The greatest number of pairs with significant score differences was observed for items 4 and 6 with eight pairs each. The general trend was that students from Aegean and West Anatolia attain significantly higher scores than the students from the regions of Northeast Anatolia and Southeast Anatolia. However, the size of the effect of regions was equal to .01 in all cases, indicating very minor practical effects. That is NUTS-1 regions accounted for only 1% of the total variation on the items. All statistically significant effect sizes were of small magnitude.

The following section describes the statistical differences between general secondary schools and vocational and technical secondary schools.

Between-School Differences

Table 9 shows the mean scores and standard deviations of general secondary schools (GSS) and vocational and technical secondary schools (VTSS) for SEB index and six items from the SEB questionnaire. All of the means are higher than 2.5 suggesting a tendency for holding sophisticated epistemic beliefs similar to the results of between region averages. However, the index mean is smaller than 0 for both tracks. Once again, this means that Turkish students are less sophisticated compared to the PISA attendee countries. Regardless, students attending GSS had higher means than VTSS students for all items and they were also closer to the PISA attendee countries. In addition, item 4 produced the maximum mean for both GSS and VTSS. Two minimum values were observed for GSS for items 2 and 6. Students from VTSS, on the other hand, had the minimum means for items 2 and 5. Their mean for the item 6 was also very close to the minimum mean with a score difference of 0.01.

Table 9

The Mean Score for SEB Index and Each Item on The PISA 2015 Scientific Epistemic Beliefs Scale for General Secondary Schools and Vocational and Technical Schools in Turkey

School Types	Measure	SEB Index	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6
General Secondary Schools	*M*	-0.07	2.95	2.87	3.00	3.05	2.89	2.87
	SD	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Vocational and Technical Secondary Schools	*M*	-0.40	2.73	2.68	2.76	2.79	2.68	2.69
	SD	0.03	0.03	0.02	0.02	0.02	0.02	0.02

Table 10 shows the mean score differences between GSS and VTSS. All of the numerical differences between the means are statistically significant. Students from GSS had a significantly higher mean than VTSS students for all items. The score differences are 0.23 ($p < .001$), 0.20 ($p < .001$), 0.23 ($p < .001$), 0.26 ($p < .001$), 0.20 ($p < .001$), and 0.17 ($p < .001$), respectively from items 1 to 6. With that said, the main effect of school types on items was equal to .01, similar to the main effect of NUTS-1 regions. In other words, whether the student is enrolled in GSS or VTSS only explained around 1% of the variations on scores for items 1 ($F(1, 5472) = 51.80$, $p < .001$), 2 ($F(1, 5429) = 50.94$, $p < .001$), 3 ($F(1, 5411) = 64.67$, $p < .001$), 4 ($F(1, 5432) = 77.27$, $p < .001$), 5 ($F(1, 5441) = 51.43$, $p < .001$), and 6 ($F(1, 5411) = 36.34$, $p < .001$). Lastly, the main effect of school type on SEB index was also equal to .01

(F(1, 5475) = 75.75, p < .001). Similar to the per item results, GSS students (M = -0.07, SD = 0.02) had a significantly higher SEB index mean than VTSS students (M = -0.40, SD = 0.03, p < .001).

Table 10

The Mean Score Differences Between General Secondary Schools and Vocational and Technical Secondary Schools

Item Number	Mean Difference
1	0.23**
2	0.20**
3	0.23**
4	0.26**
5	0.20**
6	0.17**

Note. * *p* < .05. ** *p* < .01.

To sum up, students from both GSS and VTSS tended to agree with statements corresponding to sophisticated epistemic beliefs. Nevertheless, both tracks were less sophisticated compared to the average student from PISA attendee countries. In addition, all of the mean score differences between GSS and VTSS were significant, and they were in favor of GSS students. Nevertheless, between school differences had minor practical effects on the differences between scientific epistemic beliefs.

The following describes the interaction effect of NUTS-1 regions with both tracks of schools (that are general secondary schools and vocational and technical secondary schools).

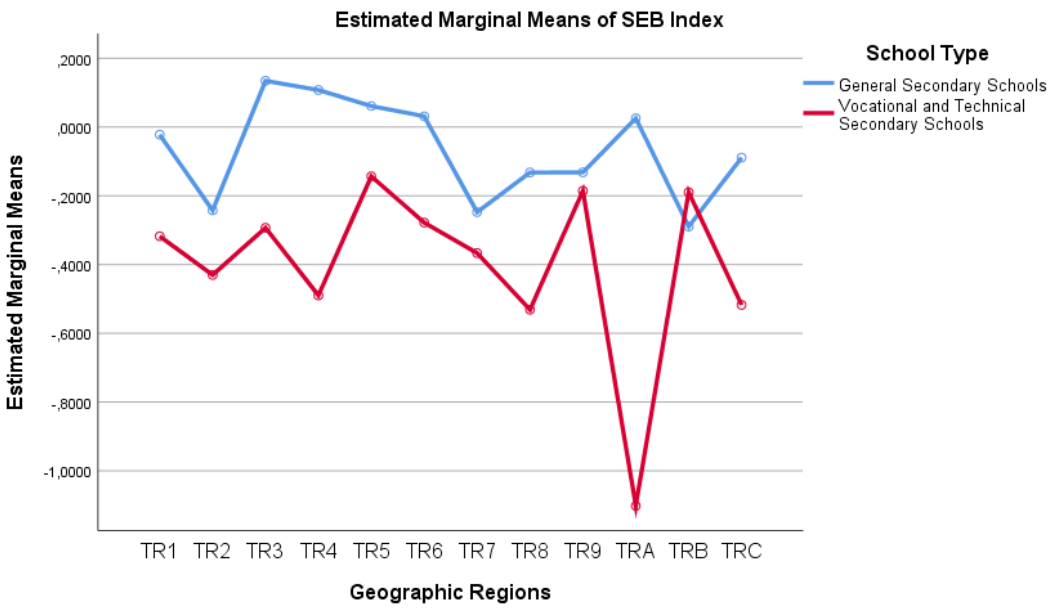
The Interaction Effects

For SEB index, the size of the interaction effect of NUTS-1 regions with VTSS and GSS tracks was of small magnitude. Numerically, it was equal to .01

(F(11, 5475) = 3.34, p < .001). As Figure 3 shows, profile plot for SEB index indicates that the interaction effect occurred mostly due to the extremely low performance of Northeast Anatolia's VTSS students. Even compared to the GSS students from other regions, Northeast Anatolia's GSS students are holding more sophisticated scientific epistemic beliefs. However, VTSS students from the same region are the only student group who was one standard deviation away from the PISA 2015 SEB index mean. This shows that extreme differences between GSS and VTSS students from Northeast Anatolia was one of the main reasons behind the significant interaction effect. A similar picture was observed for per item results.

Figure 3

The Profile Plot Depicting the Estimated Marginal Means for SEB Index

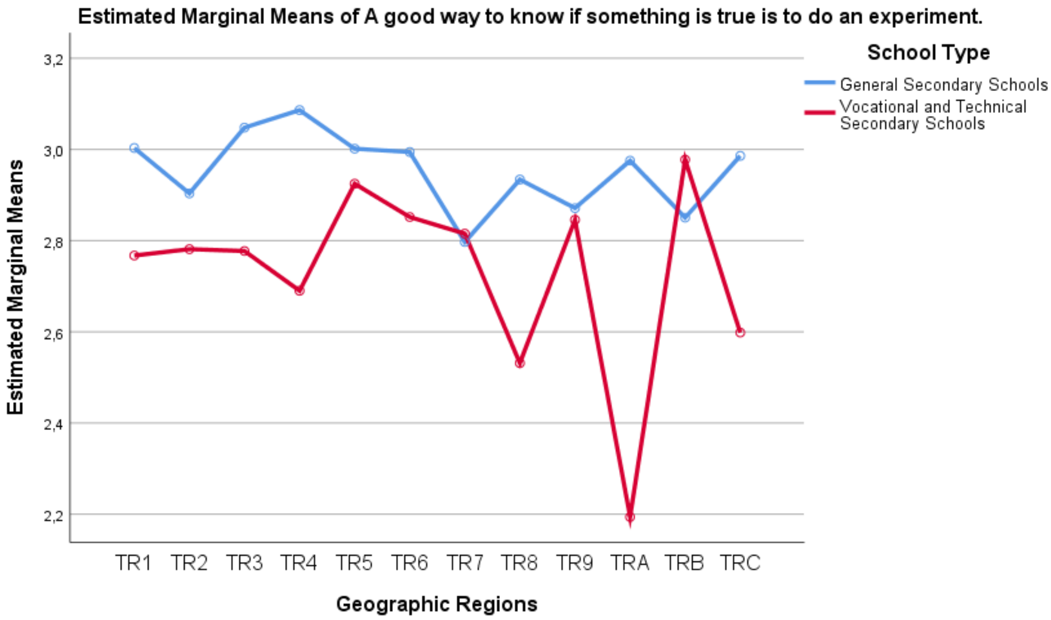


For the item 1 (*A good way to know if something is true is to do an experiment*), the size of the interaction effect of NUTS-1 regions and school types was equal to .01 (F(11, 5472) = 3.75, p < .001) congruous with the main effects. This magnitude indicates that the practical effect of the interaction was small. There was a significant interaction effect which can also be seen in the Figure 4. That is the lines for general secondary schools (GSS) and vocational and technical secondary schools

(VTSS) were crossing each-other between the pairs of regions with unusually high or low performance of students per school type. As an illustration, there were two intersection points involving Central East Anatolia because the VTSS students from there had an unusually high mean score while the GSS students had an unusually low mean score.

Figure 4

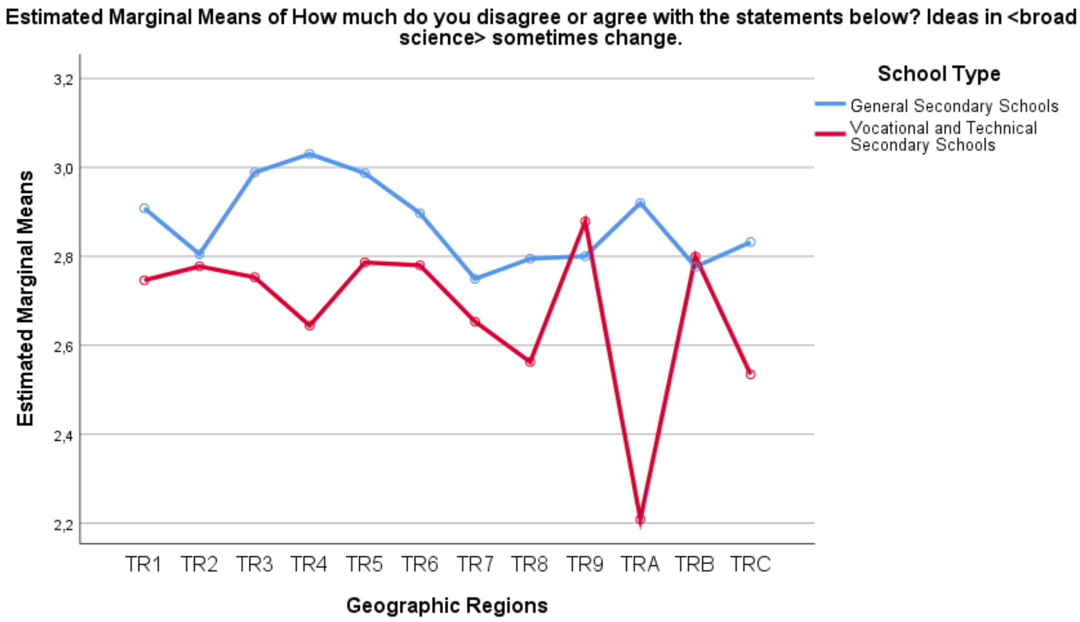
The Profile Plot Depicting the Estimated Marginal Means for The Item 1



The item 2 (*The ideas in <broad science> books sometimes change*) produced almost the same results with item 1 except minor changes in degrees of freedom and the error. The size of the interaction effect was equal to .01 ($F(11, 5429) = 3.15$, $p < .001$). Figure 5 illustrates the interaction effect for item 2 with the lines for GSS and VTSS crossing each-other at somewhere between West Black Sea to East Black Sea, East Black Sea to Northeast Anatolia, Northeast Anatolia to Central East Anatolia, and Central East Anatolia to Southeast Anatolia. These interactions were once again caused by extreme mean scores attained by students from these regions. More precisely, VTSS students from Northeast Anatolia had an extremely low score, but VTSS students from East Black Sea outperformed their peers from GSS. Thus, the lines eventually crossed each-other.

Figure 5

The Profile Plot Depicting the Estimated Marginal Means for The Item 2



Similar to the previous results, the size of the interaction effect for the item 3 (*Good answers are based on evidence from many different experiments*), was equal to .01 (F(11, 5411) = 3.15, p < .001). As shown in Figure 6, the interaction effect seems to have been stemming from the mean scores of the students from the regions of Northeast Anatolia and Central East Anatolia.

The results for the item 4 (It is good to try experiments more than once to make sure of your findings) were also parallel to the previous findings. The interaction effect was equal to .01 (F(11, 5432) = 3.35, p < .001) this time as well. Figure 7 presents evidence for the interaction effect with the lines for GSS and VTSS crossing each-other at two points. The intersection of the lines was once again due to the exceptionally low mean of VTSS students from Northeast Anatolia and VTSS from Central East Anatolia exceptionally outperforming GSS students from the same region.

Figure 6

The Profile Plot Depicting the Estimated Marginal Means for The Item 3

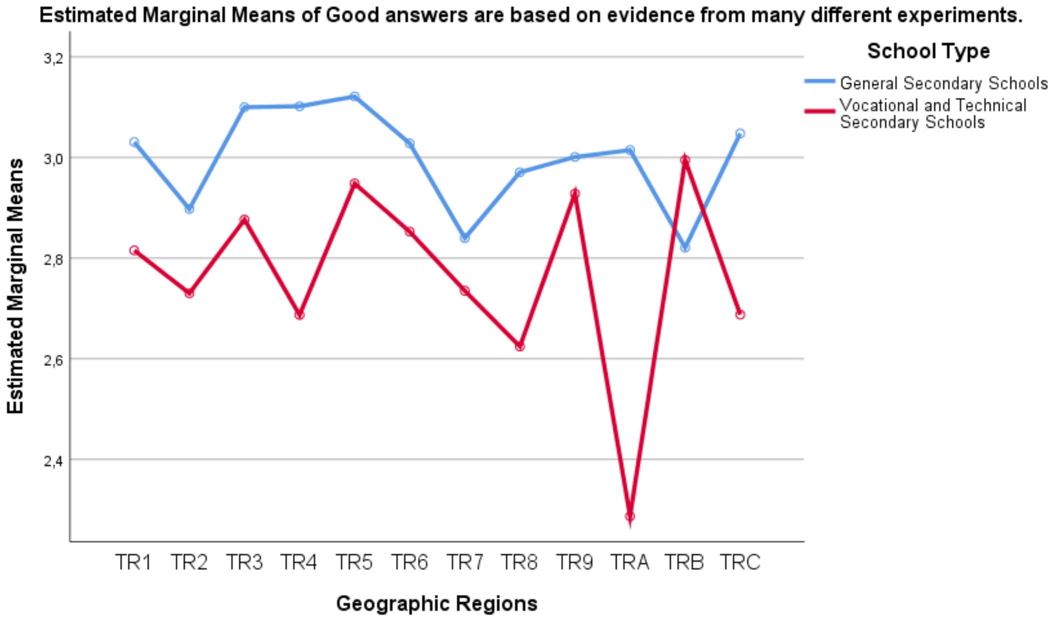
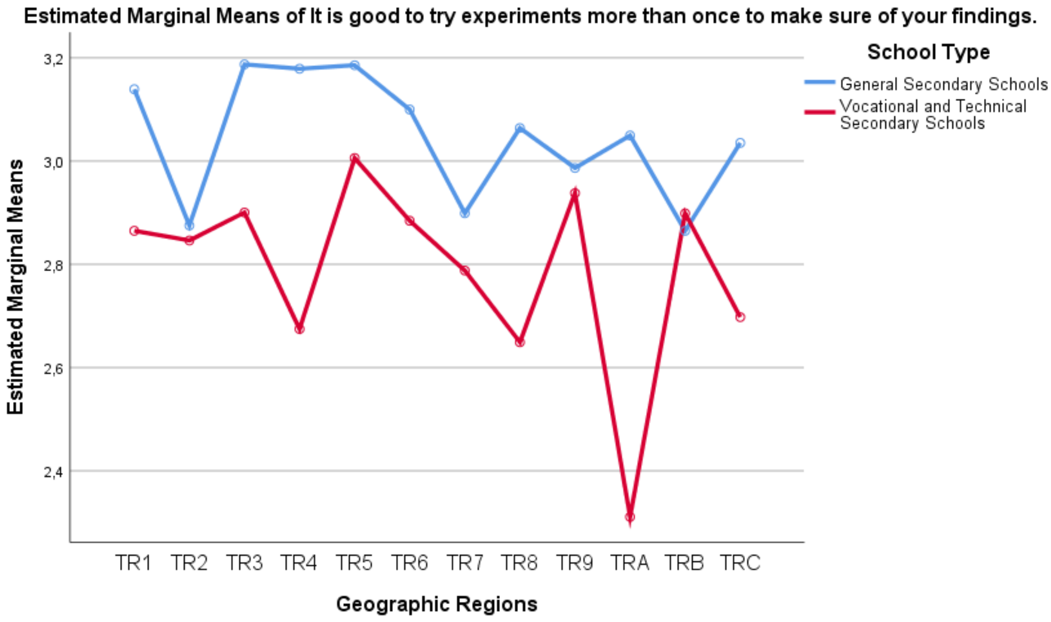


Figure 7

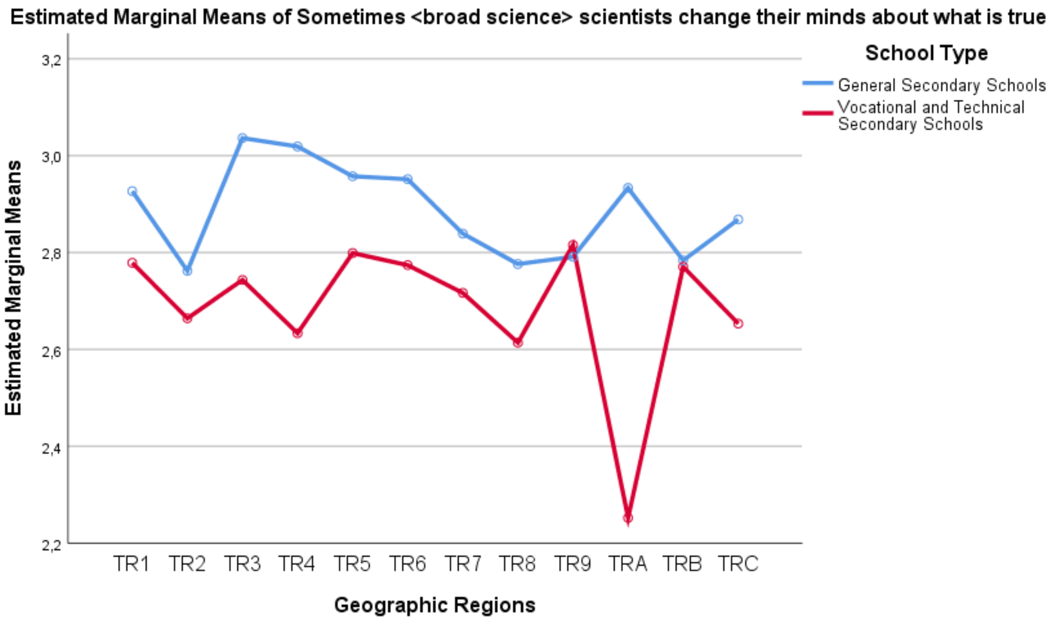
The Profile Plot Depicting the Estimated Marginal Means for The Item 4



The results for the item 5 (Sometimes <broad science> scientists change their minds about what is true in science) were not much different from above results as well. The size of the interaction effect equaled .01 (F(11,5441) = 2.33, p = .007). In Figure 8, the lines for GSS and VTSS can be seen crossing each-other once again due to the low mean of VTSS students from Northeast Anatolia and VTSS students from East Black Sea slightly outperforming East Black Sea's GSS students.

Figure 8

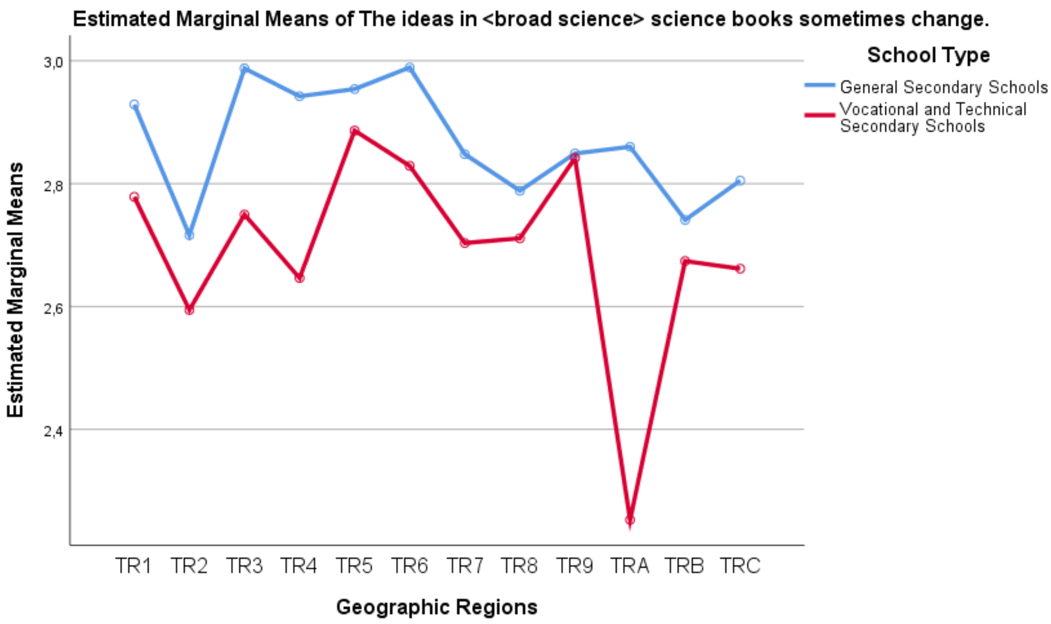
The Profile Plot Depicting the Estimated Marginal Means for The Item 5



The item 6 (*The ideas in <broad science> science books sometimes change*) was the only item for which the interaction effect was not significant (F(11, 5411) = 1.49, p = .127). That is no variation on scores for item 6 was explained by the combined effect of NUTS-1 regions and school types. Still, as can be seen from Figure 9, VTSS students from Northeast Anatolia maintained their exceptionally low averages, but VTSS students from other regions failed to outperform GSS students enough to make their interaction statistically significant.

Figure 9

The Profile Plot Depicting the Estimated Marginal Means for The Item 6



To sum up, the interaction of NUTS-1 regions and school types was significant for items 1 – 5 and SEB index. Item 6 was the only item for which there was no significant interaction effect. However, the size of the effect was equal to .01 for items with significant interaction and the index score, indicating very minor practical effects. That is the combined effect of NUTS-1 regions and school types only accounted for around 1% of total variations on SEB scores. In other words, all statistically significant effect sizes were of small magnitude, indicating very low practical effects.

The following describes the combined effect of school types and NUTS-1 regions of Turkey on SEB index which is followed by per item results.

Interaction of NUTS-1 Regions and School Types

For SEB index, when only the GSS students were taken into consideration, students from Aegean (M = 0.13, SD = 0.06) had a significantly higher mean than Central Anatolia students (M = -0.25, SD = 0.08, p = .013) and Central East Anatolia students (M = -0.29, SD = 0.11, p = .035). The case of the VTSS students yielded the following results. Northeast Anatolia students (M = -1.10, SD = 0.19) had a significantly lower mean than Istanbul (M = -0.32, SD = 0.05, p = .006), Aegean (M = -0.29, SD = 0.07, p = .006), West Anatolia (M = -0.14, SD = 0.08, p < .001), Mediterranean (M = -0.28, SD = 0.06, p = .003), East Black Sea (M = -0.19, SD = 0.12, p = .004) and Central East Anatolia (M = -0.19, SD = 0.13, p = .005) students. In addition, West Anatolia had a significantly higher mean than Southeast Anatolia (M = -0.52, SD = 0.08, p = .042). An important result was that VTSS students from Northeast Anatolia were the only students that attained a score one standard deviation lower than the PISA 2015 SEB average. Northeast Anatolia's VTSS students' low average was a pattern that emerged for per item results as well. When it comes to regions with significant between track differences, the following regions appeared in the results: Istanbul (p < .001), Aegean (p < .001), East Marmara (p < .001), West Anatolia (p = .047), Mediterranean (p < .001), West Black Sea (p = .003), Northeast Anatolia (p < .001) and Southeast Anatolia (p < .001). Most of these regions had significant between track differences for other items too. Table 11 depicts the means and standard deviations of VTSS and GSS students from the regions listed.

Table 11

Means and Standard Deviations for NUTS-1 Regions with Significant Between School Differences for SEB Index

NUTS-1 Region	M_{GSS}	SD_{GSS}	M_{VTSS}	SD_{VTSS}
TR1	-0.02	0.06	-0.32	0.05
TR3	0.13	0.06	-0.29	0.07
TR4	0.11	0.07	-0.49	0.08

Table 11 (cont'd)

Means and Standard Deviations for NUTS-1 Regions with Significant Between School Differences for SEB Index

TR5	0.02	0.07	-0.14	0.08
TR6	0.03	0.05	-0.28	0.06
TR8	-0.13	0.08	-0.53	0.11
TRA	0.03	0.10	-1.10	0.19
TRC	-0.09	0.06	-0.52	0.08

For the first item, there were no significant mean differences between NUTS-1 regions when only the general secondary school (GSS) students were considered. However, when the vocational and technical secondary school (VTSS) students were taken into account, nine pairs in total yielded statistically significant mean differences. As a comparison, between-region differences for the item 1 had three pairs with significant results when the students were not partitioned according to school types. Seven out of nine pairs included the region of Northeast Anatolia (M = 2.19, SD = 0.15) and in these pairs Northeast Anatolia was accompanied with Istanbul (M = 2.77, SD = 0.04, p = .021), Aegean (M = 2.78, SD = 0.06, p = .024), West Anatolia (M = 2.93, SD = 0.06, p = .001), Mediterranean (M = 2.85, SD = 0.05, p = .003), Central Anatolia (M = 2.82, SD = 0.08, p = .025), East Black Sea (M = 2.85, SD = 0.10, p = .023) and Central East Anatolia (M = 2.98, SD = 0.15, p = .001). The mean difference was in line with the findings above and Northeast Anatolia was the region with the significantly lower mean score compared to the regions mentioned. The remaining two pairs included the region of West Anatolia. West Anatolia had a significantly higher mean score than the regions of West Black Sea (M = 2.53, SD = 0.09, p = .026) and Southeast Anatolia (M = 2.60, SD = 0.06, p

= .015). Furthermore, the following NUTS-1 regions all had significant between school type differences: Istanbul, Aegean, East Marmara, Mediterranean, West Black Sea, Northeast Anatolia and Southeast Anatolia. Except Mediterranean, –for which p is .028– the p-value was smaller than .001. Table 12 lists the means and standard deviations for GSS and VTSS for these regions. As compared to the above which suggested that the between school difference was significant for item 1, the remaining five regions did not have any significant mean differences between GSS and VTSS students.

Table 12

Means and Standard Deviations for NUTS-1 Regions with Significant Between School Differences for The Item 1

NUTS-1 Region	M_{GSS}	SD_{GSS}	M_{VTSS}	SD_{VTSS}
TR1	3.00	0.05	2.77	0.04
TR3	3.05	0.05	2.78	0.06
TR4	3.09	0.06	2.69	0.06
TR6	2.99	0.04	2.85	0.05
TR8	2.93	0.06	2.53	0.09
TRA	2.98	0.08	2.19	0.15
TRC	2.99	0.05	2.60	0.06

The GSS students in East Marmara (M = 3.03, SD = 0.05) and Central Anatolia (M = 2.75, SD = 0.06) had a significant mean difference at p = .02 for the second item. The numerical mean differences between other regions were not significant for GSS students. However, VTSS students in Northeast Anatolia (M = 2.21, SD = 0.14) had a significantly lower mean than the following regions: Istanbul (M = 2.75, SD = 0.04, p = .01), West Marmara (M = 2.78, SD = 0.09, p = .031), Aegean (M = 2.75, SD = 0.05, p = .012), West Anatolia (M = 2.79, SD = 0.06, p =

.006), Mediterranean (M = 2.78, SD = 0.04, p = .004), East Black Sea (M = 2.88, SD = 0.09, p = .002) and Central East Anatolia (M = 2.80, SD = 0.09, p = .021). Six of these regions –Istanbul, Aegean, West Anatolia, Mediterranean, East Black Sea and Central East Anatolia– were in common with results for the item 1. Additionally, VTSS students from Southeast Anatolia (M = 2.54, SD = 0.05) also had a significantly lower mean score than Mediterranean students (p = .023). In total there were nine pairs of regions with significant mean differences –an increase from six pairs from above results for all students included together. The regions with significant between school differences included the region of West Anatolia in addition to all the regions mentioned for the item 1. Namely, all the regions were Istanbul (p = .004), Aegean (p < .001), East Marmara (p < .001), West Anatolia (p = .006), Mediterranean (p = .041), West Black Sea (p = .017), Northeast Anatolia (p < .001) and Southeast Anatolia (p < .001). Table 13 lists the relevant means and standard deviations.

Table 13

Means and Standard Deviations for NUTS-1 Regions with Significant Between School Differences for The Item 2

NUTS-1 Region	M_{GSS}	SD_{GSS}	M_{VTSS}	SD_{VTSS}
TR1	2.91	0.04	2.75	0.04
TR3	2.99	0.04	2.75	0.05
TR4	3.03	0.05	2.64	0.06
TR5	2.99	0.05	2.79	0.06
TR6	2.90	0.04	2.78	0.04
TR8	2.80	0.05	2.56	0.08
TRA	2.92	0.07	2.21	0.14
TRC	2.83	0.04	2.54	0.05

GSS students from the region of Central Anatolia (M = 2.84, SD = 0.06), once more, had a significantly lower mean than another region. For the item 3, this region was West Anatolia (M = 3.12, SD = 0.05, p = .026). VTSS students from Northeast Anatolia (M = 2.29, M = 0.15) represented the only region that appeared in all pairs with significant mean differences. There were six such pairs in total and the other pairs were Istanbul (M = 2.82, SD = 0.04, p = .034), Aegean (M = 2.88, SD = 0.05, p = .01), West Anatolia (M =2.95, SD = 0.06, p = .002), Mediterranean (M = 2.85, SD = 0.04, p = .015), East Black Sea (M = 2.82, SD = 0.09, p = .013) and Central East Anatolia (M = 3.00, SD = 0.10, p = .003). These six regions had significantly higher means than Northeast Anatolia for the previous items as well. A total of seven pairs of regions with significant mean differences was an increase from four pairs when the students from GSS and VTSS were considered together. Moreover, the regions with significant between school differences were the same as the regions from item 2. Namely these regions were Istanbul (p < .001), Aegean (p = .001), East Marmara (p < .001), West Anatolia (p = .025), Mediterranean (p = .003), West Black Sea (p = .001), Northeast Anatolia (p < .001), Southeast Anatolia (p < .001). Table 14 presents the means and standard deviations for the regions.

Table 14

Means and Standard Deviations for NUTS-1 Regions with Significant Between School Differences for The Item 3

NUTS-1 Region	M_{GSS}	SD_{GSS}	M_{VTSS}	SD_{VTSS}
TR1	3.03	0.04	2.82	0.04
TR3	3.10	0.04	2.88	0.05
TR4	3.10	0.05	2.69	0.06
TR5	3.12	0.05	2.95	0.06
TR6	3.03	0.04	2.85	0.04

Table 14 (cont'd)

Means and Standard Deviations for NUTS-1 Regions with Significant Between School Differences for The Item 3

TR8	2.97	0.06	2.62	0.08
TRA	3.02	0.08	2.29	0.15
TRC	3.05	0.05	2.69	0.06

The item 4 had the highest number of pairs of regions with significant mean differences for students enrolled in GSS. There were five such pairs in total. Three of the pairs involved the region of Aegean (M = 3.19, SD = 0.05) having a significantly higher mean than West Marmara (M = 2.88, SD = 0.08, p = .025), Central Anatolia (M = 2.90, SD = 0.06, p = .014) and Central East Anatolia (M = 2.87, SD = 0.08, p = .038). The other two pairs were West Anatolia (M = 3.19, SD = 0.05) and West Marmara, West Anatolia and Central Anatolia. The mean score of West Anatolia was significantly higher than West Marmara (p = .037) and Central Anatolia (p = .023). In the case of VTSS students, there were seven pairs of regions with a significant mean difference. Five of these regions included Northeast Anatolia in line with the findings above. Northeast Anatolia (M = 2.31, SD = 0.15) had a significantly lower mean score than the following regions: Istanbul (M = 2.87, SD = 0.04, p = .02), Aegean (M = 2.90, SD = 0.05, p = .012), West Anatolia (M = 3.01, SD = 0.06, p = .001), Mediterranean (M = 2.88, SD = 0.05, p = .013) and East Black Sea (M = 2.94, SD = 0.09, p = .021). These regions were similar to the ones from previous items. However, for the item 4, West Anatolia also had a significantly higher mean score than West Black Sea (M = 2.65, SD = 0.09, p = .044) and Southeast Anatolia (M = 2.70, SD = 0.06, p = .015). In total there were twelve pairs of regions with significant mean differences. This was an increase from the eight pairs when GSS and VTSS students considered together above. Once more, NUTS-1 regions with significant between school mean differences were the same as items 2 and 3. The differences were all significant at $p < .001$ for all regions except West Anatolia ($p = .021$). Table 15 lists the appropriate means and standard deviations.

Table 15

Means and Standard Deviations for NUTS-1 Regions with Significant Between School Differences for The Item 4

NUTS-1 Region	M_{GSS}	SD_{GSS}	M_{VTSS}	SD_{VTSS}
TR1	3.14	0.04	2.87	0.04
TR3	3.19	0.05	2.90	0.05
TR4	3.18	0.05	2.68	0.06
TR5	3.19	0.05	3.01	0.06
TR6	3.10	0.04	2.88	0.05
TR8	3.06	0.06	2.65	0.09
TRA	3.05	0.08	2.31	0.15
TRC	3.04	0.05	2.70	0.06

The item 5 was the last item with a significant interaction effect. The number of pairs of regions with a significant between school mean difference was rather low compared to the previous items. There were only four such pairs in total. One of the pairs originated from GSS students. Namely, the GSS students from the region of Aegean ($M = 3.04$, $SD = 0.04$) had a significantly higher mean score than the GSS students from West Black Sea ($M = 2.78$, $SD = 0.06$, $p = .014$). The remaining three pairs were from VTSS students. Conceivably, all three pairs included the region of Northeast Anatolia. The VTSS students from the region of Northeast Anatolia ($M = 2.25$, $SD = 0.14$) had a significantly lower mean score than the VTSS students from the regions of Istanbul ($M = 2.78$, $SD = 0.04$, $p = .022$), West Anatolia ($M = 2.80$, SD = 0.06, p = .023) and Mediterranean (M = 2.77, SD = 0.04, p = .027). NUTS-1 regions with significant between school mean differences were similar to the regions from the item 4, but it did not include the region of West Black Sea. The mean between school type differences were significant at p < .001 for all regions except Istanbul (p = .009), West Anatolia (p = .034), Mediterranean (p = .002) and Southeast Anatolia (p = .002). The means and standard deviations are as listed in the Table 16.

Table 16

Means and Standard Deviations For NUTS-1 Regions with Significant Between School Differences for The Item 5

NUTS-1 Region	M_{GSS}	SD_{GSS}	M_{VTSS}	SD_{VTSS}
TR1	2.93	0.04	2.78	0.05
TR3	3.04	0.04	2.74	0.14
TR4	3.02	0.05	2.63	0.04
TR5	2.96	0.05	2.80	0.06
TR6	2.95	0.04	2.77	0.06
TRA	2.93	0.07	2.25	0.04
TRC	2.87	0.04	2.65	0.04

To sum up, for each item the total number of region-pairs with a significant mean difference showed an increase when the school types were analyzed separately. However, GSS students did not have high amounts of between-region differences with the exception of item 4. That is most of the increase was due to the VTSS students. Especially, the VTSS students from Northeast Anatolia consistently had a significantly lower mean than the VTSS students from other regions. The pattern of Northeast Anatolia falling behind other regions were visible for all items. However, the pattern of Aegean and Mediterranean outperforming other regions disappeared along with the pattern of Southeast Anatolia's low performance. The pattern of West Anatolia outperforming other regions was only visible for the item 4. Between school type differences remained for all items, but the significant differences seemed problematic only for the following regions: Istanbul, Aegean, East Marmara, West Anatolia, Mediterranean, West Black Sea, Northeast Anatolia and Southeast Anatolia. The other regions did not have any significant between school mean differences.

CHAPTER 5: DISCUSSION

Introduction

This study described how scientific epistemic beliefs differed between NUTS-1 regions and school types. First, the regions and school types were compared with each-other. Then, school types were compared for each category of NUTS-1 regions of Turkey and similarly, NUTS-1 regions were compared to each other for two categories of school tracks. This chapter, in particular, is a synthesis of the first four chapters. It starts with a summary of the theoretical framework under the heading *Overview of the Study,* and it proceeds with explaining the results according to the literature which this study is based on. The section concludes with the following three sections in order: Implications for Practice, Implications for Further Research, and Limitations.

Overview of the Study

The main aim of this study was to describe the scientific epistemic beliefs inequalities in Turkey with regards to NUTS-1 regions of Turkey and two tracks of schooling (general secondary schools and vocational and technical secondary schools). The rationale for this endeavour was that scientific epistemic beliefs constitute the ability to do science (Chen & Pajares, 2010; Nussbaum et al., 2008; OECD, 2016; Trautwein & Lüdtke, 2006) and such ability should be distributed fairly within the country. Likewise, the reason why NUTS-1 regions and two tracks of schooling (namely general secondary schools and vocational and technical secondary schools) were selected as independent variables was the literature's suggestion that there exist significant differences in living conditions and educational opportunities between these two variables in Turkey (Berberoglu & Kalender (2005);

Ferreira & Gignoux, 2010; Karahasan & Uyar, 2009; Öztürk & Kayaoğlu, 2016, Suna et al., 2020b; Tomul, 2009). Hence, whether there also exist differences in scientific epistemic beliefs between these variables was a literature gap that needed to be filled.

Based on the previous literature, it was hypothesized that regions located in the west of Turkey (Istanbul, West Marmara, Aegean, East Marmara, West Anatolia, Mediterranean, Central Anatolia, West Black Sea) would significantly be more sophisticated than the regions located in the east of Turkey (East Black Sea, Northeast Anatolia, Central East Anatolia, Southeast Anatolia). Similarly, the general secondary school (GSS) students were hypothesized to be significantly more sophisticated than the vocational and technical secondary schools (VTSS) students. Further, it was hypothesized that the first hypothesis would hold true for each combination of NUTS-1 regions with two schooling tracks considered in the study. Thus, an explanatory research design was deemed fit for this study. The data was pooled from the 2015 PISA cycle which was highly representative of 15 years old students in Turkey. The 2015 cycle also included six 4-point Likert scale items on scientific epistemic beliefs. These six items and an index score associated with them were used as the dependent variables of this study and the independent variables were compared with respect to them. Two-way ANOVA was used for the analysis. However, the following assumptions were violated: no significant outliers, the data is normally distributed, and variances are homogenous. The analysis was carried out regardless and the following section summarizes and interprets the major findings of two-way ANOVA.

Major Findings and Conclusions

The following summary and interpretation of the results are structured in the following order: between-geographic region differences, between-school differences and the combined effect of geographic regions and school types on scientific epistemic beliefs (SEB).

Between NUTS-1 Regions Differences

We should start off with noting that the means of all NUTS-1 regions were larger than 2.5 for all items. This implies that most students agreed or strongly agreed with sophisticated statements about science. To put it differently, most students were sophisticated epistemic believers about science. That is the broad situation for regions seems positive based on the research that suggest more sophisticated beliefs about science will support students' argumentation skills, learning approaches, self-efficacy and conceptions of learning science (Chen & Pajares, 2010; Nussbaum et al., 2008; Tsai et al., 2011). Out of all regions, Northeast Anatolia had the lowest mean for all items with means ranging from 2.56 to 2.68. Furthermore, Northeast Anatolia's SEB index score deviated away the most from the PISA 2015's attendee countries' average. This means that Northeast Anatolia had comparatively more students who disagreed with the sophisticated positions on science. Number of studies have also highlighted Northeast Anatolia is among regions with comparatively worse schooling outcomes (Alacacı & Erbaş, 2010; Erberber, 2010; Öztürk & Kayaoğlu, 2016). On the contrary, West Anatolia had the highest mean for all items with means ranging from 2.88 to 3.10. Still, the means of the Aegean Region were similar to the means of West Anatolia with means ranging from 2.87 to 3.04. Similarly, this is to say that Aegean and West Anatolia had comparatively more students who agreed with sophisticated positions on science.

Both regions were also the regions that were closest to the PISA 2015's overall average for SEB index. These findings were in line with the previous literature that suggested Central Anatolia (or more precisely, Ankara, the capital of Turkey, and its surroundings) and Aegean was doing comparatively better academically than other regions (Demir et al., 2010; Gumus & Chudgar, 2016; Tomul, 2009). The following paragraphs talk about the significant results after stating the effect sizes.

The second finding to point out ought to be that the effect sizes, partial η^2s, all equaled .01 for all items. That is also to say that 99% of the variations in scientific epistemic scores are explained by variables other than NUTS-1 regions. Considering that huge number of studies pointed out significant differences between the eastern and western regions in Turkey, low practical implications could be because between-region inequalities have healed over time. Another more straight-forward explanation would be that scientific epistemic beliefs are not among variables that contribute to between-region inequalities. This explanation seems plausible because even though epistemic beliefs are influenced by the school environment (Jehng et al. 1993; Schiefer et al., 2022), so many other variables are part of these beliefs as well such as cultural context (Hofer, 2008), family environment (Cano & Cardelle-Elawar, 2004), individual's judgements on their experiences and so on. In other words, our stance against knowledge is influenced by everyday events and on top that, being sophisticated is associated only with thinking that knowledge is tentative. In other words, educational opportunities alone cannot explain differences in epistemic beliefs about science which this study supports. Lastly, regardless of low practical implications, there were some regions that consistently performed significantly below certain others which might be an ill omen for low performers.

Among all regions, Istanbul, Aegean, West Anatolia and Mediterranean stood out as being significantly more sophisticated than West Marmara, Central Anatolia, West Black Sea, Northeast Anatolia and Southeast Anatolia. To be more exact, West Anatolia's means were significantly higher than Northeast Anatolia's means for SEB index and six items except the item 5; they were also significantly higher than Southeast Anatolia's means for items 2, 4 and 6; its means were significantly higher than West Black Sea's means for items 2, 3 and 4; and they were significantly higher than Central Anatolia's means for items 3 and 4 as well; lastly, West Anatolia's mean for the item 6 was significantly higher than the West Marmara's mean. For the case of Aegean, its means were significantly higher than Northeast Anatolia's means for all items, and they were higher than Southeast Anatolia's means for the items 2 and 4. Somehow similarly, Mediterranean's means for the items 1, 4 and 6 were significantly higher than Northeast Anatolia's means; its means were significantly higher than Southeast Anatolia's means for the items 2 and 6; and lastly, its mean for the item 6 was higher than the West Marmara's mean. Finally, Istanbul's means for the items 4 and 6 were significantly higher than the means of Northeast Anatolia.

An important observation to note here is that, despite being in the west of Turkey, West Marmara, Central Anatolia and West Black Sea were not significantly more sophisticated than the eastern regions. In fact, the students from those regions had a significant tendency to disagree with the items 2, 3, 4 and 6 more than the students from West Anatolia. To put it in a different way, West Anatolia students seem to have a better grasp of the changing nature of scientific knowledge and the necessity of repeating experiments. One of the reasons for West Anatolia's performance could be that it is the region where Ankara (the capital) is located. Ankara is the province that has the highest average years of schooling in Turkey

(Tomul, 2009). Hence, it could be the case that education system in Turkey is successful at making students more sophisticated about science if it works as it was planned. Since Ankara is the capital, it is likely that the schooling works as it is planned. Then, the challenge for authorities would be to make the schooling work equally in all regions. Moreover, as some of the literature suggested (Suna et al., 2019), it was true that all significantly more sophisticated regions were in the west, but it turned out to be false that all the regions in the west were significantly more sophisticated than the regions in the east (as opposed to the hypotheses). Likewise, it was true that some of the regions with a significant tendency to be less sophisticated were in the east (Northeast Anatolia and Southeast Anatolia), but it failed to hold true that every region in the east is significantly less sophisticated than the regions in the west. In fact, West Marmara attained lower scientific epistemic beliefs mean scores than Southeast Anatolia despite being located in the west and achieving higher science literacy mean score in the PISA 2015 cycle (Taş et al., 2016). Numerically Southeast Anatolia's mean for science literacy was 387, whereas mean of West Marmara was 448 (highest mean in Turkey). Still, West Marmara was among the least sophisticated five regions for all items. This suggests that students in West Marmara can function in science better than others despite their comparatively more naïve epistemic beliefs on science. As Hofer (2008) suggested this might be due to a problem with the current instruments used for measuring epistemic beliefs or it might be due to a cultural context. That is, West Marmara might have developed a culture that allows students to engage in scientific knowledge successfully even with their naïve beliefs on what scientific knowledge is.

Another notable finding was that the regions of Northeast Anatolia and Southeast Anatolia seem to fail to keep up with Istanbul, Aegean, West Anatolia and

Mediterranean in holding sophisticated scientific epistemic beliefs. The lack of sophistication becomes even more pronounced when they are compared to Aegean and West Anatolia. This situation might create an issue for the following reasons. Firstly, since there seems to be considerable number of students in Northeast Anatolia and Southeast Anatolia who disagree or strongly disagree that scientific knowledge has a changing nature and that the experiments are the key to creating new knowledge in science, they might consider science to be more challenging than it normally is. This might discourage such students from studying science even if they genuinely want to be good at it. Furthermore, there could be students –even if their number is small in practice – who have the talent to continue studying science, and later work in the high-tech industry, but they might fail to realize this opportunity due to such opinions. This situation would be a missed opportunity in generating higher gross-domestic products. In addition, such students would be deprived of the opportunity of functioning in science as a sophisticated epistemic believer despite their will –which would decrease their well-being. That is to say that significantly more students in Northeast Anatolia and Southeast Anatolia compared to Istanbul, Aegean, West Anatolia and Mediterranean might not have the capability which is required for engaging with science sophisticatedly. Finally, Gumus and Chudgar (2016) have pointed it out that school-age kids who are out-of-school in the eastern Turkey had parents who were not native Turkish speakers. A similar explanation could be given here. To make it clear, the students who do not have native Turkish speaking parents might be at a disadvantage at schools and life due to a minority background. Such disadvantages could negatively affect students' beliefs about how knowledge is created.

Differences between General Secondary Schools and Vocational and Technical Secondary Schools

To summarize the results for the between-school differences, first it should be noted that the means of general secondary schools (GSS) and vocational and technical secondary schools (VTSS) were above 2.6 for all items. Similar to the above, this means that students were more likely to agree or strongly agree with sophisticated positions on science. Not surprisingly, GSS students had the higher means for all items, and they were closer to the PISA 2015's SEB index mean of 0 than VTSS students. These findings were in line with previous research that suggested GSS students were more competent academically than VTSS students (Bölükbaş & Gür, 2020; Kılıç & Sağlam, 2010; Öztürk & Özmen, 2016). The mean differences between GSS and VTSS were statistically significant for all items and SEB index. However, similar to the case with between NUTS-1 regions differences, the partial η^2s were equal to only .01. This implies that the significant mean differences have small practical implications. However, as explained above, since everyday events could affect whether a student views knowledge as tentative or fixed, low practical differences between GSS and VTSS could occur. Even so, the negative bias towards VTSS should become an issue because between school differences in Turkey start as early as middle school. The high school entrance exam usually groups students according to their socioeconomic status (SES) groups and higher SES groups get to study in more successful high schools. This means that VTSS route is also the route with low SES students (Alacacı & Erbaş, 2010; Chmielewski, 2014; Suna et al., 2020a). The fact that they are significantly less sophisticated about science require further attention since some of those differences could be attributed to the accident of birth. To put this in a different way, there is a chance that some VTSS students –even if their numbers are small– could become more sophisticated through intervention. At the very least, a follow-up study is required to ensure that accident of birth is not why these differences are occurring.

The Interaction Effect

Despite their small effect sizes of .01, the interaction effects of school types and NUTS-1 regions on scientific epistemic beliefs scores were significant for items 1 to 5 and SEB index. Once again, the significant findings do not have strong practical significance and a follow-up study is required before any intervention is initiated. However, there are still some significant results that can at the very least can be a precursor to such studies. The following talks about them.

NUTS-1 Regions with Differences between GSS and VTSS

There were only eight NUTS-1 regions with significant between school differences for the items 1 to 5 and SEB index. Namely, these regions were Istanbul, Aegean, East Marmara, West Anatolia, Mediterranean, West Black Sea, Northeast Anatolia and Southeast Anatolia. However, there were no significant between school differences in West Anatolia for the first item and, similarly, there were no significant between school differences in West Black Sea for the item 5. As mentioned previously in this chapter and in the Chapter 2, in Turkey, tracking students into different high school paths tends to group similar SES groups together (Alacacı & Erbaş, 2010). Furthermore, high SES groups are usually tracked into better high schools with better science curriculum and teachers while the low SES groups get tracked into worst ones. Both the curriculum and the scientific epistemic beliefs of teachers might have an effect on sophistication of students (Maggioni & Parkinson, 2008). Even if the students were being tracked based on their merits alone, that would not still justify differences between sophistication of GSS and

VTSS students. Someone's merits measured by an instrument at certain points of time (like the central examination in Turkey) cannot fully capture the true abilities, wills, and potentials of that person. To put it differently, the will of a VTSS student to function in science as a sophisticated epistemic believer should not be ignored regardless of their ability to do science.

Between NUTS-1 Regions Differences of General Secondary Schools

For the case of GSS students, most of the between NUTS-1 regions occurred for the fourth item which was *It is good to try experiments more than once to make sure of your findings*. As a comparison, the first item did not have any regional differences among the GSS students, and the rest of the items (item 2, 3 and 5) only had single pairs with significant mean differences. Namely the pairs were East Marmara and Central Anatolia (in favour of East Marmara) for the item 2, West Anatolia and Central Anatolia (in favour of West Anatolia) for the item 3 and, lastly, Aegean and West Black Sea for the item 5 (in favour of Aegean). For the item 4, Aegean had a significantly higher mean than West Marmara, Central Anatolia and Central East Anatolia; and West Anatolia had a significantly higher mean than West Marmara and Central Anatolia. However, the item 3 (*Good answers are based on evidence from many different experiments.*) was also about repeating experiments to produce reliable scientific knowledge, but it did not have that many significant between NUTS-1 regions differences for the GSS students. Hence, the significant differences for the item 4 might be due to how students deciphered what the question was asking. For instance, a study in Taiwan revealed that more naïve students would have better self-efficacy (Tsai et al., 2011) and epistemic beliefs studies in East Asia tend to allocate students to more naïve positions despite their high academic achievement (Hofer, 2008). That is Turkish people might culturally find it useless to cross-check the results of their studies which could explain why so many GSS students disagreed with the item 4. Other pattern that emerged to a certain degree for the GSS students was that if there is a significant mean difference, then Central Anatolia is the significantly less sophisticated region and Aegean is the significantly more sophisticated region. Since the differences of Central Anatolia emerged for SEB index and items 2, 3, and 4; it might be plausible to say that Central Anatolia's GSS students might not be sophisticated about justification of knowledge, but they understand the tentative nature of knowledge. For students from the Aegean region, differences occurred mainly for SEB index. This could mean that students studying in the region have better opportunities to develop more sophisticated beliefs about science. Nevertheless, there were considerable amount of between NUTS-1 region differences for the case of VTSS students.

Between NUTS-1 Regions Differences of Vocational and Technical Secondary Schools

The effect that NUTS-1 Regions had on the VTSS students' scientific epistemic beliefs was similar to the main effect of regions. As a matter of fact, considering that between region differences were not large in number for the GSS students, most of the between region differences could be attributed to the VTSS students – especially to the VTSS students from Northeast Anatolia. To be more precise, the number of pairs with significant mean differences was highest among all between region differences.

The most notable finding was that the means of Northeast Anatolia was significantly lower than at least three regions for items 1 to 5. Namely these regions were Istanbul (for items 1 – 5), West Marmara (for the item 2), Aegean (for items 1 – 4), West Anatolia (for items 1 – 5), Mediterranean (for items 1 – 6), Central Anatolia (for the item 1), East Black Sea (for items 1 – 4) and Central East Anatolia (for items 1 – 3). These significant differences were the most troubling ones because they were the consequence of extremely low means of the VTSS students from Northeast Anatolia. They were all smaller than 2.50, meaning that a large portion of Northeast Anatolia's VTSS students disagreed with sophisticated positions on science. Not to mention, Northeast Anatolia's VTSS students were the only group of students with means smaller than 2.50 and their SEB index mean was one standard deviation lower than PISA 2015's overall mean for the index. That is most of these students were considerably naïve epistemic believers in science. Put differently, most of them disagreed or strongly disagreed that scientific knowledge could change, and experiments require repetition. This might be an issue because all of these three values –that are Northeast Anatolia, VTSS and naïve scientific epistemic believers– are associated with negative traits such as low academic achievement (Chen & Pajares, 2010), low science literacy (Suna et al., 2020b), using surface level learning approaches (Çolak & Kaya, 2014; Kılıç & Sağlam, 2010) and so on. It seems like VTSS students from Northeast Anatolia are at a disadvantageous position. This might negatively affect their will to become sophisticated scientific believers. Even though there were couple of other significant mean differences between other regions, none of them were as worrying as Northeast Anatolia's VTSS students.

The other finding that was in line with the results for the main effects was that West Anatolia obtained a significantly higher mean than East Marmara, West Black Sea and Southeast Anatolia. However, the significant difference between West Anatolia and East Marmara occurred only for the item 4; the ones between West Anatolia and West Black Sea occurred only for items 1 and 4; lastly, the ones between West Anatolia and Southeast Anatolia also occurred only for SEB index and items 1 and 4. That is the significant differences might be considered as a good omen for West Anatolia, but they were not alarming for the others. In a similar vein, Mediterranean had a significantly higher mean than Central East Anatolia for the second item. Even so, considering that the practical significance of the study is small, such differences could be disregarded. The worrying results, despite low practical significance, belonged to VTSS students from Northeast Anatolia.

Implications for Practice

Since the effect sizes were all of small magnitude, this study has very limited implications for practice. The results that might warrant some sort of intervention in practice should be the ones that occurred consistently throughout the study, or the deep-rooted issues based on the previous research. Based on the research the deep-rooted issues surrounding education in Turkey were western regions performing better than eastern regions and, similarly, GSS students performing better than VTSS students. As explained above, this study failed to confirm that western regions are significantly more sophisticated than eastern regions. Instead, the situation was that Aegean, West Anatolia and Mediterranean seem to be more sophisticated than Northeast Anatolia and Southeast Anatolia when all students are considered together. However, most of the between region differences disappeared for GSS students. The only NUTS-1 region-related significant mean differences that warrant action involved Northeast Anatolia’s VTSS students. What this implies for practice is that, after a follow-up study to find the root of the issue, these students might be offered additional support from the school. This additional support should ideally address the root of the issue. That is, if the low mean of Northeast Anatolia’s VTSS students were due to them reading less books on science compared to their peers, then the school should give them books. If it was due to these students being assigned to inadequate science teachers, then they should be given more adequate teachers and so on.

Based on other research, tracking students into different high-school routes have negative impacts in Turkey. As mentioned above, most of these academic routes are socio-economic status (SES) routes in reality. Hence, even if the practical significance of this study is small, such a deep-rooted issue revealing itself should not be disregarded. Once again, an intervention by schools might be required following a study revealing the fundamental cause of such differences. Especially in NUTS-1 regions with between school differences (Istanbul, Aegean, East Marmara, West Anatolia, Mediterranean, West Black Sea, Northeast Anatolia, Southeast Anatolia), VTSS should be careful that their students are not less sophisticated than the students from other schools. This can be achieved through hiring more competent teachers, offering teachers workshops, making students read more science books and so on.

Implications for Further Research

One of the drawbacks of this study was that the data was collected with six forced type Likert scale items which might fail to capture the depth of students' epistemic beliefs about science. That is, scientific epistemic beliefs would be revealed more evidently with in-depth interviews because closed-ended items cannot fully demonstrate the thinking process behind the answers. Hence, a comparison of scientific epistemic beliefs of geographic regions and school types with an in-depth interview might enlighten the situation even more.

Other than repeating the study with a different instrument, further research is warranted for the two issues mentioned in the previous sections. More precisely, further research is needed to find the underlying reasons for why VTSS students from Northeast Anatolia tend to be naïve epistemic believers about science. In addition, further studies should include if well-being of Northeast Anatolia's VTSS students is being affected by their disadvantages position. Since this study only conjectured that scientific epistemic beliefs inequalities would affect the well-being of the individual without the support of data, a study is warranted to check if that is actually is the case. Another research is needed for between school differences since these differences were reported in number of different studies.

Limitations

The first limitation was that, as stated above, scientific epistemic beliefs were only measured with closed ended items and the thinking processes (which make up these beliefs) were not fully captured. The second limitation was that the data used in this study violated the assumptions of normality and homogeneity of the variances, but the analysis was carried out regardless. Still, two-way ANOVA is robust to violating the first one and the sample size was too large which might produce significant results for the Levene's test (Blanca et al., 2017; Grace-Martin, 2018). Hence, the results should still be considered valid to a certain extent. Another limitation was that the schools were grouped according to two types. In reality, there were more than ten types of schools in Turkey when this study was conducted. In fact, the Ministry of Education in Turkey referred to more types of schools in their PISA 2015 report. That is the between school scientific epistemic beliefs differences can even be more severe. One last limitation is that some students might not take the PISA examinations seriously enough to provide genuine answers (Akyol et al., 2021). Particularly for the student questionnaire (which collects information on variables such as self-efficacy and epistemic beliefs), the non-seriousness might become more challenging because PISA does not provide any information on the time spent on answering the questionnaire. For the sake of this study, students were assumed to be serious.

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