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Differences between Turkey and Finland based on Eight Latent Variables in PISA 2006

Eren Ceylan[1] and Serdar Abacı[2]

[1]Ankara University, Faculty of Educational Sciences, Ankara, Turkey and [2]Indiana University, School of Education Department of Instructional System and Technology, Indiana, USA

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ABSTRACT

Because scrutinizing the factors that derived from international studies and have potential to make a country more successful in scientific literacy has been one major concern of researchers in science education field, we carried out a study to expose the differences between a low-performing country (Turkey) and a high-performing country (Finland) with regard to their students' views of science and familiarity to ICT (Information Communication Technology) based on the PISA 2006 results. A principal component analysis was performed to the items selected from the student questionnaire and ICT familiarity student questionnaire in PISA 2006 to gather the related factors and factor scores. Then, discriminant function analysis was conducted on the basis of the factor scores to explore the differences between a low-performing country (Turkey) and a high-performing country (Finland). The results revealed that the two countries were significantly discriminated based on the seven composite (latent) variables that consist 60 observed variables regarding socioeconomic status, doing well in ICT tasks, self-efficacy in science , importance to given to science, frequency in ICT tasks, student-centered activities, and science activities in leisure time. Whereas the use of student-centered activities and ICT tasks were encouraged in the low-performing country (Turkey), students in the high-performing country (Finland) tended to have high socioeconomic status and high self-efficacy in science. In addition, the results revealed that, even though the students in the high-performing country used the ICT tasks better than the students in the low-performing country, students in the low-performing country (Turkey) tended to do more activities related to ICT tasks.

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Keywords:
PISA 2006; scientific literacy; information communication technology; dicriminant function analysis; student-centered activities

Introduction

PISA (Program for International Student Assessment), like other international studies such as TIMSS (Trends in Mathematics and Science Study) and PIRLS (Progress in International Reading Literacy Study), has attracted many researchers' interest all around the world. PISA, a project of OECD (Organization for Economic and Co-operation and Development), has been carried out through three yearly cycles to assess regularly the extent of 15-year-old students' knowledge and skills that are essential in everyday life instead of testing how well students have mastered schools' specific curriculums. And, whereas domains of reading as well as mathematical, and scientific literacy were covered, the focus was on the latter in PISA 2006.

Investigating the students' views of science and their familiarity to ICT (Information Communication Technology), which could make a country more successful in science, is very crucial. Therefore, factors that

[1] Corresponding author's address: Ankara Üniversitesi, Eğitim Bilimleri Fakültesi, Ankara, Turkey.
Telephone: +90 3123633350-7108
Fax: +90 3123636145
e-mail: ernceylan@gmail.com

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influence students' science performance have been one major concern of researchers in science education field. Among all the international studies, PISA 2006 data provides a comprehensive source for analyzing students' science performance from different points of view. In the literature, studies were carried out based on the international studies to investigate the relationship among students' science views, their familiarity to ICT and their science performances (Aypay et al. 2007, Papanastasiou, 2002, Ceylan and Berberoglu, 2007, Papanastasiou et al. 2003).

Among all of the studies based on the international data, students' self-efficacy in science, though not as highlighted as the others, has been one of the major factors for predicting students' science performance (Britner and Pajares, 2001, Bandura, 1997; Andrew, 1998; Kupermintz, 2002; Lau and Roeser, 2002). Student questionnaire of PISA 2006, in this case, enables us to evaluate and interpret students' self-efficacy in science and its relationship with the students' science performance.

Instructional practices implemented in the science classrooms have a great impact on students' science performance. According to Nolen (2003), classroom characteristics affect students' achievement more than the motivational characteristics. Among all the studies based on the international data sets, although some have found direct or teacher-centered instruction more effective than the inquiry-based or student-centered one (Aypay et al. 2007, Ceylan and Berberoglu, 2007, D' Agostino, 2000), more have suggested that students' performance can be improved when the class is better organized and students actively involved in the learning through student-centered activities (Papanastasiou, 2008; Van de Grift and Houtveen, 2006, House, 2007, 2008).

On the other hand, the analysis of some of the TIMSS data revealed the strong influence of students' home background characteristics, such as students' socioeconomic status (SES) and educational background of the family members, on students' performance (Papanastasiou, 2008, Lokan and Greenwood, 2000). Even though socioeconomic status of the students has been defined in different ways, the robust relationship between students' SES and test scores is well replicated in social sciences (White, 1982; White et al. 1993).

Integrating the computer technology to science education has been one major concern of the recent science education reforms (Papanastasiou et al. 2003). Attending to this concern, a growing number of researchers have drawn attention to the impact of educational technology on students' science achievement (Altschhuld, 1995; Yalcinalp et al. 1995; Weller, 1996). While some of the prior studies have indicated the positive correlation between computer use and achievement (Berger et al., 1994; Shaw, 1998), negative relationships have also been found between computer use at schools and students' achievement (Papanastasiou, 2002; Papanastasiou and Ferdig, 2003). In this case, the PISA 2006 data, with its questionnaire for students' ICT familarity, not only present researchers the frequency of students' computer use but also enable researches to evaluate the proficiency of students' computer usage.

Finland and Turkey which are OECD member countries participated in PISA 2006. Whereas Finland showed great success and became the highest-performing country, Turkey exhibited poor performance and ranked as the second lowest-performing country among the OECD member countries in PISA 2006. The striking difference the two countries made in PISA 2006, with regard to students' science performance, can be easily perceived when the percentages of the students in these proficiency levels are scrutinized: whereas 20.9% of the Finland students scored at or above level 5, only less than 1% of the Turkey students score at or above the level 5. In addition, while the percentage of the students below level 2 was 17.7% in Finland, it was 77.9% in Turkey (OECD, 2007).

In PISA 2006, in addition to students' assessment on scientific literacy, students' home background characteristics, their views of science (ex: their enjoyment of science, confidence in solving science tasks, general and personal value of science, and general interest in science learning), as well as their views' of science teaching and learning, were exposed through the application of student questionnaire. Moreover, students' experiences, familiarity of ICT and frequency of ICT usage for different purposes, were exhibited through the administration of ICT familiarity questionnaire. This study, instead of investigating the reasons behind the high-performance of Finland in science and the low-performance of Turkey in science, with respect to educational issues of the country (such as; science curriculums, educational policy etc.), aims to expose the differences between a high-performing country (Finland) and a low-performing country (Turkey) with respect to the PISA 2006 results. Investigating the differences between the highest-performing country, Finland, and one of the lowest-performing countries, Turkey, among the OECD member countries in PISA 2006 (based on the eight factors derived from the student and ICT familiarity questionnaires, namely, socioeconomic status, doing well in ICT tasks, self-efficacy in science, attitude towards science, importance given to science, frequency in ICT tasks, student-centered activities, and science activities in leisure time) enable us not only to identify the characteristics behind the success of Finland students in science, but also reveal some issues regarding the poor-performance of Turkey students.

Methods

Sample

PISA 2006 involved more than 400, 000 students from 57 countries, that covering the 90% world economy. The target population of PISA 2006 was defined as 15-year-old students who attended the educational institutions located in each country, grade 7 and higher. More specifically, the international target population of PISA 2006 included all students aged from 15 years and 3 (completed) months to 16 years and 2 (completed) months at the assessment period began (OECD, 2009).

Two-staged stratified sampling design was used in the PISA 2006 assessment. As a result of this sample design, 4623 students from Turkey and 4710 students from Finland were selected for PISA 2006. That is, in the present study, all the students (N = 9333) who took part in PISA 2006 from Turkey and Finland were used as the sample of this study. The sampled students, consisting of 4465 girls and 4868 boys, were selected from 160 schools in Turkey and 155 schools in Finland, regardless of type of schools. The students were selected from grade 7 and higher students who were at 15-year-old.

Instruments

Students' responses to student questionnaire for PISA 2006 and ICT familiarity questionnaire were used for this study. The student questionnaire covered information about student characteristics (grade, study program, age, and gender) and family background (occupation of parents, education of parents, home possessions, number of books at home etc.), followed up an inquiry into their views of science (enjoyment of science, confidence in solving science tasks, general and personal value of science, participation in science-related activities etc.), and of science teaching and learning (nature of science teaching at school, importance of doing well in science, academic self-concept in science etc.).

Furthermore, students were asked to answer 108 science items. In PISA 2006, IRT (Item Response Theory) scaling methods were employed to obtain the proficiency scales.

Data Analysis

Discriminant function analysis (DFA) usually used to classify individuals into groups on the basis of one or more measures or to realize the group differences (Green et al. 2000), was conducted in the present study. The DFA was performed to differentiate low-performing country (Turkey) and high-performing country (Finland) with regard to the students' responses to the selected eight composite variables on student questionnaire and ICT familiarity questionnaire for PISA 2006.

Before running the DFA, explanatory factor analysis was carried out to obtain factor scores and determine which factors to focus on. 60 variables related to students' home/family background characteristics, their views of science, their views of science teaching and learning, and their ICT familiarity were selected, based on the purpose of the study as well as the literature (Apay et al. 2007; Ceylan and Berberoglu, 2007; Yayan and Berberoglu, 2004; Papanastasiou, 2002).

The DFA was performed based on eight factor structures including 60 variables (items) from the students' responses to student questionnaire and ICT familiarity questionnaire. SPSS version 15.0 was used for data analyses. Stepwise procedure was selected in the discriminant function analysis. In addition, Wilks' lambda was minimized at each step by adjusting F-to-enter as 1.15 and F-to-remove as 1.00. To check multivariate normality Box's M was clicked. The univariate analysis of variance was selected to understand the multivariate nature of dependent variables. Furthermore, unstandardized discriminant function coefficient, the combined groups plot, residual for each case, and summary table were ticked (Green et al. 2000; George and Mallery, 2006).

Results

The international average scores of the science achievement tests in PISA 2006 for Turkey and Finland are 424 and 563, respectively. When the OECD average score of 500 is taken into account, Turkey's average is 76 points below the OECD average and Finland's average is 63 points above the OECD average. In addition, there is a statistically significant mean difference between Turkey and Finland with respect to their students' science scores in PISA 2006 (OECD, 2007).

The discriminant function was gathered by running discriminant function analysis (DFA) based on the eight composite variables for all the students in Turkey and Finland who participated in PISA 2006. As it was stated above, before the discriminant analysis was run, the principal component analysis (factor analysis) had been conducted not only to gather the factor scores, which were later used as independent variables in the discriminant analyses, but also to see the number of dimensions and delineate the dimensions of the 60 variables (items) selected from the student and ICT familiarity questionnaires of PISA 2006.

Principle Component Analysis (Explanatory Factor Analysis)

The 60 variables (items) were selected based on the literature (Apay et al. 2007; Ceylan and Berberoglu, 2007; Yayan and Berberoglu, 2004; Papanastasiou, 2002, Papanastasiou et al. 2003). To test out the assumptions of factor analysis, KMO (Kaiser-Mayer-Olkin) and Barlett's test of sphericity were adopted. The assumptions of multivariate normality and sampling adequacy (adequacy of the variables in the factor analysis) are examined by these tests. The KMO value was then found 0. 952 and indicated the fact that the distribution of values in our study was meritoriously (Kaiser's levels) adequate for conducting factor analysis. Moreover, a significant value ($p < 0.05$) was found in Barlett's test of sphericity which verified the assumption of the multivariate normality (George and Mallery, 2006).

The principle component analysis was run to obtain factor scores and see the dimensions of the selected 60 items. Eigenvalues of 1 and more than 1 and scree test were used to retain and determine the number of factors in the analysis (Stevens, 2002). Table 1 presents the dimensions as the result of the factor analysis, with their respective factor loadings. Items with 0.40 and lower of factor loadings were not taken into consideration.

Table 1. Factor Structures and Factor Loadings for Factor Analysis

ITEMS	F1	F2	F3	F4	F5	F6	F7	F8
Home possesses internet connection	**.767**							
Home possesses computer	**.764**							
Number of computers at home	**.745**							
Mother education level	**-.699**							
Home possesses dishwasher	**.675**							
Number of cars	**.657**							
Number of cell phones	**.630**							
Number of televisions at home	**.622**							
Father education level	**-.579**							
Home possesses DVD or VCR	**.511**							
Home possesses art	**.508**							
Moving files		.773						
Downloading files		.772						
Copying data to CD		.745						
Attaching e-mail		.740						
Searching internet		.711						
Using a word processor		.706						
Editing photos		.657						
Writing and sending e-mails		.644						
Using spreadsheet		.555						
Constructing a webpage		.506						
Science topics are easy for me			**.825**					
I can learn science topics quickly			**.825**					
I can understand science concepts well			**.805**					
I can easily understand new ideas			**.804**					
I can give good answers			**.778**					
Learning advanced topics would be easy for me			**.736**					
Enjoying to acquire new knowledge in science				.787				
Interested in learning about science				.778				
Having fun when learning science topics				.776				
Like reading about science				.766				
Happy doing science problems				.693				
Science brings social benefits					**.717**			
Science improves living conditions					**.698**			
Science helps us to understand natural world					**.689**			
Science is valuable to society					**.672**			
Science helps to improve economy					**.664**			
Science helps me to how I relate other people					**.562**			
Science helps me to understand					**.535**			
I will use science when I am an adult					**.461**			
Using spread sheets						.761		
Writing documents (word etc)						.709		
Writing computer programs						.703		
Using graphing programs						.699		
Collaborating with others via internet						.660		
Using educational software						.639		
Browsing the internet for information						.460		
Testing out students own ideas							**.738**	
Discussing about the topics							**.709**	
Choosing students own investigations							**.684**	
Doing experiments							**.645**	
Designing students own experiments							**.642**	
Having class debate or discussion							**.638**	
Applying science concepts to everyday problems							**.609**	
Buying books about science								.666
Attending science club								.666
Listing radio programs about science								.665
Visiting web sites about science								.645
Reading science article								.587
Watching TV about science								.522

The common characteristics of the items loaded on the same factor were taken into consideration and these eight factors were named accordingly. Table 2 indicated the factors' name, eigenvalues, and total variance.

Table 2. Factor Names, Abbreviations, Eigenvalues, and % of Variance

Factor Names	Abbreviation	Eigenvalues	% Variance
Socioeconomic Status	Factor 1 (SES)	11.30	18.83
Doing well in ICT Tasks	Factor 2 (DWC)	7.90	13.17
Self-efficacy in Science	Factor 3 (SEF)	4.86	8.10
Attitude toward Science	Factor 4 (ATS)	2.56	4.27
Importance given to Science	Factor 5 (ISC)	2.28	3.80
Frequency in ICT Tasks	Factor 6 (FCT)	1.95	3.26
Student-centered Activities	Factor 7 (SCA)	1.63	2.71
Science Activities in Leisure time	Factor 8 (SLT)	1.24	2.06

Factor analysis results indicate that, the first factor (socioeconomic status) was composed of eleven variables, the second (doing well in ICT Tasks) composed of ten, the third (self-efficacy in science) composed of six, the fourth (attitude toward science) composed of five, the fifth (importance given to science) composed of eight, the sixth (frequency in ICT tasks) composed of four ,the seventh (student-centered activities) composed of seven, and the eighth (science activities in leisure time) composed of six.

Discriminant Function Analysis (DFA)

DFA was run based on the factor scores that were extracted from the factor analysis. Then, given the independent variables of DFA, the eight factor scores were derived from the explanatory factor analysis. The dependent variable of the DFA is the country (Turkey and Finland). The independent variables, on the other hand, were named based on the explanatory factor analysis, namely, socioeconomic status, doing well in ICT tasks, self-efficacy in science, attitude toward science, importance given to science, frequency in ICT tasks, student-centered activities, and science activities in leisure time. Box's test was used to understand whether the assumption of the equality of the covariance matrices (multivariate normality) was violated.

The eigenvalue and the canonical correlation of the second discriminant analysis were found 2.42 and 0.841, respectively. The larger eigenvalue indicates the more variance in the dependent variable, is explained by the function gathered by DFA, and the discrimination among groups becomes better (Green et al. 2000). The eta square was found 0.707, indicating that 70% variability of the scores for the discriminant function was accounted for by the difference among the two countries. Wilks' lambda was found 0.292, and the discriminant function had χ^2 (7, N = 9333) = 11485.09 and $p < 0.000$. These values indicated that there were significant differences between Turkey and Finland students' response patterns to the eight composite variables at 0.05 level of significance. Table 3 summarizes these results.

Table 3. Summary of significance test and relationship statistics for DFA

Function	Eigenvalue	% of Variance	Canonical Correlation	Wilks' Lambda	X^2	df	Significance
1	2.42	100	0.841	0.292	11485.09	7	0.000

As stated, the stepwise procedure was used in the DFA. In our study, since the groups (countries) were not significantly discriminated by the factor 4 (attitude toward science), the factor 4 (attitude toward science) was excluded from the DFA. And, this is why the df value was gathered as 7. Table 4 represents the standardized correlation and correlation coefficient for the seven factor scores in the DFA. The discriminant function (DF) that indicates which factor structures differed significantly in discriminating the two groups of countries is listed in the Table 4.

Table 4. Standardized canonical discriminant function and correlations of predictor variables with the discriminant function

FACTORS	Standardized Canonical Discriminant Function Coefficients	Correlation Coefficient With Function
Socioeconomic Status (SES)	-1.100	-0.635
Doing well in ICT Tasks (DWC)	-0.292	-0.087
Self-efficacy in Science (SEF)	-0.052	-0.015
Importance given to Science (ISC)	0.320	0.096
Frequency in ICT Tasks (FCT)	0.508	0.157
Student-centered Activities (SCA)	0.388	0.117
Science Activities in Leisure time (SLT)	0.613	0.196

DF = -1.100 (SES) – 0.292 (DWC) – 0.052 (SEF) + 0.320 (ISC) + 0.508 (FCT) + 0.388 (SCA) + 0.613 (SLT)

Group centroids (Table 5) indicate the relative positions of the two countries according to the DF. These cenroids indicated, in the function, that the positively valued independent variables were for Turkey and the negatively valued ones were for Finland. Also, the group centroids indicated the average discriminant scores for subjects in Turkey and Finland (George and Mallery, 2006).

Table 5. Functions at Group Centroids

Country	Discriminant Function 1 (DF1)
Finland (high-perform)	-0.776
Turkey (low-perform)	0.805

The factor structures that students have high factor scores in Turkey can be categorized as:

1. Frequency in ICT Tasks (FCT)
2. Science Activities in leisure time (SLT)
3. Student-centered Activities (SCA)
4. Importance given to Science (ISC)

On the other hand, the composite variables that students have high factor scores in Finland can be categorized as:

1. Socioeconomic Status (SES)
2. Doing well in ICT Tasks (DWC)
3. Self-efficacy in Science (SEF)

In other words, it can be inferred that, while Turkey students tended to do more activities related to ICT tasks, do more science activities in their leisure times, do more student-centered activities in science classrooms, and give more importance to science, Finland students tended to have high socioeconomic status, do ICT tasks better, and have better self-efficacy in science.

The classification results, on the other hand, indicated that the percentage of the correctly classified students in Turkey and Finland were 89.1% and 96.5%, respectively. In addition, 92.8% of the sampled students (N = 9333) students were correctly classified which indicate good classification results.

The average factor scores for Turkey and Finland students show a consistency with the DFA results (Table 7). For example, while Turkey students had high factor mean scores for science activities in leisure time (M = 0.294), frequency in ICT tasks (M = 0.240), and student-centered activities (M = 0.180), Finland students had high factor mean scores for: socioeconomic status (M = 0.709) and doing well in ICT tasks (M = 0.132).

Table 6. Mean scores of factor structures in Turkey and Finland

	Factors						
Countries	SES	DWC	SEF	ISC	FCT	SCA	SLT
TURKEY	-0.709	-0.135	-0.023	0.148	0.240	0.180	0.294
FINLAND	0.696	0.132	0.023	-0.145	-0.235	-0.177	-0.288

DFA results revealed that students who have high socioeconomic status, do ICT tasks well, and high self-efficacy in science, can be very likely from Finland, whereas students who do more science related activities in their leisure time, do more ICT tasks, and do more student-centered activities in class are very likely to be from Turkey. The results and potential reasons leading to them will be discussed based on the relationship between the country performance and the investigated factor structures in the next section.

Discussions and Conclusion

The aim of the study was to expose the differences between a low-performing country (Turkey) and a high-performing country (Finland) with respect to the eight selected composite variables, including socioeconomic status, doing well in ICT tasks, self-efficacy in science, attitude towards science, importance given to science, frequency in ICT tasks, student-centered activities, and science activities in leisure time, which were derived from the student and ICT familiarity questionnaires of PISA 2006. Discriminant function analysis (DFA) was conducted to obtain discriminant function. In the DFA, the "factor scores of the selected composite variables" (latent variables) were treated as the independent variables, whereas "country" was determined as the dependent variable (grouping variable). The factor scores that were used as the independent variables of the DFA had been extracted by using explanatory factor analysis of the 60 related items in the student and ICT familiarity questionnaires of PISA 2006.

Discriminant function equation obtained from the DFA revealed that, the low-performing country (Turkey) and the high-performing country (Finland) were significantly discriminated on seven composite (latent) variables out of the eight selected composite (latent) variables. Examining the DFA results (the mean scores of factor structures), what we found out is that, while the mean factor scores of the composite variables such as SES, DWC, and SEF, are higher in Finland, the mean factor scores of the composite variables which are higher in Turkey are ICT, FCT, SCA, and SLT.

Several studies revealed the substantial relationship between the socioeconomic status and students' academic achievements (e.g. Yang, 2003; Gustafsson, 1998). It was also revealed that students' socioeconomic status, which explained 14% of the student performance variation in science, is one of the most powerful factors influencing students' performance in PISA 2006 (OECD, 2007). The finding that students who have high socioeconomic status are highly likely to be the students of high-performing country (Finland) shows a consistency with the previous studies, some of which have made the claim that students with high socioeconomic background tend to gain higher scores on science achievement tests (Mere et al. 2006; Aypay et al. 2007). The socioeconomic differences of the students in Finland and Turkey can be vividly observed when the international distribution on PISA economic index was examined: the percentage of students falling within the lowest 15% of the international distribution on the PISA socioeconomic index of Turkey and Finland are 62.7% and 5.6%, respectively.

Students' belief about their capability to successfully perform academic tasks was defined as self-efficacy belief, which was clearly developed in Bandura's social cognitive theory (1986). Research has consistently showed that, in addition be a strong predictor of academic achievement, course selection, and career decision across domains (Britner and Pajares, 2005), self-efficacy beliefs are positively associated with key motivation constructs such as self-regulation (Zimmerman, 2000) and self-concept (Bong and Skaalvic, 2003). Therefore, the major finding of the present study that the students in Finland (high-performing country) have a higher self-efficacy belief in science than the students in Turkey (low-performing country) supported by the previous studies as a no surprise.

One of the striking results of this study is that the student-centered activities were implemented more in low-performing country (Turkey) than in the high-performing country (Finland). However, this finding does show some consistency with the findings of earlier studies. For example, some studies (Leung, 2002; Ceylan and Berberoglu, 2007) indicated the negative relationship between student-centered activities and students' science achievement based on TIMSS data. Similarly, Aypay, Erdogan, and Sozer (2007) carried out a study to investigate the differences between low- and high- performing schools in Turkey based on TIMSS -99 data. In addition, when examining the frequency of science classroom activities in high-performing countries such as Singapore, Japan, and Hong-Kong with respect to the TIMSS results, it can be seen that student-centered activities are less implemented in science classrooms (Leung, 2002; Pelgrum and Plomp, 2002). On the other hand, House (2007, 2008) stated that students in China Taipei, who engaged more in the activities related to conducting experiments and investigations, had a tendency to acquire higher scores in science. All in all, there is a growing body of studies providing substantial theoretical and empirical evidence in support of student-centered activities which lead to higher performance of students in science (Caccovo, 2001; Yuretich et al. 2001; Stright and Supplee, 2002; Von Secker and Lissitz, 1999).

In Turkey, the revision of the national science curriculum took place in 2007. When the transition process and the features of new science curriculum in Turkey are examined, it can be seen that the new curriculum was designed to replace the old one as well as to increase the use of student-centered activities in the class. This transition was accrued so fast. The sudden shift from the science curriculum based on rigid teacher-centered activities to the science curriculum based on student-centered activities without the proper needs assessment procedures might cause some deficiencies in implementation of student-centered science activities. For example, it was revealed that the sudden change in the curriculum with insufficient preparation and without building on existing practice of teachers would simply result in the so-called "de-skilling" teachers (Amos and Boohan, 2002). Therefore, one of the reasons leading this result of this study, which indicated the more implementation of student-centered activities in Turkey, can be the improper implementation of the student-centered activities in science classes in Turkey. On the other hand, in Finland, although there was a shift from the science curriculum based on teacher-centered activities to the science curriculum based on student-centered activities, this shift took place more gradually. In Finland, during this gradual shift, the curriculum was taken more as a process rather than a product; plus, the science teachers were valued as experts who, actively involved in the development curriculum at all levels. Flexible, school-based, and teacher-planned curriculum along with the student-centered instruction represent the features behind the success of Finland in PISA (Välijärvi et al. 2000). Therefore, instead of examining the frequency of student-centered activities in the both the countries, research on proper implementation of these activities with qualitative, more in-depth, methods would be suggested to future studies.

The results about the "importance given to science" and "science activities in leisure time" composite (latent) variables seem surprising. The factor scores (means of factor scores) for the latent variables of "importance given to science" and "science activities in leisure time" were higher for students in the low-performing country (Turkey) than students in the high-performing country (Finland). However, there are some studies yielding contradictory results from ours. For example, it was revealed that students who gave more importance to science gained higher scores in science (Ceylan and Berberoglu, 2007). On the other hand, it was expected that students who engaged themselves with science related activities more in their leisure time were the students of the high-performing country. However, the results of this study indicated the opposite.

This study reveals that, whereas students in the low-performing country (Turkey) use the ICT related tasks such as more often than the students in the high-performing country (Finland), students' in high performing country (Finland) use the ICT related tasks more competently than students in the low-performing country (Turkey). The results of the previous studies related to frequency of computer use have shown some discrepancies, though. For instance, based on the TIMSS data, Papanastasiou's study (2002) revealed that, in some of the countries such as Cyprus, Hong Kong, and the United States, students gained lower scores when they use the computers more in the classrooms. In another study, the researchers drew on the PISA results and claimed that, the frequency of usage of certain types of educational software was negatively related with students' science achievement in the United States (Papanastasiou et al. 2003).

Finally, in this study, while the analysis of the PISA 2006 data indicated the clear differences between a high-performing country (Finland) and the low-performing country (Turkey), it also revealed the fact that these differences likely stem from the latent variables socioeconomic status (SES), doing well in ICT tasks

(DWC), self-efficacy in science (SEF), importance to given to science (ISC), frequency in ICT tasks (FCT), student-centered activities (SCA), and science activities in leisure time (SLT) which were derived from student questionnaire and ICT familiarity student questionnaire for PISA 2006. To understand deeply the surprising results such as finding more implementation of student-centered activities in the low-performing country, finding the factor scores (means of factor scores) for the latent variables of "importance given to science" and "science activities in leisure time" higher in the low-performing country, and finding the more computer usage in the low-performing country, but better ICT usage in students of the high-performing country, qualitative studies should be carried out in science classrooms of the both countries. Similar studies should also be conducted in other counties and for mathematics and reading achievement. Similar studies should be conducted based on TIMSS database to compare and contrast the results with this study. In addition, since the between school variance explained a great deal of variance on students' science scores in low-performing countries when compared to the high-performing countries, similar studies should be conducted to reveal the differences between high-performing schools in a low-performing county and a high-performing country and low-performing schools in a low-performing county and a high-performing country. Moreover, the latent variables that were not included in this study should be taken into consideration for further studies.

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