Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi • Cilt: 39 • Sayı: 2 • Aralık 2017, ISSN: 2149-1844, ss/pp. 503-518
DOI: 10.14780/muiibd.384174

DETERMINATION OF STUDENTS' PROFILES ACCORDING TO HOME EDUCATIONAL RESOURCES AND MATHEMATICS ACHIEVEMENT VIA LATENT CLASS ANALYSIS

Serpil KILIÇ DEPREN[*]
Seda BAĞDATLI KALKAN[**]

Abstract

The purpose of this study was to examine the correlation between mathematics achievements and ownership of the home educational resources of students via Latent Class Analysis (LCA) using Programme for International Student Assessment (PISA) 2015 study. Although 5895 15-year-old Turkish students were participated in PISA study, the data of 5355 students were included in the analysis because of the missing data of the selected variables. 12 items which were related to students' home educational resources were used in LCA analysis. As a result, 3 classes were determined; 32% of students were in 1st latent class, 29% of students were in 2nd latent class and 39% of students were in 3rd latent class. It was revealed that students in 1st latent class had only "a desk to study at", "a quiet place to study", "books to help with your school work" and "a dictionary" while students in 3rd latent class had all the home educational resources (12 items). Furthermore, it was shown that students in 3rd latent class had the highest mathematics score while students in 1st latent class had the lowest mathematics scores.

Keywords: *Latent Class Analysis, Mathematics Achievement, PISA 2015, Home Educational Resources.*

JEL Classification: *C38, C83, I21.*

GİZLİ SINIF ANALİZİ İLE EVDEKİ EĞİTİM KAYNAKLARI VE MATEMATİK BAŞARISINA GÖRE ÖĞRENCİLERİN PROFİLLERİNİN BELİRLENMESİ

Özet

Çalışmanın amacı, Uluslararası Öğrenci Değerlendirme Programı'na katılan Türk öğrencilerin evdeki eğitim kaynaklarının varlığı ve matematik başarısı arasındaki ilişkinin gizli sınıf analizi ile incelenmesidir. 2015 yılındaki Uluslararası Öğrenci Değerlendirme Programı (PISA) çalışmasına Türkiye'den 5895 öğrenci katılmasına rağmen, bu çalışmada kullanılan değişkenlerdeki kayıp verilerden dolayı 5355 öğrenci analize dâhil edilmiştir. Gizli sınıf analizinde evdeki eğitim kaynakları ile ilgili 12 değişken kullanılmıştır.

[*] Assist. Prof. Dr., Yıldız Technical University, Faculty of Arts & Sciences, Department of Statistics, serkilic@yildiz.edu.tr
[**] Assist. Prof. Dr., İstanbul Commerce University, School of Business, International Trade, sbagdatli@ticaret.edu.tr

Sonuç olarak, 3 gizli sınıf elde edilmiş ve öğrencilerin %32'si birinci, %29'u ikinci ve %39'u da üçüncü grupta yer almıştır. Birinci gizli sınıftaki öğrencilerin sadece çalışma masasına, çalışmak için sakin bir ortama, okul derslerine yardımcı kitaplara ve sözlüğe sahip olduğu, üçüncü gizli sınıftaki öğrencilerin ise sorgulanan 12 öğenin tamamına sahip olduğu gözlemlenmiştir. Ayrıca, üçüncü gizli sınıftaki öğrencilerin en yüksek matematik skoruna, birinci gizli sınıftaki öğrencilerin ise en düşük matematik skoruna sahip olduğu gösterilmiştir.

Anahtar Kelimeler: *Gizli Sınıf Analizi, Matematik Başarısı, PISA 2015, Evdeki Eğitim Kaynakları.*

JEL Sınıflaması: *C35, C38, I21.*

1. Introduction

Today's world, almost all countries are measuring their performance of educational level, living standards, health system, poverty and financial equality using different key performance indicators (KPI). Furthermore, these KPIs are used as an indicator of human development, thus countries are able to compare their development level to other countries and determine the positioning among other countries [1]. In educational area, countries are monitoring Programme for International Student Assessment (PISA), Trends in International Mathematics and Science Study (TIMSS) or Progress in International Reading Literacy Study (PIRLS) for the educational benchmark.

The main purpose of the PISA study, which was launched in 2000 and conducted in every 3 years, is to determine the need for improvement of educational system [2]. Also, it helps countries to implement efficient educational policies which allow students for further life. In every PISA survey, mathematics, science and reading achievements of students were measured. 540.000 students from 72 countries were participated in PISA 2015 study all over the world [3]. Schools and students were selected two-step stratified sampling technique.

Mathematics score is divided into 6 categories in PISA study [4]. According to the methodology of PISA, students whose mathematics scores are,

- below 421 can answer questions which are clearly defined and if only all necessary information is given.
- between 421 and 482 can interpret and recognize situations without requiring any extra information.
- between 483 and 544 can define basic procedures and use basic problem-solving strategies.

1 Fırat, E., Aydın, A. (2015). İnsani Kalkınma Endeksine göre Türkiye'nin Eğitim Endeks Göstergelerinin OECD Ülkeleri ile Karşılaştırılması, Selçuk Üniversitesi İktisadi ve İdari Bilimler Fakültesi Sosyal Ekonomik Araştırmalar Dergisi, 15(29): 63.

2 Organization for Economic Cooperation and Development (OECD) (2016). PISA 2015 Results (Volume I): Excellence and Equity in Education, OECD Publishing, pp. 38.

3 OECD, 2016, 27.

4 Milli Eğitim Bakanlığı (MEB) (2005). PISA 2003 Projesi Ulusal Nihai Raporu, Ankara, pp. 9.

- between 545 and 606 can work with complex models with constraints.
- between 607 and 668 can decide which problem solving strategies should be chosen for complex problems and also work effectively with complex models.
- above 668 can link different complex models with different sources and are capable of advanced mathematical thinking.

In the literature, many researchers were studied on factors affecting students' mathematics achievement in order to improve students' success. These factors were socio-economic and cultural status, student-teacher relationship, attitudes towards mathematics, mathematics anxiety, classroom climate, sense of belonging and teaching methods [5], [6], [7], [8].

In the literature, there were some studies about investigating the effect of home educational resources on mathematics achievement. In these studies, it was shown that motivation, classroom environment, quality of instruction and home environment had a positive effect on mathematics success. In addition, in some researches it was shown not only demographic characteristics of students but also environmental factors such as learning environment at school and at home had a significant effect on mathematics success, [9].

In the last decade, more specifically, researchers worked on the impact of home educational resources on not only mathematics achievement but also literacy and science achievements [10]. Fuchs and Woessmann [11] studied the effect of availability and use of computers at home and at school using PISA dataset. Analysis showed that there was a positive correlation between mathematics success and availability and use of computers at home.

In 2010, the effect of school and family resources on students' achievement was examined by Beese and Liang [12]. Students from United States, Canada and Finland were included in the analysis. Finally, positive correlation was shown between achievement and school and family resources. In the study of Demir, Kılıç and Ünal (2010), the effects of gender, school type, socio-economic cultural status, home educational resources (such as a desk, an own room and a computer etc.) and the use of

5 Lewis, R., Aiken, J. (1970). Attitudes toward Mathematics, Review of Educational Research, 40(4): 591-596.

6 Smith, R. et al. (1978). Evaluating Educational Environments, Bell and Howell, Colombus, OH: Merrill/Macmillan, pp. 157.

7 Topçu, M.S. et al. (2016). Factors Predicting Turkish and Korean Students' Science and Mathematics Achievement in TIMSS 2011, Eurasia Journal of Mathematics, Science & Technology Education, 12(7): 1723-1727.

8 Şirin, S.R. (2005). Socioeconomic Status And Achievement: A Meta-Analytic Review Of Research, Review of Educational Research, 75: 441-445.

9 Güvendir, M.A. (2014). Öğrenci Başarılarının Belirlenmesi Sınavında Öğrenci ve Okul Özelliklerinin Türkçe Başarısı ile İlişkisi, Eğitim ve Bilim, 39(172): 173-174.

10 Güvendir, E. (2015).A Multi-Level Simultaneous Analysis of How Student and School Characteristics Are Related to Students' English Language Achievement, Education Research and Perspectives, 42: 494-495.

11 Fuchs, T., Woessmann, L. (2014). Computers and Student Learning: Bivariate and Multivariate Evidence on the Availability and Use of Computers at Home and at School, Munich: CESifo Working Paper No. 1321, pp. 12.

12 Beese, J., Liang, X. (2010). Do Resources Matter? PISA Science Achievement Comparison Between Students in the United States, Canada and Finland, Improving Schools, 13(3): 269.

internet and computer related variables were investigated via multilevel analysis [13]. Similar to the study of Demir, Kılıç and Ünal in 2010, Kitsantas, Cheema and Ware (2011) examined the effect of homework resources (such as a desk to study at etc.), mathematics self-efficacy and time spent on homework on mathematics achievement. In the study it was shown that homework resources and mathematics self-efficacy had positive effects on mathematics achievement [14].

In the study of Arıkan, Vijver and Yağmur (2016), it was shown that student' self-confidence and home educational resources had a positive effect on students' mathematics achievement [15]. In addition, self-confidence was a differentiation indicator in order to explain mathematics achievement.

Özberk, Kabasakal and Öztürk studied on investigating the factors affecting Turkish students' mathematics achievement in PISA study in 2017 via hierarchical linear models [16]. In this study, researchers worked on three different models with different explanatory variables such as mathematics anxiety, internet and computer use, socio-economic and cultural status, home educational resources, student-teacher ratio and quality of school educational resources. In conclusion, mathematics anxiety had a negative effect on mathematics achievement while socio-economic and cultural status, home educational resources, student-teacher ratio and quality of school educational resources have positive effect on mathematics achievement.

In the literature, generally, factors affecting mathematics achievement were measured via variance analysis, multilevel models and factor analysis. In this study, the effect of home educational resources was examined using latent class analysis. In conclusion, students divided into three different groups with different characteristics according to availability of home educational resources at home and mathematics achievement of students. Thus, different action plans could be arranged for specific group of students.

The outline of this paper organized as follows. Latent Class Analysis (LCA) and the data were introduced in Section 2. In Section 3, empirical results were explained. Section 4 is the conclusion of the study.

2. Material and Methods

The data from the PISA which was conducted in 2015 in Turkey was used in the study. The data are composed of 5895 students (15-year-old students) within 187 schools. However, the data of 5355 students were included in the analysis because of the missing data of the selected variables in this study.

13 Demir, İ. et al. (2010). Effects of Students' and Schools' Characteristics on Mathematics Achievement: Findings from PISA 2006, Procedia Social and Behavioral Sciences, 2: 3102.

14 Kitsantas, A. et al. (2011). Mathematics Achievement: The Role of Homework and Self-Efficacy Beliefs, Journal of Advanced Academics, 22(2): 330-332.

15 Arıkan, S. et al. (2016). Factors Contributing to Mathematics Achievement Differences of Turkish and Australian Students in TIMSS 2007 and 2011, Eurasia Journal of Mathematics, Science & Technology Education, 12(8): 2047-2050.

16 Özberk, E.H. et al. (2017). Investigating the Factors Affecting Turkish Students' PISA 2012 Mathematics Achievement Using Hierarchical Linear Modeling, Hacettepe University Journal of Education, 32(3): 547-548.

2.1. Variables

In PISA dataset, 12 questions are related to home education resources which are (*Which of the following are in your home?);*

- o A desk to study at
- o A room of your own
- o A quiet place to study
- o A computer you can use for school work
- o Educational software
- o A link to the Internet
- o Classic literature (e.g. Shakespeare)
- o Books of poetry
- o Works of art (e.g. paintings)
- o Books to help with your school work
- o Technical reference books
- o A dictionary

With this study, 12 questions were used for classification and the target variable was student mathematics achievement.

2.2. Method: Latent Class Analysis

Lazarsfeld introduced latent class analysis in 1950 as a model based clustering with multivariate dataset. Latent Class Analysis classifies individuals with similar answer set, which can be used to determine the pattern of related cases. Since the Latent Class Regression (LCR) estimates the coefficients of the covariates simultaneously as a part of the latent class, this technique is known as a generalization of latent class classification [17], [18]. Analyses were conducted by R software version 3.4.1 in this study.

LCA is based on two basic assumptions which are local independence and exhaustiveness. Local independence assumes that latent class membership explains all of the shared variance among the observed indicators. Exhaustiveness assumption is that each individual in the population has membership in exactly one of the latent classes [19].

17 Dayton, C.M., Macready, G.B. (1988). Concomitant-Variable Latent-Class Models, Journal of the American Statistical Association, 83(401): 175.

18 Hagenaars, J.A., McCutcheon, A.L. (2002). Applied Latent Class Analysis, Cambridge University Press, pp. 89.

19 Goodman, L.A. (1974). Exploratory Latent Structure Analysis Using Both Identifiable and Unidentifiable Models, Biometrika, 61(2): 215.

Suppose that the observed categorical variables A, B and C consist of I, J and K classes, respectively. Let π_{ijk} denote the probability that an individual will be at level (i, j, k) with respect to the joint variable (A, B, C) (i=1,…,I; j=1,…,J; k=1,…,K). Suppose that there is a latent variable X, consisting of T classes that can describe the relationships among observed categorical variables (A, B, C). This means that π_{ijk} can be shown as follows [20]:

$$\pi_{ijk} = \sum_{t=1}^{T} \pi_{ijkt}^{ABCX}$$

where

$$\pi_{ijkt}^{ABCX} = \pi_t^X \pi_{it}^{AX} \pi_{jt}^{BX} \pi_{kt}^{CX}$$

denotes the joint probability. π_t^X is the probability of each category of latent variable and these probabilities are defined as mixture proportion or latent class probabilities. π_{it}^{AX} denotes the conditional probability that an individual will be at level I with respect to variable A, given that he is at level t with respect to variable X.

Generally, Chi-squared goodness-of-fit ($\chi^2 = \sum_{ij} \frac{(F_{ij} - \hat{F}_{ij})^2}{\hat{F}_{ij}}$) and Likelihood ratio ($G^2 = 2\sum_{ij} F_{ij} \ln \frac{F_{ij}}{\hat{F}_{ij}}$) tests are used if the model fits the data.

Akaike (AIC = G^2 – 2df) and Bayesian (BIC = G^2 – df(lnN)) Information Criteria are used for determining the number of latent classes [21].

3. RESULTS

3.1. Background of the Data

Firstly, the descriptive statistics of 5355 students were examined. Secondly, latent class analysis was performed for profiling the students based on home aducational resources and mathematics success.

Students' age was 15.82 on average and gender distribution of students was equal with 49.8% of the respondents was female and 50.2% was male. When examine the students' parents education level, it was shown that 37% of students' mothers education level was ISCED-1 and 30% of students' fathers education level was ISCED-1. In addition, index of economic, social and cultural status (ESCS) was – 1.45 on average (min: – 5.13 and max: 3.12). As the ESCS value increases, the economic, social and cultural status of students' also increases.

One of the questioned sections in the PISA study was the ownership of students' home educational resources. In this section, 12 different items were questioned in the PISA survey in Turkey.

20 Goodman, L.A. (1979). On The Estimation of Parameters In Latent Structure Analysis, Psychometrika, 44(1): 123-124.

21 Arıcıgil Çilan, Ç. (2015). Uygulamalı Gizli Sınıf Analizi, İstanbul:Çağlayan Kitabevi, pp. 59-60.

Table 1: Home Educational Resources Questioned in the PISA Study

	Yes
A dictionary	94,6%
A desk to study at	84,7%
A quiet place to study	83,2%
Books to help with your school work	82,8%
A room of your own	70,8%
A computer you can use for school work	67,5%
A link to the Internet	62,5%
Books of poetry	56,0%
Classic literature (e.g. Shakespeare)	52,9%
Technical reference books	41,6%
Educational software	41,4%
Works of art (e.g. paintings)	31,2%

According to Table 1, 95% of students participated in the PISA study said they had a dictionary. In addition, %85, %83 and %71 of students participated in the PISA study said they had a desk to study, a quiet place to study and a room of their own, respectively. %68 of the student said they had a computer for school work while %63 of students said they had a link to the internet. Only 31% of students said they had works of art (e.g. paintings).

Some economic, social and cultural status related questions such as number of television, cars, smartphones etc. were also asked to the students in the PISA study. 59%, 50% and 59% of students stated that they had only one television, car and room with a bath or shower in their home, respectively. Similarly, 48% and 44% of students said that they had only one computer and tablet in their home, respectively. When smart phone with internet access ownership was asked, 47% of students said that they had three or more smartphones in their home. Ratio of musical instrument and/or e-book reader ownership was relatively lower than other items. 94% and 55% of students stated that they had no musical instrument and/or e-book reader, respectively.

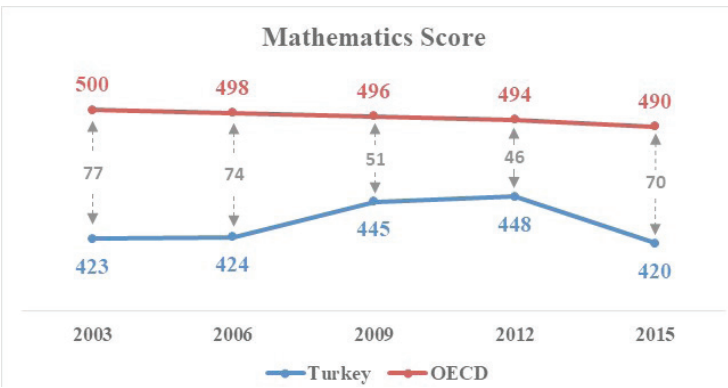

Figure 1: Average Mathematics Score of Turkey and OECD Countries

Minimum, maximum and average mathematics scores of students were 192.09, 676.35 and 419.81 in 2015, respectively. Standard deviation of mathematics score was 72.71.

OECD average mathematics score had a decreasing trend since the year of 2003 (decreased from 500 in 2003 to 490 in 2015). Turkey average mathematics score was around 423 and 448 level. In 2015, it decreased to 420 (in 2003-2006 level) after the peak in 2012 with 448. In this study, students' mathematics achievement scores were flagged as 1 if the score was above Turkey average, 0 otherwise.

3.2. Model Selection and Results of the Model

Latent Class Analysis procedure was started with determining the number of classes. In this phase, models with one, two, three, four and five classes were tested. The model results were given in Table 2.

Table 2: AIC, BIC and χ2 Statistics

Model	AIC	BIC	χ2
1-Class	72884.5	72963.5	722314.5
2-Class	65435.8	65607.1	13478.6
3-Class	64023.1	64286.5	12616.4
4-Class	64579.6	64935.2	10411.6
5-Class	64504.4	64952.2	11642.4

According to the AIC, BIC and χ^2 statistics given in Table 2, the number of latent classes that fitted the best for our dataset was three. The latent class probabilities were given in Table 3 for 3-class latent variable model.

Table 3: Latent Class Probabilities

		Class 1	Class 2	Class 3
		(31.9%)	**(29.4%)**	**(38.7%)**
A desk to study at	**Yes**	61.0%	92.6%	98.6%
	No	39.0%	7.4%	1.5%
A room of your own	**Yes**	41.9%	79.1%	88.9%
	No	58.1%	20.9%	11.1%
A quiet place to study	**Yes**	63.9%	87.9%	95.8%
	No	36.1%	12.1%	4.2%
A computer you can use for school work	**Yes**	14.4%	93.3%	92.4%
	No	85.6%	6.7%	7.6%
Educational software	**Yes**	20.0%	37.4%	62.7%
	No	80.0%	62.6%	37.3%
A link to the Internet	**Yes**	12.5%	86.1%	86.6%
	No	87.5%	13.9%	13.4%

Classic literature (e.g. Shakespeare)	**Yes**	33.7%	27.0%	89.2%
	No	66.3%	73.0%	10.8%
Books of poetry	**Yes**	44.7%	27.2%	88.0%
	No	55.3%	72.8%	12.0%
Works of art (e.g. paintings)	**Yes**	14.3%	13.4%	59.4%
	No	85.7%	86.6%	40.6%
Books to help with your school work	**Yes**	65.5%	81.5%	98.4%
	No	34.5%	18.5%	1.6%
Technical reference books	**Yes**	15.7%	35.6%	68.3%
	No	84.3%	64.4%	31.7%
A dictionary	**Yes**	87.8%	95.6%	99.5%
	No	12.2%	4.4%	0.5%

As a conclusion, 31.9%, 29.4% and 38.7% of students was in 1st, 2nd and 3rd latent classes, respectively. Latent class conditional probabilities specified that students in 1st latent class stated there were only 4 items (out of 12), which were a desk to study at, a quiet place to study, books to help with your school work and a dictionary, in their home. Students in 2nd latent class stated there were 7 items (out of 12), which were a desk to study at, a room of your own, a quiet place to study, a computer you can use for school work, a link to the Internet, books to help with your school work and a dictionary, in their home. Students in 3rd latent class stated there were 12 items (out of 12) in their home.

Table 4: Home Educational Resources Ownership by Latent Classes

	Class 1	**Class 2**	**Class 3**
	(31.9%)	**(29.4%)**	**(38.7%)**
A desk to study at	Yes	Yes	Yes
A room of your own	No	Yes	Yes
A quiet place to study	Yes	Yes	Yes
A computer you can use for school work	No	Yes	Yes
Educational software	No	No	Yes
A link to the Internet	No	Yes	Yes
Classic literature (e.g. Shakespeare)	No	No	Yes
Books of poetry	No	No	Yes
Works of art (e.g. paintings)	No	No	Yes
Books to help with your school work	Yes	Yes	Yes
Technical reference books	No	No	Yes
A dictionary	Yes	Yes	Yes

Yes: Students have the items in his/her home
No: Students do not have the items in his/her home

In the light of these results, mathematics achievement was analyzed for each latent class via LCR analysis. LCR analysis output was given in Table 5.

Table 5: Latent Class Regression Output

		Coefficient	Std. Error	t value	Pr(>|t|)
Class 2 / Class 1	**Intercept**	-0.416	0.064	-6.473	0.000
	Math Achievement (0,1)	0.842	0.088	9.583	0.000
Class 3 / Class 1	**Intercept**	-0.567	0.060	-9.519	0.000
	Math Achievement (0,1)	1.533	0.080	19.171	0.000

Number of observation: 5355; Number of estimated parameters: 40; Residual degrees of freedom: 4055; Maximum log-likelihood: – 31971.54

According to the Table 5, intercept and mathematics achievement variable was statistically significant with 95% of confidence level. In this analysis, 1st latent class was the reference class for the comparison of latent class probabilities. For the mathematics achievement variable, regression coefficients were 0.842 and 1.533 for 2nd and 3rd latent classes, respectively. So, odds ratio of being in 2nd latent class (compared with 1st latent class) was 2.3 (exp(0.842) = 2.3) and odds ratio of being in 3rd latent class (compared with 1st latent class) was 4.6 (exp(1.533) = 4.6). Thus, students whose mathematics score was above Turkey average were more likely than others to be in 2nd and 3rd latent classes, and also these students were less likely to be in 1st latent class.

Probabilities of latent class membership were calculated using coefficients given in Table 5. These probabilities were given in Figure 2.

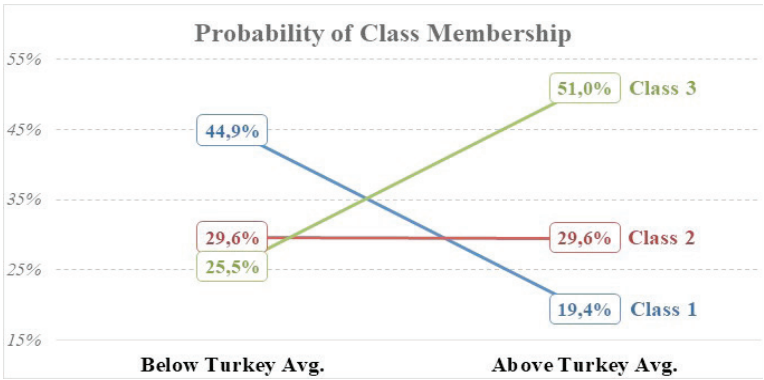

Figure 2: Latent Class Membership Probabilities

According to the information of Figure 2, a student whose mathematics score was below Turkey average was being in 1st latent class with the probability of 44.9%, being in 2nd latent class with the probability of 29.6% and being in 3rd latent class with the probability of 25.5%. In addition, a student whose mathematics score was above Turkey average was being in 1st latent class with the probability of 19.4%, being in 2nd latent class with the probability of 29.7% and being in 3rd latent class with the probability of 51.0%.

Average mathematics scores of latent classes were given in Figure 3.

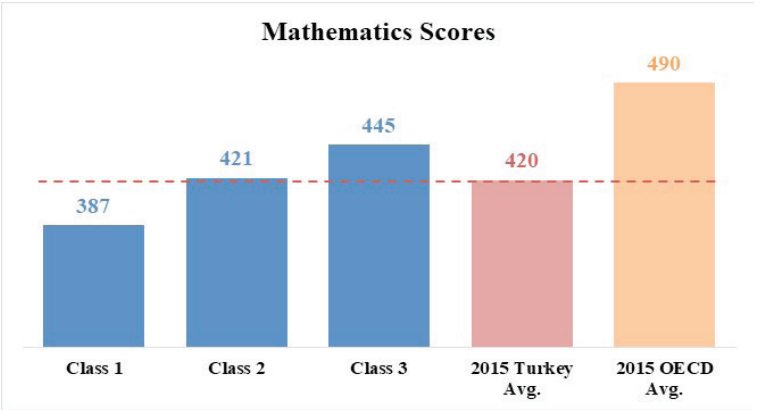

Figure 3: Comparison of Mathematics Scores by Latent Classes

According to the Figure 3, the most successful students were in 3rd latent class in terms of mathematics achievement, but their score was still lower than OECD average which was 490. In addition, 71%, 50% and 34% of students' mathematics score in 1st, 2nd and 3rd latent classes were below Turkey average. In the literature, there were many studies showing that having a computer and an internet connection had a positive effect on mathematics achievement [22], [23], [24]. Similar to the research in the literature, this study showed that if students in 1st latent class have had a computer for school work, a link to the internet in their home and a room of their own, their average mathematics score would have been 421. In other words, if these students have had a computer for school work, a link to the internet in their home and a room of their own, the ratio of students who get higher score than Turkey average would be 50%. Thus, it could be said that the effect of having a computer, a link to internet and a room for student in their home were very important for the success of mathematics. Furthermore, if the students in 2nd latent class have had an educational software, classic literatures, books of poetry, works of art and technical reference books in their home, their average mathematics score would have been 445.

In other words, if these students have had specified educational resources in their home, the ratio of students who get higher score than Turkey average would be 66%. Thus, similar to studies in the literature, it could be said that the effect of these items was an important role for the success of

22 Attewell, P., Battle,J. (2006). Home Computers and School Performance, The Information Society, 15: 6-7.

23 Fiorini, M. (2010). The Effect of Home Computer Use on Children's Cognitive and Non-Cognitive Skills, Economics of Education Review, 29(1): 65–68.

24 Jackson, L.A. et al. (2006). Does Home İnternet Use İnfluence The Academic Performance of Low-Income Children?, Developmental Psychology, 42(3): 432-433.

mathematics [25], [26]. Gender and parents' education level distribution, index of economic, social and cultural level and age averages of students who belong to three latent classes were given in Table 6.

Table 6: Demographics Characteristics by Latent Classes

	Class 1	**Class 2**	**Class 3**
	(31.9%)	**(29.4%)**	**(38.7%)**
Gender			
Female	48.9%[a]	43.6%[b]	55.2%[c]
Male	51.1%[a]	56.4%[b]	44.8%[c]
Highest Level of Schooling			
Mother			
ISCED Level 3A, 3B or 3C	18.1%[d]	25.7%[e]	40.1%[f]
ISCED Level 2	14.0%[d]	21.4%[e]	23.1%[e]
ISCED Level 1	44.0%[d]	43.3%[d]	28.8%[e]
did not complete ISCED level 1	23.9%[d]	9.6%[e]	8.0%[e]
Father			
ISCED Level 3A, 3B or 3C	19.7%[g]	21.5%[h]	50.9%[i]
ISCED Level 2	25.9%[g]	31.9%[h]	25.0%[g]
ISCED Level 1	45.3%[g]	30.7%[h]	20.6%[i]
did not complete ISCED level 1	9.0%[g]	5.9%[h]	3.5%[i]
ESCS	-2.3034[k]	-1.4443[l]	-0.7423[m]
Age	15.81[n]	15.82[n]	15.82[n]

Each superscript letter denotes a subset of LCA categories whose column proportions do not differ significantly from each other at the 0.05 level.

Gender, parents' highest level of schooling distributions and index of economic, social and cultural status were statistically significantly differentiating among latent classes with 95% confidence level according to the χ^2 analysis ($\chi_2^2=48.814$, $p=0.000$). The ratio of female students was higher in 3rd latent class and the lowest female ration was in 2nd latent class. Parents (both mothers and fathers) educational levels of students in 3rd latent class were higher than others. Furthermore, very important point was that 23.9% of students' mother education level was below ISCED 1 in 1st latent class while in 2nd and 3rd latent classes; this ratio was below 10%. Briefly, education level was increase from 1st latent class to 3rd latent class. Age of students (on average) was not statistically significantly differentiating among latent classes ($F_{2;5352}=0.021$ *and* $p=0.979$). Students in 3rd latent class had the highest economic, social and cultural level while students in 1st latent class had the lowest economic, social and cultural level. In other words, economic, social and cultural level was significantly increasing from 1st latent class to 3rd latent class. Also,

25 Roscigno, V.J., Ainsworth-Darnell, J.W. (1999). Race, Cultural Capital, and Educational Resources: Persistent İnequalities and Achievement Returns, Sociology of Education, 72: 166-167.

26 Juan, A., Visser, M. (2017). Home and School Environmental Determinants of Science Achievement of South African Students, South African Journal of Education, 37(1): 3-4.

these differences were statistically significant with 95% of confidence level ($F_{2;5352}$=*1197.327 and p=0.000*).

Some of the economic, social and cultural status related variables were examined for each latent class. These items by latent class were given in Table 7.

Table 7: Distribution of Some ESCS Related Variables by Latent Classes

How many of these are there at your home?		Class 1		Class 2		Class 3	
		n	%	n	%	n	%
Televisions	None	12	0.7%	4	0.3%	15	0.7%
	One	1311	77.0%	910	57.7%	920	44.4%
	Two	340	20.0%	543	34.5%	856	41.3%
	Three or more	39	2.3%	119	7.6%	280	13.5%
Cars	None	925	55.0%	591	37.7%	567	27.6%
	One	665	39.6%	817	52.1%	1192	57.9%
	Two	68	4.0%	120	7.7%	224	10.9%
	Three or more	23	1.4%	40	2.6%	75	3.6%
Rooms with a bath or shower	None	563	33.6%	441	28.2%	448	21.8%
	One	1019	60.7%	932	59.6%	1185	57.6%
	Two	81	4.8%	165	10.6%	348	16.9%
	Three or more	15	0.9%	25	1.6%	76	3.7%
Cell phones with Internet access (e.g. smartphones)	None	385	22.8%	76	4.8%	57	2.8%
	One	589	34.8%	317	20.2%	249	12.1%
	Two	364	21.5%	371	23.6%	410	19.9%
	Three or more	353	20.9%	807	51.4%	1342	65.2%
Computers (desktop computer, portable laptop or notebook)	None	1264	74.7%	93	5.9%	159	7.7%
	One	383	22.6%	1119	71.2%	1079	52.4%
	Two	33	1.9%	289	18.4%	585	28.4%
	Three or more	13	0.8%	70	4.5%	238	11.5%
Tablet computers (e.g. iPad, BlackBerry, PlayBook)	None	1093	64.4%	600	38.3%	493	23.9%
	One	513	30.2%	763	48.7%	1047	50.8%
	Two	78	4.6%	168	10.7%	390	18.9%
	Three or more	12	0.7%	36	2.3%	132	6.4%
E-book readers (e.g. Kindle, Kobo, Bookeen)	None	1630	96.7%	1499	96.0%	1849	90.3%
	One	28	1.7%	44	2.8%	160	7.8%
	Two	14	0.8%	9	0.6%	22	1.1%
	Three or more	13	0.8%	10	0.6%	16	0.8%
Musical instruments (e.g. guitar, piano)	None	1277	75.5%	909	57.9%	751	36.3%
	One	317	18.7%	464	29.6%	730	35.3%
	Two	67	4.0%	129	8.2%	339	16.4%
	Three or more	31	1.8%	68	4.3%	248	12.0%

According to the Table 7, similar to the index of ESCS, number of items they had was increasing from 1st latent class to 3rd latent class, except e-book readers. 22% of students in 1st latent class,

42% of students in 2nd latent class and 55% of students in 3rd latent class stated there was two or more television in their home. When they had examined the number of cars, ratios were 5%, 10% and 15% for 1st, 2nd and 3rd latent classes, respectively. 6%, 13% and 21% of students in 1st, 2nd and 3rd latent classes said that there were two or more rooms with a bath or shower.

When smartphone, computer and tablet ownership examined, it was seen that students had significantly differentiating number of items among latent classes. 58% of students in 1st latent class said there was 1 or fewer smartphone in their home while 75% and 85% of students in 2nd and 3rd latent classes said that there were two or more smartphones in their home. Similar to smartphone ownership distribution, 75% of students in 1st latent class stated there was no computer in their home. This ratio was 6% and 8% for the students in 2nd and 3rd latent classes, respectively. In addition, 23% of students in 2nd latent class and 40% of students in 3rd latent class stated that there were two or more computers in their home. When tablet distributions of latent classes were examined, 36%, 62% and 76% of students in 1st, 2nd and 3rd latent classes, respectively, stated there was more than one tablet in their home.

Number of musical instrument (such as piano or guitar) ownership was significantly differentiating among latent classes. 76% of students in 1st latent class said there was no musical instrument in their home while 42% and 64% of students in 2nd and 3rd latent classes stated there was one or more musical instrument in their home.

4. CONCLUSIONS

Since availability of home educational resources of students affect students mathematics achievement, government should take into consideration a specific action plan for families with different socio-economic level in order to increase country level mathematics achievement. In this study, it was clearly shown that students who had a computer and an internet connection at their home getting higher scores than others. Thus, government should work with related companies on providing easy terms of payment or instalment (offering special prices for students) and funds for students in order to have a computer and an internet connection. Another important finding of this study is that presence of classical literature, books of poetry and work of arts in students' homes has a positive effect on mathematics achievement. According to this result, parents encourage their children to be interested in arts and literature. In addition to this, government should include arts and literature classes into the routine curriculum to encourage students to be interested in arts and literature.

Profiling the mathematics achievement according to students' home educational resources via latent class analysis was investigated using the data of PISA 2015. We believe that this study could be a reference study for further research.

References

ACAR GÜVENDİR, M. (2014). Öğrenci Başarılarının Belirlenmesi Sınavında Öğrenci ve Okul Özelliklerinin Türkçe Başarısı ile İlişkisi, Eğitim ve Bilim, 39(172): 163-180.

ARICIGİL ÇİLAN, Ç. (2015). Uygulamalı Gizli Sınıf Analizi, İstanbul:Çağlayan Kitabevi.

ARIKAN, S., Van de Vijver, F.J.R.; Yağmur, K. (2016). Factors Contributing to Mathematics Achievement Differences of Turkish and Australian Students in TIMSS 2007 and 2011, Eurasia Journal of Mathematics, Science & Technology Education, 12(8): 2039-2059.

ATTEWELL, P., Battle, J. (2006). Home Computers and School Performance, The Information Society, 15: 1-10.

BEESE, J., Liang, X. (2010). Do Resources Matter? PISA Science Achievement Comparison Between Students in the United States, Canada and Finland, Improving Schools, 13(3): 266-279.

DAYTON, C.M.; Macready, G.B. (1988). Concomitant-Variable Latent-Class Models, Journal of the American Statistical Association, 83(401): 173-178.

DEMİR, I., Kılıç, S., Ünal, H. (2010). Effects of Students' and Schools' Characteristics on Mathematics Achievement: Findings from PISA 2006, Procedia Social and Behavioral Sciences, 2: 3099-3103.

FIORINI, M. (2010). The Effect of Home Computer Use On Children's Cognitive and Non-Cognitive Skills, Economics of Education Review, 29(1): 55–72.

FIRAT, E., Aydın, A. (2015). İnsani Kalkınma Endeksine göre Türkiye'nin Eğitim Endeks Göstergelerinin OECD Ülkeleri ile Karşılaştırılması, Selçuk Üniversitesi İktisadi ve İdari Bilimler Fakültesi Sosyal Ekonomik Araştırmalar Dergisi, 15(29): 62-87.

FUCHS, T., Woessmann, L. (2014). Computers and Student Learning: Bivariate and Multivariate Evidence on the Availability and Use of Computers at Home and at School, Munich: CESifo Working Paper No. 1321.

GOODMAN, L.A. (1974). Exploratory Latent Structure Analysis Using Both Identifiable And Unidentifiable Models, Biometrika, 61(2): 215-231.

GOODMAN, L.A. (1979). On The Estimation Of Parameters In Latent Structure Analysis, Psychometrika, 44(1): 123-128.

GÜVENDİR, E. (2015). A Multi-Level Simultaneous Analysis of How Student and School Characteristics Are Related to Students' English Language Achievement, Education Research And Perspectives, 42: 491-527.

HAGENAARS, J.A., McCutcheon, A.L. (2002). Applied Latent Class Analysis, Cambridge University Press.

JACKSON, L.A., Von Eye, A., Biocca, F.A., Barbatsis, G., Zhao, Y., Fitzgerald, H.E. (2006). Does home internet use influence the academic performance of low-income children?, Developmental Psychology, 42(3): 429-435.

JUAN, A., Visser, M. (2017). Home And School Environmental Determinants Of Science Achievement Of South African Students, South African Journal of Education, 37(1): 1-10.

KITSANTAS, A., Cheema, J., Ware, H.W. (2011). Mathematics Achievement: The Role of Homework and Self-Efficacy Beliefs, Journal of Advanced Academics, 22(2): 310-339.

LEWIS, R., Aiken, J. (1970). Attitudes toward Mathematics, Review of Educational Research, 40(4): 551-596.

MİLLİ EĞİTİM BAKANLIĞI (MEB), (2005). PISA 2003 Projesi Ulusal Nihai Raporu, Ankara.

ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT (OECD), (2016). PISA 2015 Results (Volume I): Excellence and Equity in Education, OECD Publishing.

ÖZBERK, E.H., Atalay Kabasakal, K., Boztunç Öztürk, N. (2017). Investigating the Factors Affecting Turkish Students' PISA 2012 Mathematics Achievement Using Hierarchical Linear Modeling, Hacettepe University Journal of Education, 32(3): 544-559.

ROSCIGNO, V.J., Ainsworth-Darnell, J.W. (1999). Race, Cultural Capital, and Educational Resources: Persistent Inequalities and Achievement Returns, Sociology of Education, 72: 158-178.

SMITH, R., Neisworth, J., Greer, J.G. (1978). Evaluating Educational Environments, Bell and Howell, Colombus, OH: Merrill/Macmillan.

ŞİRİN, S.R. (2005). Socioeconomic Status and Achievement: A Meta-Analytic Review of Research, Review of Educational Research, 75: 417-453.

TOPÇU, M.S., Erbilgin, E., Arıkan, S. (2016). Factors Predicting Turkish and Korean Students' Science and Mathematics Achievement in TIMSS 2011, Eurasia Journal of Mathematics, Science & Technology Education, 12(7): 1711-1737.