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Turkey-Singapore Comparison in terms of Variables Affecting PIAAC 2015 Quantitative Skills

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Abstract

This study aims to determine the variables predicting the numerical scores of Turkey and Singapore participating in the PIAAC 2015. The application was conducted on 5199 adults in Turkey and 5394 adults in Singapore between the ages of 16-65. According to the multiple linear regression analysis, gender, age, education level, employment status, and participation in any educational activity in the last 12 months significantly predict the numeracy skills of adults in Turkey and Singapore. These variables explain approximately 33% of the variance in Turkey's PIAAC numerical scores and 55% of the variance in Singapore's PIAAC numerical scores. In both countries, the variable that predicts the quantitative scores of adults the most is that the participants have a bachelor's degree. After education level, the next most predictive variable is age. A high level of education (bachelor's degree and above) and a low level of age (16-24 years old) are strong predictors of quantitative scores. Employment status is the least predictive variable of numerical scores in both countries.

Keywords: large-scale assessments, multiple linear regression analysis, international comparison

PIAAC 2015 Sayısal Becerilerini Etkileyen Değişkenler Açısından Türkiye-Singapur Karşılaştırması

Öz

Bu araştırmanın amacı PIAAC 2015 uygulamasına katılan Türkiye'nin ve Singapur'un sayısal puanlarını yordayan değişkenleri belirlemektir. Uygulama, 16-65 yaş aralığındaki Türkiye'de 5199, Singapur'da 5394 yetişkin üzerinden gerçekleştirilmiştir. Yapılan çoklu doğrusal regresyon çözümlemesine göre cinsiyet, yaş, eğitim düzeyi, çalışma durumu ve son 12 ayda herhangi bir eğitim-öğretim faaliyetine katılma durumu değişkenleri Türkiye'deki ve Singapur'daki yetişkinlerin sayısal becerilerini manidar bir biçimde yordamaktadır. Bu değişkenler Türkiye PIAAC sayısal puanları varyansının yaklaşık %33'ünü, Singapur PIAAC sayısal puanları varyansının ise yaklaşık %55'ini açıklamaktadır. Her iki ülkede de yetişkinlerin sayısal puanlarını en fazla yordayan değişken, katılımcıların lisans mezunu olmasıdır. Eğitim düzeyinden sonra en fazla yordayıcı güce sahip değişken yaş değişkenidir. Eğitim düzeyinin yüksek olması (lisans ve üzeri) ve yaş düzeyinin düşük olması (16-24 yaş arası) sayısal puanlarının güçlü birer yordayıcısıdır. Her iki ülkede de çalışma durumu sayısal puanlarını en az yordayan değişkendir.

Anahtar Sözcükler: geniş ölçekli durum belirleme, çoklu doğrusal regresyon çözümlemesi, uluslararası karşılaştırma.

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INTRODUCTION

People may learn from birth to death. This process is called "lifelong learning" in the literature, which includes learning from early childhood to the end of adulthood and is seen as a universal right to education (Benasso et al., 2022). According to Miser (2013), lifelong learning includes all learning activities in and out of school. Individuals need to fulfill their learning needs in adulthood following their years of formal education.

Adult learners' continuation of lifelong learning is ensured by adult education. Adult education is defined as education that covers formal and non-formal learning activities that have a significant impact on encouraging adults to develop their potential, adult literacy, community awareness, and participation in civil society (Okojie & Sun, 2020). It contributes to the completion of incomplete education of adults or the provision of new educational opportunities to individuals who have completed their education (Faure, 1972).

Many countries attach importance to the participation of adults in lifelong learning activities, aiming to ensure that every individual in society benefits from equal educational opportunities and acquires various skills (State Planning Organization-Devlet Planlama Teşkilatı [DPT], 2001; United Nations, 2015). Skills include cognitive, intrapersonal, and interpersonal competencies that enable individuals to use the multiple knowledge they have acquired in real-life situations (Haladyna, 1997; Kutlu, et al., 2017; Kutlu and Altıntaş, 2021). Rapid economic, scientific, and social changes and developments in countries require adults to have more and more skills.

General skills, which are defined as a means of developing a workforce that can cope with changing conditions, consist of skills such as numeracy, communication, self-learning and performance improvement, information technology, management, work organization, problem-solving, and group work (Pumphrey & Slater, 2002). In the lifelong learning declaration published by the European Union, it is stated that all individuals in society should develop skills such as literacy, numeracy, information technologies, foreign languages, and entrepreneurship by providing learning opportunities to individuals everywhere (Commission of the European Communitie, 2000). Within the framework of Education and Training 2020, it aims to increase adults' participation in lifelong learning activities and reduce the proportion of adults with low literacy, numeracy, and science skills (Eurostat, 2019). The United Nations Sustainable Development Plan aims to ensure that a significant portion of all youth and adults acquire literacy and numeracy skills by 2030 (United Nations, 2015).

Numeracy, which is included in countries' educational policies and development goals, is a comprehensive skill that requires mathematical skills and other skills such as problem-solving, reasoning, and communication (O'Donoghue, 2018). It relates to contexts involving mathematical knowledge in daily life (O'Sullivan, 2023) through thinking, reasoning, and acting (Tout, 2020). Numeracy is seen as a fundamental skill for young people and adults beyond formal education to perform an expanding range of mathematical and statistical operations and the requirements of these operations (Gal et al., 2020). Increasing technology and data use causes the world's quantitative aspect to become more prosperous and complex, requiring numerical skills in all applications in daily life, online platforms, and all kinds of communication (Hoogland & Diez-Palomar, 2022). Numeracy, which is effective in participating fully in society today and having opportunities and options to shape its future, is also accepted as critical employability skill in the global economy (Alcantara, 2022).

It is also becoming increasingly important to determine at what level adults have various skills (Organisation for Economic Co-Operation and Development [OECD], 2021). With the findings obtained from large-scale evaluations at the national and international levels, a path can be followed in education policies and planning (Simon et al., 2013). Since the 1990s, the International Adult Literacy Survey (IALS) and Adult Literacy and Life Skills (ALL) applications have been developed to evaluate adult skills between the ages of 16-65 (Kirsch & Braun, 2020). Prose literacy, document literacy, and quantitative literacy skills of adults were measured in the IALS application, launched in 1994 (OECD, 2000). In this application, skills that require numerical operations are considered numeracy literacy. In the ALL application implemented in 2003, literacy and numeracy were separated, and the problem-solving skill area was added. In each application, studies were carried out to develop skill areas.

In 2012, the IALS and ALL applications were further developed, and the Programme for the International Assessment of Adult Competencies (PIAAC) was launched. PIAAC is conducted by the OECD and consists of achievement tests of adults aged 16-65 in various countries in the areas of literacy, numeracy, and problem-solving

in a technology-intensive environment and a background survey that collects information about adults (OECD, 2013). In the achievement tests in the application, proficiency levels consisting of specific tasks were defined. Individuals were scored according to their responses to the items at these levels, and their proficiency level was determined (OECD, 2016; OECD, 2019).

The first cycle of PIAAC implementation was carried out between 2012-2018 and the second cycle is planned to be completed between 2018-2024. Turkey participated in this implementation in 2014-2015 and the implementation was carried out in 30 provinces (The Ministry of Labor and Social Security-Çalışma ve Sosyal Güvenlik Bakanlığı [ÇSGB], 2020). As a result of the implementation, adults in Turkey ranked 32nd among 34 countries with an average score of 219 points in numeracy skills, below the OECD average of 263 points. Considering the success of the countries participating in the second round of the application together with Turkey, Singapore stands out. Adults in Singapore scored 257 points in numeracy skills, below the OECD average, like in Turkey (OECD, 2016). The country ranking ranks 17th among 34 countries and is close to the OECD average. The reason why Singapore stands out here is that Singapore generally ranks high in the results of the Programme for International Student Assessment (PISA), Trends in International Mathematics and Science Study (TIMSS), and Progress in International Reading Literacy Study (PIRLS), which are international applications that measure the skills of the young population (Deng & Gopinathan, 2016; Kaur et al., 2019).

PISA, which is applied to individuals before adulthood (age 15), measures skills in reading, mathematical literacy, and science literacy (OECD, 2024). In the years when PIAAC was implemented, the mathematics achievement of students in Turkey was below the OECD average, while Singapore was above the OECD average (OECD, 2024). Considering both PISA and PIAAC results, Turkey has low numeracy skills in the youth and adult populations. In Singapore, on the other hand, the numeracy skills of the youth population in PISA are high, while the numeracy skills of the adult population in PIAAC are low. Singapore's success in the young population can be explained by consistent education policies, teacher training systems, quality school leaders, information and communication technologies, and the importance given to equal opportunities in education and mathematics, science, and technical skills (Levent & Yazıcı, 2014). It is thought that Singapore's failure to achieve the same success in the adult population and Turkey's failure in the youth and adult population may be due to various reasons.

In both countries, the adult population aged 15 and above constitutes a large proportion of the general population (Department of Statistics Singapore, 2020; Turkish Statistical Institute-Türkiye İstatistik Kurumu [TÜİK], 2021). For this reason, studies are carried out in both countries to improve the education and skills of adults, who constitute a large part of the population. In Singapore, many institutions and organizations for lifelong learning and adult education aim to improve the skills of adults and increase their employability (SkillsFuture, 2020a). With the SkilssFuture movement launched in 2014 in the country, lifelong learning is turned into a culture, and various education programs are provided to students, employers, employees, education experts, and other individuals in the country (SkillsFuture, 2020b). In Turkey, many studies have been carried out in the name of adult education since the ancient Turks. The Ministry of National Education and other public institutions, organizations, and non-governmental organizations carry out studies on adult education The Ministry of National Education has set priorities for creating a culture of lifelong learning in society, increasing access to opportunities, and expanding it: Creating lifelong learning culture and awareness in the society, increasing lifelong learning opportunities and provision, increasing access to lifelong learning opportunities, developing lifelong guidance and counseling system, developing recognition of prior learning system, developing lifelong learning monitoring and evaluation system (Ministry of National Education Lifelong Learning Strategy Document 2014-2018, 2021). Adult education activities provided through the non-formal education system are carried out through Public Education Centers, Maturation Institutes, and Open Education Schools (Ministry of National Education Regulation on Lifelong Learning Institutions, 2018). In these institutions, various programs are organized for individuals of different ages and education levels to complete their incomplete education, improve their skills and acquire a profession.

In Singapore, adult education includes courses on workplace numeracy skills for employees, numeracy skills for parents, basic numeracy skills for machine learning and software development, and differentiated learning methods for numeracy for educators, with the government paying for the courses (SkilssFuture, 2022). In Turkey, literacy courses on mathematical competence for adults, game-based mathematics education for educators, and numeracy skills used daily. Citizens can benefit from free of charge at public education centers (MoNE, 2022). In open education school programs, mathematics courses are taught in parallel with formal education programs (MoNE, 2001).

Although there are many studies on lifelong learning and adult education activities in Turkey and Singapore courses and programs are organized for numeracy skills (SkillsFuture,2022; MoNE, 2018), it is seen that PIAAC numeracy skills are low. Although there are many studies in the literature on international applications such as PISA and TIMMS (Anıl, 2009; Jeffries et al., 2020; Karali et al., 2022; Nilsen, et al., 2022; Radišić et al., 2023; Østbø & Zachrisson, 2022; Quintano et al., 2012), studies on the assessment of adult skills are more limited. The studies on PIAAC in Turkey (Karabacak and Kaygın, 2018; Köker et al., 2016; Özdemir 2019; Yıldız et al., 2018) generally focus on the level of Turkey's success in PIAAC implementation and the examination of this situation in the context of the education system. In the application in which many countries participate, there is no study comparing the achievement levels and factors affecting the achievement of other countries and Turkey. With international practices, the skills of different countries can be compared (Kirsch et al., 2013), and new policies can be produced based on similarities and differences in education systems (Erdoğan, 2003; Bakioğlu, 2017; Fischman et al., 2019).

For this reason, this study aims to compare the variables affecting Turkey's numeracy skills with Singapore, a country below the OECD average. Within the scope of the study, a literature review was conducted to determine the variables that may affect numerical scores. In the literature, it is seen that gender, age, education level, participation in any educational activity in the last 12 months, and employment status are effective on individuals' skills (Green & Riddell, 2015; Jovicic, 2016; Paccagnella, 2016; Schneeweis et al., 2014; Solheim & Lundetræ, 2018). This study aims to determine the variables that predict the numerical scores of Turkey and Singapore participating in PIAAC 2015. It is expected that the findings of the research will shed light on educators and policy makers to determine the variables predicting numeracy skills of adults and to overcome skill deficiencies. For this purpose, the following questions were sought to be answered:

1. What is the distribution of Turkey's and Singapore's numerical scores according to proficiency levels?

2. Do gender, age, education level, employment status and participation in any educational activity in the last 12 months significantly predicts the numerical scores of participants from Turkey?

3. Do gender, age, education level, employment status and participation in any educational activity in the last 12 months significantly predicts the numerical scores of participants from Singapore?

4. Do the variables predicting Turkey's and Singapore's numerical scores show similarities and differences.

METHOD

Research Model

In this study, correlational research method, one of the quantitative research methods, was used. The correlational model aims to determine the existence or degree of change between two or more variables (Karasar, 2020; Fraenkel, Wallen and Hyun, 2012). The correlational model was used in the study since the prediction levels of the variables of gender, age, education level, employment status, and participation in any educational activity in the last 12 months were examined.

Population and Sample

The study population is adults between 16-65 in Turkey and Singapore. Stratified sampling method, one of the probability sampling methods, was used in the PIAAC implementation (OECD, 2016). Stratified random sampling is the selection of subgroups classified according to various characteristics according to their proportion in the population (Fraenkel, Wallen and Hyun, 2012). The application sample is 5199 adults in Turkey and 5394 adults in Singapore who participated in PIAAC in 2016. This research was conducted on 5184 adults in Turkey and 5381 adults in Singapore after missing data and extreme value analysis. The distribution of the adults who participated in the study in Turkey and Singapore according to their demographic characteristics is given in Table 1 below.

Table 1. Distribution of Adults from Turkey and Singapore who participated in the PIAAC Application according to Demographic Characteristics

Country	Variable	Level	Number	Percentage
Turkey	Gender	Male	2627	50.5
		Female	2572	49.5
	Age	16-24	860	16.6
		25-34	1423	27.4
		35-44	1322	25.4
		45-54	907	17.4
		55 and above	687	13.2
	Education Level	Primary education or below	2989	57.5
		High School	1243	23.9
		Vocational School, Open Education Faculty(2 years)	297	5.7
		License	591	11.4
		Master's Degree	76	1.5
	Employment Status	Working	2318	44.7
		Not working	240	4.6
		Out of Labor Force	2626	50.7
	Education Participation Status (Last 12 Months)	Yes	1468	28.2
		No	3728	71.7
Singapore	Gender	Male	2675	49.6
		Female	2719	50.4
	Age	16-24	1074	19.9
		25-34	1097	20.3
		35-44	1168	21.7
		45-54	1113	20.6
		55 and above	942	17.5
	Education Level	Primary education or below	933	17.3
		High School	1234	22.9
		Post-secondary non-higher education	732	13.6
		Short-term higher education	1027	19.0
		License	1131	21.0
		Master's Degree/PhD	336	6.2
	Employment Status	Working	3989	74.0
		Not working	210	3.9
		Out of Labor Force	1194	22.1
	Education Participation Status (Last 12 Months)	Yes	3324	61.6
		No	2070	38.4

When Table 1 is analyzed, the gender distribution of adults in Turkey and Singapore is very close to each other. While the majority of participants in Turkey are between the ages of 25-34, the distribution of age groups in Singapore is close to each other. Most adults in Turkey have primary education or below, while in Singapore, they have above primary education. This shows that adults in Turkey are mostly at a lower educational level than adults in Singapore. In Turkey, there is a high proportion of working adults as well as those outside the labor force, whereas, in Singapore, most adults are working. While most adults in Turkey have not participated in any educational activity in the last 12 months, more than half of adults in Singapore have.

Data Collection

In the PIAAC application, data collection was carried out through visits to certain addresses by officials. First of all, a background questionnaire was applied in which demographic information about adults was collected. Then a paper-pencil or a computer-based assessment was made according to the computer use status of adults.

Data Collection Tools

In this research, Turkey and Singapore data were downloaded in SPSS format from the PIAAC data available on the OECD's official website. PIAAC Quantitative Skills Test and Background Questionnaire were used as data collection tools in the research.

Numeracy Skills Test: It consists of various dimensions that involve managing a situation or solving a problem (OECD, 2016). The numeracy skill test has items of different difficulty levels, which are evaluated for over 500 full points. There are 52 items in the computer-based assessment and 24 in the paper-pencil assessment. According to the success of the adults in answering the items, 6 proficiency levels were defined: Below Level 1, Level 1, Level 2, Level 3, Level 4, and Level 5. As you go from Level 1 to Level 5, the difficulty levels and score levels of the items also increase.

For the validity analysis of cognitive tests in PIAAC, a population model consisting of responses to the background questionnaire and item responses in the cognitive tests was used. The findings showed that the variance explained by Item Response Theory and the latent regression model was comparable across countries (OECD, 2019). For the estimation of the proficiency scores of the skills tests, 80 replications were performed on the weighted data in the scores of the two countries, and 10 possible values (PV1-PV-10) of each adult in the sample were used together. In the PIAAC report published by the OECD, the reliability coefficient of the numeracy skills test was reported to be 0.85 in Turkey and 0.93 in Singapore (OECD, 2016).

Background Questionnaire: The background questionnaire developed by the OECD as part of a consortium of countries was designed to be in line with the conceptual and theoretical framework, valid and reliable, comparable across groups and countries, and comparable with other international practices (OECD, 2019). The questionnaire consists of 258 items that collect demographic information about adults, education and training, employment status, literacy at work and in daily life, use of problem-solving skills in a numerical and technology-intensive environment, learning strategies, health, and parental characteristics (OECD, 2016).

Analyzing the Data

Percentage and frequency calculations were used to determine the distribution of the Turkish and Singaporean samples according to demographic characteristics. The distribution of numerical scores according to proficiency levels was determined using the International Database Analyzer (IDB) program of the International Association for the Assessment of Educational Achievement (IEA).

Multiple regression analysis was conducted with the SPSS 25 Package Program to determine which variables significantly predicted the numerical scores of Turkey and Singapore, such as gender, age, education level, employment status, and participation in any educational activity in the last 12 months. Then, the results of the multiple linear regression analysis of the two countries were compared.

In the first question of the research, IEA's IDB program was used to determine the distribution of PIAAC 2015 Turkey's and Singapore's numerical scores according to their proficiency levels. This program determines the distribution of Turkey's and Singapore's numerical scores according to their proficiency levels. Multiple regression analysis was used to determine which of the variables of gender, age, education level, employment status, and participation in any educational activity in the last 12 months significantly predicted the numerical scores of Turkey and Singapore in the 2nd and 3rd questions of the study. In the fourth question of the study, multiple linear regression analysis findings of the two countries were compared to determine whether the variables predicting the numerical scores of Turkey and Singapore show similarities and differences.

Multiple linear regression analysis is a statistical analysis method based on the prediction of a dependent variable by more than one independent variable (Büyüköztürk, 2019; Pallant, 2017). The independent (predictive) variables of the study are gender, age, education level, employment status, and participation in any educational activity in the last 12 months. The dependent (predicted) variable is numerical scores consisting of 10 possible values (PV1-10). In this study, using the standard multiple linear regression model, all independent variables were analyzed, and the effect on the dependent variable was examined. In multiple linear regression analysis, all variables must be continuous. If the variables are not continuous, a dummy variable is formed as 1 less the number of categories of the categorical variables (Keith, 2014). Since the variables of gender, age, education level, employment status, and participation in any educational activity in the last 12 months were categorical, a dummy variable was created for each. Codings of dummy variables are shown in Appendix 1.

Before the analysis, the data set was arranged, and 5 missing data from Turkey and 2 missing data from Singapore were removed. Tabachnick and Fidell (2013) stated that the methods to be applied would yield similar results if the missing data rate is less than 5% in data sets with a large sample size. To determine the extreme

values, univariate and multivariate extreme values were examined. Data outside the standard Z values of -4, +4 (Harrington, 2008) and above the critical chi-square value according to Mahalanobis distances were excluded from the analysis. After these examinations, analyses were made on 5184 data in Turkey and 5381 in Singapore.

Multiple linear regression analysis assumptions (normality, linearity, multicollinearity, and autocorrelation) were tested (Tabachnick & Fidell, 2013). It was seen that these assumptions were met from the normality and linearity graphs of Turkey and Singapore data. To determine whether there is a multicollinearity problem, it was checked whether there was a value above 0.80 in the correlation coefficients between the variables (Büyüköztürk, 2019). Since no value above this value was found in both countries, it was observed that there was no multicollinearity problem. In addition, tolerance and VIF (Variance Inflation Factors) values were also examined. The highest tolerance value for Turkey is .951, the lowest tolerance value is .409, and the VIF value is between 1 and 3. The highest tolerance value for Singapore is .965, and the lowest tolerance value is .441, with VIF values between 1 and 3. The fact that tolerance values between 0 and 1 and VIF values below 10 in Turkey and Singapore data show no multicollinearity problem (Keith, 2014). When the Durbin-Watson value for the autocorrelation assumption is examined, it is seen that it is 1.81 in Turkey and 1.90 in Singapore. The fact that this value is between 1.5 and 2.5 indicates no correlation between the variables (Kalaycı, 2016). After testing all these assumptions, multiple linear regression analysis was performed.

Research Ethics

The research was conducted taking into account all ethical procedures. In addition, Ethics Committee approval was obtained with the decision of Ankara University Social Sciences Sub-Ethics Committee dated 31/05/2021 and numbered 192.

FINDINGS

Findings Related to the First Purpose of the Study

The first aim of the study is to determine the distribution of Turkey's and Singapore's numerical scores according to proficiency levels in the PIAAC applicationThe results are shown in Table 2.

Table 2. Distribution of PIAAC 2015 Numerical Scores according to Proficiency Levels

Levels	Scores for the Levels	TURKEY Percentage	SINGAPORE Percentage	OECD Percentage
Below Level 1	0-175	20.7	13.0	6.7
Level 1	176-225	30.6	15.2	16.0
Level 2	226-275	34.0	26.8	33.0
Level 3	276-325	13.2	31.7	31.8
Level 4	326-375	1.5	12.0	10.2
Level 5	376 -500	-	1.3	1.0
Missing				1.4
Turkey $\overline{X}$= 219, Singapore $\overline{X}$= 257, OECD $\overline{X}$= 263				

Table 2 shows that the average of Turkey's numerical scores ($\overline{X}$= 219) corresponds to Level 1, and 50.6% of adults are at Level 1 and below. The proportion of adults at Level 4 and above is very low. This shows that adults in Turkey can generally answer items that require simple and one-step processes but cannot answer items that require more complex high-level skills.

Singapore's numerical score average ($\overline{X}$= 257) corresponds to Level 2 and is lower than the OECD average ($\overline{X}$= 263). The distribution of adults in Singapore by qualifications is more proportional than that of adults in Turkey and is similar to the distribution of the OECD average. While there are fewer adults at Level 1 and below in Singapore than in Turkey, there are more adults at Level 3 and above. Accordingly, the skill levels of adults in Singapore are higher than adults in Turkey.

Findings Related to the Second Objective of the Research

The second aim of the study was to determine which of the following variables significantly predicted Turkey's PIAAC 2015 numerical scores: gender, age, education level, employment status, and participation in any educational activity in the last 12 months. The results are shown in Table 3.

Table 3. Multiple Linear Regression Analysis Results for Turkey

Variable	B	Standard Error (B)	ß	t	p	Bilateral r	Partial r	R	R^2	F	p
Constant	169.123	.018		9445.829	0.000			.572	.327	2024520.13	.000
Genderdd2	19.031	.014	.182	1377.800	0.000	.256	.191				
Agedd2	31.386	.023	.252	1389.772	0.000	.150	.193				
Agedd3	24.329	.022	.199	1113.976	0.000	.101	.156				
Agedd4	22.254	.022	.179	1020.081	0.000	-.009	.143				
Agedd5	20.399	.022	.148	907.420	0.000	-.058	.127				
Edudd2	35.726	.015	.283	2307.365	0.000	.267	.310				
Edudd3	37.257	.030	.147	1237.140	0.000	.114	.172				
Edudd4	60.604	.024	.311	2529.781	0.000	.289	.337				
Edudd5	70.872	.058	.144	1218.455	0.000	.132	.170				
Empdd1	2.030	.015	.019	137.612	0.000	.217	.019				
Empdd2	-5.528	.033	-.020	-168.184	0.000	.010	-.024				
Patedudd1	11.068	.015	.096	734.697	0.000	.287	.103				
F (12.49954617=2024520.13)											

When Table 3 is examined, the variables of gender, age, education level, employment status, and participation in any educational activity in the last 12 months show a moderate and significant relationship with the numerical scores of adults in Turkey, and together they explain approximately 33% of the variance in numerical scores. (R=.572, R^2=.327, p<.01). According to the bilateral and partial correlations, there are positive and low-level, negative and low-level relationships between the predictive variables and the predicted variable. When the standardized regression coefficients (β) are examined, it is seen that the most important variable predicting the numerical scores of adults in Turkey is having a bachelor's degree. According to the t value results regarding the significance of the regression coefficient, variables such as gender, age, education level, employment status, and participation in any educational activity in the last 12 months are significant predictors of numerical scores.

Findings Related to the Third Objective of the Research

The third aim of the study is to determine which of the variables gender, age, education level, employment status, and participation in any educational activity in the last 12 months significantly predict Singapore's PIAAC 2015 numerical scores. The results are shown in Table 4.

Table 4. Multiple Linear Regression Analysis Results for Singapore

Variable	B	Standart Error (B)	ß	t	p	Bileteral r	Partial r	R	R^2	F	p
Constant	161.760	0.087		1856.927	0.000			.744	.553	265447.743	.000
Genderdd2	10.283	0.053	0.079	193.723	0.000	0.111	0.115				
Agedd2	47.017	0.098	0.273	478.797	0.000	0.210	0.276				
Agedd3	20.385	0.093	0.124	219.950	0.000	0.210	0.131				
Agedd4	11.823	0.087	0.075	135.644	0.000	0.067	0.081				
Agedd5	11.032	0.083	0.071	132.954	0.000	-0.135	0.079				
Edudd2	52.696	0.084	0.337	626.456	0.000	-0.105	0.351				
Edudd3	64.594	0.100	0.334	648.795	0.000	0.041	0.362				
Edudd4	83.859	0.092	0.497	908.861	0.000	0.146	0.478				
Edudd5	112.830	0.094	0.707	1205.748	0.000	0.368	0.585				
Empdd1	123.619	0.125	0.473	991.230	0.000	0.225	0.510				
Empdd2	-5.226	0.071	-0.035	-74.108	0.000	0.073	-0.044				
Constant	-2.451	0.146	-0.007	-16.754	0.000	0.004	-0.010				
Genderdd2	16.377	0.061	0.123	268.762	0.000	0.413	0.159				
F(13.2790354=265447.743)											

According to Table 4, the variables of gender, age, education level, employment status, and participation in any educational activity in the last 12 months give a moderate and significant relationship with the numerical scores of adults in Singapore, and together their numerical scores are approximately 55% of the variance. (R=.744, R^2=.553 and p<.01). According to the bilateral and partial correlations, there are positive and low level, positive and medium level, and negative and low-level relationships between the predictor variables the predicted variable. According to the standardized regression coefficients (β), having a bachelor's degree is the most important variable predicting the numerical scores of adults in Singapore. variables such as gender, age, education level, employment status, and participation in any educational activity in the last 12 months are significant predictors of numerical scores.

Findings Regarding the Fourth Objective of the Study

The fourth aim of the study is to determine whether the variables predicting Turkey's and Singapore's PIAAC 2015 numerical scores are similar and different. According to the findings, variables such as gender, age, education level, employment status, and participation in any educational activity in the last 12 months are significant predictors of numerical scores in Turkey and Singapore. These variables explain approximately 33% of the variance of numerical scores in Turkey, while this ratio is 55% in Singapore.

According to the bilateral and partial correlations, although there are differences between the two countries in terms of the direction and strength of the relationship between the predictor variables and the predicted variable, there are generally positive and low, negative and low-level relationships. According to the order of importance of the predictor variables on the predicted variables, having a bachelor's degree is the most important variable in both countries. According to the B coefficients, a one-unit increase in the variable of a bachelor's degree causes a change of 112,830 units in the numerical scores of adults in Singapore, while this rate is 60,604 in Turkey

DISCUSSION & CONCLUSION

In this study, which aims to determine the variables predicting Turkey's and Singapore's PIAAC 2015 numerical scores, firstly, the distribution of the numerical scores of the two countries according to proficiency levels was examined. Accordingly, Turkey's numerical score average is below Singapore and OECD averages and corresponds to Level 1. Singapore's numerical score average is below the OECD average and corresponds to Level 2. The number of adults with low proficiency levels is higher in Turkey than in Singapore. Therefore, multiple linear regression analysis was used to determine the variables affecting the numerical scores of both countries.

According to the findings, gender, age, education level, employment status, and participation in any educational activity in the last 12 months were significant predictors of numerical scores. According to the studies on PIAAC in the literature, these variables effectively affect individuals' achievement, which supports this study finding (Calero et al., 2016; Cegolon, 2015; Hinz, 2018; Provasnik, 2018; Støren et al., 2018). Predictive variables explain approximately 33% of the variance in Turkey's numerical scores, and the most important predictor of numerical scores is a bachelor's degree. In Singapore, however, predictive variables explain approximately 55% of the variance of numerical scores. Like in Turkey, a bachelor's degree is the most important predictor of numerical scores. This shows that the predictive variables predict Singapore's numerical scores more, and at the same time, the high level of education significantly affects the numerical scores in both countries. According to the B coefficients, the variable of being a bachelor's degree causes more changes in Singapore's numerical scores. It is thought that the reason for this situation may be that the number of adults at the undergraduate level in Singapore is higher than the number of adults in Turkey in the sample distributions. According to the order of importance of the variables, having high education level and a low age level are important predictors of numerical scores in both countries. In contrast, the employment status variable has the least importance.

Research findings show that numerical scores in PIAAC 2015 application are low in both countries, and variables explain this situation. The development of adults' numeracy skills is critical for the development of active citizenship, employment, individual learning and social inclusion in social, economic and societal spheres (Goos et al., 2023). Therefore, policy makers should revisit and improve their strategic initiatives to avoid exclusion due

to numeracy deficits in the public and private spheres by placing more emphasis on numeracy as a transition to a common interaction between different contexts in everyday life (Díez-Palomar et al., 2023).

Since it is seen that a high level of education has a significant effect on these scores, it is thought that it is important for adults to continue their education during formal education and to develop a culture of lifelong learning in society. The age variable also significantly affects numerical skills, and the fact that low-age individuals (16-24 years old) have more skills than older adults shows that more work is required to develop the skills of the elderly group. Although the numerical skills of the young population in Turkey are low, this situation continues in their adulthood. Although Singapore is a successful country in terms of skills among the young population, it is seen that the skills of the adult population are weak. The most important variable affecting skills in both countries is the high level of education. These findings coincide with the findings of other studies in the literature that skills decrease as age increases in the PIAAC application, while skills increase as education level increases (Calero et al., 2016; Huertas, et al., 2017; Liu, 2018; Paccagnella, 2016 and Villar, 2014). PIAAC states that education is the most important determinant of literacy and numeracy skills (Scandurra, 2012). Huertas, et al. (2017) argue that the decline in skills with aging can be compensated by increasing and qualitatively improving schooling. Cegolon (2015), on the other hand, concluded that skills can be increased through participation in formal and non-formal education activities.

Formal and non-formal education activities are discussed in the literature. According to the research, in our age of rapid change, non-formal and informal learning approaches based on individual interests and needs and formal education should be considered together to meet educational needs such as the use of technology, development of digital competencies, integration into social life (Grajcevci and Shala, 2016; Vartolomei, 2016). Today, non-formal education is not only a complementary education but also an education industry that affects formal education (Romi and Schmida, 2009). Emphasizing that the balance between formal and non-formal learning has changed and non-formal learning has become more important, Rogers (2014) suggests that formal and non-formal learning support each other by i) increasing non-formal learning, ii) using formal and non-formal learning together to regulate the non-social consequences of informal learning, iii) providing support for learners' informal learning, and iv) establishing dialogic links between formal and non-formal learning. Research in the literature and the findings of this study show that formal education and adult education activities have an impact on individuals' skills and should be evaluated together. For this reason, it is thought that formal education and adult education activities should be handled together in order to ensure the skill development of the population and educational programs should be arranged.

Since the PIAAC application provides data on adults in every field, it is important to research variables affecting other skills by reviewing the literature and conducting comparative studies between countries to improve the skills of the adult population in society. It is thought that there are fewer studies on PIAAC in Turkey compared to applications such as PISA, TIMMS, and PIRLS because of the application's low awareness. For this reason, different studies can be conducted by the Ministry of National Education and the Ministry of Labor and Social Security to promote the application. It is also recommended that policy makers should increase the awareness of this application by promoting it in the society in order to improve the skills of the adult population, and other researchers should examine the different factors affecting the skills in the PIAAC application.

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APPENDIX

Appendix 1. Defining Categorical Variables as Dummy Variables and Coding

Variable	Level	Dummy Variable	Coding	Reference Group (Group Excluded from Analysis)
Gender	Male=1 Female=0	Genderd	Male=1 Female=0	Female
Age	1=16-24 2=25-34 3=34-45 4=45-54 5=55 and above	aged	16-24= 1 25-34= 0 34-45= 0 45-54= 0 55 and above = 0	55 and above
			16-24= 0 25-34= 1 34-45= 0 45-54= 0 55 and above = 0	
			16-24= 0 25-34= 0 34-45= 1 45-54= 0 55 and above = 0	
			16-24= 1 25-34= 0 34-45= 0 45-54= 1 55 and above = 0	
Education Level (Turkey)	1=Primary education or below 2=High School 3=Associate degree or open education 4=License 5=Master's Degree/PhD	Edud	Primary school or below = 0 High School= 1 Associate degree or open education= 0 License= 0 Master's/PhD= 0	Primary education or below
			Primary school or below = 0 High School= 0 Associate degree or open education= 1 License= 0 Master's/PhD= 0	
			Primary school or below = 0 High School= 0 Associate degree or open education= 0 License= 1 Master's/PhD= 0	
			Primary school or below = 0 High School= 0 Associate degree or open education= 0 License= 0 Master's/PhD= 1	
Variable	**Level**	**Dummy Variable**	**Coding**	**Reference Group (Group Excluded from Analysis)**

Education Level (Singapore)	1=Primary education or below 2=High School 3=Post-Secondary Non-Higher Education 4=Short Term Higher Education 5=License 6=Master's Degree/PhD	Edud	Primary education or below= 0 High School= 1 Post-Secondary Non-Higher Education= 0 Short Term Higher Education= 0 License= 0 Master's/PhD= 0	Primary education or below
			Primary education or below= 0 High School= 0 Post-Secondary Non-Higher Education= 1 Short Term Higher Education= 0 License= 0 Master's/PhD= 0	
			Primary education or below= 0 High School= 0 Post-Secondary Non-Higher Education= 0 Short Term Higher Education= 1 License= 0 Master's/PhD= 0	
			Primary education or below= 0 High School= 0 Post-Secondary Non-Higher Education= 0 Short Term Higher Education= 0 License= 1 Master's/PhD= 0	
			Primary education or below= 0 High School= 0 Post-Secondary Non-Higher Education= 0 Short Term Higher Education= 0 License= 0 Master's/PhD= 1	
Employment Status	Working=1 Not working=2 Out of labor force=3	Empd	Working=1 Not working=0 Out of labor force=0	Out of labor force
			Working=0 Not working=1 Out of labor force=0	
Education Participation Status (Last 12 Months)	**Yes=1 No=0**	**Patedud**	**Yes= 1 No= 0**	**No**