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Which Country is More Effective in Science Teaching? Evidence from PISA 2015 as a Secondary School Assessment Tool

Gökhan Ilgaz[1]
Menekşe Eskici[2]
Levent Vural[3]

[1,3]*Faculty of Education, Educational Sciences Department, Dr. Trakya University, Turkey*
[1]*Email: gokhani@trakya.edu.tr*
[3]*Email: leventvural@trakya.edu.tr*
[2]*Faculty of Science and Art, Educational Sciences Department, Dr. Kırklareli University, Turkey*
Email: menekeskici@hotmail.com

(Corresponding Author

Abstract

The aim of this study is to determine how effectively different countries use educational inputs in the process of science education. The study is in the descriptive model and the data is derived from the PISA 2015 data set, which provides information to countries on secondary education programs. Data from 70 countries, including Turkey, were used in the study. The effectiveness of Turkey in the process of science teaching in secondary education has been compared with other countries and suggestions have been made to increase the effectiveness of secondary education science teaching. The data for this study are grouped into training inputs and training outputs. *"Student behaviour hindering learning", "teacher behaviour hindering learning", "shortage of educational material", "shortage of educational staff", "professional development", "teachers participation", "curricular development", "total number of science teachers at school", "index science-specific resources (sum)"* were defined as the educational inputs. The science achievements of students have been taken into account in determining which countries have more effective management of educational inputs accepted in this study. Secondary scholl level education inputs while nearby countries respectively to use effectively Slovakia (97.30%), Slovenia (91.16%), Brazil (90.50%), Turkey (89.75%), Finland (84.65%), Greece (83.31%), Denmark (83.25%), and Czech Republic (80.61%). education outcomes in Turkey is ranked as 20th in science teaching secrets to use it effectively.

Keywords: Secondary school, Curriculums, Effective science teaching, PISA 2015, Data envelopment, Training inputs and training outputs.

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Ethical: This study follows all ethical practices during writing.

Contents

Contribution of this paper to the literature
This study contributes to the existing literature by determining how effectively different countries use educational inputs in the process of science education.

1. Introduction

Science is more than merely a part of daily life; it is daily life itself. Subjects such as stirring sugar in tea to make it dissolve faster, the need to take plugs out of sockets during lightning storms, how natural events such as rain and snow occur, and the harm caused to the body by not drinking enough water, all fall under the scope of science. Considered from this point of view, not only is it true that for humans, who lead their lives as part of nature, it is impossible to live apart from science, it is also a fact that if they are not sufficiently equipped with regard to science, their lives will be made equally difficult. The importance of science stems from the fact that it encompasses not only the most basic activities in daily life, but also much more complex subjects such as the production of technology, increasing efficiency in the use of natural resources, and discovering the keys to a longer life. Developments in the field of science and reflecting them into daily life are the most significant indicators of the establishment of modern life in society and of the progress of nations. Therefore, the teaching of science plays a key role in an individual's personal development as well as in the advancement of nations.

Scientific knowledge is a lesson that is so much a part of life that Davis *et al.* (2006) stress that a science education that focuses on real challenges is the main reason for success. It can be said that science and technology lessons carried out in a social context change attitudes towards science in a positive way and support the creation of the basis for a solid scientific understanding. The best way to increase students' interest in science is to associate the lesson subjects to daily life, since it is possible for students to perceive the benefits of science when they see its reflection in daily life (Bennett *et al.*, 2007; Maltese *et al.*, 2014; Sheldrake *et al.*, 2017). If attitudes towards science become negative and if students' concerns about the subject of science affect their career choices and lead them in other directions, this will be a worrying situation for developments in the field of science. Therefore, endearing students to science builds the mainframe for their future achievements related to science (Osborne *et al.*, 2003). It would not be wrong to say that attitudes towards science form the source of skills related to scientific knowledge, technological developments and science. The problem here is that although science is so important, attitudes towards science are low. Conducted studies have shown that attitudes towards science are low because of negative experiences occurring in science lessons (Mulholland and Wallace, 1996; Palmer, 2001). Based on this, it can be said that the science education process needs to be organised in such a way as to affect students' attitudes towards science in a positive way.

It is argued that the approach to science education should be regarded as "education through science" rather than "science through education" (Holbrook and Rannikmae, 2007). The real sine qua non of science education is that students should learn science by experiencing it and not by rote. The place of the laboratory environment in science education is indisputable. The opportunity for students to learn by doing and experiencing is a great chance for those students' science learning (Hodson, 1988; Kirschner *et al.*, 2006). In addition to these, the design of a science education learning environment that includes activities focusing on skills like experimentation and reasoning, that is supported by visuals, and in which primary sources or models are used, is recommended (Evagorou *et al.*, 2015).

The need to consider the problem of how science education should be taught, rather than what should be taught, is pointed out. Science education is possible not merely by learning basic knowledge, but with the application of that knowledge. Baeten *et al.* (2010) state that education conducted with a student-centred approach supports deep learning. Success in science education is related to experiencing scientific knowledge by doing research (Clermont *et al.*, 1994; Bybee, 2014; Osborne, 2014). Moreover, there are indicators regarding the fact that conducting science education in a collaborative way will contribute to students' cognitive development as a result of their mutual interaction and sharing of ideas (Koretsky *et al.*, 2019). It is emphasised that learning and teaching science lessons in a more collaborative way will be beneficial (Huppert *et al.*, 2002).

Controversial findings related to the factors influencing success in science are found in the literature. In a study made by Stohr-Hunt (1996) it was found that success in science classes of students who had more experience was greater than that of students with less experience. In a study conducted by Cairns and Areepattamannil (2019) it was determined that based on the PISA data, inquiry-based science education was significantly negatively correlated with science success, whereas inquiry-based science education was significantly positively correlated with dispositions towards science such as interest in and enjoyment of learning science, instrumental and future-oriented motivation for science, and science self-esteem. Using the TIMSS 2015 data for Norway, Teig *et al.* (2018) concluded in their study that inquiry-based science teaching on a large scale had a negative effect on science achievement, a fact which supports the findings made by Cairns and Areepattamannil (2019).

Undoubtedly, there are various factors affecting academic success. The basic factors that affect students' academic success are considered to be teacher competencies (Rockoff, 2004; Aaronson *et al.*, 2007; Rothstein, 2010; Harris and Sass, 2011) undesirable student behaviours (Durán-Narucki, 2008; Maxwell, 2016) school facilities (Gislason, 2010; Rivera and Lopez, 2019) and the school's relationship with parents (Hill and Taylor, 2004; Jeynes, 2007). The same factors can be listed as determinants of success in the subject of science. In the PISA 2015 report, the educational inputs affecting science achievement were defined as *"student behaviours preventing learning"*, *"teacher behaviours preventing learning"*, *"lack of educational materials"*, *"lack of teaching staff"*, *"professional development"*, *"teacher participation"*, *"curriculum development"*, *"total number of* science teachers in school" and "science-specific resource index (total)".

2. Purpose of the Study

In an age in which development in science technology is taken as the basis as the most important indicator of countries' development, the process of scientific knowledge production in universities has also gained importance. The education of individuals who can produce scientific knowledge is also of equal importance. When considering that the most determining factor for success in the education process is readiness, it can be regarded as an undisputable fact that possessing competence in science in the secondary education period has an impact on educating individuals who will be able to produce scientific knowledge in higher education. Based on this, it can be concluded that the effectiveness of science teaching carried out during the secondary education process is very important for the development of nations. The more successfully science education is conducted during the secondary education process and the higher the level of readiness of students sent into higher education, the more the levels of countries' scientific knowledge production and of their technological development will increase. Therefore, it is considered important to determine the effect on success of the educational inputs that will determine the effectiveness of science teaching in secondary school curricula. The aim of this study is to determine how efficiently different countries use educational inputs in the science teaching process.

3. Method

3.1. Research Model

With the aim of evaluating the relative efficiency of the inputs or efforts put in by countries, using these countries' PISA 2015 Science scores as outputs, this study was designed according to the survey model.

3.2. Study Group

The study was conducted with data obtained from schools in 70 countries/regions that participated in the PISA 2015 study. For the analysis, in order to remove negative numbers and to facilitate interpretation, the data were converted into z scores. Since there were outliers in the input scores for Tunisia and China (Beijing-Shanghai-Jiangsu-Guangdong), these were removed. It was seen that there were no outliers in the z scores obtained for the remaining 68 countries. In the correlation analysis conducted, it was determined whether or not there was multicollinearity, and the study was carried out with 68 countries. The distributions of the countries included in the study are shown in Table 1.

Table-1. Countries and numbers of schools included in the study.

Countries	Frequency	%	Countries	Frequency	%
Albania	230	1.32	Latvia	250	1.43
Algeria	161	0.92	Lithuania	311	1.78
Australia	758	4.34	Luxembourg	44	0.25
Austria	269	1.54	China (Macao)	45	0.26
Belgium	288	1.65	Malta	59	0.34
Brazil	841	4.81	Mexico	275	1.57
Bulgaria	180	1.03	Moldova	229	1.31
Canada	759	4.34	Montenegro	64	0.37
Chile	227	1.30	Netherlands	187	1.07
Chinese-Taipei (Taiwan)	214	1.22	New Zealand	183	1.05
Colombia	372	2.13	Norway	229	1.31
Costa Rica	205	1.17	Peru	281	1.61
Croatia	160	0.92	Poland	169	0.97
Czech Republic	344	1.97	Portugal	246	1.41
Denmark	333	1.91	Qatar	167	0.96
Dominican Republic	194	1.11	Romania	182	1.04
Estonia	206	1.18	Russian Federation	210	1.20
Finland	168	0.96	Singapore	177	1.01
France	252	1.44	Slovakia	290	1.66
Georgia	262	1.50	Vietnam	188	1.08
Germany	256	1.46	Slovenia	333	1.91
Greece	211	1.21	Spain	201	1.15
China (Hong Kong)	138	0.79	Sweden	202	1.16
Hungary	245	1.40	Switzerland	227	1.30
Iceland	124	0.71	Thailand	273	1.56
Indonesia	236	1.35	Trinidad and Tobago	149	0.85
Republic of Ireland	167	0.96	United Arab Emirates	473	2.71
Israel	173	0.99	Turkey	187	1.07
Italy	474	2.71	Macedonia	106	0.61
Japan	198	1.13	United Kingdom	550	3.15
Jordan	250	1.43	United States	177	1.01
Korea	168	0.96	Uruguay	220	1.26
Kosovo	224	1.28	Spain (Regions)	976	5.59
Lebanon	270	1.55	Argentina (Buenos Aires)	58	0.33

Source: Obtained from primary data.

3.3. Data Collection Tools

The data for the schools taken as the study sample were utilized by utilizing the PISA 2015 database. These data were scaled in ready form. Within this scope, the means of these scales were used as inputs, while the countries' PISA 2015 Science success scores were used as outputs. These inputs and the questions with which they were obtained are presented in Table 2.

Table-2. The inputs and its questions.

Inputs	The Name of Inputs	Questions of Inputs	Questions
Input1	Student behaviour hindering learning (WLE)	SC061Q01TA	Student truancy
		SC061Q02TA	Students skipping classes
		SC061Q03TA	Students lacking respect for teachers
		SC061Q04TA	Student use of alcohol or illegal drugs
		SC061Q05TA	Students intimidating or bullying other students
Input2	Teacher behaviour hindering learning (WLE)	SC061Q06TA	Teachers not meeting individual students' needs
		SC061Q07TA	Teacher absenteeism
		SC061Q08TA	Staff resisting change
		SC061Q09TA	Teachers being too strict with students
		SC061Q010TA	Teachers not being well prepared for classes
Input3	Shortage of educational material (WLE)	SC017Q05NA	A lack of educational material (e.g. textbooks, IT equipment, library or laboratory material).
		SC017Q06NA	Inadequate or poor quality educational material (e.g. textbooks, IT equipment, library or laboratory material).
		SC017Q07NA	A lack of physical infrastructure (e.g. building, grounds, heating/cooling, lighting and acoustic systems).
		SC017Q08NA	Inadequate or poor quality physical infrastructure (e.g. building, grounds, heating/cooling, lighting and acoustic systems)
Input4	Shortage of educational staff (WLE)	SC017Q01NA	A lack of teaching staff
		SC017Q02NA	Inadequate or poorly qualified teaching staff
		SC017Q03NA	A lack of assisting staff.
		SC017Q04NA	Inadequate or poorly qualified assisting staff
Input5	Professional development (WLE)	SC009Q06TA	When a teacher has problems in his/her classroom, I take the initiative to discuss matters.
		SC009Q08TA	I pay attention to disruptive behaviour in classrooms
		SC009Q12TA	When a teacher brings up a classroom problem, we solve the problem together.
		SC009Q06TA	When a teacher has problems in his/her classroom, I take the initiative to discuss matters.
Input6	Teachers participation (WLE)	SC009Q09TA	I provide staff with opportunities to participate in school decision-making
		SC009Q010TA	I engage teachers to help build a school culture of continuous improvement
		SC009Q011TA	I ask teachers to participate in reviewing management practices.
Input7	Curricular development (WLE)	SC009Q01TA	I use student performance results to develop the school's educational goals.
		SC009Q02TA	I make sure that the professional development activities of teachers are in accordance with the teaching goals of the school.
		SC009Q03TA	I ensure that teachers work according to the school's educational goals
Input8	Total number of science teachers at school		
Input9	Index science specific resources (Sum)	SC059Q01NA	Compared to other departments, our school's science department is well equipped.
		SC059Q02NA	If we ever have some extra funding, a big share goes into improvement of our science teaching.
		SC059Q03NA	Science teachers are among our best educated staff members.
		SC059Q04NA	Compared to similar schools, we have a well-equipped laboratory.
		SC059Q05NA	The material for hands-on activities in science is in good shape.
		SC059Q06NA	We have enough laboratory material that all courses can regularly use.
		SC059Q07NA	We have extra laboratory staff who help support science teaching.
		SC059Q08NA	Our school spends extra money on up-to-date science equipment.

Source: Obtained from primary data.

3.4. Data Analysis

The aim of this study was to investigate whether or not the inputs or efforts considered to affect the PISA 2015 Science success scores were used efficiently by the countries. With this aim, to determine the relative efficiency, data envelopment analysis was used. The analysis was performed in line with the views of Lorcu (2008):

1. Firstly, the Decision Making Units (DMU) were determined. According to Dyson *et al.* (2001)) form inputs and s outputs, the number of decision making units should be 2 mXs. In this study, 70 countries (68 were taken for analysis; the reason for this is presented below) were sufficient as DMUs for the 9 inputs and 1 output.
2. According to Cooper *et al.* (2001) form inputs and s outputs, there should be an N number of DMUs, where N≥{m x s; 3 X (m + s). Accordingly, since 70 (68) ≥{9 X 1; 3 X (9 + 1)}=70(68) ≥{9; 30}, the number of DMUs was sufficient.
3. z distribution should be controlled. In the first z distribution in the study, since there were outliers in the input scores for Tunisia and China (Beijing-Shanghai-Jiangsu-Guangdong), these were removed. It was seen that there were no outliers in the z scores recalculated for the remaining 68 countries. Both z distributions are shown in Table 3. To facilitate interpretation of the scores and to remove negative values, conversion to T scores was performed.

Table-3. Distribution of inputs for 68 countries.

Inputs	N	Minimum	Maximum	N	Minimum	Maximum
Student behaviour hindering learning (WLE)	70	-1,87272	2,06593	68	-1,85571	2,05420
Teacher behaviour hindering learning (WLE)	70	-2,07622	2,43954	68	-2,07918	2,52854
Shortage of educational material (WLE)	70	-1,96928	2,12009	68	-1,96773	2,21297
Shortage of educational staff (WLE)	70	-2,12386	3,58366	68	-2,26788	2,37804
Professional development (WLE)	70	-2,35916	2,90058	68	-2,47614	2,14454
Teachers participation (WLE)	70	-2,09584	2,42160	68	-2,06065	2,40872
Curricular development (WLE)	70	-2,30067	2,18401	68	-2,45245	2,21827
Total number of science teachers at school	70	-2,95748	1,84587	68	-3,08392	1,85672
Index science specific resources (Sum)	70	-1,13323	5,53576	68	-1,43348	2,86126

Source: Obtained from primary data.

4. Correlation control was performed for the 68 countries. No high correlation was determined. The correlation results are presented in Table 4.

Table-4. Correlations between inputs.

No	Inputs	Input 2	Input 3	Input 4	Input 5	Input 6	Input 7	Input 8	Input 9	PISA Score
Input1	Student behaviour hindering learning (WLE)	-,107	,171	-,43**	-,038	-,013	-,113	,104	,415**	,331**
Input2	Teacher behaviour hindering learning (WLE)		,475**	,163	,227	,011	,079	-,021	-,190	,086
Input3	Shortage of educational material (WLE)			,058	,495**	-,099	-,154	-,107	,025	,187
Input4	Shortage of educational staff (WLE)				,534**	,168	,120	-,004	-,189	-,403**
Input5	Professional development (WLE)					-,058	-,067	-,201	,032	,004
Input6	Teachers participation (WLE)						,633**	,654**	,033	-,592**
Input7	Curricular development (WLE)							,671**	-,224	-,491**
Input8	Total number of science teachers at school								,038	-,481**
Input9	Index science specific resources (Sum)									,268*

Source: Obtained from primary data.
**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

5. Starting with the hypothesis that as decision-makers, we would have an effect on the inputs, analysis of the inputs was made. Moreover, under the hypotheses of constant returns and returns to scale used in approaches of this type, an attempt was made to obtain the countries' total, technical and scale efficiency values. Total efficiency was calculated with the input-based CCR model developed by Charnes *et al.* (1978) while technical efficiency was calculated with Banker *et al.* (1984) BCC model and scale efficiency was calculated with the ratio of these. Furthermore, returns to scale situations were also calculated.

4. Findings

In the study, the research results for total efficiency calculated with the CCR model, technical efficiency with the BCC model, scale efficiency with the CCR/BCC ratio, and returns to scale with total lambdas of the selected countries are presented in Table 5. According to the analyses made, a total of 15 countries/regions (Canada, Switzerland, Estonia, Finland, Hong Kong (China), Hungary, Iceland, Japan, Korea, Lithuania, Macao (China), Poland, Singapore, Slovenia and Vietnam) out of the 68 countries/regions were totally efficient. Of the countries that were totally efficient, the top three countries shown as references were Japan (37), Poland (35) and Estonia (34). Vietnam, which was a totally efficient country, was not shown as a reference for any other country. On the other hand, the totally efficient Slovenia was shown as a reference for Latvia and Sweden. Latvia's reference coefficient was extremely low, and, due to rounding down, was evaluated as zero.

When the general distribution of totally efficient countries is examined, it is seen that they mostly consist of continental European and Asia-Pacific countries. 12 of the countries (which countries) that were above the OECD average in the PISA 2015 science scores listing were also totally efficient. It was determined that the five countries that were closest to total efficiency (Taiwan (China), the Netherlands, Austria, Denmark and France) were also among the countries above the OECD average.

The analysis revealed that 53 countries were inefficient. The five countries furthest from total efficiency were Jordan, Kosovo, Trinidad and Tobago, Algeria and the Dominican Republic. Again, it is seen that these countries occupied the last places in the PISA 2015 science success listing, and that in fact, the Dominican Republic was in last place for both total efficiency and academic success. In other words, these countries' efforts were not sufficient.

Examining the countries' returns to scale situations, it is seen that apart from New Zealand, all countries had increasing returns to scale. That is to say, an input of 1 unit in their inputs resulted in an output greater than 1 in their outputs. Examining the recommendations made for countries that were not totally efficient in order for them to become efficient, it was determined that there was no reference indicator in regional terms. In most reference indicators, there was a mixture of Europe and Asia-Pacific. It was determined that especially Canada and totally efficient countries in Europe were mostly references for their neighbours.

Turkey was one of the countries that were not totally efficient. Turkey's total efficiency ratio was 71.92%. With this score, Turkey was in 51st place in the list of 68 countries. Estonia and Japan were references for Turkey. That is, for Turkey to be totally efficient, it needed to use its inputs with the input ratios of those countries.

Table-5. CCR results.

NO	DMU	CCR	Country1	λ1	Country2	λ2	Country 3	λ3	Country4	λ4	Country 5	λ5	Country 6	λ6	Total λ	Returns to Scale
1	Albania	0,8635	Hungary	0,37	Japan	0,08	Korea	0,08	Singapore	0,19					0,72	Increasing
2	United Arab Emirates	0,7140	Japan	0,15	Korea	0,12	Singapore	0,4							0,67	Increasing
3	Australia	0,9040	Canada	0,24	Estonia	0,24	Iceland	0,01	Poland	0,12	Singapore	0,31			0,92	Increasing
4	Austria	0,9666	Switzerland	0,21	Estonia	0,29	Finland	0,32	Japan	0,01	Singapore	0,07			0,9	Increasing
5	Belgium	0,8640	Switzerland	0,16	Japan	0,2	China (Macao)	0,11	Poland	0,49					0,96	Increasing
6	Bulgaria	0,8621	Japan	0,04	Poland	0,76									0,8	Increasing
7	Brazil	0,6502	Estonia	0,03	Finland	0,21	Japan	0,3	Poland	0,04					0,58	Increasing
8	Canada	1,0000	Canada	1											1	
9	Switzerland	1,0000	Switzerland	1											1	
10	Chile	0,8566	Canada	0,11	Iceland	0,59	Poland	0,08	Singapore	0,06					0,84	Increasing
11	Colombia	0,5974	Estonia	0,59	Japan	0,03									0,62	Increasing
12	Costa Rica	0,6396	Estonia	0,46	Japan	0,17									0,63	Increasing
13	Czech Republic	0,9004	Estonia	0,34	Finland	0,16	Japan	0,02	Poland	0,39					0,91	Increasing
14	Germany	0,8775	Switzerland	0,15	Estonia	0,17	Finland	0,38	Japan	0,1	Singapore	0,13			0,93	Increasing
15	Denmark	0,9596	Switzerland	0,14	Estonia	0,26	Finland	0,01	Japan	0,02	Poland	0,5	Singapore	0,04	0,97	Increasing
16	Dominican Republic	0,3872	Estonia	0,27	Japan	0,04	Poland	0,05							0,36	Increasing
17	Algeria	0,5164	Estonia	0,49											0,49	Increasing
18	Spain	0,8661	Estonia	0,18	Hungary	0,1	Japan	0,18	Korea	0,14	Poland	0,19	Singapore	0,12	0,91	Increasing
19	Estonia	1,0000	Estonia	1											1	
20	Finland	1,0000	Finland	1											1	
21	France	0,9446	Switzerland	0,56	Japan	0,01	China (Macao)	0,36							0,93	Increasing
22	United Kingdom	0,9280	China (Hong Kong)	0,46	Japan	0,03	Korea	0,17	Poland	0,21	Singapore	0,08			0,95	Increasing
23	Georgia	0,7821	Estonia	0,04	Hungary	0,18	Korea	0,33	Lithuania	0,03	Poland	0,08			0,66	Increasing
24	Greece	0,8704	Estonia	0,16	Japan	0,03	Korea	0,59							0,78	Increasing
25	China (Hong Kong)	1,0000	China (Hong Kong)	1											1	
26	Croatia	0,7852	Japan	0,49	Poland	0,35									0,84	Increasing
27	Hungary	1,0000	Hungary	1											1	Increasing
28	Indonesia	0,8515	Hungary	0,05	Korea	0,35	Singapore	0,21							0,61	Increasing
29	Republic of Ireland	0,8509	Estonia	0,63	Japan	0,13	Poland	0,14							0,9	Increasing
30	Iceland	1,0000	Iceland	1											1	
31	Israel	0,7019	Estonia	0,39	China (Hong Kong)	0,08	Japan	0,19	Korea	0,01	Poland	0,11			0,78	Increasing
32	Italy	0,7210	Estonia	0,17	Finland	0,08	Japan	0,28	Poland	0,07	Singapore	0,21			0,81	Increasing
33	Jordan	0,5733	Estonia	0,58	Japan	0,01									0,59	Increasing
34	Japan	1,0000	Japan	1											1	
35	Korea	1,0000	Korea	1											1	
36	Kosovo	0,5411	Japan	0,37	Poland	0,15									0,52	Increasing
37	Lebanon	0,5872	Japan	0,13	Korea	0,09	Singapore	0,29							0,51	Increasing
38	Lithuania	1,0000	Lithuania	1											1	
39	Luxembourg	0,9271	Switzerland	0,44	Japan	0,17	China (Macao)	0,27							0,88	Increasing
40	Latvia	0,9270	Estonia	0,32	Poland	0,6	Slovenia	0							0,92	Increasing

41	China (Macao)	1,0000	China (Macao)												1	
42	Moldova	0,6850	Estonia	0,46	Poland	0,23									0,69	Increasing
43	Mexico	0,6251	Estonia	0,09	Japan	0,39	Poland	0,15							0,63	Increasing
44	Macedonia	0,6588	Estonia	0,04	Hungary	0,13	Poland	0,41							0,58	Increasing
45	Malta	0,8411	China (Hong Kong)	0,63	Korea	0,15	Poland	0,01	Singapore	0,02					0,81	Increasing
46	Montenegro	0,7586	Japan	0,22	Poland	0,43									0,65	Increasing
47	Netherlands	0,9765	Switzerland	0,28	Estonia	0,25	China (Hong Kong)	0,41	Japan	0,03					0,97	Increasing
48	Norway	0,8980	Estonia	0,27	Finland	0,24	Japan	0,15	Poland	0,09	Singapore	0,13			0,88	Increasing
49	New Zealand	0,8794	Estonia	0,05	China (Hong Kong)	0,29	Poland	0,66	Singapore	0,02					1,02	Decreasing
50	Peru	0,5846	Estonia	0,16	Japan	0,4									0,56	Increasing
51	Poland	1,0000	Poland	1											1	
52	Portugal	0,7663	Switzerland	0,14	Estonia	0,31	Japan	0,09	Poland	0,3	Singapore	0,1			0,94	Increasing
53	Argentina (Buenos Aires)	0,6985	Estonia	0,08	Japan	0,15	Poland	0,22	Singapore	0,36					0,81	Increasing
54	Qatar	0,8148	Korea	0,22	Poland	0,02	Singapore	0,37							0,61	Increasing
55	Spain (Regions)	0,8800	Hungary	0,19	Japan	0,19	Korea	0,04	Poland	0,41	Singapore	0,11			0,94	Increasing
56	Romania	0,8624	Lithuania	0,57	Poland	0,24									0,81	Increasing
57	Russian Federation	0,7899	Estonia	0,41	Japan	0,29	Poland	0,16							0,86	Increasing
58	Singapore	1,0000	Singapore												0	
59	Slovakia	0,8867	Estonia	0,18	Hungary	0,16	Poland	0,51							0,85	Increasing
60	Slovenia	1,0000	Slovenia												0	
61	Sweden	0,9194	Canada	0,06	Estonia	0,53	Singapore	0,2	Slovenia	0,06					0,85	Increasing
62	Chinese-Taipei (Taiwan)	0,9959	Japan	0,33	Singapore	0,62									0,95	Increasing
63	Thailand	0,7457	Hungary	0,25	Korea	0,23	Lithuania	0,12	Poland	0,13					0,73	Increasing
64	Trinidad and Tobago	0,5390	Estonia	0,57	Japan	0,05	Poland	0,04							0,66	Increasing
65	Turkey	0,7192	Estonia	0,21	Japan	0,44									0,65	Increasing
66	Uruguay	0,6042	Estonia	0,46	China (Hong Kong)	0,18	Japan	0,04	Poland	0,01					0,69	Increasing
67	United States	0,8614	Canada	0,23	Estonia	0,25	Poland	0,15	Singapore	0,26					0,89	Increasing
68	Vietnam	1,0000	Vietnam	1												

Source: Obtained from primary data.

Table-6. Total, Technical and Scale Efficiencies of Countries and their Returns to Scale.

NO	Countries	CCR	BCC	Scale Efficient	Returns to Scale
8	Canada	1	1	1	
9	Switzerland	1	1	1	
19	Estonia	1	1	1	
20	Finland	1	1	1	
25	China (Hong Kong)	1	1	1	
27	Hungary	1	1	1	
30	Iceland	1	1	1	
34	Japan	1	1	1	
35	Korea	1	1	1	
38	Lithuania	1	1	1	
41	China (Macao)	1	1	1	
51	Poland	1	1	1	
58	Singapore	1	1	1	
60	Slovenia	1	1	1	
68	Vietnam	1	1	1	
62	Chinese-Taipei (Taiwan)	0,9959	1	0,9959	Increasing
47	Netherlands	0,9765	1	0,9765	Increasing
4	Austria	0,9666	1	0,9666	Increasing
21	France	0,9446	1	0,9446	Increasing
39	Luxembourg	0,9271	1	0,9271	Increasing
1	Albania	0,8635	1	0,8635	Increasing
56	Romania	0,8624	1	0,8624	Increasing
6	Bulgaria	0,8621	1	0,8621	Increasing
10	Chile	0,8566	1	0,8566	Increasing
28	Indonesia	0,8515	1	0,8515	Increasing
54	Qatar	0,8148	1	0,8148	Increasing
23	Georgia	0,7821	1	0,7821	Increasing
46	Montenegro	0,7586	1	0,7586	Increasing
65	Turkey	0,7192	1	0,7192	Increasing
44	Macedonia	0,6588	1	0,6588	Increasing
7	Brazil	0,6502	1	0,6502	Increasing
37	Lebanon	0,5872	1	0,5872	Increasing
50	Peru	0,5846	1	0,5846	Increasing
59	Slovakia	0,8867	0,9954	0,8908	Increasing
24	Greece	0,8704	0,9886	0,8804	Increasing
36	Kosovo	0,5411	0,981	0,5516	Increasing
40	Latvia	0,927	0,9802	0,9457	Increasing
17	Algeria	0,5164	0,9794	0,5273	Increasing
45	Malta	0,8411	0,9777	0,8603	Increasing
16	Dominican Republic	0,3872	0,9688	0,3997	Increasing
15	Denmark	0,9596	0,9641	0,9953	Increasing
61	Sweden	0,9194	0,9535	0,9642	Increasing
63	Thailand	0,7457	0,9519	0,7834	Increasing
13	Czech Republic	0,9004	0,9421	0,9557	Increasing
22	United Kingdom	0,928	0,9387	0,9886	Increasing
42	Moldova	0,685	0,9342	0,7332	Increasing
12	Costa Rica	0,6396	0,9255	0,6911	Increasing
48	Norway	0,898	0,9219	0,9741	Increasing
43	Mexico	0,6251	0,919	0,6802	Increasing
3	Australia	0,904	0,9182	0,9845	Increasing
55	Spain (Regions)	0,88	0,9134	0,9634	Increasing
2	United Arab Emirates	0,714	0,9107	0,784	Increasing
18	Spain	0,8661	0,9022	0,96	Increasing
67	United States	0,8614	0,8986	0,9586	Increasing
5	Belgium	0,864	0,8977	0,9625	Increasing
11	Colombia	0,5974	0,8942	0,6681	Increasing
29	Republic of Ireland	0,8509	0,8933	0,9525	Increasing
14	Germany	0,8775	0,8901	0,9858	Increasing
26	Croatia	0,7852	0,8828	0,8894	Increasing
49	New Zealand	0,8794	0,8796	0,9998	Decreasing
57	Russian Federation	0,7899	0,8772	0,9005	Increasing
33	Jordan	0,5733	0,8626	0,6646	Increasing
31	Israel	0,7019	0,8317	0,8439	Increasing
53	Argentina (Buenos Aires)	0,6985	0,8303	0,8413	Increasing
32	Italy	0,721	0,8065	0,894	Increasing
52	Portugal	0,7663	0,7824	0,9794	Increasing
64	Trinidad and Tobago	0,539	0,7692	0,7007	Increasing
66	Uruguay	0,6042	0,7688	0,7859	Increasing

Source: Obtained from primary data.

As shown the Table 6, when technical efficiency was evaluated, it was determined that 33 countries were technically efficient, while 35 countries were not technically efficient. This proportion is almost fifty fifty. 18 of the countries (Taiwan (China), the Netherlands, Austria, France, Luxembourg, Albania, Romania, Bulgaria, Chile, Indonesia, Qatar, Georgia, Montenegro, Turkey, Macedonia, Brazil, Lebanon and Peru) that were not totally efficient appeared as technically efficient.

Another type of efficiency examined in the study was that of scale efficiency. The results of the analysis reveal that only 15 of the totally efficient countries (Canada, Switzerland, Estonia, Finland, Hong Kong (China), Hungary, Iceland, Japan, Korea, Lithuania, Macao (China), Poland, Singapore, Slovenia and Vietnam) appeared as scale efficient. None of the 18 countries that were technically efficient (Taiwan (China), the Netherlands, Austria, France, Luxembourg, Albania, Romania, Bulgaria, Chile, Indonesia, Qatar, Georgia, Montenegro, Turkey, Macedonia, Brazil, Lebanon and Peru) appeared as scale efficient. A total of 35 countries (Slovakia, Greece, Kosovo, Latvia, Algeria, Malta, the Dominican Republic, Denmark, Sweden, Thailand, the Czech Republic, Great Britain, Moldova, Costa Rica, Norway, Mexico, Australia, Spain (Regions), the United Arab Emirates, Spain, the United States, Belgium, Colombia, the Republic of Ireland, Germany, Croatia, New Zealand, Russia, Jordan, Israel, Buenos Aires (Argentina), Italy, Portugal, Trinidad and Tobago and Uruguay) were neither technically nor scale efficient. These countries could not produce on a suitable scale and used their resources incorrectly, leading to waste (Lorcu, 2008).

The analysis results revealed that Turkey was not scale efficient. With a ratio of 71.92%, Turkey was in 56th place in the list of countries. The countries below Turkey were Middle Eastern (Jordan, Lebanon and Algeria), Balkan (Kosovo and Macedonia), and especially Latin American (Trinidad and Tobago, Costa Rica, Mexico, Colombia, Brazil, Peru and the Dominican Republic) countries. Turkey and the other countries need to reorganize their inputs in order to become totally efficient. This situation is expressed as hypothetical input. For these inputs, the percentage reduction rates for the inputs of these countries are presented in Table 7.

Table-7. Percentage reduction rates for countries' hypothetical inputs.

NO	DMU	Input1	Input2	Input3	Input4	Input5	Input6	Input7	Input8	Input9
62	Chinese-Taipei (Taiwan)	0,41	0,41	1,179666	13,7512	19,3463	6,1131	18,7791	18,1933	8,6619
47	Netherlands	2,35	34,3886	31,68467	2,3500	11,9847	2,3500	4,1952	27,0037	2,3500
4	Australia	3,34	17,21739	11,32106	3,3400	20,6639	3,3400	3,3400	3,3400	12,6728
15	Denmark	4,04	4,04	18,85167	4,0400	4,0400	27,9978	27,6577	4,0400	4,0400
21	France	5,54	16,34248	16,20656	5,5400	17,1621	31,7544	5,5400	28,0071	17,9762
22	United Kingdom	7,2	7,2	7,2	9,7808	7,2000	37,2942	26,9896	41,0381	7,2000
39	Luxembourg	31,120877	20,99233	7,29	7,2900	24,1121	38,5281	7,2900	36,5538	24,9321
40	Latvia	23,622925	13,14401	7,3	7,3000	31,0314	24,0729	22,0382	23,2473	7,3000
61	Sweden	8,06	21,56784	18,4718	8,0600	28,7500	8,0600	23,3917	11,0841	8,0600
3	Australia	21,029468	9,6	23,64318	9,6000	9,6000	9,6000	25,6593	27,4727	9,6000
13	Czech Republic	9,96	15,23478	9,96	9,9600	9,9600	17,4456	10,0054	23,8044	26,0640
48	Norway	10,2	10,2	31,56588	10,2000	10,2000	16,0262	21,6251	32,7815	10,2000
59	Slovakia	11,33	22,87238	11,33	21,5541	11,3300	33,7618	28,8305	43,0068	18,9558
55	Spain (Regions)	12	12	12	12,0000	30,1987	26,7861	22,7905	12,0000	12,3412
49	New Zealand	12,06	17,3037	22,60662	12,0600	22,2703	12,0600	24,7238	37,4955	12,0600
14	Germany	12,25	12,79305	20,84747	12,2500	26,2408	12,2500	12,2500	12,2500	21,6741
24	Greece	16,51095	12,96	12,96	23,4581	34,2359	30,0037	29,4406	25,6073	12,9600
18	Spain	13,39	13,39	13,39	13,3900	23,4020	28,3511	18,7795	13,3900	13,3900
5	Belgium	13,6	18,96346	28,59455	13,6000	32,0794	32,2257	13,6000	24,6390	13,6000
1	Albania	13,65	13,65	13,65	43,8646	27,0993	56,0900	49,6056	44,2956	13,6500
56	Romania	34,344399	24,94393	13,76	13,7600	28,3417	33,8643	44,5774	40,9121	46,3502
6	Bulgaria	13,79	22,57853	23,63463	22,0770	13,7900	52,0827	48,0497	54,5018	21,8415
67	United States	13,86	25,50405	20,2285	13,8600	13,8600	33,8979	34,4570	37,5156	13,8600
10	Chile	24,697078	14,34	34,68483	14,3400	14,3400	14,8210	20,8200	34,3366	14,3400
28	Indonesia	14,85	14,85	14,85	58,7276	37,2498	45,6712	48,2556	43,9182	18,5493
29	Republic of Ireland	36,729693	14,91	22,19725	15,4192	14,9100	24,5992	29,7712	15,2819	14,9100
45	Malta	25,562443	15,89	15,89	20,7528	15,8900	61,7133	36,0633	29,7510	15,8900
54	Qatar	43,972102	18,52	18,52	30,2472	18,5200	52,2928	42,7348	52,7342	49,5123
57	Russian Federation	37,134488	41,40629	26,24585	21,0100	21,2443	39,1383	21,0100	44,8810	21,0100
26	Croatia	21,48	51,59208	30,13419	34,9890	21,4800	42,3832	50,2355	57,3564	29,1336
23	Georgia	21,79	21,79	21,79	34,9955	21,7900	56,4775	51,4114	45,0387	21,7900
52	Portugal	23,37	23,37	23,37	23,3700	43,9348	38,4243	33,0523	23,3700	41,5322
46	Montenegro	24,14	46,49518	37,35317	43,5811	24,1400	63,1785	62,7513	68,1030	44,1156
63	Thailand	25,43	25,43	25,43	25,4300	38,4761	35,5938	48,9402	40,7981	37,6314
32	Italy	27,9	31,54264	29,13209	27,9000	27,9000	34,2268	27,9000	27,9000	38,3123
65	Turkey	28,08	52,33819	34,74174	28,0800	41,4593	64,3816	69,6966	67,3763	37,6027
2	United Arab Emirates	46,31994	28,6	28,6	39,2833	42,5411	45,6664	47,7577	51,8846	28,6000
31	Israel	39,215089	29,81	29,81	31,3629	29,8100	45,6293	29,8319	41,3017	29,8100
53	Argentina (Buenos Aires)	30,15	33,06685	31,08413	30,1500	30,1500	32,6883	30,1500	34,9841	31,0367
42	Moldova	34,810714	40,1603	37,51735	42,6619	31,5000	52,3699	47,1707	50,7961	31,5000
44	Macedonia	34,12	34,49138	34,12	42,2547	34,1200	62,2931	64,6883	61,5516	55,9165

7	Brazil	34,98	57,70405	45,2428	34,9800	34,9800	71,8150	62,6351	76,6881	34,9800
12	Costa Rica	36,04	55,87323	48,22179	54,5544	51,1341	50,2251	46,0711	49,6859	36,0400
43	Mexico	37,49	51,12929	37,49	40,3785	37,4900	56,8647	60,7133	71,5741	37,9340
66	Uruguay	45,460843	39,58	46,42855	39,5800	39,5800	55,2151	46,1444	47,0768	39,5800
11	Colombia	43,833594	40,26	43,6059	48,8245	43,7563	50,9612	50,1059	44,2320	40,2600
37	Lebanon	51,632562	41,28	41,28	53,3953	47,9188	62,6416	48,3802	60,0132	41,2800
50	Peru	41,54	44,93124	46,2811	43,7699	43,9571	49,1171	59,1633	69,6916	41,5400
33	Jordan	57,27877	42,67	54,89973	56,4964	55,9529	64,2589	53,8926	53,6599	42,6700
36	Kosovo	45,89	55,39768	47,9673	54,1936	45,8900	73,1962	73,1858	79,7636	55,9755
64	Trinidad and Tobago	46,256612	53,31624	58,46661	53,2495	46,1000	58,7632	53,4892	46,1000	46,1000
17	Algeria	60,995029	51,69957	63,98131	54,9547	57,1371	62,8556	49,7818	49,2289	48,3600
16	Dominican Republic	61,28	62,53561	65,5459	65,8370	61,2800	78,9322	78,4211	78,3243	61,2800
Mean		26,341275	28,34484	27,78411	27,5067	28,8968	40,0066	37,12907	40,36946	26,92325
Standard Division		15,801207	16,03278	15,04331	17,38627	13,73561	19,49362	18,68829	18,98823	15,199
Minimum		0,4100	0,4100	1,1797	2,3500	4,0400	2,3500	3,3400	3,3400	2,3500
Maximum		61,28	62,53561	65,5459	65,83699	61,28	78,9322	78,42111	79,7636	61,28

Source: Obtained from primary data.

For hypothetical input 1, the lowest percentage was recommended for Taiwan (China), which was the country closest to total efficiency, while the highest percentage was recommended for the Dominican Republic, which was in last place for success and total efficiency. For this input, a mean percentage reduction of 26.341275% was recommended for all countries. A slightly above average reduction of 28.08% was recommended for Turkey.

For hypothetical input 2, the lowest percentage was recommended for Taiwan (China), which was the country closest to total efficiency, while the highest percentage was recommended for the Dominican Republic, which was in last place for success and total efficiency. For this input, a mean percentage reduction of 28.34484% was recommended for all countries. A reduction of 52.33819%, which was almost twice the average, was recommended for Turkey.

For hypothetical input 3, the lowest percentage was recommended for Taiwan (China), which was the country closest to total efficiency, while the highest percentage was recommended for the Dominican Republic, which was in last place for success and total efficiency. For this input, a mean percentage reduction of 27.78411% was recommended for all countries. An above average reduction of 34.74174% was recommended for Turkey.

For hypothetical input 4, the lowest percentage was recommended for the Netherlands, which was the second closest country to total efficiency, while the highest percentage was recommended for the Dominican Republic, which was in last place for success and total efficiency. For this input, a mean percentage reduction of 27.5067% was recommended for all countries. A slightly above average reduction of 28.08% was recommended for Turkey.

For hypothetical input 5, the lowest percentage was recommended for Denmark, which was the fourth closest country to total efficiency, while the highest percentage was recommended for the Dominican Republic, which was in last place for success and total efficiency. For this input, a mean percentage reduction of 28.8968% was recommended for all countries. An above average reduction of 41.4593% was recommended for Turkey.

For hypothetical input 6, the lowest percentage was recommended for the Netherlands, which was the second closest country to total efficiency, while the highest percentage was recommended for the Dominican Republic, which was in last place for success and total efficiency. For this input, a mean percentage reduction of 40.0066% was recommended for all countries. A well above average reduction of 64.3816% was recommended for Turkey.

For hypothetical input 7, the lowest percentage was recommended for Austria, which was the third closest country to total efficiency, while the highest percentage was recommended for the Dominican Republic, which was in last place for success and total efficiency. For this input, a mean percentage reduction of 37.12907% was recommended for all countries. A well above average reduction of 69.6966% was recommended for Turkey.

For hypothetical input 8, the lowest percentage was recommended for Austria, which was the third closest country to total efficiency, while the highest percentage was recommended for the Kosovo, which was in fourth from last place for total efficiency. For this input, a mean percentage reduction of 40.36946% was recommended for all countries. A well above average reduction of 67.3763% was recommended for Turkey.

For hypothetical input 9, the lowest percentage was recommended for the Netherlands, which was the second closest country to total efficiency, while the highest percentage was recommended for the Dominican Republic, which was in last place for success and total efficiency. For this input, a mean percentage reduction of 26.92325% was recommended for all countries. An above average reduction of 37.6027% was recommended for Turkey.

5. Discussion

In this study, based on the data of the PISA 2015 report, the science achievement of students in 68 countries was evaluated with reference to educational inputs, which are considered to affect their success. 15 of the countries included in the study (Canada, Switzerland, Estonia, Finland, Hong Kong (China), Hungary, Iceland, Japan, Korea, Lithuania, Macao (China), Poland, Singapore, Slovenia and Vietnam) were totally efficient. Based on this, it can be said that these countries used their inputs and efforts efficiently and conducted their activities on a suitable scale (Lorcu, 2008). They were able to successfully manage the factors regarded as educational inputs in the PISA 2015 report, namely "student behaviours preventing learning", "teacher behaviours preventing learning", "lack of educational materials", "lack of teaching staff", "professional development", "teacher participation", "curriculum development", "total number of science teachers in school" and "science-specific resource index (total)". In this way, they increased achievement in science. Examining the literature, studies have been conducted that support this finding. In a study conducted by Lavonen and Laaksonen (2009) based on the PISA 2006 data, it was concluded that the source of Finnish students' success in science lessons was practical work in class and the students' deductions. A knowledge-based society, development of educational equality and decisive power on a local level, and teacher education were regarded as the most important education policy issues underlying students' high performance in science lessons in the PISA 2006 report. Similarly, in a study conducted by McConney *et al.* (2014) based on the PISA 2006 data, it was stated that science achievement of students in Australia, Canada and New Zealand was related to how much they experienced inquiry-based teaching and learning. In Tang (2015) study, the results of the analyses made based on the PISA 2006 data for 5,995 students in the USA and Taiwan revealed that with their science teaching-learning activities, students in the USA had more opportunities to learn science than students in Taiwan. It was revealed that in the USA, students who had a higher socioeconomic level had more opportunities with regard to reform-based science learning activities. Moreover, it was determined that students' higher socioeconomic level bore no relation to reform-based science learning in Taiwan.

The data in the PISA 2015 report were also evaluated for different countries according to science teachers' perceptions school principals' perceptions and implementation of the teaching programme. In their study, Chi *et al.* (2018) used the science performance of students in Beijing, Shanghai, Jiangsu and Guangdong, and background research data for PISA 2015, and the results revealed that rather than teacher support, disciplinary climate had a positive effect on the relationship between inquiry-based science activities and students' science achievement for both genders. In Oztürk (2018) study based on the PISA 2015 data, it was determined that for different socioeconomic levels there were significant relationships between scientific literacy and environmental awareness, and between scientific literacy and environmental optimism. In a study by Susongko and Afrizal (2018) using the PISA 2015 data for Indonesian students, it was concluded that environmental awareness was related to the students' enjoyment of learning science, their self-efficacy in science, their instrumental motivation, inquiry-based instruction in science learning, and their science proficiency and epistemic beliefs. In Lau and Lam (2017) study, according to the PISA 2015 data, adaptive instruction, teacher-directed instruction and interactive application were positively correlated with science performance in all regions. The regions apart from Japan and Korea tended to have a high frequency of teacher-directed instruction facilitated by more or less authoritative discussion in class.

It was seen that of the countries having total efficiency, the three countries mostly shown as references were Japan, Poland and Estonia. In Lewis (1995) study, it is argued that Japanese schools support their students' academic success because they meet the students' needs, thereby supporting strong, positive emotional ties between students and their school, and this supports the finding obtained in this study that Japan was one of the country's most often taken as an example. Zawistowska (2014) considers that the greatest impact on the increase in Poland's PISA scores was the educational reform made in 1999. In this reform, it is considered that the most important change affecting PISA data was the introduction of assessments other than multiple choice. It may be considered that these changes in the education system in Poland are a reason why Poland was shown as a reference for countries that were not totally efficient.

It was revealed that the countries furthest from being totally efficient were Jordan, Kosovo, Trinidad and Tobago, Algeria and the Dominican Republic. In a study conducted by Al-Amoush *et al.* (2011) it was concluded that science teachers and preservice science teachers in Jordan tended to use traditional teaching methods, based on which, it can be said that the fact that the country was among the most unsuccessful in the PISA data may be related to procedures in the teaching process. In a study made by Al-Amoush *et al.* (2014) teaching-learning beliefs of German, Turkish and Jordanian preservice teachers were determined and compared. These findings correspond to the research findings made by Al-Amoush *et al.* (2011). The preference of the Jordanian teacher candidates was the general educational approach, which was the teacher-centred approach. The preference of the German teacher candidates was the modern educational approach. The situation of the Turkish preservice teachers was between these two extremes. Although they had an approach close to the traditional educational approach, they had more modern educational beliefs than those of the Jordanian teacher candidates.

It was concluded that apart from New Zealand, all countries had increasing returns to scale. In other words, an input of 1 unit in the inputs resulted in an output greater than 1 in the outputs. Fernandez *et al.* (2008) emphasised that New Zealand needed to update its physics curriculum. The justification for this was shown to be the lack of communication between teachers and curriculum designers. In support of the study findings, criticisms were made by Buabeng (2015) to the effect that physics teachers in New Zealand were not trained to be adequately equipped, and that they were not sufficiently qualified to be able to use investigative teaching methods or techniques, or to make correct assessments, in their lessons.

In this study, the results also revealed that there was no relationship between being a totally effective country and geographic proximity. In a study by Taht and Must (2010) the PISA data of five neighbouring countries, namely Russia, Latvia, Estonia, Sweden and Finland were evaluated. Differences were determined among scores. It was considered that these differences may be due to differences in cultural influences on personality or to national educational and social policies. Similarly, in a study carried out by Herbst and Wojciuk (2017) it was stressed that the neighbouring countries of the Czech Republic, Hungary, Poland and Slovakia had institutional differences in their education systems and that differences between national approaches towards educational reforms were reflected especially in education centralisation, school autonomy, accountability and financial mechanisms.

It was seen that Turkey lagged behind many countries in terms of total efficiency. This situation shows that there are problems related to the use of educational inputs. In a study by Anil (2011) in which the 2006 PISA data were used, "time" was the variable that best predicted science success and the factor most clearly determining success. The other factors that predicted science achievement were "environment", "education" and "attitudes", respectively.

Bakir *et al.* (2015) determined that success rates in PISA data were related to countries' socioeconomic statuses. It was stated that Turkey's low achievement levels were due to the fact that national income is also low. In a study by Kahraman and Celik (2017) an attempt was made to determine Turkish students' success and sources in the PISA 2012 data. It was found that attendance at nursery school, school starting age, mother's employment status, parents' educational level and numbers of computers and books at home affected student success. Having a working mother and high school starting age had a negative effect on student success. On the other hand, attendance at nursery school, parents with a high educational level and a high number of books and computers in the home had a positive impact on students' achievement. Moreover, it was determined that the sociocultural and environmental locations of the students affected their success.

Based on these findings, it can be recommended that in order for countries whose science success was determined as low in the PISA report to increase their success, they should manage their educational inputs and take reference countries that are suitable for themselves as examples. It can be recommended that when organising and implementing their education programmes, they should take their educational inputs and successful countries into consideration. It can also be recommended to researchers that they undertake similar studies using the PISA data, and that they examine the reasons for the findings of this study with different methods.

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