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# Multilevel Classification of PISA 2015 Research Participant Countries' Literacy and These Classes' Relationship with Information and Communication Technologies*

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**Abstract**

In this study, it is aimed to distinguish the reading skills of students participating in PISA 2015 application into multi-level latent classes at the student and country level. Furthermore, it is aimed to examine how the clusters emerged at country-level is predicted by variables as students have the information and communication technology (ICT) resources. The population of this research, which is in a descriptive survey model consists of all students who are aged 15 from 72 countries which participated in the PISA 2015 application. As for sample, it is made up of 519.334 students and 17.908 schools which were chosen randomly for PISA 2015 application from these countries. In analyzing data, a multi-level latent class and three-step analysis were employed. Analyses have shown that having ICT resources at home is the most influential variable on the reading skills of countries. It is determined both in in-country and across countries that there are some differences in ICT resources at home and school. In this context, it may be stated that the equal opportunity in education has not been provided in many countries on international scale.

**Keywords:** PISA, reading achievement, information and communication technologies, multilevel latent class analysis

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## Introduction

Programme for International Student Assessment (PISA) is an application which is carried out in every three years and which aims to evaluate countries' education system worldwide by testing knowledge and skills of 15 years of age students (Organisation for Economic Co-operation and Development-OECD, 2016a). PISA 2015 application is carried out on computer base for the first time (OECD, 2016b) and some countries did not participate in application, instead they received old PISA questions with paper and pencil application. According to the results of this application, compared to 2012, some increases and decreases are observed in some countries' averages. According to 2012 application, the field in which countries experienced decrease in the averages the most is the reading skill (OECD, 2016a). Reason for this situation might be application's being computer based, since factors such as length of reading texts might have affected reading skills more than the other fields. This was also seen in the results of some countries which responded to both digital and paper-pencil questions in PISA 2009 and 2012. According to the results of this application, there is no difference between digital and paper-pen application scores of students with high reading achievement, yet it is observed that among the other performance levels, there is a difference between students' digital and paper-pen application scores. This situation is considered to depend on the skills used in online reading. Because there may be changes in students` familiarity with basic information and communication technologies (ICT) skills (e. g., the ability to use keyboards and mouse for text entry) (OECD, 2015). At the same time, some countries and economies were found to have a second level and above reading skill in paper-pencil application and they are found out to perform below the second level when they were evaluated with computer-based application. In Colombia, Hungary, Israel, Poland, the Russian Federation, Spain and the United Arab Emirates, one in ten students showed a poor performance in digital reading yet they did better in paper-pencil application. Many students in these countries may have difficulty with the general ICT skills which are required to interact with the test platform and thus show poor performance in digital reading in spite of their relatively good reading skills (OECD, 2015).

Tunisia, which is one of the countries that received all questions in computer environment in PISA 2015 application, and upon comparing reading skill scores with the 2012 application, it is seen that Tunisia is the country that experienced the highest decrease in reading ability scores with 21 points, and followed by Turkey with 18 points. There are also countries that increased their scores in 2015 application. Being one of these countries, Argentina has the highest increase in score with 46 points, nevertheless this country received all questions with paper-pencil application. Russia is the country that participated in the computer-based application and increased the reading skill score the most, with 17 points and it is followed by Qatar with 15 points (OECD, 2016a). When the results are broadly evaluated, it is thought that the students` computer literacy may have been in the background of increases and/or decreases in the scores.

Rapid changes in today's world present serious challenges for the education system. The most changing area is information and communication technology (Eryaman, 2007; Allen & van der Valden, 2012). In the last decade, competencies in information and communication technologies have also become an important feature in the labour market and everyday life (Anikó, 2016). These competencies are among the 21st century skills (Finegold & Notabartolo, 2010). International education policies are determined considering the increasing importance of computer skills and digital literacy in the society. Countries are now increasingly seeking to integrate information and communication technologies into both the school infrastructure and teaching-learning methods (Eryaman, 2006; Anikó, 2016). Schools' possessing the necessary infrastructure and creating equal opportunities for all students, ensures that the children of poor families have equal conditions, thanks to the school environment (Holmlund, 2016), because, family background is seen to be effective for students in reaching equal opportunities in education (Schütz, Ursprung, & Woessmann, 2005). Besides, there is a widely shared view that regardless of family background, all children should have equal opportunities to live and equal opportunities to succeed in their lives (Holmlund, 2016). In this

context, the identification of the ICT resources that students have in their homes and schools will also allow to examine the equal opportunities in education.

When the related studies in the field literature are examined, there are some research in which positive or negative relations between ICT and the students' reading achievement are found, along with studies in which no meaningful difference is found between them. When we look at some studies that find positive relationships between students' reading achievement and ICT; it is observed that Italian students with high reading achievement in the PISA 2009 application used computers better than the ones with low achievement and ICT had a more positive influence on the achievement of these students (Freddano & Diana, 2016). In another research based on the data of PISA 2012 application in Turkey, it is determined that as the availability of the ICTs based materials (such as laptop, printer, USB, internet connection) at the school and the frequency of student's use of these materials increase, the reading performances also increase (Bilican Demir & Yıldırım, 2016). In another study which is conducted using PISA 2012 Hungary application data, it is seen that ICT access at home and its use contributed to school success (Anikó, 2016). In a longitudinal study conducted in the USA, it is seen that students 12-13 years of age who had a low reading skills at the beginning developed reading skills via using internet (Jackson, von Eye, Witt, Zhao, & Fitzgerald, 2011). In a study conducted with PISA 2000 application data, positive relationships are found between computer presences at home or at school and student performance (Fuchs & Wößmann, 2005).

Looking at the studies in which negative relations between students' reading success and ICT are found or no meaningful difference is observed, it is seen in a study conducted on the data of PISA 2009 application in Turkey that there are negative relations between students' reading success and computer and internet usage durations at home and school (Gürsakal, 2012). In another study based on PISA 2012 Turkey application data, it was determined that the presence of ICT-based materials at home and the frequency of usage did not predict their reading performance significantly (Bilican Demir & Yıldırım, 2016). In a longitudinal study carried out in the USA it is seen that use of ICT has no significant effect on reading skills of students aged 12-13 with above-average reading (Jackson, et al., 2011). In a study conducted with PISA 2000 application data when the family background and school features are controlled, a negative relation is seen between having a computer at home and academic achievement, while no significant relation is observed between having a computer at school and academic achievement (Fuchs & Wößmann, 2005).

Upon looking at the field literature, it is seen in the studies conducted on the effects of ICTs on reading achievement that they are usually confined to a single country data and there is no consistency between the findings of the studies, and the results vary from country to country and according to the presence of ICT resources at home or at school. For this reason, it is necessary to conduct further studies on this subject. Since competencies in information and communication technologies are also important in the labour market and everyday life, this study is also thought to contribute to international education policies. In addition, conducting a study which deals with all countries in order to be able to see the trend in this field gives opportunity to both generalize and to approach equal opportunity in education at the international level. For these reasons; it is aimed to distinguish the reading skills of the students participating in the PISA 2015 application in multi-level latent classes at student and country-level in this study. Furthermore, it is aimed to examine how information and communication technology resources students have at home and the number of computers at the school and the ratio of computers with internet access at school variables predict the clusters emerged at the country-level. In this context, the questions to be answered in this study are:

1) How are the latent classes emerged at the student and country-level of reading achievement of all students participating in the PISA 2015 application?

2) How are the latent classes emerged at the country level according to the reading achievements predicted by the information and communication technology resources that the students have at home, and the number of computers at school and the ratio of computers with internet access at school?

## Method

### Model of Research and Population and Sampling

The population of this research, which is in a descriptive survey model consists of all students who are aged 15 from 72 countries which participated in the PISA 2015 application. As for sample, it is made up of 519.334 students and 17.908 schools which were chosen randomly with stratified sampling for PISA 2015 application from these countries. The number of students participating in the application according to the countries is given in the Table 1.

Table 1. The number of students participating in the application according to the countries

| Countries | f | Countries | f | Countries | f |
|---|---|---|---|---|---|
| Albania* | 5215 | Indonesia* | 6513 | Romania* | 4876 |
| Algeria* | 5519 | Ireland | 5741 | Russian Federation | 6036 |
| Australia | 14530 | Israel | 6598 | Singapore | 6115 |
| Austria | 7007 | Italy | 11583 | Slovak Republic | 6350 |
| Belgium | 9651 | Japan | 6647 | Vietnam* | 5826 |
| Brazil | 23141 | Jordan* | 7267 | Slovenia | 6406 |
| Bulgaria | 5928 | Korea | 5581 | Spain | 6736 |
| Canada | 20058 | Kosovo* | 4826 | Sweden | 5458 |
| Chile | 7053 | Lebanon* | 4546 | Switzerland | 5860 |
| Chinese Taipei | 7708 | Latvia | 4869 | Thailand | 8249 |
| Colombia | 11795 | Lithuania | 6525 | Trinidad and Tobago* | 4692 |
| Costa Rica | 6866 | Luxembourg | 5299 | United Arab Emirates | 14167 |
| Croatia | 5809 | Macao (China) | 4476 | Tunisia | 5375 |
| Czech Republic | 6894 | Malta* | 3634 | Turkey | 5895 |
| Denmark | 7161 | Mexico | 7568 | Macedonia* | 5324 |
| Dominican Republic | 4740 | Moldova* | 5325 | United Kingdom | 14157 |
| Estonia | 5587 | Montenegro | 5665 | United States | 5712 |
| Finland | 5882 | Netherlands | 5385 | Uruguay | 6062 |
| France | 6108 | New Zealand | 4520 | B-S-J-G (China) | 9841 |
| Georgia* | 5316 | Norway | 5456 | Spain (Regions) | 32330 |
| Germany | 6504 | Peru | 6971 | USA (Massachusetts) | 1652 |
| Greece | 5532 | Poland | 4478 | USA (North Carolina) | 1887 |
| Hong Kong | 5359 | Portugal | 7325 | Argentina* | 1657 |
| Hungary | 5658 | Puerto Rico (USA)* | 1398 | | |
| Iceland | 3371 | Qatar | 12083 | | |

Note: f: frequency, *: countries that do not participate in computer based application

As seen in Table 1, it is observed that the largest number of students participated from Spain (Regions) with the highest number (32330) followed by Canada with 20058. The lowest participation is seen from Puerto Rico (USA) with 1398 students. Differences can be seen between the rates of students participating in the PISA since the sampling is done considering the number of students in the 15-year-old group for each country. As it can be seen in Table 1, 15 countries [Albania, Algeria, Indonesia, Romania, Vietnam, Jordan, Kosovo, Lebanon, Trinidad and Tobago, Malta, Macedonia, Moldova, Georgia, Argentina, and Puerto Rico (USA)] did not participate in the computer based application.

### Data Collection and Data Collection Tools

In this study, data which collected in PISA 2015 application in all countries are used. Data for all countries are obtained from international website of the PISA. In this study, reading literacy are described as “understanding, using, reflecting on and engaging with written texts, in order to achieve

one's goals, to develop one's knowledge and potential, and to participate in society." (OECD, 2013, p.9). The students' reading scores are converted to a scale with a mean of 500 and a standard deviation of 100. Moreover, students' scores are divided into seven different levels of competency. These levels and scores are as follows: level-6: higher than 698.32, level-5: higher than 625.61, equal to or lower than 698.32, level-4: higher than 552.89 and equal to 625.61, level-3: higher than 480.18 and equal to or less than 552.89, level-2: higher than 407.47 and equal to or less than 480.18, level-1a: higher than 334.75 and equal to or less than 407.47, level-1b: equal to or less than 334.75 or up to 262.04 (OECD, 2013).

In this study, reading skill scores of the students are taken as dependent, while index of information and communication technologies resources students have at home, the number of computers in school and ratio of computers with internet access in school variables are taken as independent variables. Information and communication technology (ICT) resources index (ICTRES) that students have at home is derived from; whether students have educational software (ST20Q05) and/or whether there is internet connection at home (ST20Q06) and the number of computers at home (ST21Q03) variables. The high level of this value means that there are more ICT sources at home (OECD, 2011). The number of computers at school and the ratio of computers with internet access at school variables contain numerical information provided by the school principals through the school survey.

### Data Analysis

The analysis of the data was carried out in two stages. Firstly, multilevel latent class analysis (MLCA) is used in order to investigate latent classes which were composed by students' reading skills between students and countries. It is accepted that all observable variables originates of an unobservable latent variable in latent class analysis (Vermunt & Magidson, 2004). However, in most practices in education fields, people (level-1) are sampled from clusters (level-2) such as schools or countries. This situation gives rise to correlations between observations from the same group (Asparouhov & Muthen, 2008). Latent class analyses are advised to be advanced to multilevel models for that reason. It is let in multilevel latent class models that membership probabilities and/or item response probabilities can change randomly between groups (Vermunt, 2003; Vermunt & Magidson, 2005). All probabilities ranging from a model with a latent class at student and country level to the best fitting model are tested in the MLCA. In the model selection, the simplest model (which has minimum latent class and the least predictive parameter) is preferred (Vermunt, 2003; Vermunt & Magidson, 2004). Fitting measures such as log-likelihood (LL) and Bayesian information criterion (BIC) are used in order to define the best number of clusters. However, related literature (Lukočienė, Varriale, and Vermunt, 2010) recommends only using of BIC value. Thus, this research was used BIC value as criteria regarding model selection. Secondly, three-step analysis is employed in order to determine chosen independent variables' ability to predict emerged latent classes (Vermunt, 2010). Latent Gold 5.1 package programme is used in analyses (Vermunt & Magidson, 2013a, 2013b). Furthermore, country level weightings are employed while analyzing.

## Findings and Comments

As a result of the MLCA, which was done in order to distinguish reading success into latent classes at student and country level, the model with four clusters at student level and six clusters at country level fitted the best. The fitting statistics for this model were obtained as LL: -3441908,3500 and BIC: 6884228,2209. Information on the size, average values, and competency levels of the latent classes emerged at the student and country levels are given in the Table 2.

Table 2. Student and Country Level Latent Classes and Averages

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Student level | Cluster(C)s | C-1 | C-2 | C-3 | C-4 | | |
| | Percentages | 11 | 41 | 28 | 20 | | |
| | Average | 356.33 | 407.13 | 495.81 | 573.10 | | |
| Latent Classes (LC) | | LC-1 | LC-2 | LC-3 | LC-4 | LC-5 | LC-6 |
| Country level | Percentages | 17 | 1 | 7 | 13 | 26 | 35 |
| | Average | 401.38 | 405.01 | 428.36 | 437.48 | 494.70 | 503.18 |

As can be seen in Table 2, the average of the first cluster emerged at the student level is 356.33 (la level of competence, low-level achievement) and 11% of the students are in this cluster. 41% of the students are in the second cluster and they have an average of 407.13 (la and second level of achievement, medium-low level achievement). Students at the third cluster constitutes 28% of the group and their average is 495.81 (third level of competence, medium level achievement). The possibility of students to be in the fourth cluster is 20% and the average of this group is 573.10 (fourth level of competence, medium-high achievement).

When clusters emerged at country level are examined, the average of Cluster1 [Albania, Algeria, Brazil, Dominican Republic, Georgia, Jordan, Kosovo, Lebanon, Moldova, Peru, Puerto Rico (USA), Qatar, Tunisia, Macedonia] is 401.38 (la level of competence- low-level achievement). Countries which have the lowest reading skill are in this cluster. Nine of these countries has taken old PISA questions with pencil and paper application. The average of Cluster2 (Indonesia) is 405.01 (la level of competence, low-level achievement). This country as well participated in the pencil and paper application. The average of Cluster3 (Colombia, Costa Rica, Mexico, Thailand, Turkey) is 428.36 (second level of competence, medium-low level). All countries in this cluster participated in the computer based application. The average of Cluster4 (Bulgaria, Lithuania, Malta, Montenegro, Romania, Slovak Republic, Trinidad and Tobago, United Arab Emirates, Uruguay) is 437.48 (second level of competence, medium-low level). The average of Cluster5 [Chile, Chinese Taipei, Croatia, Denmark, Greece, Hungary, Iceland, Italy, Latvia, Macao, Portugal, Russian Federation, Vietnam, Slovenia, Spain, United Kingdom, Spain (Regions), Argentina (Ciudad Autónoma de Buenos)] is 494.70 (third level of competence, medium level achievement). Vietnam and Argentina, which are among countries in the fifth cluster participated in pencil and paper application. The average of Cluster6 [Australia, Austria, Belgium, Canada, Czech Republic, Estonia, Finland, France, Germany, Hong Kong, Ireland, Israel, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Poland, Singapore, Sweden, Switzerland, United States, B-S-J-G (China), USA (Massachusetts), USA (North Carolina)] is 503.18 (third level of competence- medium level achievement). All countries in this cluster participated in the computer based application and they have the highest achievements. Table 3 shows the results of the 3-step analysis conducted to examine the probability of finding independent variables in classes emerged at country-level.

Table 3. Likelihood of independent variables to be found in country-level clusters

| Variables | C-1 | C-2 | C-3 | C-4 | C-5 | C-6 |
|---|---|---|---|---|---|---|
| ICT Resources* ($R^2$=0.51) | | | | | | |
| -1.922 → -0.904 | 0.50 | 0.12 | 0.25 | 0.06 | 0.06 | 0.02 |
| -0.855 → -0.334 | 0.21 | 0 | 0.08 | 0.23 | 0.30 | 0.17 |
| -0.328 → -0.0833 | 0.03 | 0 | 0.01 | 0.18 | 0.38 | 0.40 |
| -0.0818 → 0.171 | 0 | 0 | 0 | 0.14 | 0.33 | 0.53 |
| 0.179 → 0.696 | 0 | 0 | 0 | 0.06 | 0.22 | 0.71 |
| The number of computers in school* ($R^2$=0.26) | | | | | | |
| 0.106 → 0.331 | 0.40 | 0.10 | 0.20 | 0.12 | 0.12 | 0.06 |
| 0.381 → 0.567 | 0.26 | 0.02 | 0.10 | 0.18 | 0.25 | 0.19 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.569 → 0.804 | 0.04 | 0 | 0.02 | 0.19 | 0.35 | 0.40 |
| 0.805 → 0.978 | 0 | 0 | 0 | 0.12 | 0.33 | 0.55 |
| 0.982 → 1.850 | 0.04 | 0 | 0.02 | 0.06 | 0.25 | 0.63 |
| Ratio of computers with internet access in school* ($R^2$=0.50) | | | | | | |
| 0.320 → 0.811 | 0.63 | 0.12 | 0.12 | 0.04 | 0.05 | 0.05 |
| 0.839 → 0.954 | 0.11 | 0 | 0.19 | 0.20 | 0.27 | 0.23 |
| 0.955 → 0.977 | 0.01 | 0 | 0.03 | 0.18 | 0.35 | 0.43 |
| 0.978 → 0.989 | 0 | 0 | 0.01 | 0.13 | 0.33 | 0.53 |
| 0.989 → 1 | 0 | 0 | 0 | 0.11 | 0.30 | 0.59 |

Note: * p <.05, the probabilities above 0.30 are displayed in bold.

Given in the Table 3, when the probability of the independent variables to be found in the classes formed at the country level are analyzed, ICT sources are seen to be the most effective variable on reading skills ($R^2$ = 0.51) of countries and followed by computer with internet access ratio ($R^2$ = 0.50). Students who have the lowest level (-1.922 to -0.904) ICT resources are with 50% probability seen in the Cluster1, which is the group where the countries with the lowest reading achievement are. Students who have the highest level of ICT resources (0.179 to 0.696) are found to have 71% probability to be in Cluster-6, in other words the group with the highest level of reading achievement.

When the situation is evaluated for the number of computers at school, the students with the lowest percentage to have computer at school (0.106 to 0.331) are in Cluster 1 with a probability of 40% (the group with the lowest reading achievement). It has been determined that students in schools which have computers at the highest level (0.179 to 0.696) are in the Cluster-6 with a probability of 63%, that is, the group with the highest level of reading achievement. There is a similar situation for the rate of computers with internet access at school variable too. Students in cluster-1 have a 63% chance of having an internet connected computer ratio at the lowest level (.32 to 0.811). Students with schools which have a very high rate (0.978 to 1.00) of computers with internet access have an 89% (.30 + .59) probability to be in the Cluster-5 and Cluster-6 (students with medium and high level of reading achievement).

When the results are broadly evaluated, Indonesia, which is the only country in cluster 2, has the lowest resources of information and communication technology at home, the lowest number of computers in the school and the lowest rate of computers with internet access at school. These resources are also at low levels at home and at school in countries in Cluster 3. However, it also possess 1% and 2% schools in which the number of computers at school and rate of computers with internet access at school are at high levels. It can be stated that the countries in Cluster 4 have these resources at home and at school at low-medium level, and the countries in Cluster 5 have these resources at medium-high level.

When the results are evaluated in general, students who have the lowest information and communication technologies resources at home, number of computers in school and ratio of computers with internet access in school are most probably in the Cluster 1 (countries with the lowest achievements). Students who have these resources in the highest level are most probably in Cluster 6 (countries with the highest achievements).

## Discussion, Conclusion and Recommendations

In this study, it is aimed to distinguish the reading skills of students participating in PISA 2015 application into multi-level latent classes at student and country level. Moreover, it is aimed to examine how the clusters emerged at country-level is predicted by variables as students have the information and communication technology (ICT) resources at home and school. As a result of the analyses conducted, at student level the model with four clusters and at country level the model with six clusters fitted the best. In the student-level clusters, while is a group formed by the students at the

fourth competency level in the reading achievement, the average of the best group in the classes emerged at the country level corresponds to the third level of competency. It is thought that this situation is resulted from the change of the range between successful and unsuccessful students in the country.

When the country-level clusters are examined, nine of the countries with the lowest reading skills [Albania, Algeria, Georgia, Jordan, Kosovo, Lebanon, Moldova, Puerto Rico (USA), and Macedonia] have received the old PISA questions with paper-pencil application. While some of these countries (Algeria, Kosovo, Lebanon, Macedonia, and Puerto Rico) are participating in the PISA application for the first time, others seem to have had very low achievement upon evaluating PISA 2012 reading achievement. In this context, even though they took the old PISA questions with paper-pencil application, these countries have achieved low success regardless of their ICT skills. Vietnam and Argentina are countries in Cluster 5 also participated in the paper-pencil application, yet they were in the third competency level, the medium-performing group. Vietnam, with the reading score averaged 508, placed again at the third proficiency level in PISA 2012 application (OECD, 2014). However, it is quite surprising that Argentina has risen to the third level competence in PISA 2015 when it had a low level reading achievement at 1a competence with an average score of 396 in PISA 2012. This situation may be related to the increase in expenditure of education in Argentina, and it is also thought that it might be originated from the high teacher salaries paid in order to increase the teacher quality (UNESCO, 2015).

Students with the lowest level of resources regarding information and communication technology at home, the number of computers at school and the ratio of computers with internet connection at school are most likely to be in the Cluster 1 (countries with low-level achievement: Albania, Algeria, Brazil, Dominican Republic, Georgia, Jordan, Kosovo, Lebanon, Moldova, Peru, Puerto Rico (USA), Qatar, Tunisia, and Macedonia). It is seen that all the countries in the Cluster 3 (Colombia, Costa Rica, Mexico, Thailand, and Turkey) participated in computer-based application, while Indonesia, the only country in Cluster 2, participated in paper-pencil application. These countries are composed of students with low reading achievement as well as low sources of information and communication technology at home, low number of computers at school and low rate of computers with internet access at school. When PISA 2012 reading success of these countries are assessed, it is seen that all countries except for Colombia have diminished the average reading achievement score in 2015 (OECD, 2014; OECD, 2016a). In this context, the low success of these countries may be due to the inadequacy of ITC resources at home and at school and participating in the PISA 2015 computer-based application, yet other factors may have influenced in the background.

The ratio of students in countries in the Cluster 1, 2 and 3, which have low level and medium-low level reading achievements to own moderate or high level of ICT resources at their homes is zero. The inadequacy or lack of ICT resources at home is in fact an indirect indication that the socioeconomic status of the family is low in the background. At the same time, the state of countries in this cluster having moderate and high levels of the number of computers at schools, the rate of computers with internet access at schools are zero or very low. This also indicates that the state of having ICT resources either within the country or among countries changes. In addition, the results of the analyses showed that having ICT resources at home is the most influential variable on the reading skills of the countries, followed by the rate of computers with internet access at school with a close ratio. In this context, it can be stated that the rate of computers with internet access at school is as effective as the socio-economic level of the family on the reading skills of the students. In the field literature, family background (Schütz, et al., 2005) and school resources (Borman & Dowling, 2010; Gamoran & Long, 2006; Holmlund, 2016) are found to be effective for students to reach equal opportunities in education. In this context, it can be deduced that equality of opportunity in education is not provided in many countries on the international scale. Countries in these clusters are encouraged to examine the policies of countries with high-level reading achievement and take advantage of these policies that are appropriate for their country's circumstances.

In the International Computer and Information Technology Literacy Study report, Thailand and Turkey are the countries with the lowest ICT development index score among the participating countries (Fraillon, Ainley, Schulz, Friedman, & Gebhardt, 2014). In both countries, the sources related to information and communication technology at home, the number of computers at school and the rate of computers with internet access are in a low level, and they are in the Cluster-3, which has medium-low level achievement in this study. It is stated in the same report that while Turkey is the lowest spending country with less than three percent of its gross domestic product (GDP), Denmark is the country with the highest expenditure on education with about nine per cent of its GDP (Fraillon, et al., 2014). Considering that Denmark is included in the group with medium level reading achievement in this study, even though it is important for countries to invest in education from GDP, examples of good countries should be examined for it to bring the desired achievement. In addition, in this study, Denmark is in the fifth group, in the group with third level reading competence. Countries in this group have medium- high level sources of information and communication technology at home, the number of computers at school and ratio of computers with internet access at school. This finding is consistent with the findings of some studies in countries in this cluster. In a study conducted in Italy, which is one of the Cluster5 countries, it was consistent with the finding that Italian students with high reading achievements in the PISA 2009 application were using computers better than the ones with low achievement and that the ITC had more positive influence on the success of these students (Freddano & Diana, 2016). In a study conducted using PISA 2012 data on Hungary, which is among the countries in Cluster 5, and it was seen that ITC access at home and its use contributed to school success (Anikó, 2016).

The students in Cluster 6, which have the highest student ratio, are in the third competency level and have medium-high success. All of these countries in this cluster participated the computer-based application and they are the countries with the highest achievements [Australia, Austria, Belgium, Canada, Czech Republic, Estonia, Finland, France, Germany, Hong Kong, Ireland, Israel, Japan, Korea, Luxembourg, Netherlands, New Zealand, Norway, Poland, Singapore, Sweden, Switzerland, Switzerland, United States, B-S-J-G (China), USA (Massachusetts), USA (North Carolina)]. These countries are at the same time in the group in which students with the highest level of information and communication technology resources at home, the number of computers at school and the ratio of computers with internet access at school are most likely to be in. This finding is also consistent with the finding of some studies in the countries in this cluster. For example; in a longitudinal study conducted in the USA (Jackson, et al., 2011), which is among the countries in this cluster, it is seen that students at the age of 12-13 with a low reading ability at the beginning developed their reading skills with internet usage. A significant relationship in a positive way between the reading scores of the PISA 2000 application and the Canadian students' having computer or internet connection at home is detected (Bussière & Gluszynski, 2004). In another study which is conducted on all countries participating in the PISA 2000 application, positive relationships are seen between computer presences at home or at school and student performance (Fuchs & Wößmann, 2005).

There is almost no student in most successful clusters with inadequate resources regarding information and communication technologies at home or schools. When it comes to the students with low level achievements, there seems to be almost no students having these resources in high levels. In this sense, it can be deduced that students who have these resources at home or schools are more successful; however, it is not compared with a direct differentiation between the reading skills of countries which participated in the pencil and paper application and countries which participated in computer based application. On the other hand, when the state of having ICT resources in the classes formed according to the students' reading skills is examined, it can be said that the relationship between them is in the positive direction.

The study that is carried out also has some limitations. For this reason, the results obtained should be evaluated within these limits. The first one of these limitations is related to the statistical model used in the study. It is not possible to obtain direct cause-and-effect relationship since the statistics used are probabilistic models. For this reason, interested researchers can examine the results

obtained in the context of cause-and-effect relationships. The second limitation is also gathering information on students' mathematics and science skills in PISA application. Only the reading skills are used in this study. In this context, interested researchers can carry out studies on other skills as well.

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