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The Effect of Reading Comprehension Skills on Mathematics and Science According to PISA Data

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ABSTRACT

The aim of the study is to determine whether the reading comprehension skill has an effect on mathematics and science achievement, and which variables affect the success and to what extent. In line with this purpose, the sub-problems of the research were the student characteristics measured in the PISA student questionnaire, the important variables that predicted the students' science achievement in terms of reading comprehension and mathematics scores, and the important variables that predicted students' mathematics achievement in terms of student characteristics and reading comprehension scores measured in the PISA student questionnaire. Since the aim of the study was to determine the variables that are important in predicting PISA mathematics and science achievement in scales measuring students' affective characteristics and tests measuring achievement levels, the type of research was determined as a relational quantitative research design. The sample of the research consists of 6,890 students studying in 186 schools representing 12 regions in Turkey, selected by PISA in PISA 2018 application by stratified random sampling method from a population of 1.038.993 people from Turkey. In the research, the OECD database, which was opened for sharing in 2020, was used during the data collection phase. In the study, variables belonging to 2018 PISA data were used to predict mathematics and science achievement. The data were analyzed by data mining and quantitative data analysis methods. In the analysis of the data, SPSS Modeler and WEKA programs were used as a basis and in a systematic way, respectively. Excel and SPSS programs; SPSS Modeler and WEKA were used as utilities while transferring data and calculating some statistics. In the light of research findings, reading comprehension skill was determined as the most basic skill for science and mathematics success. In addition, mathematical literacy positively affects science achievement.

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Keywords: Reading comprehension skill, PISA math and science achievement, data mining, decision tree, prediction importance

INTRODUCTION

Gaining the necessary skills in life in schools has started to form the basis of today's education understanding. With the thought that the skills to be gained at all education levels should be the skills that the individual will use in his/her life, a new perspective has developed in education (Lerman et al., 2008). Thus, the acquisition of life skills has brought the concept of skill-based education to the agenda, and it has become important to develop the skills and abilities necessary for the life of the individual. Since the function of skills is considered important in transforming knowledge into abilities, the Program for International Student Assessment, which is given by the Organisation for Economic Cooperation and Development (OECD) with the abbreviation PISA, makes evaluations to determine the level of these skills.

The OECD Program for International Student Assessment (PISA) conducts studies to assess the level of life skills of students who are close to completing the compulsory education period. The PISA test, which is carried out every three years, is applied to 15-year-old students worldwide. The purpose of the PISA test is to determine whether students have the life skills that will enable them to be successful in adulthood. In this way, it evaluates the extent to which students have acquired the necessary knowledge and skills in life. In 2000, the first study was carried out in 32 countries, including 28 OECD members, and it is planned to carry out this evaluation every three years. Assessment is done in the areas of reading, math skills and science literacy. Assessments made within the scope of PISA provide data on students' knowledge and skills in the fields of reading, mathematics and science literacy, as well as student performance, perception of difficulty and competence, reading pleasure, teacher support and guidance, fear of failure, and students' own learning

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goals. The application is carried out with a series of tests and an attitude questionnaire. It is important that the items in the test are applied rather than theoretically based. Recent studies show that the items in the PISA test are related to students becoming successful adults. In other words, evaluations not only provide information about the acquisition of knowledge and skills necessary for life at school, but also refer to different factors that affect the process of acquiring these skills. In the evaluations, data about the performance of the countries are collected as well as the student performance. For example, according to the data of the Organization for Economic Cooperation and Development (OECD, 2003), the countries with the highest student performance are the countries that are most successful in reducing the impact of social disadvantage (Panther, 2020).

Reading, mathematics and science literacy skills are measured in PISA assessments made on the assumption that students who have come to the end of compulsory education acquire basic skills will contribute to their becoming successful adults (Baird et al., 2011). These skills, which are evaluated within the scope of PISA, are explained by the OECD (2010). Reading skills, which are defined as comprehension, using, thinking about and dealing with written texts, include areas such as reaching goals, developing knowledge and potential, and participating in society. In mathematical literacy, which focuses on the individual's capacity to determine and understand the role that mathematics plays in life, to make well-founded decisions for the world and to use mathematics for this; meeting the needs of his life as a constructive, engaged and reflective citizen. Science literacy, on the other hand, is defined as an individual's scientific knowledge and this knowledge to define problems, acquire new information, explain scientific facts, draw evidence-based conclusions on science-related issues and understand the characteristic features of science. Science literacy includes the fields of understanding the material, intellectual and cultural environment of science and technology, and being a reflective citizen with the ideas of science and science (OECD, 2010). The most recent PISA assessment, which focuses on reading comprehension, was conducted in 79 countries in 2018. In PISA 2018, it was aimed to determine the skills of comprehension, using, evaluating texts, thinking about texts and interacting with texts (Kasap, 2022; OECD, 2019). In this direction, the Ministry of National Education of Turkey (MoNE, 2022) aims to provide 15 basic skills by associating them with the achievements in the curriculum. Among these skills, mother tongue literacy, information literacy, information and communication technologies literacy, science literacy skills are directly related to reading and reading comprehension skills.

Reading and reading comprehension skills form the basis of lifelong learning and learning to learn skills. Reading comprehension skill is accepted as a basic life skill in many national and international studies (Carnevale et al., 2013; Goodman et al., 2013; Nouri et al., 2017; OECD, 2003; Karacaoğlu, 2020; Moreno-Herrero et al., 2018; Stobart et al., 2011). In addition, the results of the research emphasizing that there is a relationship between reading comprehension skills and achievements and skills in different fields reveal that there is a relationship between reading comprehension skills and learning outcomes, thinking, self-expression skills and cognitive achievement (Bozan, 2012; Chung, 2010; Coşkun, 2010; Çam, 2006; Demirel & Epçacan, 2012; Gilakjani & Sabouri, 2016; Karacaoğlu, 2020; Şen Baz & Baz, 2018). As can be understood from the researches, reading comprehension skills are directly related to student success in other courses (Akay, 2004; Bastug, 2014; Barnard-Brak et al., 2017; Epçaçan, 2018; Karasu & Haşıloğlu, 2019; Obalı, 2009; Proudfoot, 2016; Reed et al., 2017; Savolainen et al., 2008; Yılmaz, 2015). Caponera et al. (2016), in their study in which they looked at the relationship between reading comprehension, mathematics and science achievement, concluded that there was a high correlation between all three subjects, but confirmed the effect of reading skills on mathematics achievement, but concluded that the effect on science achievement was not clear.

Considering the variables measured and data size in the PISA assessment conducted in 2018, which focused on reading comprehension skills, examining the relationship between different variables in order to better interpret PISA data will contribute to the development of education policies, curricula, methods and techniques. In particular, the relationship between reading skills, which are the basis of all skills, and math and science skills, and to what extent reading comprehension skills affect mathematics and science achievements has been a matter of interest. For this reason, whether or not the reading comprehension skill has an effect on mathematics and science success, and which variables affect the success and to what extent, is seen as a problem to be answered in this study. In line with this problem, answers were sought for the following sub-problems.

Sub-Problems of the Research

1. What are the important variables that predict students' science achievement in terms of student characteristics, reading comprehension and math scores measured in the PISA student questionnaire?
2. What are the important variables that predict students' mathematics achievement in terms of student characteristics and reading comprehension scores measured in the PISA student questionnaire?

METHOD

Type of Research

The type of research can be expressed as a relational quantitative research design since it is aimed to determine the predictive variables that are important in terms of predicting the PISA mathematics and science achievement of the PISA Turkey sample, which was chosen as the study sample, with scales measuring students' affective characteristics and tests measuring their achievement levels (Büyüköztürk et al., 2018). The research is limited to 2018 Turkey PISA data.

Study Universe and Sample

In the PISA sampling process, a two-stage random stratified sample selection is made. In the first stage, the schools where 15-year-old students will be enrolled are determined, in the second stage, 42 students from each selected school are chosen with equal probability and the number of students selected from each school must be at least 20 (OECD, 2019). The sample of Turkey consists of 6,890 students studying in 186 schools representing 12 regions in Turkey, selected by PISA by stratified random sampling method from a population of 1,038,993 people from Turkey in the PISA 2018 application (MoNE, 2019; OECD, 2019). In this study, the answers of 6890 students in the Turkish sample on the variables used in the research were examined and after the individuals with the missing data on the variables were deleted on a list basis, the study sample was formed with 6798 people.

Data Collection

The data used in the research process were obtained from the database opened for sharing in 2020 using the address http://www.oecd.org/pisa/data/2018database/ In the prediction of mathematics achievement within the scope of the research, a total of nine independent variables belonging to the 2018 PISA data and PV1MATH, which is one of the ten plausible values corresponding to the mathematics achievement level, were taken as the dependent variable. On the other hand, in predicting science achievement, 10 independent variables in total belonging to 2018 PISA data and PV1SCIE, which is one of the ten plausible values corresponding to science achievement level, were taken as dependent variable.

Data collection tools

In the research, the data were obtained from the reading comprehension, science, mathematics test and student questionnaire in the PISA reading comprehension test administered in 2018. In the research process, mathematics achievement was taken as the dependent variable in the Multiple Regression model, and science achievement was taken as the dependent variable in the Classification and Regression Tree model. In order to obtain the dependent variable to be used in each of the two models, first of all, PV1MATH and PV1SCIE values, which were obtained as continuous quantitative variables in mathematics and science achievement scores, were used. PV1MATH and PV1SCIE values are the values deemed appropriate among the 10 plausible values (PV1,PV2,…,PV10) received by each student in the PISA 2018 mathematics and science achievement test. The finding in the simulation study conducted by Wu (2005) that using any of the reasonable values alone is sufficient for estimating the universe parameters with a high degree of accuracy supports the selection of the PV1 value as the dependent variable of this research. The independent and dependent variables and their codes used in this study are given in Table 1.

Table 1. Independent Variables, Dependent Variables and Codes

Variable name	Code	Variable name	Code
Teacher's stimulation of reading engagement perceived by student	STIMREAD	Self-concept of reading Perception of competence	SCREADCOMP
Joy/Like reading	JOYREAD	Self-Reading difficulty perception	SCREADDIFF
Perception of difficulty of the PISA test	PISADIFFF	Reading comprehension success	PV1READ
Teacher support	TEACHSUP	Math achievement	PV1MATH
Teacher-directed instruction	DIRINS	Science achievement	PV1SCIE
fear of failure	GFOFAİL		

#ÈÛÈ Analysis

In the analysis of the data, SPSS Modeler and WEKA programs were used in a systematic way. Excel and SPSS programs; SPSS Modeler and WEKA were used as utilities while transferring data and calculating some statistics. In the SPSS program, multiple regression analysis and mean assignment method to fill in the missing data were performed.

In the classification and regression tree (CRT) model created for the first sub-problem within the scope of the research, a total of 10 variables as independent variables STIMREAD, JOYREAD, PISADIFFF, TEACHSUP, DIRINS, GFOFAIL, SCREADCOMP, SCREADDIFF, PV1READ, PV1MATH, and the two-level science achievement variable (0=unsuccessful, 1=successful) was taken as the dependent variable.

For the second sub-problem, both a multiple regression model and a classification and regression tree model were created. For each of these two models, nine variables, STIMREAD, JOYREAD, PISADIFFF, TEACHSUP, DIRINS, GFOFAIL, SCREADCOMP, SCREADDIFF, PV1READ, were taken as independent variables, and a two-level mathematical success variable (0=failed, 1=successful) as the dependent variable.

The reason why the statistical method, the multiple regression method, was not used in the first sub-problem of the research, but only the classification and regression tree method based on data mining was used, is that there is a multicollinearity problem because the relationship between PV1READ and PV1MATH variables is very strong. In decision trees, there are no assumptions about the normal distribution of scores required in statistical analyzes and the absence of multicollinearity problems between variables (Kantardzic, 2011, s.192).

PISA 2018 OECD mathematics achievement average was used in the classification of PV1MATH scores, and PISA 2018 OECD science achievement average was used in the classification process of PV1SCIE scores (MoNE, 2019). Continuous quantitative PV1MATH value was classified as unsuccessful between 0-488.999 and successful between 489-1000 and mathematics achievement variable was obtained categorically. On the other hand, the continuous quantitative PV1SCIE value was classified as unsuccessful between 0-488.999 and successful between 489-1000 and science achievement variable was obtained categorically.

While classification and regression tree and multiple regression models were used in the data mining process in this study, the W_FSTUWT (Final Trimmed Nonresponse Adjusted Student) weight variable was included in each analysis. While performing analyzes on PISA data, the weight variable should be used due to the structure of the data (Arıkan et al., 2020). Then, Multiple Regression analysis was performed in SPSS program and both predictive variables and model performance measures were calculated.

Finally, after determining the important variables selected by the model as a result of the analyzes based on the classification and regression tree method with the SPSS modeler program for the first and second sub-problems, the performance criteria of the models created for the training data, test data and cross-validation data in the WEKA program were calculated with these variables.

FINDINGS

Findings on Important Variables That Predict Students' Science Achievement in Terms of Student Characteristics, Reading Comprehension and Mathematics Scores

The results of the correlation analysis performed to determine the relationships between the success variables used in the study are given in Table 2.

Table 2. Correlation Values Between Variables

Variables	PV1READ	PV1MATH	PV1SCİE
PV1READ	1		
PV1MATH	.806**	1	
PV1SCİE	.869**	.833**	1

When Table 2 is examined, it is seen that the correlation level between the variables is in the range of 0.806-0.869, and it is close to each other and significant ($p<0.01$). If the order of the level of relationship between the variables is to be made; it is seen that the highest level of relationship is between reading scores and science scores. Afterwards, the relationship between mathematics scores and science scores was high. Finally, the relationship between reading scores and math scores was also found to be high.

The predictive significance level graph for seven variables with predictive significance chosen by the model among the 10 independent variables included in the model to predict science achievement with the classification and regression tree application is given in Figure 1

Predictor importance

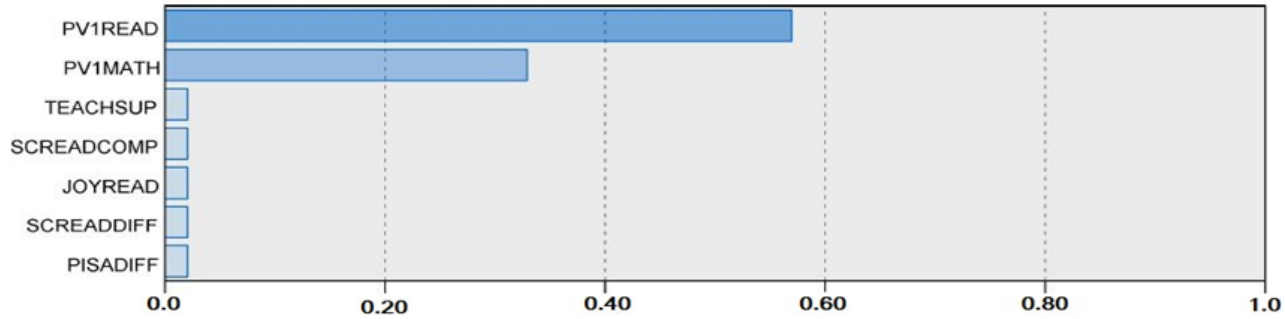

Figure 1. Graph of Important Variables Predicting Science Achievement in The CRT Model

If the predictive significance levels of the variables that predict science achievement are examined in the graph in Figure 1, it is seen that the reading comprehension variable is the most effective variable in predicting science achievement. After the reading comprehension variable, the mathematics variable was also found to be an effective variable in predicting science achievement. On the other hand, it was determined that teacher support (TEACHSUP), reading proficiency perception (SCREADCOMP), reading pleasure (JOYREAD), reading difficulty perception (SCREADDIFF), PISA test's perception of difficulty (PISADIFF) variables were found to have weak effects in predicting science achievement.

The decision tree graph of the two variables with the highest predictive significance chosen by the model among the 10 independent variables included in the model to predict science success with the Classification ÈÕËıı1ÌÎÙÌÚÚÐÖÕıı3ÙÌÌııÈ××ÓÐÊÈÙÐÖÕııÐÚııÎÐÝÌÕııÐÕıı%ÐÎÜÙÌıılõ

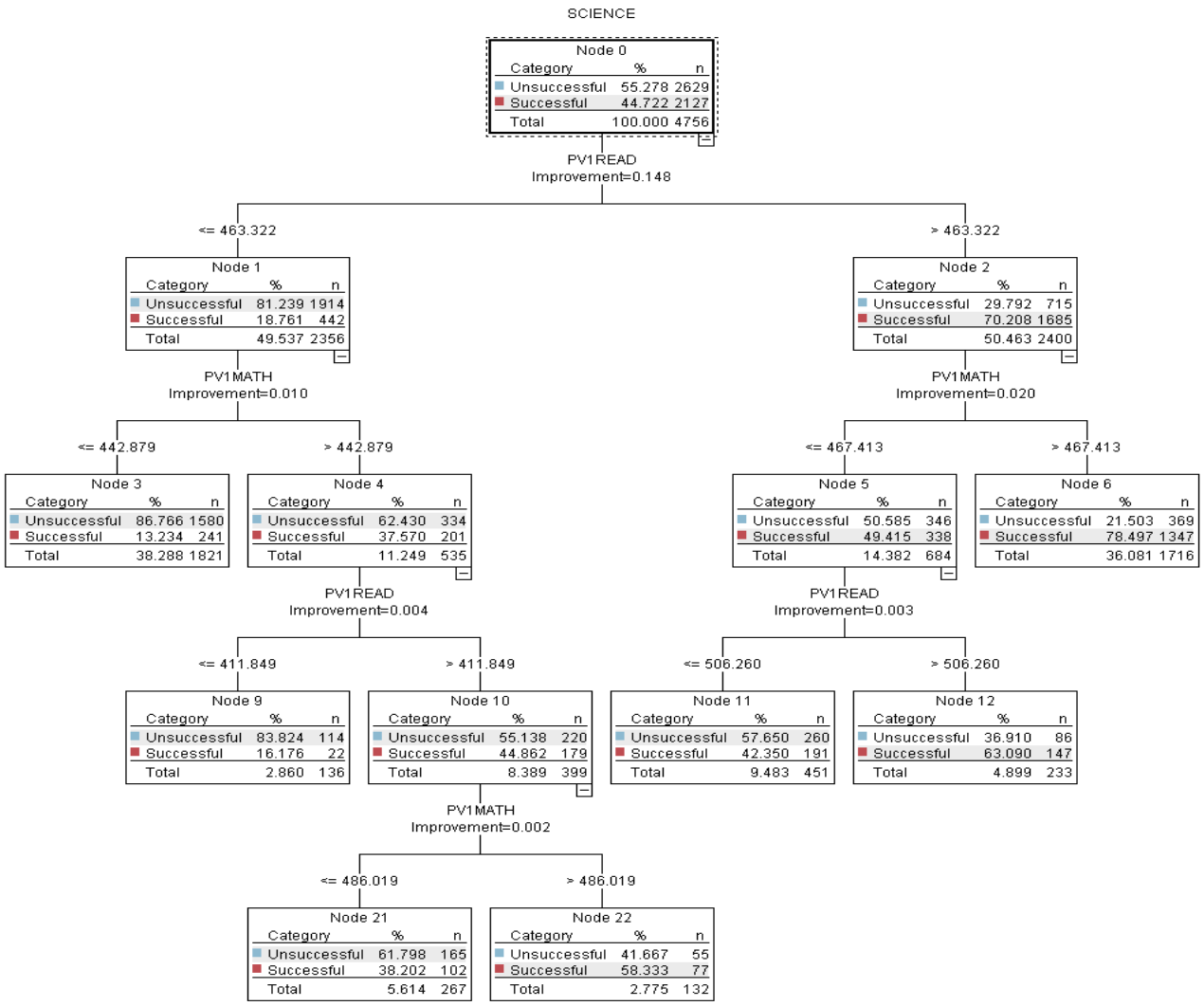

Figure 2. Decision Tree Regarding The Important Variables Selected With The CRT Model of Science Achievement

When the decision tree in Figure 2 is examined, the percentage of students who are successful in science is 44,722%, while the percentage of unsuccessful students is 55,278% in the Turkish sample. The most important variable predicting science achievement is reading comprehension. This finding is consistent with the graph in Figure 1, where the predictor importance of the variables predicting science achievement is given. If the reading comprehension score is equal to or below 463,322, the percentage of those who are successful in the field of science is 18,761%, while the percentage of those who are unsuccessful is 81,239%. If the reading comprehension score is above 463,322, the percentage of those who are successful in the field of science is 70,208%, while the percentage of those who are unsuccessful is 29,792%. When the reading comprehension score is equal to 463,322 and less than or greater than 463,322, the most important variable that determines the science achievement is the mathematics variable. This finding shows that the most effective predictor of science success is mathematics success after reading comprehension success. This result is consistent with the graph in Figure 1, where the predictor importance of the variables that predict science achievement is given. If the reading comprehension score is equal to or below 463,322 and the mathematics score is equal to or below 442,879, the percentage of those who are successful in science is 13,234%, while the percentage of those who are unsuccessful is 86,766%. If the reading comprehension score is equal to or below 463,322 and the mathematics score is greater than 442,879, the percentage of those who are successful in science is 37,570%, while the percentage of those who are unsuccessful is 62,430%. If the reading comprehension score is greater than 463,322 and the mathematics score is equal to or below 467,413, the percentage of those who are successful in science is 49,415%, while the percentage of those who are unsuccessful is 50,585%. If the reading comprehension score is greater than 463,322 and the mathematics score is greater than 467,413, the percentage

of those who are successful in science is 78,497%, while the percentage of those who are unsuccessful is 21,503. Similar comments will continue in the same way down the lower leaves. In the light of the findings obtained, the results obtained from the predictive importance graph and the decision tree show similarity in terms of the importance degrees of the variables that are effective in predicting science achievement.

As a result of the analysis made with the Classification and Regression Tree method, the performances of the model, which was formed over seven variables with predictive importance chosen by the model in predicting science achievement, are given in Table 3.

Table 3. CART Model Performances for Science Achievement Status

			Absolute Performances			Relative Performances		
	Variable	**Data**	**PCC**	**MAE**	**RMSE**	**Kappa**	**RAE**	**RRSE**
PV1SCIE	Important variables (7)	All data	80,729	0,292	0,382	0,607	59,262	76,982
		Validity data	75,757	0,327	0,410	0,508	66,225	85,357
		Test data	76,936	0,316	0,355	0,531	64,244	82,823

PCC: Percentage of correct classification, MAE: Mean absolute error, RMSE: Root of square mean squared error, RAE: Relative absolute error, RRSE: Root Relative Square Error.

According to the analysis results for all data, cross-validity and test data for the Turkish sample in Table 3, when seven variables with predictive significance chosen by the model are used, the percentage of correct classification (PCC) is higher for all data and good for cross-validity and test data. On the other hand, when the reliability of the model created in terms of error measures and kappa coefficient obtained as a result of analyzes for all data, cross-validity and test data is examined, the reliability of the model is moderate in all three cases. Although there is no clear interpretation of Kappa statistics, generally 0.00-0.20 is low, 0.21-0.40 is significant, 0.41-0.60 is moderate; 0.61-0.80 is an important level and 0.81-1.00 is expressed as an excellent level (Landis and Koch, 1977).

Findings on Important Variables That Predict Students' Mathematics Achievement in Terms Of Student Characteristics and Reading Comprehension Scores Measured in The Pısa Student Questionnaire

The predictive significance graph of the variables with predictive significance chosen by the model among the nine independent variables included in the model to predict mathematical success with the Classification and Regression Tree application is given in Figure 3.

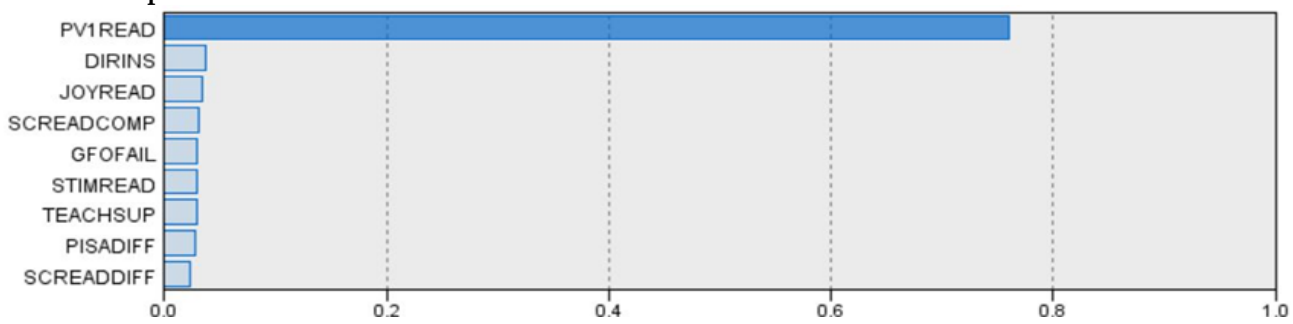

Figure 3. Graph of The Important Variables Predicting Mathematics Achievement in The CRT Model

If the predictive significance levels of the variables that predict mathematics achievement are examined in the graph in Figure 3, it is seen that the reading comprehension variable is the most effective variable in predicting mathematics achievement. Teacher's instructional orientation (DIRINS), reading pleasure (JOYREAD), reading proficiency perception (SCREADCOMP), fear of failure (GFOFAIL), teacher's encouragement to read (STIMREAD), teacher support (TEACHSUP), PISA test's perception of difficulty (PISADIFF), perception of reading difficulty (SCREADDIFF) variables were found to have a weak effect on predicting mathematics achievement.

As a result of the analysis made with the Classification and Regression Tree method, the performances of the model, which was formed over nine variables with predictive importance selected by the model in predicting mathematics achievement, are given in Table 4.

Table 4. CART Model Performances for Mathematics Achievement Status

			Absolute Performances			Relative Performances		
	Variable	Data	PCC	MAE	RMSE	Kappa	RAE	RRSE
PV1MATH	Important variables (9)	All data	79,670	0,295	0,384	0,574	61,999	78,740
		Validity data	74,095	0,336	0,428	0,448	70,630	87,715
		Test data	73,258	0,339	0,439	0,425	71,389	90,178

PCC: Percentage of correct classification, MAE: Mean absolute error, RMSE: Root of square mean squared error, RAE: Relative absolute error, RRSE: Root Relative Square Error.

According to the analysis results for all data, cross-validity and test data for the Turkish sample in Table 4, when nine variables with predictive significance chosen by the model are used, it is seen that the percentage of correct classification (PCC) is higher for all data and good for cross-validity and test data. On the other hand, when the reliability of the model created in terms of error measures and kappa coefficient obtained as a result of analyzes for all data, cross-validity and test data is examined, the reliability of the model is moderate in all three cases.

When both the skewness coefficient and the kurtosis coefficient of the distribution of the research variables for the multiple regression analysis were examined, it was determined that the skewness coefficients were in the range of (-0.586 and 0.189), and the kurtosis coefficients were in the range of (-0.505 and 0.461). The findings indicate that the data used in the research show a normal distribution for all variables. The results of multiple regression analysis performed to evaluate the relationships between dependent and independent variables are given in Table 5. In the prediction of mathematics achievement, which is the dependent variable in the multiple regression analysis, nine other variables were taken into account as the independent variable, except for the science achievement variable.

Table 5. Multiple Regression Analysis Results

Variables	B	Std. Error	β	T	p	Tolerance	VIF
Constant	75.587	3.681		20.532	.000*		
Perception of difficulty of the PISA test	-2.328	.711	-.025	-3.275	.001*	.860	1.163
Joy/Like reading	-6.872	.751	-.076	-9.153	.000*	.710	1.409
Self-concept of reading Perception of competence	-4.684	.757	-.052	-6.189	.000*	.712	1.405
Teacher's stimulation of reading engagement perceived by student	2.206	.684	.026	3.225	.001*	.787	1.271
Teacher-directed instruction	-4.370	.689	-.050	-6.346	.000*	.802	1.247
PV1READ	.826	.008	.820	106.962	.000*	.840	1.191

$p^* < 0,05$

When Table 5 is examined, it was determined that only six of the nine independent variables initially included in the model were significant as a result of the fourth step, using the backward stepwise method of predicting the mathematical literacy variable of the students. This conclusion was reached due to the significance levels of the variables ($p<0.05$). When the standard regression coefficient (β) of each variable was examined, it was determined that the variable with the highest predictive significance in predicting mathematics achievement was the variable of reading comprehension. It can be said that the reading comprehension variable has a great predictive power compared to other variables. The order of the other predictive variables from the highest predictive value to the lowest is reading pleasure, reading proficiency perception, teacher's orientation towards education, teacher's encouragement to read, and the perception of difficulty of the PISA test. However, it can be said that the predictive levels of these variables are close to each other. If the table is interpreted depending on the standard regression coefficients, one standard deviation increase in the reading score causes a 0.820 standard deviation increase in the mathematics achievement score. One standard deviation increase in the reading pleasure score causes a -0.076 standard deviation decrease in the mathematics achievement score. Other variables can be interpreted similarly. According to the findings,

while the variables of reading comprehension and teacher's encouragement to read affect mathematics achievement positively, other variables affect it negatively. On the other hand, when the VIF and tolerance values of the predictor variables selected by the model were examined, it was determined that there was no multicollinearity problem between the predictor variables. The presence of multi-connection problem refers to cases where VIF values are greater than 10 and tolerance values are less than 0.10 (Gujarati, 1995).

According to Table 5, the results of the multiple linear regression model can be expressed mathematically as follows.

Mathematics Achievement = 75,587+2,206.(STIMREAD)+0,826.(PV1READ)-2,328.(PISADIFF)-4,370.(DIRINS)-4,684.(SCREADCOMP)-6,872.(JOYREAD)

Table 6. Multiple Regression Model Summary Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	P	D-W
PV1MATH	.816	.665	.665	577.798231	2247.3	0.000*	1.738

In the multiple regression analysis, it was determined that there was no autocorrelation between the predictive variables because of the Durbin-Watson value (D-W=1,738). The fact that this value is in the range of 1.5-2.5 indicates that there is no auto-correlation between the variables and the model is reliable (Kalaycı, 2010, p. 267). There is a significant relationship between the predictor variables in the regression analysis and the mathematics achievement score (R=0.816, R^2=0.665, p<0.01).

The findings obtained in the research were discussed by comparing them with the studies in the literature, and conclusions and recommendations were obtained in the light of findings and discussions.

DISCUSSION

For the purposes of the research, the findings regarding the effect of PISA reading comprehension skill on mathematics and science achievement and the effect of mathematics skill on science achievement were discussed together with the findings in different studies.

In terms of PISA reading comprehension, mathematics and science scores, the relationship between reading scores and math scores, and math scores and science scores was found to be high. When the important variables that predict students' science achievement are examined, reading comprehension skills and mathematics achievement directly affect science achievement. The most effective variable in predicting science achievement is reading comprehension skill, followed by mathematical literacy. With this finding, Barnard-Brak et al. (2017) finding that reading and mathematics are important for science success is similar. The finding that reading comprehension and mathematical literacy skills have a significant effect on the prediction of science success, and the finding that there is a relationship between students' reading comprehension achievements and their success in Turkish, mathematics, social studies, and science and technology courses, as a result of the research conducted by Yılmaz (2015), is similar. It was determined that students with high reading comprehension scores were successful in mathematics, Turkish, social studies, science and technology courses, respectively. This finding is supported by the study by Mullis, Martin, and Foy (2011) in which they investigated the effect of reading skills on TIMSS mathematics and science achievement. It has been found that students who are better readers are in a better position to learn more and are more successful in other subjects besides mathematics and science. Similarly, according to the findings of the study conducted by Obalı (2009), it was concluded that students who are successful in mathematics and reading comprehension are also successful in science lessons. On the other hand, Caponera et al. (2016) in their study in which they looked at the relationship between reading comprehension, mathematics and science achievement, concluded that the effect of reading skills on science achievement is not clear. Unlike this finding, it was determined in the study that reading comprehension skill had a positive effect on science achievement. In the studies conducted by Aksoy and Doymuş (2011) Karasu and Haşıloğlu (2019), Kaya (2017), Uzun and Alev (2013), the results emphasizing that reading comprehension skill has a positive effect on science achievement support this finding.

It was determined that the variables of teacher support, perception of reading efficacy, reading pleasure, perception of difficulty in reading, and perception of difficulty of the PISA test had less effect on predicting science achievement than reading comprehension and mathematical literacy skills. In the study conducted by Koyuncu and Fırat (2020) investigating the predictors of reading performance and how reading performance predicts mathematics and science performances in Turkey, China and Mexico PISA 2018 evaluation, the highest occupational status index of parents, time spent in early childhood education and care, attitude

towards school. The result that learning activities and sense of belonging to school are not significant predictors of literacy is similar to the findings of this study. In the study conducted by Koyuncu and Fırat (2020), it was determined that variables such as enjoying reading, teacher support, and perception of difficulty were more effective on reading skills. Although it has been determined that these variables do not affect science achievement as much as reading comprehension and mathematical literacy, it can be seen when the literature is examined that these variables can affect reading comprehension skills. Çelik and Yurdakul (2020), in their study named investigation of PISA 2015 reading ability achievement of Turkish students in terms of student and school level variables, determined that teacher's education level and student behaviors that prevent learning have a significant effect on reading skill scores.

When the important variables that predict students' mathematics achievement in terms of student characteristics and reading comprehension scores measured in the PISA student questionnaire were examined, it was determined that the reading comprehension variable was the most effective variable in predicting mathematics achievement. This finding is similar to the research conducted by Proudfoot (2016) for the effect of reading comprehension skill on mathematics achievement. Proudfoot (2016) emphasized that reading comprehension curricula can help students in mathematics at the beginning, and that teachers should enrich teaching for more. Fuentes (1998) states the importance of the relationship between reading comprehension and mathematics, by stating that it is generally thought that mathematics only includes numbers, but that it is forgotten that mathematics also includes comprehension, thinking and language processes. Akay (2004), Bastug (2014), Caponera et al. (2016), Larwin (2010) and Sertsöz (2003), the findings of this study show similarities with the findings of the positive effect of reading comprehension skill on mathematics achievement.

It was determined that the variables of teacher's orientation of education, reading pleasure, reading efficacy perception, fear of failure, teacher's encouragement to read, teacher support, perception of difficulty in PISA test, and perception of reading difficulty had little effect on predicting mathematics achievement. In a study conducted by Ertem (2020) to determine the relationship of PISA 2018 results with student, teacher and society variables, it was determined that life satisfaction, the proportion of teachers with at least a master's degree, parent participation in school management and socio-economic status predicted reading, science and mathematics literacy. In addition, it was determined in the study that parent participation in school management was the strongest predictor for reading skills, and life satisfaction was the strongest predictor for both science and mathematics literacy.

It has been determined that the variable with the highest predictive significance in predicting the mathematical literacy of students is the reading comprehension variable. It can be said that the reading comprehension variable has a great predictive power compared to other variables. It was determined that the other predictive variables, from the highest predictive value to the lowest, were reading pleasure, reading proficiency perception, teacher's orientation towards education, teacher's encouragement to read and PISA test's perception of difficulty. The predictive levels of these variables were found to be close to each other. According to the findings, while the variables of reading comprehension and teacher's encouragement to read affect mathematics achievement positively, other variables affect it negatively. Ma, Luo, and Xiao (2021), who examined the relationship between teacher support perceived by the student and the reading self-concept's reading comprehension skills and reading pleasure with the example of China's PISA 2018, emphasized that the effect of teacher support perceived by the student on reading skills is significant at the student level. It was found that teacher support perceived by the student had an indirect effect on reading skills, and reading self-concept and reading pleasure were significant at both student and school levels. It shows that perceived teacher support is beneficial for student learning by promoting academic self-concept and reading pleasure.

As a result of the analyzes conducted to predict students' PISA mathematics achievement, it was found that both models used to read comprehension success as the most effective variable in predicting success, while the other predictors had little predictive significance. Fear of failure, teacher support, and perception of reading difficulty were found to be less important variables. According to the findings of this research conducted on PISA 2018 data, reading comprehension skill affects both mathematics and science achievement. Mathematical literacy also affects science achievement. With this finding, as a result of the analysis made by Kiray et al. (2015) using decision tree and clustering method on the data collected from the results of Turkish students who participated in three international exams, TIMSS 1999, PISA 2003 and PISA 2006, students' reading and problem solving skills were improved both in mathematics and in mathematics. affects science

achievement; the findings that mathematical literacy affects science achievement is similar. On the other hand, Kiray et al. (2015) emphasize that science achievement affects mathematics achievement. According to the findings of this study, reading comprehension skills and mathematical literacy affect science achievement. The effect of reading comprehension skill on science achievement is higher than mathematical literacy. Barnard-Brak et al. (2017) supports the research.

CONCLUSION

As a result of the findings and discussions obtained in line with the aims of the research, the results were reached. According to the findings of the research conducted on PISA 2018 Turkey data, reading comprehension skill was determined as the most basic skill for academic success in different fields. Reading comprehension skill affects both mathematics and science achievement. In addition, mathematical literacy also affects science achievement. Students with high reading and reading comprehension skills are more successful in lessons. Teacher's orientation of education, reading pleasure, reading efficacy perception, fear of failure, teacher's encouragement to reading, teacher support, perception of difficulty in PISA test, perception of reading difficulty affect mathematics achievement less. From the most important to the least, reading pleasure, reading proficiency perception, teacher's orientation to education, teacher's encouragement to read and PISA test's perception of difficulty affect mathematics achievement. Reading comprehension skill is more effective than all of these listed. It has been determined that the most effective variable in predicting students' mathematics achievement is their reading comprehension skill. Reading pleasure and perception of reading proficiency are the variables that most affect mathematics achievement after reading comprehension. While reading comprehension and teacher's encouragement to read affect mathematics achievement positively, perception of reading proficiency, fear of failure, teacher support, perception of difficulty in PISA test and perception of difficulty in reading affect mathematics achievement negatively. Fear of failure, teacher support, and perception of reading difficulty were found to be less important variables.

In PISA 2018 Turkey data, it was determined that the relationship between reading scores and math scores and between math scores and science scores was high. Reading comprehension skills and mathematical literacy directly affect science achievement. The most effective variable in science achievement is reading comprehension skill, followed by mathematical literacy.

Teacher support, reading efficacy perception, reading pleasure, reading difficulty perception, and PISA test difficulty perception have less effect on science achievement than reading comprehension and mathematical literacy skills in predicting science achievement. Although it has been determined that these variables do not affect science achievement as much as reading comprehension and mathematical literacy, these variables may affect reading comprehension skills.

It has been determined that reading comprehension skill affects mathematics achievement in terms of student characteristics and reading comprehension score measured in the student questionnaire in PISA 2018 Turkey data. Reading comprehension skill positively affects mathematics achievement.

SUGGESTIONS

Suggestions made based on the results of the research are listed below:

Since the most basic skill that a contemporary individual should have is reading comprehension, practices that will increase reading motivation, allow interpretation of what he reads and create pleasure in reading can be given more space in schools.

Since the reading comprehension skill has been determined as the most basic skill for academic success in different fields, studies such as reading, reading comprehension, speed reading, questioning reading, and critical reading can be focused on for students from primary school. Various curricula can be developed on these subjects.

Since science achievement also affects reading comprehension skills and mathematical literacy, subjects related to mathematics literacy and reading comprehension can be included in the curriculum more.

Curricula of Turkish, mathematics and science courses can be designed by associating them with each other with an interdisciplinary approach. Reading comprehension passages in Turkish lessons can be prepared from science and mathematics subjects. Texts containing math and science readings can be studied in schools. Such books can be used in individual studies.

Since reading pleasure affects mathematics achievement the most after reading comprehension skills, various curricula and activities can be prepared in order to provide students with reading pleasure in schools and adults in later ages.

Affective trainings can be organized for students in science and mathematics classes on reading proficiency perception, fear of failure, perception of difficulty in exams, and coping with perception of difficulty in reading, and self-regulation skills in emotion management can be gained with teacher support. Students can benefit from student coaching curricula in these subjects.

Evaluations similar to those made at the international level can be made at the national level through central examinations. Apart from the university entrance or high school entrance exam, skill-based assessments can also be made at different levels and grade levels.

Different methods can be developed to improve reading comprehension skills, and how to use these methods can be integrated into the content of teacher curricula and taught to pre-service teachers and in-service teachers through in-service training.

With digitalization in recent years, text messages; short texts, such as annotated results from search engines, and tabbed, multi-page websites; the impact of digital literacy in curricula can be increased due to the emergence of long texts such as newly accessible archive material scanned from microfiche. In addition, as a result of Turkey's participation in PISA with its computer infrastructure since 2015, digital literacy activities can be included in schools as a result of digital literacy gaining importance in PISA.

In future researches, studies on the predictive power between different variables and comparisons between countries can be made with statistical methods such as data mining on evaluation data made in different PISA samples and different years outside of Turkey.

Research can be conducted on the ways to improve reading comprehension skills and the variables that affect reading skills. In-depth data can be accessed through qualitative studies in classrooms where reading comprehension texts and science and mathematics activities are carried out.

Declarations

Conflict of Interest

No potential conflicts of interest were disclosed by the authors with respect to the research, authorship, or publication of this article.

Ethics Approval

The formal ethics approval was granted by the Hacettepe University Rectorate Ethics Committee. We conducted the study in accordance with the Helsinki Declaration in 1975.

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Research and Publication Ethics Statement

The study was approved by the research team's university ethics committee of the Hacettepe University (Approval Number/ID: 35853172-300). Hereby, we as the authors consciously assure that for the manuscript "The Effect of Reading Comprehension Skills on Mathematics and Science According to PISA Data" the following is fulfilled:

- This material is the authors' own original work, which has not been previously published elsewhere.
- The paper reflects the authors' own research and analysis in a truthful and complete manner.
- The results are appropriately placed in the context of prior and existing research.
- All sources used are properly disclosed.

Contribution Rates of Authors to the Article

The authors provide equal contribution to this work.

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