Id: 1125723

Participatory Educational Research (PER)
Vol.9(6), pp. 206-220, November 2022
Available online at http://www.perjournal.com
ISSN: 2148-6123
http://dx.doi.org/10.17275/per.22.136.9.6

The Predictive Power of Reading Comprehension, Attitude Toward Sciences, Test Technique, And Science Subject Matter Knowledge In Predicting Pisa Scientific Literacy Test Total Score

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Article history
Received:
03.05.2022

Received in revised form:
01.07.2022

Accepted:
28.07.2022

Key words:
PISA, scientific literacy, scientific literacy and reading comprehension, PISA test of scientific literacy question types

The purpose of this study is to identify to what extent that the reading comprehension, question types, attitude toward science, test method, and subject matter knowledge predict the PISA scientific literacy scores of the students. The study uses the method of correlational research, which is a type of quantitative research method. We reached out to 321 students who were randomly chosen using the method of cluster sampling. Five separate tests were used in the study: PISA 2015 science literacy test, 12 gap-filling exercises were asked to determine the students' level of surface reading comprehension, Five open-ended questions were asked to determine the in-depth reading comprehension level of the students, 5-point Likert scale composed of 13 items was used to determine the students' attitude toward sciences, 20 multiple-choice questions with 5 choices, regarding four units of the eighth-grade sciences curriculum and a 5-point Likert scale composed of 10 items was used to determine to what degree students use clues to guess the correct answer when solving multiple-choice tests. The research showed that the students' PISA scientific literacy scores, and the scores that they got in the multiple-choice and open-ended questions of PISA scientific literacy test were strongly positively correlated with the independent variables of the research (surface reading comprehension, in-depth reading comprehension, scientific subject matter knowledge, attitude toward sciences, using test techniques).The independent variables of the research set forth the 43% of the variance of the PISA scientific literacy test total scores, 46% of the variance of the success score in open-ended questions, and 34% of the variance of the success score in multiple-choice questions. The research also reached the conclusion that the students performed much better in multiple-choice questions compared to the open-ended questions about the same text (situation/problem).

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Introduction

Today, countries transfer a great amount of economic and human resources into education. Considering the large quantities of resources being reserved for educational purposes, it is evident that all countries aim to predict the quality of the future human resources and make necessary arrangements by taking these projections into account. Thus, a fair number of studies are being conducted, and these researches yield credible results regarding the country's education, offering guidance to the education administrators. However, there is a need for reliable research studies that yield credible results showing the country's position in the worldwide ranking. Therefore, international organisations conduct exams such as TIMSS, PIRLS, etc. PISA (Programme for International Student Assessment) is also one of these exams, held by OECD (Organisation for Economic Co-operation and Development).

PISA is a large-scale multi-purpose assessment that is administered every three years. 15-year-old students attending formal education who have had at least 7 years of compulsory education take this assessment test. The students are given tests that include both open-ended questions, and also multiple-choice questions (Sağlam, Pekyürek, and Yılmaz, 2020). The data obtained from these tests are comparatively assessed. PISA shows the scores and rankings of the participating countries in the related fields. Those who determine the educational policies in the participating countries compare the knowledge and skills of their own students with those of the other participating countries' students and develop standards so that the quality of the national education improves, determining the strengths and weaknesses of the educational system, and taking measures (MEB, 2010, 2013).

PISA does not measure the students' ability to reach the aims of the national education programmes. PISA measures the students' 21st century skills, and functional skills such as problem-solving skills in social settings or real-life situations. The assessment retrieves data regarding the students' mathematical literacy, scientific literacy, reading skills, motivations, opinions about themselves, learning styles, school climate, and families (OECD, 2014, 2013-a, 2013-b, 2012). PISA also has an assessment that measures scientific literacy. In the recent years, the opinion stating that science education should put much more emphasis on scientific literacy, nature of science, and philosophy of science rather than transferring theoretical knowledge has gained momentum (Bell & Lederman, 2003). American National Research Council (1996) defines scientific literacy as an individual's ability to gather scientific information from the right sources and analyse and utilise the information in the most proper way. In this context, it could be argued that the aim of the scientific literacy education is to teach students to skillfully read and comprehend the scientific resources that they use when making decisions and perform a critical analysis of them.

However, it must herein be considered that the PISA scientific literacy scores of the students show much more than their scientific literacy levels. For example, PISA measures scientific literacy with written assessment tests. We may assume that the scores of the students may be affected by the factors that influence the education system (family, socio-economic background, the qualities of the teachers, the management and infrastructure of the schools, curriculum, instructional time, etc.). Furthermore, student qualities (scientific subject matter knowledge, reading comprehension skills, methods of solving multiple-choice questions, or attitude toward sciences, etc.) may also influence the PISA scientific literacy score. Student qualities which are deemed independent variables in this research may briefly be analysed as stated below:

Reading Comprehension

Traditional approaches define reading as “phonation of written symbols” and reading comprehension as “the outgrowth of this phonation”. However, today, these definitions are deemed invalid. In the recent years, constructivism, which is an approach that explains how reading and comprehension are practiced much better, has been widely accepted by the educational circles. This approach defines reading as “the process in which the information that reaches to the cognition as a result of a process obtained by the phonation of written symbols, composed of elements such as perception, attention, memory, etc., and controlled by metacognition, is being correlated with prior knowledge, and new knowledge is created in the mind by using cognitive skills (sequencing, classification, problem-solving, deductive reasoning, etc.) (Akyol, 2014; Başaran, 2013-a; Guthrie & Wigfield, 2000; Paris et. al., 2009; Snow, 2002).. That is to say, reading is constructing new meanings as a result of the interaction with the author, writing a new text in reference to another text. Phonation is not the aim, but the tool of this process. It is apparent that reading is the process of assigning new meanings pertaining to the text. The success of this process is dependent on strategic reading. Strategic readers are aware of their own cognitive structure, and therefore, are able to decide upon the appropriate reading speed, purpose of reading, and reading strategies.

Reading, therefore meaning construction, has numerous variables. For example, reading process, which consists of more than 30 skills or dimensions, requires one to use cognitive skills adeptly, such as knowledge of alphabet, grammar, and vocabulary; comprehension of letter-sound correspondence, and mechanical reading; perception, associating the information presented in the text with one’s prior knowledge, interpretation, assessment, classification, sequencing, and alike and manage these processes concomitantly. Moreover, reading is influenced by reading speed, text structure, text type, the student’s attitude toward the specific text type, and familiarity with it (Başaran,2014). Even the students who display all of these qualities may not have the same level of reading comprehension. Prior knowledge is another factor of great importance which influences reading comprehension. As individuals read a text, they construct the meaning by using their prior knowledge (Cain, et al., 2004; Lai, et al., 2014; Oakhill, et al., 2015; Taylor, 2011). That is to say, when we read a text, we inevitably change and transform the new knowledge

Type of Question: Another important factor that may affect students’ PISA scientific literacy score is the type of the test questions. Conducting a multiple-choice test may seem like the most economic and fair way to test a large number of applicants. However, multiple-choice tests are much less reliable in that they indirectly give the right answer to the student, and the students tend to use various test methods and techniques, and therefore, select the most reasonable choice, rather than memorise the information, or solve the problem. Moreover, students make sure that the choice is reasonable, even if it is the right choice (Başaran, 2013-b). The clues that the students use to find the reasonable choice may be listed as follows: references (nominal clauses or units of meaning taken from the paragraphs, listed among the choices), structural similarity (structures that are found among the choices such as cause/effect, problem/solution, listing the qualities, description or comparison, etc.), sentence formation, wording (similarities in wording both in the paragraph, and also among the choices), the place of the information in the paragraph, lexical correspondence, the length of the sentences in the choices, keywords (what is the most important…? , summarize…, retell…). Students with the same level of knowledge may get different scores on multiple-choice tests even though they do not use these techniques. The reason being is that comprehension has a complex structure and is unique to each student. Not every student construe the same meaning out of the same text. The prior knowledge of the students, the reading strategies they use, the purpose of reading, etc. may also influence reading comprehension, and therefore, make a difference in finding the right choice. Another factor is the vocabulary that are unknown to the student, but of critical importance for finding the right choice. Test anxiety is also quite an important factor. A student who has test anxiety may be influenced by excitement, inattentiveness, or other emotional factors, and not be able to find the correct answer. In open-ended questions, however, the student's writing skills, attitude toward writing, or psychological state has the potential to affect the score that the student gets (Jenkins & Pany, 1978; Katz et. al., 1990; Valencia & Pearson, 1988).

Attitudes toward Science: Regardless of the type of question asked, or the quality being measured, factors regarding attitude also have a potential of influencing the success score. Attitude may be defined as the emotional readiness which develops as a consequence of experience and influences the emotions and behaviours of an individual. The attitude that the students adopt toward sciences may influence not only the students' level of acquiring the skills and knowledge, but also the emotional and cognitive behaviours, along with the mental readiness level. The students who adopt a positive attitude toward sciences may much more actively and effectively take part in the process for a much longer period of time, as they will be much more interested in science during the lessons and test processes (Cunningham, & Turgut, 1996; Sanger, 2000).

Purpose of the Study

Analysing the PISA science literacy scores, you may realise that specific countries (such as South Korea, Hong Kong, Singapore, Japan, China, or Finland) achieve the highest scores in general. However, Turkey, having participated in PISA in the years of 2003, 2006, 2009, 2012, 2015 and 2018, has been below the average score of the OECD countries regarding scientific literacy in each of these years (OECD, 2019).

These results compelled the regulators who introduce education policies in Turkey to take some precautions. For example, over the past 15 years, Turkey has allocated a much larger share of its gross national income to education, made huge investments in educational technology, and made improvements in the occupational rights of the teachers, the classroom capacity, class size, laboratory facilities, etc. Furthermore, national teacher education programme has been revised, science education instructional time has been increased, national science education programme has been radically changed, and revised several times (Ekici & Yılmaz, 2013; Eryılmaz & Uluyol, 2015; MEB, 2018; Uyar, 2017).

Despite all these efforts and investments, the increase in the students' scientific literacy scores has not been satisfactory. Science programme, the quality of the courses, instructional time, the qualities of the teachers, and the improvements in the infrastructure has been partially effective on PISA results. The problem statement of this research is to what extent do reading comprehension, test type, attitude towards science, test techniques, content knowledge predict students' PISA science literacy score?

Method

The method of correlational research, which is a type of quantitative research method, was used in this study investigated the relationship between students' reading comprehension, test type, attitude towards science, test techniques, content knowledge and PISA science literacy. This design analyses the existence and degree of correlation between two or more variables, without any disruption or outside influences (Creswell, 2011).

Study Group

The study population consists of 8th graders who attended in state schools located in Esenler and Zeytinburnu districts, where middle-class families live in Istanbul, during the spring semester of 2020-2021 academic year. The study group, on the other hand, was determined by using cluster sampling method. Random sampling requires one to choose the members or clusters by applying a random selection. In cluster sampling, however, the members are not chosen from the study population one by one, but the clusters (year/class) that they form are chosen. Four state schools located in Esenler and Zeytinburnu districts, and 12 classes of these schools were randomly chosen for the research. 346 students who continued their education in these chosen classes were included into the sample survey. Later on, 25 students included in this sample survey who were inclusion students with the recommendation of the school counselor, over the age of 15, children of immigrant status families, and specific learning disabilities were excluded from the sample survey.

Data Collection Tools

The research uses the method of "Inventory of Variables Influencing Scientific Literacy". The inventory is composed of five chapters: The first chapter of the inventory defines PISA 2015 science literacy test. The research includes eight multiple-choice, and eight open-ended questions about five texts taken from this test. The students sat for only one of these tests. However, the students' answers to open-ended questions and multiple-choice questions have been assessed separately. Upon the assessment, we have achieved three separate scores from open-ended questions, multiple-choice questions, and PISA science literacy test.

In the second chapter of the inventory, 12 questions were asked based on a text named "The Tailor and the Old Man" to determine the reading comprehension level of the students. The questions were gap-filling exercises which directly gave the answers in the text, and had an answer composed of one or more words, so as to determine the students' level of surface reading comprehension (clearly expressed in the text, rather requiring the use of lower-order cognitive skills, measured by questions pertaining to memorisation and recognition). Each wrong answer got 0 points, each partly true answer got 1 point, and each correct answer got 2 points. Five open-ended questions were asked to determine the in-depth reading comprehension level of the students (not precisely expressed/implied in the text, intertextual references, requiring the use of higher-order cognitive skills). Each question brought a score on a 0-5 scale, wrong answers bringing 0 points, and right answers bringing at most 5 points. Three domain experts who have completed their doctorate on teaching language skills have confirmed the validity of these questions. Some examples of in-depth learning questions may be:

(1) *"Why could the tailor have left the electric heater on?"*
(2) *"How must the old man have felt after hearing the tailor's life story?" Some examples of surface learning questions may be:*
(3) *"One ………….. night, the young man forgot to turn off the electric heater when he closed the shop, and the fire that went out led to his downfall".*
(4) *"The young man and his rich friend met in/on/at …………….. for the first time."*

In the third chapter of the inventory, a 5-point Likert scale composed of 13 items, developed by the researchers, was used to determine the students' attitude toward sciences. The content validity of the scale has been ensured by the judgement of three domain experts. Factor analysis has been conducted to develop structural validity. The analysis revealed two factors which explained the 67,34% of the total variance (having fun while learning, usefulness), and the fact that the load factors of all 13 items were higher than ,30. Furthermore, Cronbach Alfa coefficient was found to be ,77 in a test conducted to ensure the reliability of the scale. Some examples of the questions in this test are as follows:

(1) Reading science books is fun.
(2) I never get bored learning about science.
(3) Science help me understand the universe.
(4) Science make our lives much easier.

In the fourth chapter of the inventory, 20 multiple-choice questions with 5 choices, regarding four units of the eighth-grade sciences curriculum (Seasons and Climate, DNA and Genetic Code, Matter and Industry, Energy Transformations and Environmental Science) were asked. These questions were standardised questions prepared for measuring terminology knowledge. The content validity of these questions has been ensured by the judgement of three domain experts. The reliability assessment has been made with correct answers getting "1" point and wrong answers getting "0" points on a 20-point scale. The item discrimination and difficulty indexes have been measured using the answers that the students that compose the subgroup and supergroups gave. The item analysis showed that the item discrimination indexes have been measured to be over 0.25. Furthermore, the item difficulty indexes were of average difficulty. The results of these tests are as shown below:

Table 1. Reliability Test Results Regarding Success in Domain Knowledge

N	**Number of items (n)**	**Average item difficulty index (pjx)**	**Average item discrimination index (rjx)**	**Reliability coefficient (r/α)**
321	20	,574	,475	,728

In the fifth chapter of the inventory, a 5-point Likert scale composed of 10 items, developed by the researchers, was used to determine to what degree students use clues to guess the correct answer when solving multiple-choice tests. The content validity of the scale has been ensured by the judgement of three domain experts. Factor analysis has been conducted to develop structural validity. The analysis revealed a factor which explained the 62,57% of the total variance, and the fact that the load factors of all 10 items were higher than ,30. Furthermore, Cronbach Alfa coefficient was found to be ,71 in a test conducted to ensure the reliability of the scale. Some examples of the questions in this scale are as follows:

(1) When I solve multiple-choice tests, I take notice of keywords such as "To summarize it all, as a result of, etc.", which are expressions that underline the important information in the paragraph given.
(2) When I solve multiple-choice tests, I take notice of the length of the choices.
(3) When I solve multiple-choice tests, I focus on finding the answer in the the paragraph, rather than understanding the paragraph."

Data Collection Procedure

The research was conducted by the students' science teachers within course hour in the classroom environment, and under the supervision of researchers. Assessments were completed within a week, in three course hours, on separate days. We interviewed the science teachers at the sampled schools, and explained the purpose and method of the research to these teachers. Teachers assessed the inventory in their classes on a voluntary basis. The quantitative data obtained upon these assessments were analysed using the SPSS 25.0 program. In order to determine whether parametric or nonparametric tests would be used in the analysis of the data, the data sets -although the sample size was 321- were subjected to normality tests (kurtosis and skewness). Correlation analysis was made (Pearson Product Moment Correlation Coefficient-r) to determine the relationship between the independent variables of the study, and to determine whether there is a multicollinearity between these variables; t test was conducted to determine the significance of the difference between the scores of the students on the multiple-choice and open-ended questions in the PISA science literacy test; regression analysis was performed to test the predictive power of the independent variables of the study on the PISA science literacy test success score. First of all, we contacted the classroom counselors of the students who were included in the study and gave information about the conduction of the study. Through these teachers, the parents of the students were informed, and their consent was obtained. Then, we reached out to the science teachers of these classes and gave information to them. We observed that these teachers voluntarily participated in the research. No personal data were inquired regarding the students participating in the study, but it was said that the subjects who wished to drop out of the study upon answering the measurement tools could inform the classroom counselor. There were no students or science teachers who dropped out of the study. Yıldız Technical University Ethics Committee has confirmed that the research and the scale used are in accordance with scientific ethical rules.

Findings

The findings reached at the end of the implementation of these practices are given and interpreted in the tables below.

Table 2. Students' Normality Test Results Regarding Open-Ended Question Tests, Multiple-Choice Question Tests, PISA Scientific Literacy Test, in-Depth Reading Comprehension Test, Surface Reading Comprehension Test, Attitude Toward Sciences Test, Test Technique Usage, and Subject Matter Knowledge Tests

Tests	**Coefficient of Skewness**	**Coefficient of Kurtosis**
Open-ended questions (OEQ)	,055	-,080
Multiple-choice questions (MCQ)	-,245	,243
PISA test total score (PTTS)	-,044	-,047
In-depth comprehension (IDC)	,119	-,832
Surface comprehension (SC)	,955	,369
Scientific subject matter knowledge (SSMK)	-,468	-,432
Attitude toward sciences (ATS)	,045	-,239
Using test techniques (UTT)	,479	-,619

Table 2 shows the students' normality test results regarding open-ended question tests, multiple-choice question tests, PISA scientific literacy test, in-depth reading comprehension test, surface reading comprehension test, attitude toward sciences test, test technique usage, and subject matter knowledge tests. When these values are assessed, it shows that coefficients of skewness and kurtosis change between -,832 and +,955. The coefficients of skewness and kurtosis must be between +1,5 and -1,5 (Tabachnick and Fidell, 2007), for the scores achieved in social sciences to be deemed to show the qualities of a normal distribution. Therefore, we could argue that the scores assessed in the research show the qualities of a normal distribution.

Table 3. The Difference Between the Students' Scores in Open-Ended Question Tests and Multiple-Choice Question Tests

Test types (Df=640)	N	X	S	t	p
Open-ended questions	321	3,78	1,31	11,938	,000
Multiple-choice questions	321	5,10	1,48		

Table 3 shows the significance of the difference between the students' scores of open-ended questions and multiple-choice questions about the same text (problem). As stated in the table, the mean score of the students' scores is 3,78 in the open-ended questions, and 5,10 in the multiple-choice questions. The difference between the students' scores of open-ended questions and multiple-choice questions is important as the t test shows ($t_{(df=640)}$ = 11,938 ;p<.05). We may interpret this finding as students being more successful in multiple-choice questions.

Table 4. The Correlation Between Students' Scores in Open-Ended Question Tests, Multiple-Choice Questions Tests, PISA Scientific Literacy Test, in-Depth Reading Comprehension Test, Surface Reading Comprehension Test, Attitude Toward Sciences Test, Test Technique Usage, and Subject Matter Knowledge Tests

Variable		(OEQ)	(MCQ)	(PTTS)	(IDC)	(OYA)	(SSMK)	(ATS)	(UTT)
OEQ	r	1							
	p								
MCQ	r	,814**	1						
	p	,000							
PTTS	r	,946**	,958**	1					
	p	,000	,000						
IDC	r	,566**	,498**	,556**	1				
	p	,000	,000	,000					
SC	r	,471**	,397**	,453**	,535**	1			
	p	,000	,000	,000	,000				
SSMK	r	,503**	,410**	,476**	,396**	,284**	1		
	p	,000	,000	,000	,000	,000			
ATS	r	,401**	,353**	,394**	,472**	,265**	,275**	1	
	p	,000	,000	,000	,000	,000	,000		
UTT	r	,423**	,399**	,431**	,497**	,523**	,258**	,356**	1
	p	,000	,000	,000	,000	,000	,000	,000	

Table 4 shows the correlation between students' scores in open-ended questions (OEQ), multiple-choice questions (MCQ), PISA scientific literacy test (PTTS), in-depth reading comprehension (IDC), surface reading comprehension (SC), attitude toward sciences (ATS), test technique usage (UTT), and subject matter knowledge tests (SSMK). The table displays the strong correlation (p<.000) between the dependent variables discussed in the research (PISA scientific literacy score, open-ended question test score, and multiple-choice question test score) and the independent variables of the research (in-depth reading comprehension, surface reading comprehension, subject matter knowledge, attitude toward sciences, and test technique usage). The analysis revealed a factor which explained the 62,57% of the total variance, and the fact that the load factors of all 10 items were higher than ,30. In the examination, it was seen that there was a high correlation between the independent variable of the study (PTTS) and the independent variables of the study (OEQ and MCQ). However, this situation cannot be considered as a multicollinearity. It was observed that the dependent variables had a correlation higher than .750 among themselves (OEQ and MCQ). Thereupon, WIF values were examined, and all values were found to be below 10,000. This finding was interpreted as there was no multicollinearity problem among the variables.

Table 5. The Predictive Power of In-Depth Reading Comprehension (IDC), Surface Reading Comprehension (SC), Science Subject Matter Knowledge Test (SSMK), Attitude Toward Sciences (ATS), and Test Technique Usage (UTT) in Predicting PISA Scientific Literacy Test Total Score (PTTS)

Dependent Variables	**Independent Variables**	**B**	**Std. Error**	**B**	**t**	**p**	**Semipartial-R**	**Partial-R**
PISA Test Total Score (PTTS)	Constant	1,447	1,173		1,234	,218		
	OEQ	,165	,037	,258	4,466	,000	,556	,244
	SC	,089	,032	,147	2,743	,006	,453	,153
	SSMK	,219	,038	,271	5,803	,000	,476	,311
	ATS	,037	,015	,118	2,415	,016	,394	,135
	UTT	,089	,041	,114	2,152	,032	,431	,120

PISA Scientific Literacy Test Total Score = 1,447 constant + *In-Depth Reading Comprehension (*IDC) ,165 + *Surface Reading Comprehension (SC)* ,089 + *Subject Matter Knowledge Test (SSMK)* ,219 + *Attitude Toward Sciences (ATS)*,037 + *Test Technique Usage (UTT)*,089

Bivariate correlation results on Table 5 show students' PISA scientific literacy test scores to be positively correlated with in-depth reading comprehension, surface reading comprehension, attitude toward sciences, test technique usage, and science subject matter test scores. Analysing standardised regression coefficients, we see that the independent variables' relative order of importance is science subject matter knowledge, in-depth reading comprehension, surface reading comprehension, attitude toward sciences, and test technique usage respectively. These factors, all together, explain the 43% (R=,659 ve R2=,435) of the PISA test total score.

Conclusion and Discussion

The research results suggest that Students' PISA scientific literacy test total score is positively related to the test's multiple-choice and open-ended question scores, and the independent variables of the research (in-depth reading comprehension, surface reading comprehension, attitude toward sciences, test technique usage, science subject matter knowledge). Independent variables explain the 43% (R=,659 ve R2=,435) of the PISA scientific literacy test total score. These variables' relative order of importance is science subject matter knowledge, in-depth reading comprehension, surface reading comprehension, attitude toward sciences, and test technique usage respectively. Students performed much better in solving multiple-choice questions compared to the open-ended questions about the same text (situation/problem). It is important to note that the independent variables of the research influence the success scores regarding PISA scientific literacy test total score, and the open-ended and multiple-choice questions of this test differently. Science subject matter knowledge and in-depth reading comprehension being the most influential variable over these tests' variance, other independent variables were observed to differ in influence rate and relative order of importance.

Another interesting research result is that using test techniques is much more influential on the multiple-choice question test than surface reading comprehension and attitude toward sciences. Moreover, we found that the independent variables of the research have the lowest prediction rate (34%) regarding multiple-choice questions. Students, having developed unique techniques to solve multiple-choice problems, may have played a role in this outcome. Students, solving tens of multiple-choice questions everyday to prepare for national exams, are therefore much more familiar with multiple-choice questions. Students may also have developed various techniques to solve multiple-choice questions. We may deduct from this finding that using multiple-choice questions to measure scientific literacy, which essentially require identifying the correct answer, may lead to a lack of reliability in the measurement process.

One of the main objectives of science education is boosting the students' positive attitude toward sciences. It is equally important for students to be willing to comprehend the laws of nature that explain the events happening around them and enjoy the learning process as much as it is important for them to actually comprehend the laws of the nature. We could suggest that the students' success in sciences class increase as their positive attitude toward sciences improves. This research, too, suggests that there is a strong positive correlation between the attitude toward sciences and scientific literacy. This conclusion also corresponds to the relevant literature (Altınok, 2004; Craker, 2006; German, 1988; Kozcu et al., 2007; Osborne, 2003; Papanastasiou & Zembylas, 2004; Usta, 2009). However, the prediction rate of the attitude remains quite low. The reason for this may be the studying habits of the eight grade students. Today, students, as stated above, prepare for national exams to get into more competent high schools. These exams, unfortunately, only measure the cognitive behaviours. This situation leads to many negative educational results. One of these results is the students leaving their attitude toward sciences or any other lesson aside, and only focusing on finding the correct answer to the question in front of them (Aydın & Bulgan, 2017; Büyüköztürk, 2016; Eraslan & Eraslan,2009; Gijbels & Dochy, 2006). Students, owing to this habit, may have also solved PISA questions regardless of their attitude.

The research shows that there is a strong correlation between scientific literacy and reading comprehension regardless of the total score, whether it is measured by multiple-choice questions, or open-ended questions. Most particularly, in-depth reading comprehension explains nearly 16% of the variance in scientific literacy. Relevant literature also supports this finding. As a matter of fact, reading comprehension is an important variable that lies at the heart of all types of school education, and predicts the general academic success. A large number of studies show that reading comprehension is strongly correlated with the success in lessons such as maths (Grimm, 2008; Lerkkanen et al. 2005; Pape, 2004; Passolunghi & Pazzaglia 2005; Pellerin, 2012), or social sciences (history, geography, citizenship knowledge) (Aslanoğlu, 2007), which belong to different fields, and require different intelligence types. You could suggest that the research results (Bayat et al., 2014; Camine & Camine, 2004; Kolıć-Vehovec et al., 2011; Korkmaz, 2011) that set forth the strong correlation between the success in science classes and scientific literacy, which is one of the main objectives of this class, support the result reached in this research. Students' good comprehension of the situation/problem/question given in the exam within a text may have led to this conclusion. However, the usage of cognitive and superior cognitive techniques that good and strategic readers always use in the reading process may have also been used in scientific literacy and led to these results.

Independent variables discussed in the research explain 43% of the variance in the students' scientific literacy score measured by PISA questions. We could say that the result achieved (43%) is much lower than the expected value, considering that this result has been achieved upon taking reading comprehension, science subject matter knowledge, test technique usage, and attitude toward sciences which are correlated to student qualities. However, this result may be interpreted differently when assessed with the results of other studies analysing the other factors influencing PISA scientific literacy score. For example, the content of the science classes, textbooks, questions found in the textbooks, and asked in the national exams are quite different than the questions that the students encounter in PISA exam. These differences have the potential to influence students' PISA scientific literacy test scores (İskenderoğlu & Baki, 2011). Another important variable that influences PISA scientific literacy score is the qualities of school principals (Çalışkan, 2008), teachers who conduct the science classes (Kilpatrick, 2001), and the socio-economic environment where the school is located. Availability of computers at home, access to internet connection, and students' computer skills also affect scientific literacy (Kaya & Doğan, 2012). Furthermore, the number of instructional materials allocated per student, the quality of instructional material, and the class size (Karabay, 2013) are also variables that influence PISA scientific literacy score. PISA scientific literacy test results show that country rankings rarely change, and while some countries get scores above the average, some other countries get scores below the average (PISA, 2019). All these results just go to show that scientific literacy level is both influenced by the student factors (science subject matter knowledge, in-depth reading comprehension, surface reading comprehension, attitude toward sciences, and test technique usage, and so on.), and also influenced by socio-economic status of the countries. In other words, socio-economic-technologic opportunities are of great importance for the students to achieve full potential regarding scientific literacy.

Scientific literacy, a crucial skill regarding assessing and utilising the information correctly to understand nature, solve problems regarding nature, and develop technologies, is a greatly important educational goal. This research analyses the predictive power of the student factors regarding scientific literacy level, which is measured by PISA test questions. Research results show that other factors besides students' subject matter knowledge are also crucial. Assessing these findings, we recommend teachers to do activities that improve students' reading comprehension levels regarding scientific texts/situations, while also communicating scientific information to students in science classes. In addition, teachers should carry out activities that focus on finding and improving the students' cognitive entry behaviours in the science classes (Millar, 2006).

It is safe to say that the students are not able to fully utilise their subject matter knowledge on scientific literacy tests. Inasmuch as the research results show that subject matter knowledge can predict scientific literacy, its predictive power is quite low. This may be because of the context in which students gain subject matter knowledge: students obtaining domain knowledge by way of direct instruction, and using the information only in exams, instead of real-life situations. Therefore, curricula, class content, questions in textbooks, types of questions in the national exams, and the qualities that they measure should be arranged regarding scientific literacy. We advise science teachers to correlate scientific literacy to the subject of the classes.

Cognitive processes and methods used to comprehend (read) nature and natural sciences, and read a text are substantially quite similar: Both types of reading requires the construction of meaning for the symbols in the mind. Students may make mistakes on a problem that they could easily solve otherwise due to misunderstandings regarding the text, or constructing a wrong meaning of a term in the text. The reason why students make such mistakes may underlie students' reading comprehension levels, rather than their subject matter knowledge, or level of skills to utilise the knowledge. In this context, we advise science teachers to not only focus on transfering scientific knowledge and skills in science education. Teachers should also teach the skills of comprehending scientific terms well and using them correctly; construing the right meaning out of texts; constructing the right meaning in their minds; reading at a normal speed, and using the right reading strategies. In this teaching process, especially, cognitive modelling method (thinking aloud during the problem-solving process) is surely quite influential. Teacher employment, teacher training policies, class size, the quality and quantity of the instructional materials used, all of which are indicators of a country's socio-economic development, also influence scientific literacy. Therefore, we could suggest that countries must regard educational resource allocation as a medium long-term social and economic investment and take the necessary precautions that will increase the quality of the education. Of course, in this process, the affective characteristics of students must not be neglected, and be constantly kept track of as well as their cognitive characteristics.

Even though PISA was developed by a large number of domain experts, assessment and evaluation experts, and linguists, a study analysing the effects of cultural and lingual differences on the exam could be useful. In addition, the influence of the approaches of national programmes regarding scientific literacy comprehension and teaching on PISA score differences between countries may also be analysed. Moreover, it must be taken into account that the students' real scientific literacy levels may come out much more differently than how PISA results show. In this context, we suggest the correlation between the students' utilisation of scientific literacy in real-life situations and their success in exams to be analysed.

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