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Perception and Reality: Two Dimensions of Scientific Literacy Measures

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ABSTRACT
In the 21st century, individuals are expected to be scientifically literate and develop themselves in this direction. However, wrong judgments about self-competence, such as overconfidence, can cause mistakes in the process of solving problems related to science and technology and prevent making the right decisions. This situation, known as the Dunning-Kruger effect, is defined as a person's overconfidence in their abilities, knowledge, and skills. The aim of this study is to examine the relationship between individuals' perceptions and observed levels of scientific literacy. Survey method was employed to conduct the study. The science literacy scale (SLS) developed by researchers was administered to 5426 adults aged between 18 and 65. The participants were asked to make predictions about the scores they could get from SLS before and after it was administrated. A significant and positive relationship between the pre- and post-scores that the participants predicted to receive from the scale and the scores they got from the scale was found. The difference between the individuals' observed science literacy levels and their predicted scores generally decreases by educational degree. The individuals' awareness of their real situation increased after seeing the questions in SLS.

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Introduction

Today, science and technology affect every aspect of our lives. We use our competence in science and technology to make sense of many situations that we encounter in daily life and to make decisions about them. (Bingle & Gaskell, 1994). Day by day, people who do not have a profession related to science (laypeople) need more scientific knowledge to solve their problems and make informed decisions. The scientific knowledge and skills people need to make social and personal decisions or to assess the risks that correspond to scientific literacy competence (Ryder, 2001; Tabak, 2015). Individuals' perceptions of any competence seem to play an important role in the correct use of these competencies. (Pennycook et al., 2017). In this case, it is thought that self-assessment of the scientific literacy level can directly affect our reactions to the situations we encounter.

The process of self-perception includes the reaction of an individual mostly conveyed in the form of self-evaluation. The process of self-evaluation is influenced by many factors including personality traits, abilities, specialties, or skills, and they play a key role in making decisions based on this evaluation (Dunning et al., 2004). There are various studies in the literature on how individuals evaluate themselves (Kruger & Dunning, 1999; Phillips et al., 2003; Snowden, 2002). These studies were carried out with a wide variety of groups and people including people in the field of political science (Anson, 2018), laboratory technicians (Haun et al., 2000), drivers who failed driving tests (Mynttinsen et al., 2009), and players in chess tournaments (Park & Santos-Pinto, 2010). The basis of these studies is based on the work of Kruger and Dunning (1999) with university students. In this study, it has been suggested that individuals with low competence or skills perceive themselves at higher levels of competence or skills than they actually are (Kruger & Dunning, 1999). With this research, the situation that is described as "ignorant courage" or "ignorant self-confidence" in the society was passed to the literature as the "Dunning-Kruger Effect" as a scientific term.

Although there have been studies in different fields related to the Dunning-Kruger effect, the validity of similar effects has not been examined in the context of broad public masses and scientific literacy. In Turkey, to the best of our knowledge and capacity, there are no studies conducted in this direction before. It is important to determine the level of scientific literacy of Turkish society in decision-making processes regarding both individual and professional issues in daily life and socio-scientific issues that concern society, as well as determining the perceptions of competence in this matter. In this context, the aim of the study is to determine the relationship between the scientific literacy levels of adults and their perceptions of scientific literacy competence.

Theoretical Framework

The Dunning-Kruger effect is defined as being more confident or insecure about a person's own abilities, knowledge, and skills than needed. This situation occurs due to the fact that individuals cannot make accurate evaluations about themselves (Nickerson, 1998). This misjudgment often involves a positive bias, and people may feel overconfidence based on little information about what they can or cannot do (Schlösser et al., 2013). Excessive confidence or insecurity can cause people to make wrong evaluations about the behaviors they do or will do and the decision to be made (Schlösser et al., 2013). These wrong evaluations also affect the lifelong learning process of the individual and may cause them to see themselves as more competent than they actually are in this process (Yasa, 2018). Researchers carry out comprehensive studies on how people evaluate themselves affect their quality of life, the decisions they make, or their educational life and they also try to explain the patterns of people's behaviors (Critcher & Dunning, 2009). For example, in their study with adults, Pennycook et al. (2017) stated that not being aware of the person's inadequacy would have extensive consequences, and they foresee that this inadequacy requires competence to be aware of, but the lack of this competence will reveal the wrong prediction and decision-making behaviors of the person. This wrong estimation and decision-making can be in the form of exaggerating one's own performance or underestimating one’s own capabilities (Dunning et al., 2003; Ehrlinger et al., 2008; Kruger & Dunning, 1999; Williams et al., 2013). The reason for this situation may be due to the individual's personal characteristics (gender, cultural differences, etc.) as well as the type of the area being evaluated (Fu et al., 2005; Moore & Healy, 2008). An example of this case is that cultural perception affects our personal perceptions, hence our career choices are shaped accordingly and that women are more underrepresented in science than men. Similar to the inequality in gender representation in science, scientific literacy has also been seen as a characteristic of men (Miller et al., 2015). This situation can affect women's own perceptions of scientific literacy.

After the 1980s, scientific literacy has become the main goal of science education in many countries, and it has become the main objective of the science education programs of developed countries to educate all citizens who can follow and adapt to scientific and technological developments (Bybee, 1997; Laugksch, 2000; Turgut, 2007). Today, scientific literacy is seen as a competence that an individual must have to adapt to modern society (Kesik, 2016; Özgelen, 2010; Soobard, 2015). Scientific literacy is defined as knowing the basic scientific concepts and principles, using scientific thinking and process skills in solving a problem, valuing science and technology, mastering concepts related to science as well as socio-scientific and technological literacy (Bybee, 1997; DeBoer, 2000; Karataş et al., 2018; Laugksch, 2000; Miller, 1983). Holbrook and Rannikmae (2009) state that scientific literacy has an important function not only for gaining knowledge but also in making decisions and acting responsibly within the society (at home, at work, in the community) as a citizen.

Although educational institutions have an essential role in raising scientifically literate individuals, in our ever-changing world of knowledge, the existence of lifelong learners and self-improvement of individuals. (Argyris, 1991; Geisinger, 2016). It is argued that people may maintain their scientific literacy after school where a need emerge to develop themselves in a field that they perceive themselves incomplete throughout their lives. (Aikenhead et al., 2011; Somyürek & Çelik, 2017). It is stated that this need for improvement can only be possible with an accurate evaluation of their own perceptions (Cengiz & Karataş, 2016; Valentine et al., 2004). People who constantly monitor their own actions, decisions, competencies, and skills will naturally be more aware of their current situation and willing to change. At the same time, individuals who can make self-assessment will be able to remain scientifically literate as lifelong learners because they are aware of their shortcomings and hence organize their own learning (Panadero et al., 2017).

There are many studies that examine the scientific literacy levels of individuals from various perspectives (Dani, 2009; Laugksch & Spargo, 1996; Losh; 2006; Naganuma, 2017; Sarkar & Corrigan, 2014; Wu et al., 2012). Naganuma (2017) compared the scientific literacy of Japanese people according to demographic variables including gender, age, and educational status and noted that there was no significant relationship between gender and scientific literacy, but that there was a significant relationship between educational level and scientific literacy. Similarly, Wu et al. (2012) tried to determine the attitudes of Taiwanese people towards science and technology by using the scientific literacy scale. The study reported that the gender variable was in favor of men and that the higher the education level, the higher the positive attitude towards science. Losh (2006) tried to predict the scientific literacy levels of the American people with respect to their educational level and reported that the higher the level of the higher the scientific literacy score. However, no study examining the relationship between the scientific literacy levels of individuals and their perceptions of their scientific literacy levels has been encountered to the best of the ability of the authors. In this study, the measured scientific literacy levels of individuals will be examined by comparing their perceptions of their scientific literacy levels.

In addition, the items in the scientific literacy scale were used as a data collection tool to determine to what extent the participants gave their answers with confidence or to what extent they predicted the level of their scientific literacy. The scale consists of items that require participants to state that a given proposition is true or false, and if they are not sure about the answer, they may choose the option of "no idea". It is assumed that in a measurement tool consisting of items with this structure, participants can make predictions without having sufficient knowledge about some items. In this case, there is a 50% probability of giving a correct answer. This situation, which can be called a chance success, affects the validity of the information obtained from the scale. In order to determine this situation, the participants in this study were asked to evaluate themselves in terms of their scientific literacy before and after the scale was administrated. In particular, the difference between the scores obtained after the administration and the estimated score reveals the result that individuals make predictions without realizing it. This result may require discussing the validity of the data obtained from the self-report data collection tools in which individuals express their own views. In addition, the relationship between individuals' demographic variables, including the level of education, and gender, and their perceptions of their knowledge of a subject or competencies were examined and were compared with the measured values.

The Purpose of the Study

The purpose of this study is to compare adults' perceptions of their scientific literacy levels with their levels determined by the scientific literacy scale. This comparison is also examined in terms of the levels of education and genders of the individuals. In this context, the following questions are sought.

- What is the relationship between adults' perceptions of their scientific literacy levels and their measured levels?

a. What is the relationship between adults' perceptions of their scientific literacy levels and their measured levels in terms of gender?

b. What is the relationship between adults' perceptions of their scientific literacy levels and their measured levels in terms of education levels?

Methodology

This study was designed in accord with the survey research methodology which is one of the quantitative research designs. The survey design is a non-experimental research design that aims to determine and explain the existence and degree of the relationship between two or more variables and allows definition and prediction (Christensen et al., 2015; Ekiz, 2009).

Population and Sample

The population of this study constitutes adult citizens of Turkey, aging from 18 to 65. The sample in which the study was conducted was selected by stratified and proportional sampling. It was determined the number of citizens to be reached in each province by downsizing 1/4800 on a provincial basis according to educational level and gender strata. As a result, the sample of the study consisted of 5426 citizens between the ages of 18-65 selected from a total of 14 provinces; two provinces (one small and one large) from each of the seven geographical regions of Turkey. Table 1 represents the distribution of the number of citizens in the sample in terms of gender and the level of education. To ensure the maximum diversity and the highest representability, the most and the least populated provinces of each region were selected. The provinces with the lowest population density were also selected to include people with a more homogeneous structure and more limited opportunities.

Table 1

Demographics of the Sample

Level of Education	Gender (f)		
	Male	Female	Total
Illiterate	19	59	78
Literate but not graduated from a school	46	75	121
Elementary school graduate	359	471	830
Middle school graduate	524	508	1032
High School graduate	663	738	1401
Community school (associate degree)	126	155	281
University graduate	630	721	1351
MS degree	122	131	253
Doctoral degree	47	31	78
Total	2537	2889	5426

Data Collection

In this study, the "Scientific Literacy Scale" (SLS) developed by the researchers was used as a data collection tool (see Appendix 1 for sample items). The scale consists of 36 items about science that are answered as "right, wrong, or I have no idea." The dimension and scope of the scale were determined by 58 academics who were the experts in their fields using the Delphi technique, and questions were generated accordingly (Hsu & Sandford, 2007). The pilot study of the scale was conducted with 597 adults residing in Trabzon, Turkey and selected through a stratified and proportional sampling. During the pilot implementation phase, the pilot scale, consisting of 80 items was applied by dividing it into two equivalent forms with 40 questions in line with the opinions of the experts of measurement and evaluation, in terms of convenience and applicability. In applying the equivalent forms of the scale, attention has been paid to the proportionality of the distribution of variables such as education, age, and gender in the equivalent forms (Karataş et al., 2019). Items with low discrimination power were removed from the scale based on the results of the item analysis run with the obtained data, and then corrections were made on the items deemed necessary to be corrected (Karataş et al., 2019). While the reliability coefficient of Form 1 was 0.79, that of Form 2 was found to be 0.80. As a result, the 36-question final scale for the main study was developed based on the necessary corrections and item statistics. The reliability coefficient of the scale was calculated as 0.85 for the sample of the study.

Data Collection Process

The data collection process of this research was carried out in 14 provinces; two provinces from each of the seven geographical regions of Turkey. Data collection was carried out in three ways: online, mobile application-based, and face-to-face with the participants. After obtaining permission from the local authorities, the SLS was administered to the voluntary adults in public areas of the cities, such as public education centers, training centers of municipalities, shopping centers, etc. The SLS was employed to illiterate people face to face by reading each question and selecting their choices for that question. The online and application-based data collection parts of the scale were employed by the participants reaching the scale online (Google Forms or a mobile application developed for the scale). In addition to scientific literacy items, the question "How many points do you think you can get out of 100 points from this scale which consists of science-related questions?" was posed and the answers were recorded for each participant. The data collection process took approximately eight months to complete.

Ethical Considerations

In order to ensure the validity and reliability of the study, friendly environment was tried to be provided in face-to-face implementation where the participants could respond comfortably. Before the application, brief information was given to the sample group about the purpose of the study and the content of the questionnaire, the researcher provided information such as "your identity and contact information will not be asked and all information you would give will remain anonymous", "the data will only be used for research purposes" and "the participation is voluntary." After getting their consent for the study, the SLS was employed. Although completing the SLS takes approximately 20-25 minutes, additional time required for the individuals to respond comfortably is also provided. In the online and mobile application-based data collection stages, the necessary notifications were provided to the participants before the scale was applied. Since the participants accessed the scale with their mobile devices, they completed the scale at the appropriate time and place.

Data Analysis

In the analysis of the data obtained, the answers received from the participants were scored as "1" if they were "true," "0" either if they were "wrong" or "I have no idea." The highest score a participant can get from the scale is 36 and the lowest score is 0. In order to improve the readability, the scores obtained by the individuals were converted to 100, and then the analyses were carried out. The correlation coefficients and descriptive statistics were obtained for the data. In addition, the answers given to the question "How many points do you think you can get out of 100 points from the SLS which consists of science-related questions?" before they started to answer the survey, were referred to as “preliminary score prediction,” and the answers given after completing the SLS were named as “post-score prediction.”

Results

In the analysis of the data obtained, the relationship between the pre-score prediction and post-score predictions of the individuals and the actual scores they got from the scale were examined first. As reported in Table 2, all correlation coefficients were found to be significant at the 0.01 level. It was seen that the correlation coefficient between the observed scores of the individuals and the score predictions before the scale was employed was 0.30 and the correlation was significant. The scores they expected after completing the scale show a higher correlation with the actual test scores than the scores they expected to receive before they saw the items in the SLS. Although the scores predicted by the individuals after seeing the questions in the scale were closer to the scores they got from the test, a high, positive, and significant relationship between the pre- and post-prediction scores of the individuals (r = 0.74) showed that seeing the questions was not effective enough to change their mind.

Table 2

Pearson Correlation Coefficient

	Observed Score	Pre-Score Prediction	Post-Score Prediction
Observed Score	1		
Pre-Score Prediction	0.30**	1	
Post-Score Prediction	0.39**	0,74**	1

Note. **: p<0,01

Table 3 shows the percentages of individuals expecting lower or higher scores compared to their actual scores before and after seeing the SLS. Accordingly, 39.4% of the individuals predicted a lower score compared to their actual scores in both their pre and post estimates. On the other hand, 44.1% of the participants expected that they would get higher scores than their observed scores in their preliminary and post-score estimates. In addition, according to the results, 53.4% of the individuals predicted that they would get a higher score than their observed scores in their preliminary score estimates and 51.3 percent in their post-score estimates.

Table 3

Proportional Change of Preliminary and Final Score Predictions

		Post-Score Prediction		
		Low	High	Total
Pre-Score Prediction	Low	%39.4	%7.2	%46.6
	High	%9.3	%44.1	%53.4
	Total	%48.7	%51.3	

As seen in Table 4, when the average score of the individuals by their educational level was examined, the average of the pre-predictions of illiterate people was 44.90 and 48.09 after the SLS was employed, while the average of the measured scores is 36.04. The average of the pre-score estimates of the doctoral graduates is 73.47 and the average of the post-score estimates is 74.10, while the average of the actual scores was 79.21. It was observed that secondary school, high school, associate's (two-year program after high school), bachelor's degree, and who were literate but did not graduate from a school, decreased their estimated scores after seeing the questions. However, it was seen that individuals with all education levels below university education actually got lower scores than their preliminary estimates. In addition, it was observed that the individuals with undergraduate and graduate degrees got higher scores on the SLC compared to their preliminary estimates. However, the score predictions of the participants with a PhD or master's degree increased from pre to post and got closer to their observed scores after seeing the questions. Looking at the average of the predicted scores corresponding to each number of lines (see Appendix 2), it was observed that as the number of correct responses increased, the predicted scores also increased, but in the post-score estimates, there was a decrease in this respect compared to the preliminary score estimates. Considering the individuals answering "I have no idea" to the questions, the average number of "no idea" responses decreased with the level of education, with the exception of participants having associate degrees (graduates of two-year programs).

Table 4

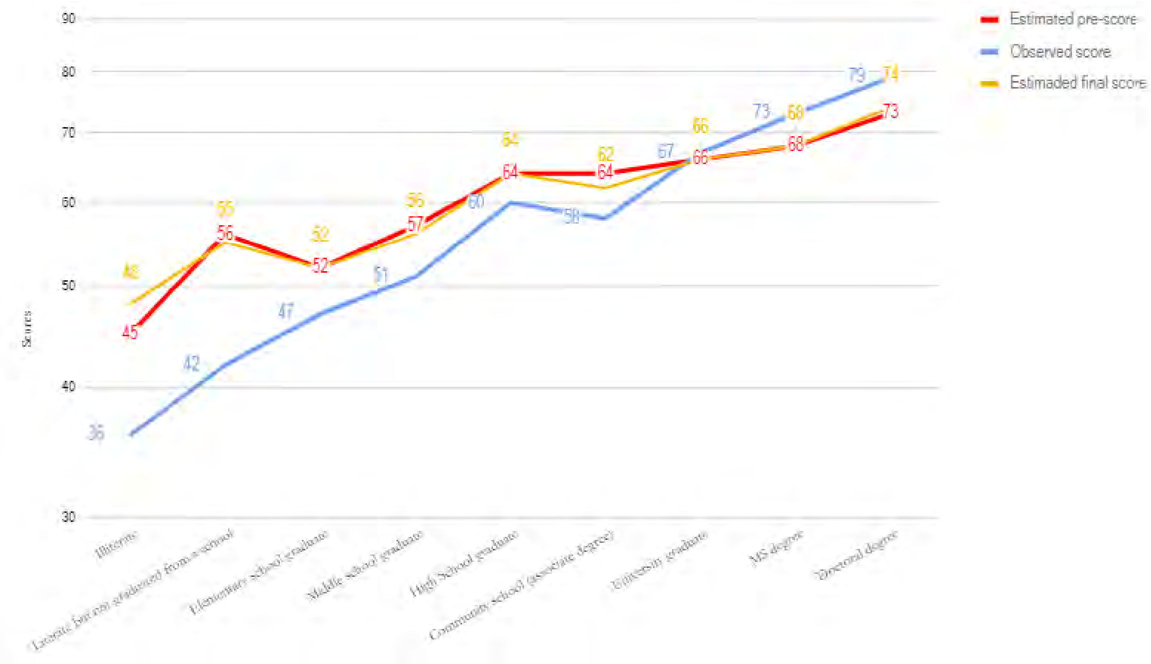
Average Sores and "I Have No Idea" Responses by Educational Degree

Educational Degree	Pre-prediction	Observed score	Post-prediction	Average "No Idea" responses
Illiterate	44.90	36.04	48.09	13.68
Literate but not graduated from a school	55.73	42.04	55.60	11.99
Elementary school graduate	52.50	46.78	52.64	10.13
Middle school graduate	57.39	50.85	56.54	9.34
High School graduate	64.20	60.22	63.97	6.47
Community school (associate degree)	63.82	57.87	61.66	6.76
University graduate	66.44	67.11	66.10	5
MS degree	67.68	72.65	68.35	3.92
Doctoral degree	73.47	79.21	74.10	2.38
Total	61.48	58.07	61.17	7.74

When the data in Table 4 was plotted, the differences between the pre- and post-score estimates and the measured scores were more evident. Predicted and observed score lines intersected at the scores of the university graduates. The slope reverses with postgraduate education that is to say the observed scores of these participants were higher than their predicted scores as it can be seen in Figure 1. In other words, university graduates predicted their scores with the most accuracy.

Figure 1

The Slope of Three Scores by Educational Degree



Regarding gender, as seen in Table 5, while the average of pre-score predictions of the male participants was 63.25, the average of their post-score predictions was 63.32, and that of their observed scores was 58.97. While the average pre-score predictions of female participants was 59.92, the average of their post-score predictions was 59.27, and that of their observed scores was 57.30. This result conveyed that males predicted higher scores than females did. Although there was a slight difference, after answering the questions, women's post-score predictions moved towards their observed scores, while males' scores moved further away from the observed scores. When the scores obtained were compared, it was observed that although the difference between the males and females was not high, both pre- and post-score predictions of the females were closer to their observed scores.

Table 5

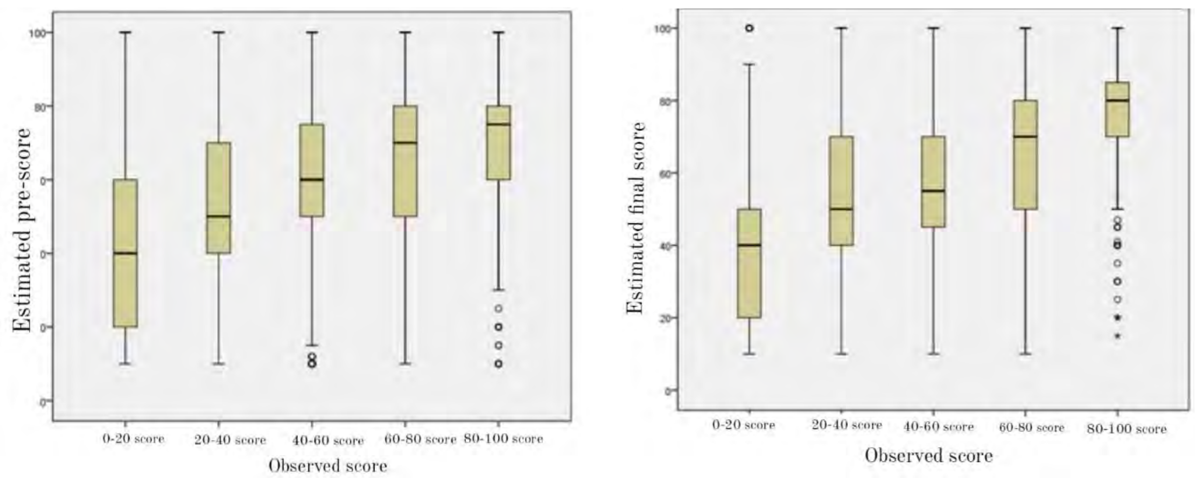
Predicted and Observed Average Scores by Gender

Gender	Pre-prediction	Observed score	Post-prediction	Average "No Idea" responses
Male	63.25	58.97	63.32	7.91
Female	59.92	57.30	59.27	6.54

The distribution of the predicted scores that the individuals expected from the SLS before and after answering the questions by their observed scores would provide more information to decide how answering the questions affected the participants' self-assessment (see Figure 2). Figure 2 shows the distribution of pre- and post-score predictions according to the observed scores the individuals got from the SLS. The estimated preliminary scores of the individuals who scored between 0-20 in SLS ranged between 10 and 100 points. These box plots show how similar the estimated scores are in each score range. Accordingly, as the observed scores of individuals from the scale increased, the estimated scores moved towards the observed one. In other words, the deviation of the estimated scores decreased as the scores obtained from the scale increased (see Appendix 2). In addition, as the score obtained from the scale increased, the estimated average score also increased. Another remarkable point was that as the scores obtained from the scale increased, the number of individuals who predicted low scores also increased.

Figure 2

Distribution of Pre and Post Predicted Scores by Observed Scores from the SLS



Discussion and Conclusion

In this study, adults' perceptions of scientific literacy levels were compared with their observed scores from the Scientific Literacy Scale (SLS). These comparisons were also scrutinized in terms of the educational levels and genders of the individuals. The results of the analysis showed that the individuals' measured scientific literacy scores were significantly related to their perceptions about their scientific literacy levels. The findings revealed that the post-score predictions moved towards the measured scores when compared to the preliminary predicted scores.

After answering the questions on the scale, it was observed that people's perceptions about their scientific literacy levels were closer to the measured ones. However, it was determined that this awareness was limited to some educational levels. The opposite trend was observed in the illiterate group. In their post-score predictions, illiterate people predicted that they would score higher than their actual scores. This coincides with the Dunning-Kruger effect (Kruger & Dunning, 1999). In other words, it was seen that the illiterate participants were not aware of their inadequacy in science. In all education levels except the illiterate group, the gap between observed and perceived scores either reduced or remained the same. In particular, the post-score prediction of the associate degree graduates (two-year vocational program after high school) approached more to the measured scores than the other groups.

However, in the previous studies, it has been emphasized that individuals’ awareness of their lack of scientific literacy requires skills, and the situation cannot be noticed by the individuals unless the knowledge they lack is corrected (Schlösser et al., 2013). In other words, it can be said that telling an individual that they have insufficient knowledge in a field does not increase their awareness. Being aware of this situation is related to the concepts of metacognition and self-evaluation (Turğut, 2015). As a matter of fact, it can be claimed that the participants who predicted closer scores to their actual scores in their post-score predictions showed that their self-assessment awareness increased. Especially the improvement in the predictions of the participants with associate’s degree indicates that they are ready for self-assessment but they need a criterion for this. The results obtained indicated that the scientific literacy scale played a key role as a criterion in the self-evaluation of the participants. This also indicates that citizens - with the exception of illiterates - have a certain level of meta-cognitive reasoning, although they see themselves as better than they really are up to university level. After seeing the questions, the high expectation rate from the test decreased from 53.4 to 51.3. The decrease in the expectation may have happened due to perceiving the questions as difficult. However, according to the results, the score that 25 percent of the individuals in the sample predicted to get from the SLS after answering the questions approached the score they actually got, while the expected scores of 27 percent moved away from the score they actually got.

Various differences were observed in the preliminary scores predicted before answering the SLS regarding the educational levels. It was observed that individuals having education up to university education made higher estimates than their observed scores, while the ones with a university, master's, or doctoral degrees predicted lower scores than their measured scores. This result coincides with the findings of Somyürek and Çelik (2017). Personality, career-expertise, or abilities are effective in making decisions about the daily lives of individuals (Dunning et al., 2004). Depending on these characteristics, individuals increase their expectations from themselves and enter into a positive bias towards themselves. These results are consistent with the results of the study conducted by Kruger and Dunning (1999). However, interestingly, it was observed that individuals with a degree from a university or later educational levels had a decrease in their post-score predictions which approached their observed scores. Likewise, it has been reported in the literature that individuals with high competence or education reflect low self-efficacy perceptions. In addition, it has been stated that the field or difficulty level of the subject being evaluated is also effective in the individual's self-assessment (Fu et al., 2005; Moore & Healy, 2008; Stankov & Crawford, 1997). However, although the item difficulty coefficient of the SLS is 0.55, the fact that less accurate predictions were made by most of the groups shows that their self-perception about scientific literacy was low. Individuals whose perceptions of their own scientific literacy competencies did not coincide with reality are likely to be erroneous in their science-related decisions since their decisions will be based on false assumptions (Tarter & Hoy, 1998). Efforts to improve the educational levels of society will enable individuals to be more realistic in making decisions regarding professional and personal development including science-related issues.

Seeing own lack of competence or skills in a field is considered a skill of self-awareness (Schlösser et al., 2013). As a matter of fact, the perception of the participants who had a master's or doctorate, own scientific literacy at a lower level than the observed one indicated that their skills have developed and they are well aware that they cannot be very competent in every aspect of science as science compromise of wide and deep topics, concepts and fields. On the other hand, one of the reasons why highly educated individuals perceive their levels lower than observed may be due to the imposter syndrome, which is one of the results of perfectionism and expertise in the field. Perfectionists may never feel themselves adequate. Experts, on the other hand, have competence in their own fields and, since they are aware of the limits of this competence, they may have the understanding that "we can never know enough." This situation may increase their anxiety of being insufficient in terms of knowledge and experience from the outside (Chapman, 2017; Knights & Clarke, 2014).

Another finding of this study was that the difference between the predicted (both pre- and post-) and the observed scores were found to be lower for women than for men. People's self-evaluation skills would be related to gender as well as their culture (Schlösser et al., 2013). As a result of the analysis made for the gender variable in this study, the decrease in the post-score estimates of women showed that they had more realistic expectations than men after answering the questions. This result reveals that men behave more confidently than women. In the literature, it is stated that gender is effective in excessive self-confidence (Barber, & Odean, 2001; Correll, 2001; Jakobsson et al., 2013; Meier-Pesti & Penz, 2008). It is possible for women to see themselves incompetent as a symptom of the imposter syndrome in science-related literacy, whereas men have been dominant for many years and have difficulty in finding role models for themselves because they have been accepted as housewives for a long time in social life (Breeze, 2018).

The results shed light on the discussions about data collection tools and their validity in social sciences. As known, most of the data collection methods other than observations, especially in social sciences, are based on self-reporting tools such as questionnaires, scales, and interviews. In the literature, it is stated that the data obtained from the scales about feelings and attitudes need to be supported with a secondary source because of the possibility that an individual can express what s/he thinks is desired or good (Denzin, 2012). Individuals might act to please researchers, but also because of inadequate self-evaluation. In other words, although individuals' opinions, perceptions, views, and evaluations are subjective, these evaluations may not always be conscious. In other words, people's awareness of themselves may not coincide with reality.

Suggestions

Education not only improves the professional competencies of individuals but also helps them evaluate themselves in an effective way. Therefore, all formal and informal efforts made to improve the average level of education, which is still low in many countries, should be supported. In this context, the sustainability of the activities of science fairs/festivals, museums, and science centers that address the general public should be increased. Thus, those who consider the level of scientific literacy higher than it is will be able to improve themselves without facing judgment.

When designing studies in social sciences, it is necessary to include supportive measurement/data collection processes, taking into account that perceptions may also distort their real experiences while collecting data about the situations and experiences of individuals in their environment in order to increase the validity of the study. For this reason, besides collecting self-reporting data, the techniques that allow direct measurement such as observations, eye tracking, heartbeat, brain neurological movements, and facial expressions should be included while designing a study.

Although there is no big difference in scientific literacy scores, the lower perception of women compared to men may be socially related to the place of women in society. For this reason, by referring to more female scientists in the textbooks, it can be ensured that they take role models.

As revealed in this study, the validity of studies based on using only one type of data collection tool should be questioned. In addition, the use of a similar type of a second tool for triangulation can only provide reliability in the research. For example, supporting survey data and data we obtained through an interview can only be used to improve the reliability of the findings. For more valid findings, it is necessary to use data collection tools for more direct observation. In order to overcome the problem of such a method that poses a threat to the validity of the obtained data, more direct or physiological measurement methods such as FMRI (Functional Magnetic Resonance Imaging), eye tracking, and facial expressions, which have recently begun to find more use, should be employed.

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Appendix

Appendix 1

Sample SLS items

1. When water is boiled, it decomposes into oxygen and hydrogen molecules.
2. While an item is carried to the fifth floor, it gains more potential energy if it is carried by stairs instead of an elevator.
3. The small intestine is an organ of the urinary system as it is involved in the elimination of nutrients from the body.
4. An increase or decrease in the number of birds in a region negatively affects the balance in the ecosystem.

Appendix 2

Predicted and Observed Scores According to the Correct Number

Number of Correct Answers	Points Equivalent	Preliminary Score Prediction	Post-Score Prediction	Number of Correct Answers	Points Equivalent	Preliminary Score Prediction	Post-Score Prediction
1	2.78	34.44	31.67	19	52.78	59.88	59.49
2	5.56	55.00	43.33	20	55.56	60.33	61.27
3	8.33	32.92	32.92	21	58.34	60.42	60.03
4	11.11	44.23	43.08	22	61.12	61.01	60.46
5	13.89	44.05	40.90	23	63.89	63.95	61.87
6	16.67	50.32	48.87	24	66.67	64.28	65.62
7	19.45	43.95	42.91	25	69.45	64.12	63.87
8	22.22	46.83	44.19	26	72.23	65.64	67.54
9	25.00	54.82	52.15	27	75.01	67.58	68.72
10	27.78	52.36	49.11	28	77.78	67.18	68.34
11	30.56	55.04	53.36	29	80.56	67.14	69.03
12	33.34	55.73	55.71	30	83.34	69.67	72.90
13	36.11	50.79	49.32	31	86.12	72.01	75.81
14	38.89	57.29	55.46	32	88.90	74.78	78.40
15	41.67	55.67	51.80	33	91.67	77.01	79.13
16	44.45	58.98	55.60	34	94.45	78.29	82.76
17	47.23	55.85	53.91	35	97.23	76.56	82.50
18	50.00	59.69	57.38	36	100.00	82.50	82.50