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Original Research

Measuring Scientific Literacy Among Ahvaz Citizens

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Abstract

This study attempts to measure scientific literacy among the citizens of Ahvaz. The data collection tool was a validated questionnaire with 5 dimensions, 25 components, and 316 items. The study's statistical population involved all the citizens of Ahvaz over 18 years of age, and the stratified random sampling method was utilized. Besides, 600 questionnaires were distributed in Ahvaz Municipality, of which 401 completed questionnaires were finally analyzed. Data was analyzed using a one-sample t-test and Friedman test via SPSS and Excel software. The results showed that the scientific literacy among the citizens of Ahvaz was above average. It is therefore suggested that managers and policymakers in Ahvaz use the results of the present study and conduct periodic surveys on the scientific literacy of Ahvaz citizens to solve their problems and improve their level of scientific literacy. The validated questionnaire used in the present study can be administered in similar studies on micro and macro scales.

Keywords: Scientific Literacy, Science, Assessment, Ahvaz Citizens.

Introduction

A review of the recorded literature can help recognize the importance of scientific literacy. In a paper published in *Science Journal* in 1989, Culliton (1989) stated that only 6% of Americans and 7% of Britons had a desired level of scientific literacy. He also noted that less than half of Americans and only a third of Britons knew that the Earth revolves around the sun once a year. Besides, most people surveyed thought that antibiotics kill viruses. 12% of Americans stated that astrology is not scientific, and 88% made mistakes in quick mathematical calculations.

Data from the US National Center for Educational Statistics in 2006 also showed that only 18% of grade 12 students reached the skill level (cited in Liu, 2009, 304). Hardinata and Permanasari (2019) surveyed students' academic literacy in Indonesia based on the Program for International Student Assessment (PISA) from 2000- 2015. The results of the PISA survey of

the year 2012 showed that Indonesia's education system is still far from expectations. Out of 65 PISA member countries, Indonesia ranks 64th. However, in the PISA test in 2015, Indonesia ranked 64th out of 72 countries, and the test score increased from 382 in 2012 to 403.

The studies above are examples of scientific literacy among different groups. Note that thinkers have considered the concept of scientific literacy. Durant (1994) argued that there are three approaches to scientific literacy, each emphasizing a completely different aspect of science. The first approach emphasizes the content of science (scientific knowledge), the second approach insists on the process of science (scientific method), and the third approach focuses on social structures or institutions of science (scientific culture). According to him, these three approaches show that ordinary people try to know things about science in a complex set of science and technology.

Moreover, a review of texts shows that several conceptual and evaluative types of research have been done on scientific literacy and related concepts. The totality of the research conducted on the subject can be divided into seven categories as follows:

Category 1 is conceptual research related to scientific literacy: such as Hurd (1958, 1990), and DeBoer (2000) research that deals with the historical, philosophical, and contemporary meanings of scientific literacy, or Gräber et al. (2001) described the concept of scientific literacy.

Category 2 is research that developed or improved a tool or indicator to measure scientific literacy. For instance, Rundgren, Rundgren, Tseng, Lin and Chang, (2012) developed a tool for measuring people's scientific literacy based on media coverage.

Category 3 examined scientific literacy in a country, city, etc. The first public survey of science was conducted in 1957 in the United States by the National Science Foundation. The survey measured dimensions such as interest in science, attitudes toward science, and people's knowledge. Moreover, Wu, Zhang and Zhuang (2018) examined China's scientific literacy and showed that the average scientific literacy of Chinese people in the country's central regions is less than 6%. Naganuma (2017) examined the scientific literacy of the Japanese. Miller (1995) also examined American adults' scientific literacy. For the first time in 2011, Ghaneirad and Morshedi surveyed the scientific literacy of the citizens of Tehran.

Category 4 Studies examining scientific literacy in a particular subject, such as Rusilowati, Nugroho, Susilowati, Mustika, Harfiyani and Prabowo (2018) in the field of energy or Meyers (1991) on the level of scientific literacy on radioactive waste.

Category 5 has developed and introduced methods for measuring scientific literacy, such as De Oliveira, Gerevini and Guimaraes Strohschoen (2012), or Romine, Sadler and Kinslow (2016).

Category 6 Studies that have examined scientific literacy by a particular gender or educational or age group, such as Chao and Wei (2009), studied the scientific literacy of Chinese men and women and showed that men's scientific literacy is higher than men's women.

Category 7 Studies that proposed a method or technique to strengthen the scientific literacy of different groups, such as Elliott (2006), who introduced a technique to strengthen the scientific literacy of teachers-students.

In most studies, the results indicate a low level of scientific literacy among people in different countries. Although various tools have been proposed to measure scientific literacy, no standard tools have been found. In addition, most studies have measured citizens' scientific literacy based on one or more dimensions of cognition, behavior, attitude, evaluation, and

knowledge.

The reality, however, is that without a proper understanding of the place of science in everyday life and without an understanding of who scientists are and how science advances, what dangers and hopes they pose to human life, and what role governments play in the advancement and control of science, and what scientists have to do with the level of development and welfare of the Society, the general public cannot participate actively and effectively in this regard (Maeseele, 2007). Moreover, a review of texts and documents related to scientific literacy in Iran shows that this issue has not received much attention, both conceptually and in terms of the survey. This study thus intends to examine the scientific literacy of Ahvaz citizens.

According to the 2016 census, Ahvaz was one of the eight metropolises of Iran with a population of 1,184,788 people, from whom 92.4% (94.9% men and 89.7% women) were literate. Of the total literate population of 972,981 in Ahvaz, 23.9% were at the level of literacy and elementary, 15.6% in middle school, 33.5% in secondary, and 26.7% in higher education (Statistical Centre of Iran, 2021). According to the Iranian University Reference website, there are 69 scientific and academic centers in Khuzestan province, 15 active in the city of Ahvaz, and they have already been published in 45 scientific journals. Researchers in universities and scientific centers of Khuzestan province have published 81585 scientific articles, including 9373 journal articles and 50612 articles in domestic scientific conferences and 9373 articles. In 2018, universities in Khuzestan province accommodated 101,161 students and 5,389 faculty members (Iranian University Reference Database, 1400).

According to the information mentioned and considering the subject of the research, which was to examine the scientific literacy of Ahvaz citizens about science, and since no scientific information and research findings in this field were already available in Ahvaz, the present study has sought first to review and categorize research related to the subject of scientific literacy and then to determine the status of Ahvaz citizens' scientific literacy based on the five dimensions of cognition, behavior, attitude, evaluation, and knowledge. The following research questions stand out:

1. What is the understanding level of science and scientific subjects among Ahvaz citizens?
2. To what extent do the citizens of Ahvaz carry out scientific activities and programs?
3. What is the attitude of Ahvaz citizens towards science and scientific issues?
4. What is the assessment of Ahvaz citizens regarding their level of science and knowledge and its impact on their lives?
5. What is the scientific knowledge level of the citizens of Ahvaz?

Materials and Methods

This research includes two parts: 1) the construction and validation of a scientific literacy instrument and 2) the assessment of the scientific literacy of Ahvaz citizens based on the instrument constructed. For constructing and validating a scientific literacy instrument, first, the items and dimensions of the scientific literacy questionnaire were identified using a qualitative approach and a documentary analysis. Then the initial questionnaire was developed and given to the members of the Delphi panel, and its dimensions and components were gradually finalized. In the second stage, with a quantitative approach, the questionnaire was first validated using two indicators: Relative Content Ratio (CVR) and Content Validity Index (CVI), and also based on Cronbach's alpha. Finally, the questionnaire was approved in five

dimensions (cognitive, behavioral, attitude, evaluation, and knowledge), 25 components, and 316 items. The number of items in each cognitive, behavioral, attitudinal, evaluative, and cognitive dimension is 46, 60, 170, 21, and 19, respectively. For the second part, based on this validated questionnaire, the scientific literacy status of Ahvaz citizens was assessed.

A survey approach was used to measure the scientific literacy of the citizens of Ahvaz. The data collection instrument is a validated questionnaire that has already been explained. The statistical population of the study includes Ahvaz citizens over 18 years of age who are, according to the census of 2016 of the Statistics Center of Iran, 820.000 people. The sample size was comprised of 384 individuals based on Cochran's formula. The stratified-random sampling method was utilized, and 600 questionnaires were distributed in the eight districts of Ahvaz Municipality. The participants finally completed four hundred-one questionnaires, which were then analyzed (Table 1). Data were analyzed using descriptive and inferential tests (one-sample t-test and Friedman) under SPSS and Excel software.

Table 1

Status of distributed questionnaires in Ahvaz

Urban areas of Ahvaz / Statistics	1	2	3	4	5	6	7	8	Total
Sample size	44	33	61	42	36	59	51	58	384
Number of questionnaires distributed	69	53	94	66	57	91	80	90	600
Number of completed questionnaires	48	37	60	45	38	57	55	61	401

Results

Descriptive findings

To describe the Ahvaz people's scientific literacy and its merit to the country, this section provides information about the characteristics of 401 research samples.

A: Description of the age groups of Ahvaz citizens by gender

Table 2 shows the age group versus gender status of 392 Ahvaz citizens who answered the questionnaire (9 people did not declare their gender).

Table 2
Status of Ahvaz citizens' age groups by gender

Total	Over 66	61-65	56-60	51-55	46-50	41-45	36-40	31-35	26-30	21-25	Under 20	Age	
182	11	12	5	8	20	13	19	36	28	22	8	No.	Male
46.4	2.8	3.1	1.3	2	5.1	3.3	4.8	9.2	7.1	5.6	2	%	
210	11	5	3	12	8	15	34	42	33	25	22	No.	Female
53.6	2.8	1.3	0.8	3.1	2	3.8	8.7	10.7	8.4	6.4	5.6	%	
392	22	17	8	20	28	28	53	78	61	47	30	No.	Total
100	5.6	4.3	2	5.1	7.1	7.1	13.5	19.9	15.6	12	7.7	%	

The data in Table 2 show that most female (10.7%) and male (9.2%) citizens surveyed in this study are 31-35 years old.

B: Description of education of Ahvaz citizens by gender

Table 3 shows the educational status of 398 Ahvaz citizens who answered the questionnaire (3 did not declare) by gender.

Table 3
Education status of Ahvaz citizens by gender

Total	Clerical educations	Doctorate	Master's degree	Bachelor's degree	Associate degree	Diploma	Middle school degree	Elementary		
183	7	4	30	47	26	47	16	6	No.	Male
46	1.8	1	7.5	11.8	6.5	11.8	4	1.5	%	
215	4	4	35	62	18	61	26	7	No.	Female
54	1	1	5.8	15.6	4.5	15.3	6	1.8	%	
398	11	8	65	109	44	108	40	13	No.	total
100	2.8	2	16.3	27.4	11.1	27.1	10.1	3.3	%	

The data in Table 3 show that most Ahvaz men and women had a diploma or bachelor's degree (11.8%).

C: Description of Ahvaz citizens' high school field of study by gender

Table 4 shows the high school fields of study of 311 Ahvaz citizens who answered the questionnaire by gender (90 people had less than a middle school degree or did not declare their education level).

Table 4
Field of study of high school students in Ahvaz, by gender

Total	Theology	Manual skills degree	Vocational training degree	Literature	Science	Math		
142	2	6	30	34	30	40	No.	Male
45.7	0.6	1.9	9.6	10.9	9.6	12.9	%	
169	6	8	15	49	66	25	No.	Female
54.3	1.9	2.6	4.8	15.8	21.2	8	%	
311	8	14	45	83	96	65	No.	Total
100	2.6	4.5	14.5	26.7	30.9	20.9	%	

The data in Table 4 show that most male high school students in Ahvaz (12.9%) had a Math diploma, while the female students had a Science degree (21.2%).

D. Job description of Ahvaz citizens by gender

Table 5 shows the job status of 387 Ahvaz citizens who answered the questionnaire (14 did not declare) by gender.

Table 5
Job status of Ahvaz citizens by gender

Total	Retired	Clergy	University student	High school student	Homemaker	Jobless	Self employed	Private job	Government job		
176	15	18	15	14	0	18	45	21	29	No.	Male
45.5	3.9	4.7	3.9	3.6	0	4.7	11.6	5.4	7.5	%	
211	5	8	35	39	37	20	28	15	24	No.	Female
54.5	1.3	2.1	9	10.1	9.6	5.2	7.2	3.9	6.2	%	
387	20	26	50	53	38	38	73	36	53	No.	Total
100	5.2	6.7	12.9	13.7	9.8	9.8	18.9	9.3	13.7	%	

The data in Table 5 show that most male citizens of Ahvaz were self-employed (11.6%) while most female citizens were students (10.1%) or housewives (9.6%).

Inferential Results

In this section, using a one-sample t-test, the average score of each component of each dimension was compared with the mean value of 3 to determine the status of that component. Friedman test was also used to determine which component has a higher or a lower level in different dimensions.

Question 1: What is the understanding level of science and scientific subjects among Ahvaz citizens?

Table 6 below shows the results of a one-sample t-test for cognitive dimensions of scientific literacy.

Table 6
One-sample t-test for cognitive dimensions of scientific literacy

Result	Sig.	T	S.D	M	N	Cognitive dimensions
Above average	0.004	2.892	0.587	3.084	401	Understanding of science
Above average	0.045	1/933	0.903	3.106	401	Understanding of scientific structures
Above average	0.002	3.090	0.848	3.130	401	Understanding of scientific subjects and terms

S.D= Standard Deviation, M= Mean, N= Number

According to the results of Table 6, the value of significance levels for all cognitive dimensions is less than the significance level $\alpha = 0.05$, and the values of t-test statistics are reported to be positive. Therefore, among the citizens of Ahvaz, the dimensions of *understanding science*, *understanding scientific structures*, and *understanding scientific subjects and terms* have been evaluated above average. As a result, it can be said with 95% confidence that the citizens of Ahvaz have a more-than-average understanding of science, scientific structures, and scientific subjects and terms.

The results of the Friedman test to prioritize the cognitive dimensions of scientific literacy under study are presented in Table 7.

Table 7
Friedman test to rank the cognitive dimensions of scientific literacy

Result	Sig Significance level	χ^2 Test statistic	Dimensions of scientific literacy	
Non-significant difference	0.807	0.419		
Rank	Mean rank	Dimensions		Row
-	2.03	Understanding of science		1
-	1.98	Understanding of scientific structures		2
-	1.99	Understanding of scientific subjects and terms		3

Based on the data in Table 7, the significance level of the Friedman test for examining the components is greater than the significance level value of $\alpha = 0.05$. As a result, it can be said with 95% confidence that the level of understanding of science and scientific subjects among Ahvaz citizens in all cognitive dimensions has been the same and above average.

Question 2: To what extent do the citizens of Ahvaz carry out scientific activities and programs?

Table 8 shows the results of a one-sample t-test for behavioral dimensions of scientific literacy.

Table 8
One-sample t-test for behavioral dimensions of scientific literacy

Result	Sig	T	S.D	M	N	Behavioral dimensions of scientific literacy
Above average	0.000	7.061	0.711	3.25	401	Use of media and scientific resources
Below average	0.000	-20.832	1.043	0.8931	386	Visiting scientific places or exhibitions
Above average	0.000	7.801	0.717	3.279	401	Consulting with knowledgeable people
Above average	0.000	11.955	0.633	3.378	401	Participation in scientific programs
Below average	0.000	-226.298	0.234	0.346	401	Doing scientific activities

According to the results of Table 8, the value of significance levels for the components of the *use of media and scientific resources*, *consulting with knowledgeable people*, and *participation in scientific programs* is less than the value of significance level $\alpha = 0.05$, and the values of the t-test statistics are reported to be positive. Therefore, among the citizens of Ahvaz, the number of activities performed in these components is more than average.

The value of significance levels for the components of *visiting scientific places or exhibitions* and *doing scientific activities* was less than the significance level $\alpha = 0.05$, and the values of t-test statistics were reported as negative. Therefore, among the citizens of Ahvaz, the number of activities performed in these components is below average. As a result, it can be said with 95% confidence that the citizens of Ahvaz perform each behavioral dimension of *public understanding of science* to a different extent.

The results of the Friedman test to prioritize the behavioral dimensions of scientific literacy under study are presented in Table 9.

Table 9
Friedman test to rank the behavioral dimensions of scientific literacy

Result	Sig Significance level	χ^2 Test statistic	Behavioral dimensions of scientific literacy	
Significant difference	0.000	1048.829		
Rank	M Mean rank	Dimensions		Row
3	3.78	Use of media and scientific resources		1
4	2.33	Visiting scientific places or exhibitions		2
2	3.87	Consulting with knowledgeable people		3
1	4	Participation in scientific programs		4
5	1.01	Doing scientific activities		5

Based on the data in Table 9, the significance level of the Friedman test for examining the components of *behavioral dimensions of scientific literacy* is less than the significance level value of $\alpha = 0.05$. Therefore, the components had dissimilar performance levels. As a result, it can be said with 95% confidence that the *behavioral dimensions of scientific literacy* among Ahvaz citizens are very low but not similar. The highest level belonged to the component of *participation in scientific programs* and the lowest to the component *of doing science activities*.

Question 3: What is the attitude of Ahvaz citizens towards science and scientific issues?

Table 10 shows the results of the one-sample t-test for *attitudinal dimensions of scientific literacy*.

Table 10

One-sample t-test for attitudinal dimensions of scientific literacy

Result	Sig Significance level	T statistic	S.D	M	N	Attitudinal dimensions of scientific literacy
Below average	0.000	-6.293	0.916	2.712	401	Interest in science
Below average	0.000	-10.254	0.978	2.499	401	Trust in scientific and media resources
Above average	0.000	12.978	0.740	3.481	399	Giving importance to science, scholars and scientific subjects
Below average	0.000	-99.651	0.275	1.628	401	Scientific progress of Iran
Above average	0.000	4.231	0.667	3.141	401	Attitudes toward the ability of the country's educational structures to familiarize Society with scientific subjects
Above average	0.000	5.631	0.649	3.182	401	Belief in science and the reliability of scientific fields and disciplines
Above average	0.000	13.910	0.732	3.508	401	Competence and aptitude of specialists in the administration of scientific affairs of the country
Above average	0.000	16.073	0.816	3.655	401	Attitudes toward science and scientific subjects
Above average	0.000	13.743	1.177	3.808	401	Attitudes toward scientists and experts
Above average	0.000	18.100	0.614	3.555	401	The Success of specialists in performing assigned responsibilities
Below average	0.000	-2.429	1.111	2.864	398	Country support for science and scientific subjects
Above average	0.000	30.874	0.690	4.065	401	obstacles and problems of scientific progress in the country
Above average	0.000	8.069	0.940	3.379	401	Society's trust in experts and scientists
Above average	0.000	11.353	0.730	3.414	401	Society's trust in specialists (physicians, lawyers, etc.)

According to the results of Table 10, the significance levels for the components of *giving importance to science, scholars, and scientific subjects*,' *Attitudes towards the ability of the country's educational structures to familiarize Society with scientific subjects, belief in science and reliability of scientific fields and disciplines, competence and aptitude of specialists in the administration of scientific affairs of the country, attitudes towards science and scientific subjects, attitudes towards scientists and experts, Success of specialists in performing assigned responsibilities, obstacles, and problems of scientific progress in the co*untry, *Society's trust in experts and scientists*, and *Society's trust in specialists (physicians, lawyers, etc.)* were less than the significance level of $\alpha = 0.05$ and the values of t-test statistics were positive. Therefore, among Ahvaz citizens, the attitude towards these components is above average.

The values of significance levels for the components of *interest in science, trust in scientific and media resources*,' *scientific progress of Iran,* and *country support for science and scientific subjects* are less than the significance level of $\alpha = 0.05$, and the values of t-test statistics were reported to be negative. Therefore, among Ahvaz citizens, the attitude towards these components is below average. As a result, it can be said with 95% confidence that the citizens of Ahvaz have a different attitude towards each of the dimensions of *scientific literacy*.

The results of the Friedman test to rank the attitudinal dimensions of scientific literacy under study are presented in table 11.

Table 11

Friedman test to rank the attitudinal dimensions of scientific literacy

result	Sig Significance level	χ^2 Test statistic	Attitudinal dimensions of scientific literacy	
Significant difference	0.000			
rank	M Mean rank	Dimensions		Row
12	6.17	Interest in science		1
13	5.03	Trust in scientific and media resources		2
6	9.85	Giving importance to science, scholars and scientific subjects		3
14	1.73	Scientific progress of Iran		4
10	7.87	Attitudes toward the ability of the country's educational structures to familiarize Society with scientific subjects		5
9	8.08	Belief in science and the reliability of scientific fields and disciplines		6
5	10.23	Competence and aptitude of specialists in the administration of scientific affairs of the country		7
3	11.05	Attitudes toward science and scientific subjects		8
2	12.31	Attitudes toward scientists and experts		9
4	10.26	The Success of specialists in performing assigned responsibilities		10
11	7.11	Country support for science and scientific subjects		11
1	13.11	obstacles and problems of scientific progress in the country		12
7	9.54	Society's trust in experts and scientists		13
8	9.53	Society's trust in specialists (physicians, lawyers, etc.)		14

Based on the data in Table 11, the significance level of the Friedman test for examining the components of *attitudinal dimensions of scientific literacy* is less than the significance level of $\alpha = 0.05$. As a result, the attitude towards the components has not been the same. Consequently, it can be said with 95% confidence that the citizens of Ahvaz have estimated each of the attitudinal dimensions of scientific literacy to a different extent. In other words, the citizens of Ahvaz have the best attitude towards the components of *obstacles and problems of scientific progress in the country* and *attitudes towards scientists and experts. In contrast,* they have the worst attitude towards the component of *scientific progress in Iran*.

Question 4: What is the assessment of Ahvaz citizens regarding their level of science and knowledge and its impact on their lives?

Table 12 shows the results of a one-sample t-test for dimensions of assessing scientific literacy.

Table 12

One-sample t-test for dimensions of assessment of scientific literacy

result	Sig Significance level	T Statistic	S.D	M	N	Dimensions of assessing scientific literacy
Above average	0.000	4.388	0.877	3.192	401	Effectiveness of the Iranian researchers and scientists' research in solving problems
Below average	0.000	-99.484	0.268	1.668	401	The impact of science on people's lives
Above average	0.000	6.086	2.072	3.640	393	Assessing the level of knowledge of the Iranian people

According to the results of Table 12, the significance levels for the components of the *effectiveness of the Iranian researchers and scientists' research in solving problems* and *assessing the level of knowledge of the Iranian people* is less than the significance level of $\alpha = 0.05$, and the values of t-test statistics are positive. Therefore, among the citizens of Ahvaz, the values of these components are more than average.

The significance level value for the component of *the impact of science on people's lives* was lower than the significance level $\alpha = 0.05$ and the valuesof t-test statistics were reported to be negative. Therefore, among the citizens of Ahvaz, the values of these components are below average. As a result, it can be said with 95% confidence that the citizens of Ahvaz have estimated each of the dimensions of *assessing scientific literacy* to a different extent. The results of the Friedman test to rank the dimensions of assessing scientific literacy considered in this study are given in Table 13.

Table 13
Friedman test to rank the scientific literacy assessment dimensions

Result	Sig Significance level	χ^2 Test statistic	Dimensions of assessing scientific literacy	
Significant difference	0.000	273.432		
Rank	Mean rank	Dimensions		Row
1	2.39	Effectiveness of the Iranian researchers and scientists' research in solving problems		1
2	2.28	The impact of science on people's lives		2
3	1.33	Assessing the level of knowledge of the Iranian people		3

Based on the data in Table 13, the value of the significance level of the Friedman test for examining the components of *dimensions of assessing scientific literacy* is less than the significance level of $\alpha = 0.05$. As a result, the evaluation results of different components were different. Therefore, it can be said with 95% certainty that the *dimensions of assessing scientific literacy* among the citizens of Ahvaz are not the same. The best assessment is related to the component of the *effectiveness of the Iranian researchers and scientists' research in solving problems*, and the lowest assessment is related to the component of *assessing the level of knowledge of the Iranian people*.

Question 5: What is the scientific knowledge level of the citizens of Ahvaz?

Table 14 shows the results of a one-sample t-test to assess the scientific knowledge level of the citizens of Ahvaz.

Table 14
One-sample t-test to examine the components of the level of scientific knowledge

Result	Sig Significance level	T statistic	S.D	M	N	Components of scientific knowledge level
Above average	0.000	29.093	0.50	1.78	394	The center of the Earth is very hot.
Above average	0.000	9.406	0.744	1.35	400	All radioactive radiation comes from artificial products.
Above average	0.000	10.269	0.701	1.36	400	Plants produce the oxygen we use to breathe.
Above average	0.000	5.241	0.505	1.13	401	The father's genes determine whether a fetus is born a boy or a girl.
Average	0.907	0.116	0.826	1.01	397	Lasers work by combining sound waves.
Above average	0.000	4.136	0.812	1.17	398	Electrons are smaller than atoms.

Result	Sig Significance level	T statistic	S.D	M	N	Components of scientific knowledge level
Above average	0.029	2.194	0.844	1.09	399	Antibiotics kill not only viruses but also bacteria.
Average	0.055	1.928	0.861	1.08	395	The Earth's continents have moved and will continue to move for millions of years.
Above average	0.000	4.980	0.393	1.10	398	Smoking causes lung cancer.
Average	0.090	1.702	0.823	1.07	400	Early humans lived at the same time as dinosaurs.
Average	0.499	0.677	0.893	1.03	394	Milk contaminated with radioactive radiation can be drunk after boiling.
Above average	0.000	19.005	0.653	1.62	399	The Earth revolves around the sun every 24 hours.
Above average	0.000	7.172	0.751	1.27	395	Vaccination can cure many human diseases.
Above average	0.000	6.782	0.790	1.27	399	Light travels faster than sound.
Above average	0.000	12.495	0.704	1.44	396	The movement of the Earth's plates leads to earthquakes.
Above average	0.003	2.984	0.821	1.12	400	Hepatitis B viruses do not spread through the air.
Above average	0.029	2.185	0.825	1.09	399	Genes determine the color of a flower.
Above average	0.005	2.798	0.805	1.11	399	Sounds are scattered only in the air.
Average	0.270	1.104	0.840	1.05	377	The world began with a big bang.

According to the results of Table 14, the values of the significance levels for the components of *the center of the Earth are very hot*; *all radioactive radiation comes from man-made products, the oxygen we use to breathe is produced by plants, the father's genes determine whether a fetus is born a boy or a girl, electrons are smaller than atoms, antibiotics kill not only viruses but also bacteria, smoking causes lung cancer, the Earth revolves around the sun every 24 hours, vaccination can cure many human diseases, light travels faster than sound, the movement of the Earth's plates leads to earthquakes*., *hepatitis B viruses do not spread through the air, the color of a flower is determined by genes*, and *sounds are scattered only in the air* were less than the significance level of $\alpha = 0.05$ and the values of t-test statistics were reported to be positive. Therefore, among the citizens of Ahvaz, the level of scientific knowledge in these components has been evaluated as above average.

Besides, the values of the significance levels for the components *lasers work by combining sound waves,* and *the Earth's continents have moved and will continue to move for millions of years*. *Early humans lived at the same time as dinosaurs*; m*ilk contaminated with radioactive*

radiation can be drunk after boiling, and *the world began with a big bang* was greater than the significance level of α = 0.05. Therefore, among the citizens of Ahvaz, the level of scientific knowledge in these components has been evaluated as moderate.

As a result, it can be said with 95% confidence that the citizens of Ahvaz have different views on each of the components of the *level of scientific knowledge*.

The results of the Friedman test to rank the components of the *level of scientific knowledge* that has been considered in this research are presented in Table 15.

Table 15

Friedman test for ranking the components of scientific knowledge level

Result	Sig Significance level	χ^2 Test statistic	Components of scientific knowledge level	
Significant difference	0.000	447.873		
Rank	Mean rank	Components		Row
1	13.75	The center of the Earth is very hot. (True)		1
3	11.35	All radioactive radiation comes from man-made products.		2
5	10.73	Plants produce the oxygen we use to breathe.		3
13	9.21	The father's genes determine whether a fetus is born a boy or a girl.		4
16	9	Lasers work by combining sound waves.		5
9	9.45	Electrons are smaller than atoms.		6
11	9.25	Antibiotics kill not only viruses but also bacteria.		7
15	9.03	The Earth's continents have moved and will continue to move for millions of years.		8
18	8.93	Smoking causes lung cancer.		9
19	8.87	Early humans lived at the same time as dinosaurs.		10
17	8.98	Milk contaminated with radioactive radiation can be drunk after boiling.		11
2	12.54	The Earth revolves around the sun every 24 hours.		12
7	10.14	Vaccination can cure many human diseases.		13
6	10.16	Light travels faster than sound.		14
4	11.28	The movement of the Earth's plates leads to earthquakes.		15
10	9.42	Hepatitis B viruses do not spread through the air.		16
14	9.19	Genes determine the color of a flower.		17
8	9.50	Sounds are scattered only in the air.		18
12	9.24	The world began with a big bang.		19

Based on the data in Table 15, the significance level of the Friedman test for examining the components of *scientific knowledge l*evel is less than the significance level value of α = 0.05. Therefore, the components' scientific knowledge level has not been the same. As a result, it can be said with 95% confidence that the level of scientific knowledge of the citizens of Ahvaz is various. The highest knowledge is related to the components of the center of the Earth, which is very hot and revolves around the sun every 24 hours. The lowest value is related to *early humans living simultaneously as dinosaurs*.

Discussion

Today, due to the importance of science and technology in human life and significant advances in science and technology in various fields, the popularization of science in Society has become a vital issue and concern of some statesmen and policymakers in different countries. In Iran, the role of science and technology in the country's development has been mentioned in the development plan laws of the country. This is especially emphasized in the country's third to sixth economic and social development plans, which are based on scientific development, knowledge-based development, and knowledge-based economy. One of the key issues that must be seriously and continuously considered in the country's scientific and knowledge-based development is the continuous assessment and monitoring of Iranians' understanding of science and technology. This monitoring has not been done systematically and periodically in Iran so far. Therefore, by continuously measuring Iranian scientific literacy, we can help determine the success rate of educational systems and the success rate of scientific and cultural contexts created in Society. Accordingly, in the relationship between science and Society, we can realize which fields of science (e.g., mathematics, medicine, health, environment, etc.) have an acceptable level and which ones need further development and support in Iranian Society. As such, it is also possible to understand the extent of people's participation and involvement in scientific affairs, for which appropriate planning, decision-making, and poly-making can thus be provided. These measurements also help to improve the quantitative and qualitative transmission of knowledge to the people.

On the other hand, without measuring the level of Iranians' scientific literacy and the extent of people's understanding of the place of science in their daily lives, it is impossible to know the status of their participation in scientific affairs. With this argument, studying the Iranians' understanding of science and technology in general and studying the understanding of the citizens of each region and city, in particular, are essential. Given those above, the present study has been conducted on scientific literacy by the citizens of about.

In total, the study of various texts in the field of scientific literacy indicates 7 thematic categories as follows: 1) conceptual research related to scientific literacy, public understanding of science and design of assessment tools, 2) research related to the construction or development of tools or indicators for measuring public understanding of science, 3) research related to the development of scientific literacy in a country, city, etc., 4) research related to scientific literacy in a particular subject, 5) research related to inventing and introducing methods for measuring scientific literacy, 6) research related to the study of the scientific literacy by a particular gender, educational or age group, and 7) research related to methods or techniques to strengthen the scientific literacy by different groups.

In the present study, a validated questionnaire was used to measure scientific literacy, based on Ghaneirad and Morshedi questionnaire (2011), the British public understanding of science questionnaire, the American National Science Foundation questionnaire, and the PISA. The questionnaire measures Ahvaz citizens' scientific literacy through five dimensions of cognition, behavior, attitude, evaluation, and knowledge with 25 components and 316 items.

In general, it can be said that Ahvaz citizens have more than average knowledge of science and scientific structures, subjects, and terms. Among the behavioral components, *participation in scientific programs* is higher. The citizens of Ahvaz had the best attitude towards the components of *obstacles and problems of scientific progress in the country* and *attitudes towards scientists and experts*. Among the components of the evaluation dimension, the

effectiveness of the Iranian researchers and scientists' research in solving problems is in the first place. Finally, the results indicate that the level of scientific literacy of Ahvaz citizens is above average. This result is consistent with the results of Ghaneirad and Morshedi (2011), who examined the scientific literacy status of Tehran citizens and found that their target population's scientific literacy level is equal to 52 out of 100. Overall, based on the results, the status of scientific literacy by the citizens of Ahvaz is above average. It is therefore suggested that managers and policymakers in Ahvaz use the results of the present study and conduct periodic surveys on scientific literacy in the future to solve problems and improve the level of scientific literacy by the citizens of Ahvaz.

Overall, the results show that the attitude of Ahvaz citizens toward science is more than their knowledge. This finding is in line with the results of Ghaneirad and Morshedi (2011). However, the knowledge level of Ahvaz respondents is higher than that of some countries mentioned in this study. This seems to be due to the interest of Ahvaz respondents in science and scientific issues, the novelty of this research, and the use of the web and social networks for data collection. In addition, given that the questionnaire was available to the respondents for several hours, other factors could lead to the difference in the respondents' knowledge level in the two studies.

Moreover, the respondents considered the knowledge level of the Iranian people acceptable. However, they believed that the impact of science on people's lives is insignificant. The results also revealed that Ahvaz respondents were less inclined to visit scientific places or exhibitions. At the same time, in legal, religious, and technical issues, they consulted experts or referred to scientific sources.

Conclusion

The results indicated that Ahvaz citizens' understanding of science is above average. It can be concluded that the acceptable situation of scientific literacy in Ahvaz, can be due to the cultural development of the country, the development of universities and higher education institutions in different parts of the country, the expansion of literacy in the country, development of information and communication infrastructure, widespread use of Internet and Cyberspace, especially in recent years. Therefore, more research is needed to determine the status of citizens' scientific literacy in other parts of the country, as well as its causes and factors. According to the results of this research, establishing a Scientific Literacy Center (SLC) in Ahvaz municipality is suggested as continuously monitoring citizens' scientific literacy level every two years. Secondly, it was found that the Ahvaz citizens have a strong or weak attitude towards some research components. Therefore, it is suggested to promote cases with a weak or moderate attitude towards them in educational and research centers and Ahvaz municipality; necessary planning and policies should be made to improve and strengthen these components. Furthermore, the validated questionnaire can be used in similar research to measure Iranians' understanding of science on a micro and macro scale.

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References

Chao, Z. & Wei, H. (2009). Study of the Gender Difference in Scientific Literacy of Chinese Public. *Science, Technology and Society*, 14(2), 385-406. https://doi.org/10.1177/097172180901400209

Culliton, B. J. (1989). The dismal state of scientific literacy: Studies find only 6% of Americans and 7% of British meet standard for science literacy. *Science*, 243(4891), 600. https://doi: 10.1126/science.243.4891.600

DeBoer, G.E. (2000). Scientific Literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. Journal of Research in Science Education, 37(6), 582-601. https://doi.org/10.1002/1098-2736(200008)37:6<582::AID-TEA5>3.0.CO;2-L

De Oliveira, A.M., Gerevini, A.M. & Guimaraes Strohschoen, A.A. (2017). Diary: A methodological tool for the development of scientific literacy. *Revista Tempos E Espacos Educacao*, 10(22), 119-131. https://doi.org/10.20952/revtee.v10i22.6429

Durant, J. (1994). What is scientific literacy? *European Review*, 2(1), 83–89. https://doi.org/10.1017/S1062798700000922

Elliott, P. (2006). Reviewing newspaper articles as a technique for enhancing the scientific literacy of student-teachers. *International Journal of Science Education*, 28(11), 1245-1265. https://doi.org/10.1080/10670560500438420

Ghaneirad, M.A. & Morshedi, A. (2011). Survey of public understanding of science and technology; pilot study in Tehran. *Journal of Science & Technology Policy*, 3(3), 93-110. https://dorl.net/dor/20.1001.1.20080840.1390.3.3.8.6 [in persian]

Gräber, W., Nentwig, P., Becker, H.J., Sumfleth, E., Pitton, A., Wollweber, K. & Jorde, D. (2001). Scientific literacy: From theory to practice. In *Research in Science Education-Past, Present, and Future*, (pp. 61-70). Springer, Dordrecht. https://doi.org/10.1007/0-306-47639-8_6

Hardinata, A. & Permanasari, A. (2019). Gender difference and scientific literacy level of secondary student: A study on global warming theme. In *International Conference on Mathematics and Science Education* (ICMSCE 2018). 1157. https://doi: 10.1088/1742-6596/1157/2/022016

Hurd, P.D. (1990). Historical and philosophical insights on scientific literacy. Bulletin of Science, Technology & Society, 10(3), 133-136. https://doi.org/10.1177/027046769001000303

Hurd, P.D. (1958). Science literacy: Its meaning for American schools. *Educational leadership*, 16(1), 13-16. Retrieved from http://edcipr.com/wp-content/uploads/2016/09/Hurd_1958_Science-literacy.pdf

Iranian University Reference Database. (1400). Universities of Khuzestan province. Retrieved from https://www.uniref.ir/Province13.html

Liu, X. (2009). Beyond science literacy: Science and the public. *International Journal of Environmental and Science Education*, 4(3), 301-311. Retrieved from https://files.eric.ed.gov/fulltext/EJ884399.pdf

Maeseele, P.A. (2007). Science and technology in a mediatized and democratized Society. *Journal of science communication*, 6(1), A02. https://doi.org/10.22323/2.06010202

Meyers, F.D. (1991). Scientific literacy and public education about high-level radioactive

waste. In *High Level Radioactive Waste Management: Proceedings of the second annual international conference. Proceedings*, 146-150.

Miller, J. (1995, August). Scientific literacy among American adults and a look at the future. In *abstracts of papers of the American Chemical Society* (Vol. 210, pp. 40-IEC). PO BOX 57136, Washington, DC 20037-0136: Amer Chemical Soc.

Naganuma, S. (2017). An assessment of civic scientific literacy in Japan: development of a more authentic assessment task and scoring rubric. *International Journal of Science Education*, Part B, 7(4), 301-322. https://doi.org/10.1080/21548455.2017.1323131

Romine, W.L., Sadler, T.D. & Kinslow, A.T. (2016). Assessment of scientific literacy: Development and validation of the Quantitative Assessment of Socio-Scientific Reasoning (QuASSR). *Journal of Research in Science Teaching*, 54(2), 274-295. https://doi.org/10.1002/tea.21368

Rundgren, C.J., Rundgren, S.N.C., Tseng, Y.H., Lin, P.L. & Chang, C.Y. (2012). Are you SLiM? Developing an instrument for civic scientific literacy measurement (SLiM) based on media coverage. *Public Understanding of Science*, 21(6), 759-773. https://doi.org/10.1177/0963662510377562

Rusilowati, A., Nugroho, S.E., Susilowati, E.S.M., Mustika, T., Harfiyani, N. & Prabowo, H.T. (2018). The development of scientific literacy assessment to measure student's scientific literacy skills in energy theme. *Journal of Physics: Conference Series*, 983, 012046. https://doi:10.1088/1742-6596/983/1/012046

Statistical Centre of Iran. (2021). Population. Retrieved from https://ssis.sci.org.ir/ [in Persian]

Wu, .S, Zhang, Y. & Zhuang, Z.Y. (2018). A Systematic Initial Study of Civic Scientific Literacy in China: Cross-National Comparable Results from Scientific Cognition to Sustainable Literacy. *Sustainability*, 10(9), 3129. https://doi.org/10.3390/su10093129