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SCALE DEVELOPMENT OF THE EDUCATIONAL VALUE OF THE HISTORY OF SCIENCE FROM THE STUDENT'S PERSPECTIVE

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Abstract

It is important to know what scientific knowledge is and what processes it goes through and how this knowledge will be used by scientists in future researches. While there are studies in the literature examining the effects of the history of science practices on the nature of science, no scale has been found for secondary school students on the history of science. The development of the scale and the realization of its validity and reliability stages were studied with a total of 228 secondary school students studying in Nizip district of Gaziantep province in the 2020-2021 academic year. Students were determined by random sampling method. From the validity and reliability studies, a scale consisting of 21 items and three factors named as "Interest in the History of Science", "Awareness in the History of Science" and "The Contribution of the History of Science to Learning" emerged. The levels of the Instructional Value of the History of Science Scale from Students' Perspectives, which was created with 21 expression items, were scaled with a five-point Likert scale, by making validity and reliability analyzes. The final version of the scale is presented in the appendices.EFA and CFA results were examined in construct validity studies, and the KMO (Sampling Adequacy Measure) value was found to be .92. In calculating the reliability of the scale, the Cronbach alpha internal consistency coefficient value was found to be 0.909.

Keywords: History of science; science education; eductional value; nature of science

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1. Introduction

1.1. Introduce the problem

George Sarton begins his work Ancient Science and Modern Civilization with these words: “When I was a kid, the multiplication table was called the Pythagorean Table, but the teacher didn't tell us who Pythagoras was; maybe he didn't know either." (Laçin Şimşek & Çalışkan, 2016). Schools offer many courses, but the historical foundations of these courses are not mentioned. Teaching the history of science in lessons poses a problem.

History of science; it is about the effort of science to become a science. The history of science is not only about how scientific knowledge came to be, but also about what happened while reaching scientific knowledge. From this point of view, what science is, its origin, development, the life of people who contribute to science, scientific institutions and tools, the relationship of science with the economic, political, religious and social context, the transfer of scientific knowledge between different cultures, etc. examines the issues (Fazlıoğlu, 2004).

According to (Ortaç, 2005), what science is, how a scientist works, how a scientific study is conducted; in order to understand how the social, economic, technological and cultural situation of the society can affect scientific studies, it is necessary to refer to the history of science frequently.

The purpose of science is to create theories by developing logical and systematic explanations for natural phenomena; to explore principles and concepts. By transferring scientific processes to learning environments, it is aimed that students do research to understand the world and understand how scientific knowledge develops by directly participating in the scientific process (MEB, 2018).

If science is defined as a collection of organized knowledge, the history of science is the description of the development of this knowledge (Sarton, 1997). The history of science also describes the process from the birth of science to its development (Laçin Şimşek, 2009). The history of science is the process of understanding the stages of scientific knowledge, the contribution of society to science, the struggle of scientists and the materials they use in this process, the recognition of scientific activities, the scientific results that occur, and the events they encounter (Topdemir & Unat, 2014).

The history of science is the story of the birth and development of science (Erdem, 2005). How humanity came from the past to the present, achievements in science, difficulties, interesting sources of inspiration, examples of creative imagination, difficulties experienced in the scientific process, examples of courage in the wars against dogmas, successes and happiness, innovations, new periods created by scientific discoveries are important parts of the history of

science. (Erdem, 2005). History of science is the way that enables students to interact with the culture of science (Güney & Şeker, 2009).

History of Science includes the cultural knowledge and lifestyle of societies. Scientific thinking methods, mental activities of people fall into the subject area of the history of science. In this respect, the history of science includes cultural, scientific and political factors. Science is the first place a civilization will turn to show the greatness of its historical past. In order to reveal scientific achievements, nations have to carry out important and fundamental studies on both their own history of science and the history of science of other civilizations (Unat, 2002).

It is not the only task of the history of science to comprehend the development and processes of science from past to present. It helps to comprehend the emergence and spread of scientific theories at different times by making use of historical information. It helps us question the importance of people in their daily lives, the way scientists think. With the help of the history of science, the effects of social institutions on development; we question its mutual relations with religion, philosophy and art and its place in the creation of technical knowledge (Ortaç, 2005). Science history activities help students discover themselves. It enables students to establish good relations with science (Justi & Gilbert, 2000).

History of science; it provides an understanding of the development of knowledge. At the same time, he was interested in the fact that science is effective in human development, not limited to the ideas of scientists (Chapel, 2004).

Studies in the history of science have an important place in distinguishing between science and non-scientific (Matthews, 1992).

Since 2005, subjects in primary education courses, especially in science and social studies, have been associated with the history of science. However, in studies examining the curriculum and books, it has been determined that the history of science is not sufficient, and the history of science is generally used to enrich the narrative (İngeç, Tekfidan, Karagöz, & Keskin, 2016; Kandil-İngeç, Tekfidan, & Karagöz, 2016; Laçin Şimşek, 2009; Laçin Şimşek, 2011). In order for the history of science to be used effectively in education, it is necessary to use the history of science actively in the lessons and to be valued by the teachers.

1.2. Purpose of the research

There are a limited number of studies on the history of science in Turkey. Therefore, this study aims to develop a scale to determine the educational value of the history of science from the perspective of students. The inability to reach such a scale in Turkey necessitated its development.

1.3. Importance of Research

The benefits of including the history of science in teaching have been demonstrated by different researchers (Duschl 1990; Matthews 1992; McComas 1998; Justi & Gilbert, 2000; Laçin Şimşek, 2011; Yıldız, 2013).

The study of science and history, which includes the interaction of different disciplines, and the study of discovering science together with related tools, has a field feature that contributes to the diversity of science by producing new information. (Unat,2021) In general, science education was aimed at raising scientifically literate individuals. Being scientifically literate is the basis of understanding the sciences. The limitation of scientific literacy is the acquisition and historical development of two important sub-sciences. (Başkan Takaoğlu, 2018) Those who learn through science execution courses will shape their own research adventures with the ways that previous scientists followed scientific courses. Evaluation of student observations and evaluation of these usage usages are of great importance in terms of completing the development of the dimensions and identifying science with science.

History of science; understanding the nature of science; it is important to know what scientific knowledge is and what processes it goes through and how this knowledge will be used by scientists in future research. The important part that distinguishes this study from other studies is that while we found studies in the literature examining the effects of history of science practices on the nature of science, no scale was found for secondary school students on the history of science. In this respect, it is thought that the study will contribute to the literature.

1.4. Counts

It was assumed that the secondary school students participating in the study filled the scale with an unbiased perspective.

In the study, it was assumed that environmental conditions and other variables affected each student equally.

It was assumed that the secondary school students participating in the study genuinely responded to the data collection tools.

It was assumed that the secondary school students participating in the research represented the universe in the best way.

1.5. Limitations

- This study is limited to 228 students in public secondary schools.
- This study is limited to the first semester of the 2020-2021 academic year.
- The research is limited to the province of Gaziantep, a province located in the southeast of Turkey.

2. Method

In this section, the titles of "Research Model", "Study Group", "Data Collection", "Data Analysis" are included.

2.1. Model of the Research

This research aims to develop a scale to determine the educational value of the history of science from the perspective of students. For this purpose, the scale was developed. The developed scale was applied to the study groups. The data obtained from the study groups were analyzed. The development process of the scale, the study group and the analysis of the data are presented.

2.2. Sample

This study, which is planned to develop a scale to reveal students' views on the educational value of the history of science, and to carry out the validity and reliability stages, was conducted in the 2020-2021 academic year with a total of 228 students studying in Nizip district of Gaziantep province. Worked with middle school students. Students were determined by random sampling method. The data were obtained online with the voluntary participation of students. The descriptive information of the participants in the study group according to some variables is presented in Table 1.

Table 1. Percentage and distribution of the study group according to some variables

Variable		**Number of Persons**	**%**
Gender	Girl	126	55
	Male	102	45
Grade Level	5	50	21
	6	74	32
	7	51	22
	8	53	25
Total		228	one hundred

2.3. Developing the Scale

In the process of developing the History of Science Scale in the Perspective of Students, an item pool was first created. Expert opinions were taken and the content validity of the items was determined.

2.4. Establishing the Item Pool

After determining the items to be used in the scale, the relevant literature was scanned and an item pool was created. A pool of 30 items, which is thought to be related and relevant to the research topic, was created. Care was taken to ensure that the expressions of the items were simple to understand and suitable for the level of secondary school students. The scale was prepared in a 5-point likert structure. Likert scale type is used in tools prepared to determine the thoughts, perceptions and attitudes of individuals about a subject or concept (DeVellis, 2014). In the prepared measurement tool, statements such as “strongly disagree (1 point)”, “disagree (2 points)”, “moderately agree (3 points)”, “agree (4 points)” and “strongly agree (5 points)” were written.

2.5. Getting Expert Opinions

In order to ensure the content validity of the scale, which was developed to reveal students' views on the educational value of the history of science, 2 experts in the field of scale development and 1 faculty member with a knowledge of the History of Science examined and evaluated the measurement tools. In the expert opinion form prepared , there is a section for rating the suitability against the items of the scale. In this rating, the terms item evaluation level is insufficient, can be improved and sufficient are used. In the description section; Suggestions can be made about the items written. All opinions of the experts were combined and the compliance rate was checked for content validity. In line with the suggestions of the experts, a few spelling changes were made to make the items clear and the number of items was reduced to 23. The pilot application phase of the 23-item measurement tool was started.

2.6. Pilot Implementation Phase

A pilot study was conducted with 20 secondary school students to determine the clarity of the instructions and items prepared in the developed scale and to control the response time of the students. The final version of the scale was determined in the light of the feedback received from the students who participated in the pilot application. After the pilot application, it was decided that the 23-item scale would be suitable for the 23-item application. No changes were made to the items during the pilot implementation phase. It was decided that 20 minutes was appropriate as a response time.

2.7. Data Collection

When the literature is examined, it is seen that for the sample size of the Exploratory Factor Analysis (EFA) studies, 5 times the number of items in a 5-point Likert-type scale will be sufficient, and in addition, there will be less than 100 participants, 500 participants will be very

good and 1000 participants will be excellent. (Cattell, 1978; Everitt, 1975). In the confirmatory factor analysis process, 10 times the number of items is sufficient for the number of participants (Kline, 2011). Based on this situation, it can be said that the number of participants (n=228) reached in the study is sufficient for both exploratory and confirmatory factor analysis processes.

The developed scale was applied online in Google Forms. After adapting the prepared scale to Google Forms, students from school groups were reached and an application was made. Participants participated in the research voluntarily.

2.8. Analysis of Data

The validity of the scale in the analysis of the data; structure, aspect, content and concordance validity. In the construct validity studies, firstly EFA was performed and then the process was continued with CFA. Structural features of the scale were examined with EFA and its sub-dimensions were tried to be determined. The accuracy of the structure found by CFA was checked. Expert opinions were used for face and content validity. Correlation values between the sub-dimensions of the scale supported concordance validity. Cronbach's alpha internal consistency coefficient was used to calculate the reliability of the scale. JASP program was used for data analysis.

By examining current scale development studies, the article has been enriched by considering the working process, methods and techniques in these studies.(Şahin, Turan, & Asal Özkan, 2022; Üztemur, & Dinç, 2022; Yılmaz & Jafarova, 2022). The Method section describes in detail how the study was conducted, including conceptual and operational definitions of the variables used in the study, Different types of studies will rely on different methodologies; however, a complete description of the methods used enables the reader to evaluate the appropriateness of your methods and the reliability and the validity of your results, It also permits experienced investigators to replicate the study, If your manuscript is an update of an ongoing or earlier study and the method has been published in detail elsewhere, you may refer the reader to that source and simply give a brief synopsis of the method in this section.

3. Results

In this section, there are the reliability, Exploratory factor analysis (EFA) and Confirmatory factor analysis (CFA) findings of the Instructional Value of the History of Science Scale from Students' Perspectives.

3.1. Findings Regarding Validity

The degree to which the scale determines the instructional value of secondary school students in the history of science has been examined in terms of structure, coherence, content and face

validity. Construct validity was determined by EFA. Then control was achieved with CFA. The construct validity of the scale was checked with exploratory and confirmatory factor analyses.

3.2. Exploratory factor analysis

EFA was conducted to determine whether the items in the scale form revealed a certain structure. For eligibility to perform EFA, the data were first subjected to KMO and Bartlett's Test. It was decided that the scale data were suitable for EFA.

Table 2. KMO and Bartlett test results

KMO Sampling Adequacy measure		0.92
Bartlett Test of Sphericity	x^2	3426. 418
	sd	253
	p	< .001

The KMO value was found to be .92. It was determined that the Bartlett test was statistically significant ($\chi 2$=3426. 418, sd=253, p<.001). According to the findings, it is seen that the data are suitable for factor analysis. The factor load values of the items to which EFA was applied were examined. Items with factor loadings below .45 were eliminated. Afterwards, attention was paid to ensure that each item had a high factor value in only one factor. The factors and factor loads of the scale are given in Table 3.

Table 3. Factor loads table

Item No.	**Factor Partner Variance**	**factor 1**	**factor 2**	**factor 3**
M12	0.319	0.800		
M11	0.362	0.759		
M9	0.455	0.679		
M16	0.425	0.659		
M4	0.528	0.625		
M10	0.539	0.619		
M18	0.470	0.559		0.446

M15	0.518	0.550		0.423
M8	0.543	0.537		
M3	0.602	0.528		
M17	0.473	0.431		0.580
M21	0.097		0.939	
M20	0.168		0.910	
M22	0.173		0.907	
M19	0.202		0.886	
M23	0.234		0.870	
M2	0.547			0.637
M7	0.510			0.615
M1	0.624			0.544
M5	0.567			0.543

When Table 3 is examined, it is seen that factor loading values for Factor 1 are between 0.407 and 0.800, factor loading values for Factor 2 are between 0.870 and 0.939, and factor loading values for Factor 3 are between 0.543 and 0.637.

Similarly, when the common factor variances of all items in the scale are considered; it is seen that all values are between 0.407 and 0.939. According to these results, it can be said that the contribution of all items in the scale to the total variance is at a good level. At the same time, item total correlation values were determined to be between 0.168 and 0.649. When it comes to the next stage, it has been determined that the factors in the relationship between the sub-dimensions of the scale are at the level of positive and significant relationship with each other. The naming of the factors has been done. It was decided that it would be appropriate to name the factors formed by the examined items as "Interest in the History of Science", "Awareness in the History of Science" and "The Contribution of the History of Science to Learning". The correlation coefficients between all the factors of the scale are shown in Table 4.

Table 4. Correlation Coefficients Between Factors

	Interest in the History of Science	Awareness of the History of Science	The Contribution of the History of Science to Learning
Interest in the History of Science	1,000	0.018	0.175
Awareness of the History of Science	0.018	1,000	-0.007
The Contribution of the History of Science to Learning	0.175	-0.007	1,000

As a result of the EFA, it was decided that the scale should have a three-dimensional structure.

Confirmatory factor analysis: After EFA, CFA was applied to test the suitability of the 3-dimensional structure of the Instructional Value of the History of Science Scale from Students' Perspectives. The JASP program was used in the analysis of the data. After the CFA analysis, it is seen that the t values of the observed variables are significant at the 0.01 level.

The fit criteria for the model determined as a result of the applied CFA and the results obtained from the analysis are presented in Table 5.

Table 5: CFA results

	x^2	sd	P
Basic Model	3,575,393	253	<.001
Factor Model	397,292	222	

Results from CFA; indicates that the three-dimensional structure of the scale is adequate for the level of compliance.

Table 5: Second Level CFA results

Examined Compliance indexes	Perfect Compliance Criteria	Acceptable Compliance Criteria	Regarding Scale Values
GFI	.95 ≤ GFI ≤ 1.00	.80 ≤ GFI ≤ 95	0.87
AGFI	.90 ≤ AGFI ≤ 1.00	.85 ≤ AGFI ≤ .90	0.86
CFI	.95 ≤ CFI ≤ 1.00	.90 ≤ CFI ≤ .95	0.94
NNFI	.95 ≤ NNFI ≤ 1.00	.90 ≤ NNFI ≤ .95	0.94
IFI	.95 ≤ IFI ≤ 1.00	.90 ≤ IFI ≤ .95	0.94
RMSEA	.00 ≤ RMSEA ≤ .05	.05≤ RMSEA ≤.08	0.06
SRMR	.00 ≤ SRMR ≤ .05	.05 ≤ SRMR ≤ .10	0.05

(Cokluk, Şekercioğlu & Büyüköztürk, 2014; Hu & Bentler, 1999)

Results from CFA; shows that the fit indices are in the acceptable range. This indicates that the three-dimensional structure of the scale has sufficient level of compliance.

In addition, the factor loadings of the three-dimensional model obtained as a result of CFA are given in Figure 1.

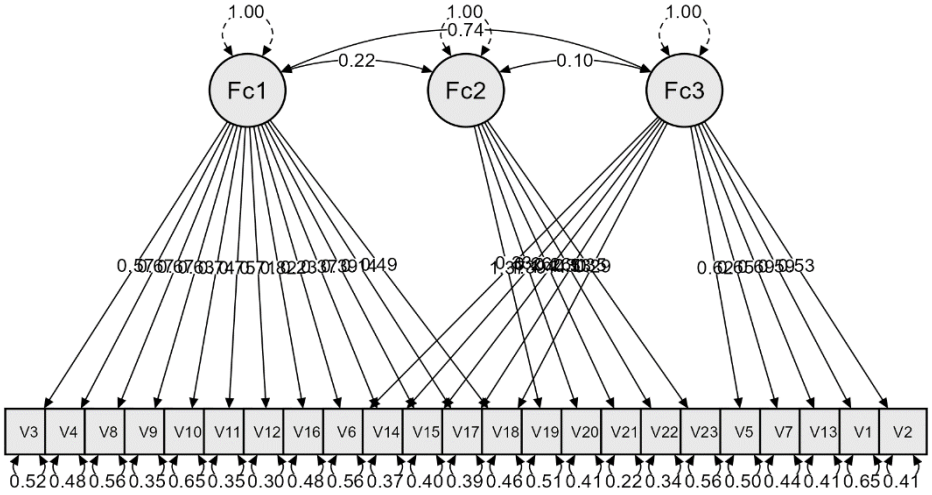

Figure 1. DFA factor loading values

The factor load diagram of the scale is shown in Figure 1. Item correlations were found to be between 0.39 and 0.52 in the first dimension; 0.51 to 0.56 in the second dimension; in the third dimension, it is seen to be between 0.41 and 0.50. In this case, it is seen that the correlation coefficients of the items in the Instructional Value of the History of Science Scale from Students' Perspectives are between 0.39 and 0.56. Considering the RMSEA, CFI, GFI, RMR, SRMR, GFI and AGFI values, it can be stated that the scale has 23 items and a three-dimensional model with "acceptable goodness of fit".

3.3. Concordance validity: [A] value of 1.78 obtained by dividing x2 by degrees of freedom indicates perfect fit. Similarly, SRMR shows acceptable fit. RMSEA shows acceptable fit. When a holistic evaluation is made, it can be stated that the items of the scale generally show acceptable compatibility. The scale was evaluated as usable as it is.

3.4. Face and content validity : For the face and content validity, the opinions of 2 assessment and evaluation and 1 history of science field experts were consulted. Experts stated that the 23-item form of the scale was suitable in general. It was agreed that the scale items were sufficient in terms of content validity.

3.5. Findings Regarding Reliability

According to (Büyüköztürk, 2007), reliability is defined as the consistency between the answers given to the scale items by the participants who answered the scale. The Cronbach Alpha value for the whole scale was calculated as 0.909 using the JASP program.The Cronbach Alpha value obtained shows that this developed scale is a reliable measurement

tool that can be used to measure the Instructional Value of the History of Science from the Perspective of Students.

The levels of the Instructional Value of the History of Science Scale from Students' Perspectives, which was created with 21 expression items by making validity and reliability analyzes, were scaled with a five-point Likert scale. Expressions in Likert style; "strongly disagree (1 point)", "disagree (2 points)", "moderately agree (3 points)", "agree (4 points)" and "strongly agree (5 points)" . All items in the scale contain positive statements. There are 5 reverse items in the scale. The score that can be obtained from the scale varies between 28 and 95.

4. Discussion and Conclusions

This study aims to develop a scale to determine the educational value of the history of science from the perspective of students. In line with this purpose, the Instructional Value of the History of Science Scale from Students' Perspectives was developed. In the study, scale development steps were followed. Validity and reliability analysis studies of the developed scale were carried out. The draft form of the measurement tool initially consisted of 30 items. 7 of these items were eliminated according to expert opinions. Again, 2 of these items were eliminated in the CFA process. From the validity and reliability studies, a scale consisting of 21 items and three factors named as "Interest in the History of Science", "Awareness in the History of Science" and "The Contribution of the History of Science to Learning" emerged. The levels of the Instructional Value of the History of Science Scale from Students' Perspectives, which was created with 21 expression items by making validity and reliability analyzes, were scaled with a five-point Likert scale. Expressions in Likert style; "strongly disagree (1 point)", "disagree (2 points)", "moderately agree (3 points)", "agree (4 points)" and "strongly agree (5 points)" . All items in the scale contain positive statements. There are 5 reverse items in the scale. The score that can be obtained from the scale varies between 28 and 95. The final version of the scale is presented in the appendices.

As a result, it has been determined that the scale developed in this study is a valid and reliable measurement tool that can be used to determine the Instructional Value of the History of Science from the Student's Perspective of secondary school students. Scale; It can also be used to determine the educational value of secondary school students' history of science. The validity and reliability studies of the scale were carried out with secondary school students. The inability to reach a scale for secondary school students on the history of science makes the research important. Therefore, it is recommended to use the developed scale to determine the educational value of the history of science, and it is recommended to conduct validity and reliability studies for different grade levels in secondary school.

Suggestions within the scope of this research can be given as follows;

- Researchers who will study to examine the educational value of secondary school students' science history of a particular teaching material or method can use the prepared scale as a data collection tool in their studies.
- Researchers who need to develop scales for different subjects can follow the development stages of this scale and carry out scale development studies.

Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest

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Appendix A. An example appendix

ATTACHMENTS

The Instructional Value Scale of the History of Science from the Perspective of the Student

Our dear students;

As you know, your lessons include activities that involve the development of science and the lives of scientists. We collect data for a scientific purpose. After reading each item, please tick the most appropriate option from the options to the right of the items to indicate how much you agree. Please do not leave any blank items and mark only one option ***(X)*** *for each item . Thank you very much in advance for your help and we wish you good luck in your work.*

	Never Agree	**I do not agree**	**Moderately Agree**	**I agree**	**Completely**
1. I see the history of science and how scientific studies are carried out.					
2. With the history of science, I see the contribution of inventions and inventions to the progress of humanity.					
3. Giving examples from the history of science helps me understand the subjects better.					
4. Giving examples from the history of science increases my desire to do research.					
5. Giving examples from the history of science allows me to get to know scientists.					
6. Giving examples from the history of science allows me to see that scientific knowledge can change over time.					
7. Giving examples from the history of science makes me understand that science is a process.					
8. I understand the importance of imagination in the development of science by giving examples from the history of science.					
9. Examples from the history of science develop the idea that I can be a scientist in my mind.					
10. Learning about the lives of scientists encourages me to do research.					
11. Giving examples from the history of science improves my research skills.					
12. The history of science allows me to understand that science is the result of human activities.					
13. Giving examples from the history of science gives me different perspectives.					

14. Giving examples from the history of science allows me to see the motivation behind scientific studies.					
15. Giving examples from the history of science allows me to see how scientific studies facilitate people's daily life.					
16. Giving examples from the history of science gives me the ability to question.					
17. Giving examples from the history of science in the lessons prevents me from understanding the subjects.					
18. I think that reading texts about the history of science is a waste of time.					
19. I consider the history of science to be an outdated field.					
20. Giving examples from the history of science confuses me.					
21. I think that giving examples from the history of science in the lessons does not help me.					