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Investigation of the Nature of Science Studies in Turkey through Meta-Synthesis[1]

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Abstract

The aim of this study is to examine the published researches on the nature of science in Turkey by means of meta synthesis (thematic content analysis). For this purpose, the journals published in Turkey in the field of educational sciences and included in international indexes (SSCI), the nature of science, the nature of scientific knowledge, science education, nature of science, nature of scientific knowledge and science education keywords were scanned. A total of 24 articles reached in this way was analyzed in detail by considering parameters such as method/pattern, sampling level, data collection tool, data analysis method, research result, research recommendation, sources examined about the dimensions of nature of science and academic fields of researchers. As a result of these analyzes, the majority of the researches were conducted in order to examine the natural competencies, opinions and perceptions of science in the students. Besides, it has been determined that studies that examine the nature of science with applied studies have also been done. In addition to these findings, an equal number of studies have been achieved at the level of sampling at almost all levels of learning except primary school. This study has been completed with a number of suggestions for teaching the nature of science to students at all levels of learning, increasing the quality of their work and their tendencies.

Introduction

There has been a significant increase in the researches on educational sciences and field education in Turkey since the 1990s (Çalık, Ünal, Coştu & Karataş, 2008, Sözbilir, 2013, Umdu Topsakal, Çalık & Çavuş, 2012). As of today, almost every subject related to field education is

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being studied by Turkish academicians simultaneously with academicians from abroad. And even in recent years there have been huge increases in projects based on international co-operation. When the results of these studies are examined, it appears that a large number of similar works supporting or contradict each other in the same subject area (Selçuk et al., 2014). On the other hand, it is also evaluated that the researches made do not contribute to the expected level of production of educational policies for implementation (Çalık & Sözbilir, 2014).

From this point of view, there is a need to classify applied researches, to evaluate and synthesize the trends and research results in order to provide clear suggestions about the researches, practices and policies to be made in the following years in the subject areas (Çalık, 2013, Suri and Clarke, 2009). From the analytical work at the descriptive level which is the answer of the question, "Why?", there is a need what in the field of education? (Çalık et al., 2008, Karadag, 2009, Göktaş, Küçük et al., 2012, Umdu Topsakal et al., 2012). To meet this need, meta-synthesis (thematic content analysis) studies have been started in recent years (Au, 2007).

Meta-synthesis studies involving the synthesis and interpretation of a research topic, a critical theme, or the creation of key templates on a topic help to deeply understand the subject from a holistic point of view (Au, 2007) and to identify areas of priority work. On the other hand, a qualitative synthesis and exemplification of similar aspects of studies that deal with different aspects of a subject can also be a rich reference source for young researchers, teachers and decision makers who do not have the opportunity to reach all the work (Çalık, Ayas and Ebenezer, 2005; Ayas and Coll, 2006; Ültay and Çalık, 2012).

Based on these explanations, studies based on the nature of science have gained momentum since 2000 in Turkey. This claim can be supported from the higher education board of Turkey (YÖK) thesis database about the nature of science in the last ten years. There are a huge amount of thesis at the level of master's and doctoral degrees and also at least a few presentations about the nature of science in every congress and symposium program organized in national and international scale in Turkey. The nature of science is expressed as an area where science history, science philosophy, science sociology and science psychology intersect. While there is no agreed definition of this concept, it is nevertheless often attributed to the epistemological foundations and characteristics of scientific knowledge. Science epistemology, on the other hand, includes values and insights in the development of scientific knowledge and scientific knowledge (Akerson et al., 2000).

When the literature related to the subject area is examined, there have been many researches on the subject of understanding of the students' perceptions about the nature of science from every level by means of qualitative and quantitative measurement tools, teaching by using different methods, examining the relations between the concepts of nature of science and other variables. However, the ways in which students are more effective in explaining and developing their understanding of the nature of science are still being debated. Therefore, in the subject area of science, it is believed that the thematic examination of the results of studies based on different research paradigms and studies on students at different levels of learning can bring a depth to the subject area. The aim of the research in this context is to examine the published articles in internationally respected journals in Turkey regarding the nature of science using meta-synthesis (thematic content analysis) method.

Method

In this research, meta-synthesis (thematic content analysis) method was used because it was aimed to thematically review the articles published in internationally respected journals about the nature of science. Thematic content analysis is a synthesis of the trends and results of work

done in a field by creating a thematic template and a critical view (Au, 2007, Çalık & Sözbilir, 2014).

Collection of Data

Within the scope of this study, articles published in edible journals published in the field of education in Turkey and scanned in international indices (SSCI) have been examined. In this context, electronic access open archives of magazines named in Journal of Theory and Practice (KUYEB), Journal of Education and Science and Journal of Hacettepe University Faculty of Education (HÜEF) have been scanned. The nature of science, the nature of scientific knowledge, science education, nature of science, nature of scientificknowledge and science of science key words were used. Because of the limited number of articles, all studies were collected, regardless of publication year, sampling level and other criteria. A total of 24 articles reached in this way were examined.

Analysis of Data

As a result of the scans, full texts of the articles reached were transferred to the Nvivo 10 analysis program. These articles have been examined in accordance with the thematic content analysis method. Each article was examined step by step and general coding was done. By setting out from the code, appropriate themes were created for the sections of the articles. As a result of this process; the year of publication, the purpose of the research, the method of research, the level of sampling, the data collection tool, the data analysis method, the results of the research, suggestions, bibliographical references to the scientific components of the nature of science and academic research areas of the researchers. A sample section of the review of the articles is given in Table 1.

Table 1. An Example of the Analysis of the Articles Included in the Survey

the year of publication	the purpose	the method of research	the level of sampling	the data collection tool	the data analysis method	the results of the research	suggestions,	scientific components of the nature of science	academic research areas of the researchers
2015	It is aimed to examine the effects of documentary films on 8th grade students' views of the nature of science.	Qualitative Document review	-	-	Descriptive analysis	The role of creativity in science, subjectivity in science and the socio-cultural nature of science have not been sufficiently emphasized	The nature of science, one of the dimensions of science literacy, should be included in secondary	Philosophy of science	Mathematics and science education

Each article reviewed was evaluated according to the above example. In this way, a total of 52 codes and 10 themes were created. In the reviewed articles, the main purpose of the research is to cover the coding made by considering the general research question. For this reason, sub-research questions were not taken into consideration. In some of the investigated studies, multiple data collection tools were used and accordingly, multiple data analysis methods were preferred. For this reason, the frequency of codes for data collection and analysis methods in the current study is higher than the total number of studies. Similarly, no coding has been done on the level of sampling for studies in the current study and for the type of document

review. For this reason, the number of codes related to the sample level does not coincide with the total number of studies.

On the other hand, in cases where no pattern is specified in the method of the investigated investigations (for example, only those studies carried out according to the qualitative research methodology), they are coded in the other form. Alternative tools in the context of data collection tools; Includes illustrations provided by the participants, concept maps, conceptual change texts, projects, homework, class activities and achievement test. The Alternative Scoring Key code given in the data analysis methods indicates that the analyzes made using rubrics or scoring themes related to nature of science are analyzed.

The results of the studies examined and the references of the suggestions contain the coding made by considering the most basic results and suggestions of the studies. In this respect, each of the results of the sub-problems in the research were not taken into consideration individually; The results of the basic research question were examined. In a similar vein, the most prominent suggestion was taken into account, instead of all suggestions in the study. The findings of the study are interpreted based on this framework.

Validity and Reliability Study

The articles reviewed were analyzed in detail by the thematic content analysis method. In order to avoid any data loss in this process, the articles were examined one by one; Attention has been paid to the number of articles examined by the number of references under each theme. Some of the articles were independently coded by both investigators. Then, these codes were compared and the compliance rate was examined. The compliance rate of the codes was determined to be 0.92 according to the formula of Miles and Huberman (1994). Then, with the help of the classification of codes, researchers have set appropriate themes for the purpose of the research. Thus, 8 temples that provide a holistic view have been reached.

Results

The studies examined within the scope of the research are presented in this section with the help of themes and codes. The demonstration of the data was done under the headings of the themes and with the help of tables.

Theme 1. Publishing Years of Research

The frequency distribution according to the published years of the research is given in Table 2.

Table 2. Frequency Distribution of Scientific Studies by Years Published

Theme	**code**	**f**
Publishing Year	2005	1
	2006	3
	2008	1
	2009	1
	2010	2
	2011	3
	2012	5
	2013	2
	2014	2
	2015	4
Total		**24**

According to Table 2; two of them were in 2013, two in 2014, and four in 2015. In 2005, three of these studies were carried out in 2005, three in 2006, one in 2008, two in 2010, three in 2011, five in 2012, two in 2013 and two in 2014. According to this report, studies on the nature of science are mostly made in 2012 and 2015. The studies conducted in 2005, 2008 and 2009 were limited.

Theme 2. Research Aim

The frequency distribution of codes generated for the research purpose theme is given in Table 3.

Table 3. Frequency Distribution for the Purposes of Scientific Research

Theme	**code**	**f**
Purposes of Research	Perception, Opinion and Level Determination Regarding the Nature of Science	9
	Examining the Nature of Science with Applied Studies	9
	Investigation of Curriculum-Nature of Science	4
	Explaining the facts with the understanding of the nature of science	2
Total		**24**

According to Table 3; while the purpose of science is to determine the perceptions, opinions and levels of the nature of the nature of the studies on the subject matter; And nine were designed to determine the effects of applied studies on the understanding of the nature of science. On the other hand, while the four aims of the study are to examine the relationship between the curriculum and the nature of science, The other two were conducted in order to determine how the students explained the facts with the understanding of nature of science. It is, according to this evidence, that the natural works of science were mostly intended to determine the perceptions, opinions and levels of the participants and to examine the effects of the applied studies on the understanding of the nature of science. The studies aiming to explain facts with the natural understanding of science are limited.

Theme 3. Research Method

The frequency distribution of codes generated for the research methodology is given in Table 4.

Table 4. Frequency Distribution of Methods Used in Scientific Research

Theme	**code**		**f**
Method	Quantitative	Experimental	6
		Scanning	2
	Qualitative	Document Review	3
		Case Study	2
		Action Research	1
		Case Study	1
		Other	5
	Mixed (Quantitative + Qualitative)		4
Total			**24**

According to Table 4; A total of 8 studies were conducted according to quantitative methods, six of which were in the experimental model and two were in the screening model. A

total of 12 studies were conducted qualitatively, three of which were document reviews, two were case studies, one was an action research, one was case study and five were not mentioned. In addition, four of the studies were carried out in accordance with the hybrid method. According to this account, the natural studies of science were carried out mostly in accordance with qualitative methods; While the number of researches based on mixed method was limited.

Theme 4. Level of Sampling

Table 5 shows the frequency distribution of codes generated for the Template Level contact.

Table 5. Frequency Distribution at the Sampling Level in Scientific Research

Theme	**code**	**f**
Sampling Level	Middle School	7
	University	6
	High school	4
	Teachers	3
	Graduate	1
Total		**21**

According to Table 5; Seven of the group, sampled during the studies on the nature subject of science, are in the middle school, six university, four high school, three teachers and one at the post graduate level. According to this data, studies are generally collected at secondary and university levels.

Theme 5. Data Collection Tool

The frequency distribution of the codes generated for the Data Collection Agent theme is given in Table 6.

Table 6. Frequency Distribution of Data Acquisition Tool Used in Scientific Studies

Theme	**code**	**f**
Data Acquisition Tool	Interview-Open Ended Questions	12
	Nature of Science Opinion Survey	10
	Likert Scale	7
	Alternative Tools	6
	Written texts	3
	Observation	2
Total		**40**

According to Table 6; 12 of the studies on the nature of science subject area were collected through interview-open-ended questions, 10 with the nature of science opinion survey, seven with likert scale, six with alternative tools, three with written texts and two with observation. According to these data, the data of the studies were mostly collected through interview and the nature of science opinion survey. It was revealed that observation and written texts were used in limited numbers.

Theme 6. Data Analysis Method

The frequency distribution of the codes created for the Data Analysis Method theme is given in Table 7.

Table 7. Frequency Distribution of Data Analysis Method Used in the Nature of Science Studies

Theme	**code**		**f**
Data Analysis Method	Qualitative	Content Analysis	12
		Descriptive Analysis	10
	Quantitative	ANOVA	2
		Chi-square	2
		Mann-Whitney U	2
		regression	2
		T-test	1
		ANCOVA	1
		MANOVAs	1
		Kruskal-Wallis	1
	Alternative Scoring Key		2
Total			**36**

According to Table 7; a total of 22 studies, including 12 content analysis and 10 descriptive analysis, have been analyzed by qualitative data analysis methods. In addition, 12 studies, two of which were ANOVA, two were Khi-square, two were Mann Whiyney U, two were Regression, one was t-test, one was ANCOVA, one was MANCOVA and one was Kruskal Wallis test. In addition, two of the studies were analyzed with the help of alternative scoring keys. According to these data, the nature of science studies were mostly analyzed using qualitative data analysis methods; it was revealed that quantitative data analysis methods were used less frequently.

Theme 7. Research Result

The frequency distribution of the codes created for the Research Result theme is given in Table 8.

Table 8. Frequency Distribution for the Results of the Nature of Science Research

Theme	**code**	**f**
Results	Results for the Impact of Applied Studies	11
	Nature of Science Results for Proficiency Level	10
	Results for the Curriculum	3
Total		**24**

According to Table 8; 11 of the studies on the nature of science subject area are the results for the effect of applied studies, 10 of them are the results for the nature of science proficiency level and three of them are the results for the curriculum. According to these data, the majority of the studies examined reached the results determining the effectiveness of an applied strategy and the nature of science competencies; The results for the curriculum turned out to be limited.

Theme 8. Research Proposals

The frequency distribution of the codes created for the Research Proposals theme is given in Table 9.

Table 9. Frequency Distribution for the Suggestions of the Nature of Science Researches

Theme	**code**	**f**
Suggestions	Suggestions for Curriculum	10
	Suggestions for Activities Improving the Nature of Science	6
	Suggestions for Future Studies	4
	Suggestions for Education Environment	3
Total		**23**

According to Table 9; 10 of the studies on the nature of science subject area were made for the curriculum, six for the activities that improve the nature of science, four for the future studies and three for the educational environments. According to these data, most of the studies examined made suggestions for the curriculum; recommendations for the educational environment were limited.

Theme 9. Bibliography for Components of the Nature of Science

The frequency distribution of the codes created for the bibliography theme for the components of the Nature of Science is given in Table 10.

Table 10. Frequency Distribution for Sources Containing the Components of the Nature of Science in the Nature of Science Research.

Theme	**code**	**f**
Sources Containing the Components of the Nature of Science	Philosophy of science	7
	History of Science	5
Total		**12**

According to Table 10; in seven of the studies on the nature of science subject, reference was made to the Science Philosophy and five to the History of Science.

Tema 10. Academic Field of the Nature of Science Researchers

The frequency distribution of the codes created for the nature of science researchers' academic fields of study is given in Table 10.

Table 11. Frequency Distribution of the Nature of Science Researchers towards Academic Research Areas

Theme	**code**	**f**
Nature of Science Researchers towards Academic Research Areas	Science Education	49
	Basic training	2
	educational Sciences	1
Total		**51**

According to Table 11; It has been determined that 49 of the natural researchers of science continue to work in the field of Science Education, while the two continue to work in the field of Basic Education and one in the field of Educational Sciences.

Discussion and Results

In this section, the results of the meta-synthesis of the researches related to the nature of science are given. The studies published in the journals scanned within the scope of the study on the nature of science were first encountered in 2005. By changing the Science Education Curriculum in 2004, the addition of the "science literacy" dimension to the vision of the program (MEB, 2005) and the initiation of studies on the subject of the nature of science started. Similarly, the increase in the weight of scientific subjects in the Science Education Program, renewed in 2013, has accelerated recent studies in the nature of science (Ayvacı, 2007; Erdaş, Doğan & İrez, 2014; Köseoğlu, Tümay & Budak, 2008; Küçük, 2006; MEB, 2013). As of this year, studies published on the nature of science in all three journals examined within the scope of the study showed a great increase between 2012 and 2015, while in other years few studies were conducted.

When the nature of science studies are examined according to their aims; Research mostly aimed to determine perceptions, opinions and competencies about the nature of science and to develop existing perceptions with applied studies (see Muşlu & Akgül, 2006; Doğan, 2011; Çetinkaya, Sağır & Kılıç, 2013; Turgut & Duru, 2015). Increasing the number of studies for these purposes, reveals that the studies in this field are easier than others or there may still be unexplained issues regarding the nature of science. On the other hand, it is seen in the literature that there are also experimental studies and studies to improve the perception of the nature of science (see Demirbaş & Yağbasan, 2006; Turgut, Akçay & İrez, 2006). In this context, focusing on due diligence related to the nature of science on one hand and applied studies on the other, implies two things: (i) the theoretical bases of the problem and / or the subject in the subject area are started to be explained thoroughly, (ii) although some researchers are still doing due diligence. Another noteworthy situation in the literature is; The number of studies aimed at explaining the scientific facts with the understanding of the nature of science and researching the activities related to the nature of science in the science curriculum was limited. From this point of view, there is a need for studies to raise individuals who gain sufficient understanding about the nature of science in terms of post-positivist paradigm and explain scientific facts in this way.

When the nature of science studies are analyzed in terms of methods, there are studies in which quantitative methods are also used, the qualitative methods are mostly in the studies (see Kılıç, Haymana & Bozyılmaz, 2008; Leblebicioğlu, Metin & Yardım, 2012; Muşlu & Akgül, 2005; Turgut, 2009). There are a few mixed-method studies in this field. In this context, studies based on quantitative and mixed method contradict the post-positivist paradigm on which the nature of science is based. Therefore, it can be said that quantitative studies in the literature that are based on positivist philosophy are lacking in the context of the four dimensions of the nature of science - science philosophy, science psychology, history of science, sociology of science.

When the nature of science studies are analyzed in terms of sampling level, it turned out that researches are mostly done on students studying in secondary and university, but almost no studies on pre-school and primary school students (see Çetinkaya, Turgut & Duru, 2015; Çil & Çepni, 2012; İrez & Özyeral -Bakanay, 2011; Metin & Leblebicioğlu, 2015; Turgut, 2009). The high number of studies in which undergraduate students are assigned as working groups is a result of the fact that the researchers working full-time at the university often choose the easily accessible sample selection. Studies on high school level, on-the-job teachers and samples with

postgraduate education were rather limited (see Bora, Arslan & Çakıroğlu, 2006; Doğan et al., 2011; Köksal, 2010). This means that the rapid changes in science and technology in recent years have had important effects on the social life and preferences of all people, including scientists. Therefore, the nature of science can be interpreted as a preference for researchers working in the subject area as they prefer to do research on the sample in the distant regions rather than in the remote. The study by Yavuz and Coşkun (2008) supports this situation. Another interesting situation is that there is no study for teaching the nature of science at preschool and primary school levels. It is known in the studies on concept teaching that individuals provide their conceptual development starting from an early age, if these concepts are scientific / supposedly scientific, they resist change and even these concepts cannot be corrected even with a well-structured education. In a study by Küçük (2013), it has been suggested that the concepts related to the nature of science were adopted from an early age like scientific concepts. Similarly, Güler and Akman (2006) stated that scientific images in individuals began to take shape from a young age. Therefore, it is important that science education and studies on this subject start from a very young age. Again, it has been determined that the issues related to the teaching of the nature of science are mostly studied by academics working in the field of science education (see Table 11). This needs to be criticized for research in the literature on the subject area, which includes common insights among students that science is only accepted as science. In other words, while students see science as a science on the one hand, researches on the nature of science and science are conducted only by science educators. However, science should be studied as science, social sciences and medical sciences and by researchers to show the normal distribution. Otherwise, the study of the nature of science and science by academicians in the subject of science in higher education and science teachers in primary and secondary education may cause students of all levels to accept science only as science.

When data collection tools used in studies in the subject of nature of science are examined, data has been collected mostly in semi-structured interviews in the studies (see Güney and Şeker, 2012; Muşlu & Macaroğlu-Akgül, 2006; Turgut, 2006). Similarly, Lederman et al. (2002), the semi-structured questionnaire designed by the Nature of Science Opinion Questionnaire was also frequently used (Aslan & Taşar, 2013; Hacıeminoğlu, 2014). Since the nature research of science is based on the qualitative paradigm by nature, it is more suitable to work with qualitative methods. At this point, long-term studies are needed to examine both the scientific understanding of individuals and the development-change of these understandings. Alternative tools (concept maps, drawings, classroom activities, homework, etc.) have been used in recent years to meet this need (see Çil & Çepni, 2012; Yenice, 2015). In this process, although there is a need for research based on written texts and preferring to collect data through observation, their number was limited (see Güney & Şeker, 2012). It is recommended to consider the subject of the nature of science from an interpretive point of view (Küçük, 2006; LeCompte and Preissle, 1993) and in this process, especially closed-ended questionnaire measurement tools that have limited effect in revealing the understanding of individuals about science.

When the studies in the subject of nature of science are examined in terms of results; it is seen that the results regarding the positive reflections of the applied studies such as scientific discussion, in-service training and science camp are reached (see Doğan et al., 2011; Metin & Leblebicioğlu, 2015; Sağır & Kılıç, 2013). It is common for new practices to produce positive results in experimental studies (Balım, İnel & Evrekli, 2008; Saturated, Şimşek & Bayrakçeken, 2004). At this point, instead of sharing the positive result in favor of the experimental group as the most important result in intervention-based studies, there is a need for results regarding how the intervention process is designed and how the intervention program can be operated especially by other researchers, ie the usefulness of the program. Again, in the studies

examined, the results of individuals having wrong concepts about the nature of science are reached quite a lot (Aslan & Taşar, 2013; Köksal, 2010; Tekkaya & Kılıç, 2012), with the objectives and content of the education programs that can be accepted as the main reason for the emergence of these wrong concepts. The conclusions reached regarding the educational status and assessment dimensions were limited (Şardağ et al., 2014). This result reveals that the studies carried out are mostly result-oriented and that the process / education programs revealing the result are not adequately examined / inspected in terms of the nature of science.

When the nature studies of science are analyzed in terms of the suggestions presented, it is determined that superficial suggestions are mostly produced for the curriculum (see Erdoğan and Köseoğlu, 2012; Turgut, 2009). In the relevant literature, there are findings indicating that the suggestions made by traditional education researchers are mostly abstract and superficial (Küçük & Çepni, 2005) In this context, limited studies both to examine the structure of the curriculum and to eliminate the shortcomings of the program in terms of the nature of science encourage making such suggestions. Although this has been done, how to do this has not been thoroughly explained by the researchers. This situation is also encountered in the suggestions for organizing the learning environments / classes in which applications are made in terms of the nature of science.

Based on this discussion, the following suggestions can be made to those who will work in the field of the nature of science in the subject area:

- ✓ The nature of science, covers the philosophy, history, psychology and sociology of science. It is important that those who will work on this issue do not start working without having a good education in these four areas and having sufficient knowledge.
- ✓ Since the studies in the subject of nature of science are the subject of not only science but also other disciplines; It is important that researchers in other fields of study also contribute sufficiently to this process.
- ✓ Studies on the subject of the nature of science should be planned and carried out on the basis of post-positivism and based on a qualitative paradigm. In this process, based on the interpretative understanding, long-term qualitative data collection methods should be used.
- ✓ The nature of science should be considered as a concept; moving from the knowledge that the concepts are structured in the mind from an early age and that the wrong concepts are largely resistant to change, it is very important to carry out studies that can positively structure the students' understanding of science in pre-school and / or elementary school, instead of constantly assessing their understanding of students in secondary-higher education.
- ✓ Perhaps the most important work to be done in a short time; to evaluate the education programs, textbooks, scientific children's magazines and additional study resources of all disciplines that have sufficient evidence to guide the scientific images of children and to determine the factors affecting the development of the nature of science.

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