

## Evaluation of Trends in Theses on Socio-Scientific Issues: The Case of Turkey

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### Abstract

The purpose of the current study is to determine the trends in M.A and Ph.D. theses on socio-scientific issues. To this end, thesis studies completed between 2008 and 2018 on socio-scientific issues were analyzed in terms of the year of thesis and publication type, the university where the thesis is done, the purpose of the thesis, research methods and designs, study groups and their size, data collection tools and the socio-scientific issues preferred for investigation. The thesis studies analysed in the current study were reached from the Higher Education Council Thesis Search Centre Database in Turkey. As a result of the current study, it was determined that such thesis studies started in 2008, the great majority of them are master's theses, the quasi-experimental design, one of the quantitative research methods, was frequently used, documents were generally used as the data collection instruments and pre-service teachers were used as the study groups in most of them. Moreover, in these thesis, the effect of instructional applications directed socio-scientific issues on the related variable (mostly argumentation skill/quality/ability and decision-making skills) has been frequently investigated and the most popular socio-scientific issues selected in these theses were found to include global warming, climate change and nuclear energy. In light of the findings of the current study, suggestions were made for future research and applications to be conducted on socio-scientific issues.

**Keywords:** Socio-scientific Issues; Thesis Studies; Science Education

**DOI:** 10.29329/ijpe.2020.268.8

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## INTRODUCTION

In the development of a country, the education system and in the development of an education system, scientific research and applications play an important role. The way to obtain objective, valid and reliable information that is necessary for educational decisions is directly related to the quality of research in the field of education (Yalçın, Bilican, Kezer, & Yalçın, 2009). New ideas and discussions are produced through scientific research conducted in different scientific disciplines and the results are shared with other scientists and interested parties (Ozan and Köse, 2014). However, scientific research and applications have a mission beyond providing academic communication. Academic publications produced as a result of scientific research have goals and contributions such as:

- Providing a perspective for the existing theories to continue their development and producing new theories,
- Strengthening academic communication among scientists and helping them to progress in their academic career,
- Disseminating the produced scientific knowledge through the society,
- Providing guidance for new scientific research to be conducted (Chang, Chang, & Tseng, 2010; Lin, Lin, Potvind, & Tsai, 2018; Mortimore, 2000; Ültay & Çalık, 2012)

According to Ültay and Çalık (2012), scientific publications, especially the ones based on the revision of educational research, have much to offer to teachers, researchers, educational policy makers and curriculum developers. For example, research involving the analysis of the data elicited in the past is important in determining the methods to be used in the field of education (Tekin, Aslan and Yılmaz, 2016). Therefore, as in many sub-disciplines, research in science and technology education affects the science education policies and curriculum development processes of our country.

As in all scientific fields, the results of scientific research in the discipline of science education are valuable as long as they become operational in practice. In fact, for many years, researchers have stated that research results do not generally make sense in science teaching practices (Shymansky and Kyle, 1992) and mentioned the weak effects of their efforts (de Jong, 2007). Research directed to science education, however, is not only critical in helping teachers improve classroom practices and contributing to their scientific literacy identity, but is also critical in knowing what has been researched in the past and what needs to be discovered in the future (Chang, Chang and Tseng, 2010).

### **A Review of Science Education Research in Turkey and in the World**

Having a detailed outlook of research in a field of science and taking a bird's eye view of academic publications are of great importance in terms of evaluating educational research and identifying trends. This type of research has been conducted in the literature to evaluate science education research and to determine trends (Doğru, Gençosman, Ataalkın and Şeker, 2012; Lin, Lin, Potvind and Tsai, 2018; Ültay and Çalık, 2012; Chang, Chang and Tseng, 2010; de Jong, 2007). In order to determine the place and direction of the research on science education in the world, systematic and periodically repeated studies in the literature can be investigated (Tsai and Wen, 2005; Lee, Wu and Tsai, 2009). Tsai and Wen (2005) analyzed the studies published between 1998 and 2002 in three international science education journal (International Journal of Science Education, Science Education and Journal of Research in Science Teaching) and found that most of the articles published in these journals were produced in English speaking countries (particularly America, England, Australia and Canada), that the researchers mostly preferred to conduct empirical studies, that the subjects that were most intensely investigated in these studies were students'

conceptions and conceptual changes and that the emphasis put on these subjects decreased over time. Moreover, they emphasized that in the period between 1998 and 2002, social, cultural and social gender problems were found to be more interesting among science educators. Lee, Wu and Tsai (2009) analyzed the published articles in the same three journals in 2003-2007 as a continuation of the study conducted by Tsai and Wen (2005) and compared their findings with the results of the Tsai and Wen (2005). According to the results of the research, the articles published in these journals by authors living in countries other than the four main English speaking countries (i.e. USA, UK, Australia and Canada) have increased in the last ten years. Consistent with the findings of Tsai and Wen (2005), during this five-year period (2003-2007), science educators were closely interested in the context of student learning. At the same time, it was determined that studies on argumentation attracted the attention of science educators in the last decade and it was among the most cited subjects. Chang, Chang and Tseng (2010) attempted to determine the trends in the articles about science teaching published in four journals (International Journal of Science Education, Journal of Research in Science Teaching, Research in Science Education and Science Education) in 1990-2007 by using scientometrical methods. As a result of this study, it was determined that conceptual change and concept maps were the most studied research subjects in the related year period, but the number of publications decreased in 2000s. It was emphasized that studies on professional development, the nature of science and socio-scientific issues, conceptual change and analogy attracted more attention over the years. Most recently, Lin, Lin, Potvind and Tsai (2018) conducted a comprehensive analysis of the articles published in three international science education journals (Science Education, Journal of Research in Science Teaching and International Journal of Science Education) in 2013-2017 through systematic content analysis. Researchers have noted that within 20 years, preferences for research have changed in the three journals; for example, while the subjects related to conceptual understanding, alternative concepts, and conceptual change (Learning-Conceptions) were at the top of the list of the most studied subjects in the period between 1998 and 2002 (Tsai and Wen, 2005), their popularity showed a continues decrease from 2003 towards 2017. As a result of the analysis of the 10 most cited articles, it was found that issues such as inequality in science education, STEM education and undergraduate research experiences were emphasized the most.

When the studies investigating the trends in science education were examined, it was found that one of such studies was conducted by Tatar and Tatar (2008). Tatar and Tatar (2008) conducted a study on the basis of the key words of 680 articles published in 26 peer-reviewed journals in 2000-2006 and found that subjects in the elementary school science and math curriculums were less investigated than the subjects in the secondary school and university science and math curriculums and the authors of these articles mostly focused on misconception in science education and attitudes in math education. Karamustafaoğlu (2009) examined all the published issues of 12 journals, nine in print and three with internet access, in order to determine basic orientations in science and technology education by subject areas. They identified the most popular research topics in science education for our country as interdisciplinary relations, educational philosophy, computer assisted science and technology teaching, curriculum development, learning activities and attitude towards science and technology. Ergun and Çelik (2011) conducted a study to determine the trends in science education in Turkey in 2008 and classified a total of 114 master's and doctoral theses according to "research area", "methodology of the study" and "sampling of the study". According to the research area, the most researched area was found to be descriptive. This is followed by studies on science curriculum and science literacy. The area where the least research was conducted was found to be environmental education. In terms of research methodology, the most frequently used methods were found to be experimental and survey methods. In none of the studies investigated, meta-analysis was used and phenomenological, action research, document analysis and case study methods were found to be the least preferred ones. Çalık, Ünal, Coştu and Karataş (2008) examined 444 thesis documents completed between 1990 and 2007. They found that there were general trends in the science education research in Turkey: (1) to promote science education between 1990 and 2000, (2) to follow up new perspectives on the basis of international trends. They also stated that studies involving an intervention and descriptive studies were clearly widespread and that environmental education subjects were studied the least. It was also determined that the most frequently used method was the

experimental design while action research, phenomenological and meta analysis methods were the least preferred ones.

### **Investigation of the Studies Conducted on Socio-Scientific Issues**

In the last decade, socio-scientific issues that have social, scientific, political, economic and ethical dimensions, that lead to a dilemma and debate in society, that involve open-ended, unstructured, different perspectives and solutions have become the focus of science education (Evren Yapıcıoğlu and Kaptan, 2017; Fang, Hsu and Lin, 2019; Sadler, 2004). Socio-scientific issues, as the name implies, are real life issues. It is a trend that supports individuals to have a say in decisions about scientific applications that they will encounter in real life and contributes to their being trained as conscious and responsible citizens. In this respect, these subjects are gaining greater importance in science education reform documents (for example, Next Generation Science Standards (NGSS), 2013; American Association for the Advancement of Science (AAAS), 1990) and curricula (MoNE, 2013). Since the 2000s, there has been an accelerated increase in research on socio-scientific issues. These studies are reflected in the curricula and teaching practices of many countries. For example, in the National Science Curriculum revised in 2015 in Korea, socio-scientific issues were further emphasized because they were found to be closely related to the acquisition of various core competences and skills (Lee, 2017). In Turkey, socio-scientific issues, for the first time, were conceptually involved in the 2013 science curriculum. Although the importance of socio-scientific issues was emphasized in the curriculum, it can be said that its reflection on classroom practices was still not sufficient.

In the literature of science education, there are studies conducted for the analysis and general evaluation of the studies on socio-scientific issues. For example, Topçu, Muğaloğlu and Güven (2014) examined 11 articles and 13 thesis studies and as a result concluded that the studies on socio-scientific issues in Turkey could be classified under two sub-themes called as the studies in which socio-scientific issues are the means and the studies in which socio-scientific issues are the ends. In addition, they found that most of the studies were at the master's level and quantitative and conducted to describe the pre-determined variables. Tekin, Aslan and Yılmaz (2016) examined 122 articles in five journals with high impact factors at international level between 2004 and 2015. The researchers, in contrast to the results reached by Topçu, Muğaloğlu and Güven (2014), found that there were more qualitative studies in the international literature than quantitative studies. In addition, arguments, decision making and informal reasoning were found to be the most studied variables related to socio-scientific issues. In the journals examined, half of the preferred samplings were found to be comprised of middle school and high school students, followed by university students. In their study, Genç and Genç (2017) concluded that the articles published in the period between 2000 and 2014 on socio-scientific issues in Turkey mostly focused on the themes of knowledge level, attitude and awareness and that in qualitative studies, undergraduate students were preferred more and that the most frequently researched socio-scientific issue was global warming. Lee (2017) analyzed the studies focused on socio-scientific issues by using the thematic content analysis method. It found that researchers in Korea primarily focused on identifying factors that might affect students' informal reasoning processes in socio-scientific issues, secondly on examining decision-making models in socio-scientific issues, and thirdly on teaching practices in socio-scientific issues.

### **Significance and Purpose of the Study**

Today socio-scientific issues are among the subjects frequently faced and debated by people in Turkey and in the world. Chang, Chang and Tseng (2010) stated that socio-scientific issues had attracted more and more attention over the years in studies conducted in the field of science education. In the studies based on the revision and evaluation of the studies on socio-scientific issues, published articles were found to be used as the most popular data sources (Genç and Genç, 2017; Lee, 2017; Tekin, Aslan and Yılmaz, 2016). In determining the trends in a research subject area, theses done in this area can be said to be an important data source. The fact that thesis studies are published in the

language of the country in which they are done most of the time may cause limitation in terms of international exchanges. Moreover, most of the thesis studies are not published in international platforms as articles, papers, books etc. This restricts the functionality of thesis studies in practice.

Like other similar studies in the literature, though Genç and Genç (2017) and Topçu et al. (2014) analyzed the studies conducted on socio-scientific issues in Turkey, their studies are limited to the period between 2000 and 2014. Given that socio-scientific issues have been increasingly becoming subjects of research and that these issues just started to be addressed with the 2013 science and technology curriculum, it can be said that it is necessary to analyze the studies conducted on these issues after 2014. In addition, as different from the existing studies, in the current study, the investigation of socio-scientific issues was limited to thesis studies and moreover, the theses were also investigated from different aspects such as their distribution across universities and the data collection tools used so that more detailed information could be obtained. To this end, theses done in Turkey were used as the main data source and more detailed analyses were performed compared to similar studies in the literature.

Undoubtedly, as scientific research is carried out, new scientific applications and technological products will be developed and people will be confronted with different socio-scientific issues. Therefore, the focus of the current study is on socio-scientific issues that are increasingly emphasized in science education reform documents and are included in science curriculums. With the present study, it is believed that contribution will be made to the sharing of scientific publications (theses done in Turkey) produced in a national framework on socio-scientific issues in international academic environments. In addition, the current study can be said to be a guide for researchers who will plan new research on socio-scientific issues. Thus, the purpose of the current study is to determine the trends in thesis studies on socio-scientific issues in Turkey. To this end, answers to research questions (1. What is the distribution of the theses by year? 2. What is the distribution of the theses across universities? 3. Which research methods were used? 4. Which study groups were used? 5. What is the size of preferred study groups? 6. Which data collection tools were preferred? 7. What are the preferred socio-scientific issues? 8. What is the categorical distribution of the theses according to their purposes?) sought.

### **Research Methodology**

In the present study, the general survey model was employed to conduct a detailed evaluation of theses done on socio-scientific issues in Turkey. The survey method is used to identify trends in a research universe (Fowler, 2008) and to make a description by taking the photo of the current situation (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2010). In the general survey model, a survey is conducted in a universe made up of a large number of elements either on the whole universe or a part of it in order to reach a general judgment about the universe (Karasar, 2006). As a result, the stated purpose of the current study made it necessary to use the survey model.

### **Data Collection Process**

In the current study, the Higher Education Council Thesis Search Centre Database official site was used to reach the thesis studies done on socio-scientific issues in Turkey. As a result of the preliminary search, it was determined that the first thesis on socio-scientific issues was published in 2008. For this reason, it was decided to include the theses done in the period between 2008 and 2018 in the current study. In the search, the Turkish key words “sosyobilimsel” and “sosyo-bilimsel” and their English translations (socioscientific and socio-scientific) were used. As a result of this search, a total of 55 thesis studies were reached. From among these theses reached, five of them were excluded as four of them don't have access permission and one of them used a sampling out of Turkey (the thesis search process was terminated on 18.02.2019). As a result, a total of 50 thesis study documents constituted the main data source of the study. The criteria used to select the studies to be included in the current study are as follows,

- Had to be conducted in the period between 2008 and 2018,
- Sampling must be from Turkey,
- The title of the thesis must include the concept of socioscientific or socio-scientific,
- The thesis must have an access permission in the National Thesis Search Database.

### **Data Analysis**

The data of the study were analyzed by using the content analysis method. The content analysis method refers to a systematic coding and classification operation used to organize certain concepts around codes and themes in existing qualitative data in order to discover the tendencies, frequencies, relationships and structures of the words and sentences used in a large number texts (Vaismoradi, Turunen, Bondas, 2013; Yıldırım and Şimşek, 2008). The main data source of the current study is master's and doctoral thesis documents. In the current study, the thesis data were analyzed qualitatively and then quantitatively converted into tables and graphs.

The analysis process was carried out in two stages. In the first stage, parameters (year and university in which the study was conducted, type of research, method and design of research, study group and its size and data collection tools) were determined in order to determine some descriptive main characteristics of the theses and then the coding was performed. In the second stage, content analysis directed to the variables examined by the thesis studies and the socio-scientific issues they addressed was carried out. In the current study, first the coding process was carried out and similar codes were brought together to create the themes. By combining similar codes, themes were reached. Frequencies of the repeated codes were entered into Microsoft Excel.

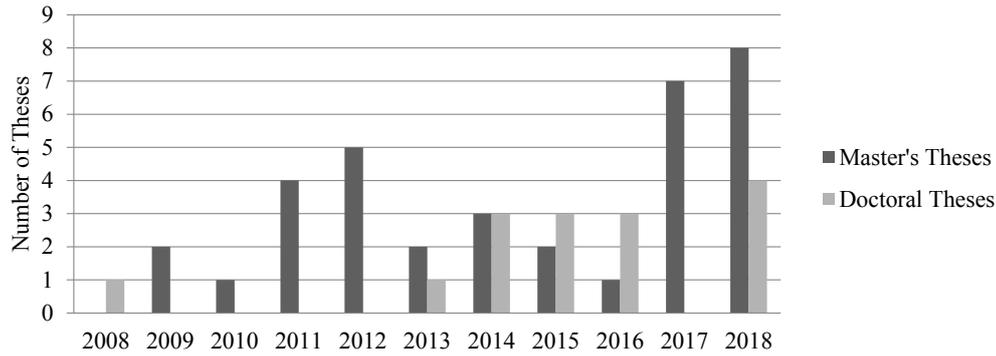
### **Validity and Reliability Studies**

In the current study, the selected theses were analyzed by reading again and again to avoid data loss. The coding process was completed nearly within a two-month period. Each thesis study was analyzed on the basis of the pre-determined parameters. Then, the similar codes emerging was combined and thus themes were created. Moreover, as stated by Bağ and Çalık (2017), a confirmation process was followed starting from the findings of the study and progressing towards the themes, codes and finally the raw data. The findings of the data were explained in an unbiased and detailed manner. The fact that the main data source of the current study is documents also strengthens the objectivity of the data. In order to determine the reliability of the coding process, 10 theses accounting for 20% of the research data in the current study and parameters were coded by two experts specialized in qualitative research methods. The inter-rater agreement was calculated by using the formula proposed by Miles and Huberman (1994) and found to be 0.95 and as this is over 0.70, it can be argued that the coding is highly reliable.

## **RESULTS**

### **Distribution of the Thesis Studies by Year**

In the current study, a total of 50 thesis studies completed in the period between 2008 and 2018 were obtained. Of these 50 theses, 35 are master's theses and 15 are doctoral theses. The distribution of these master's and doctoral theses by year is given in Figure 1.

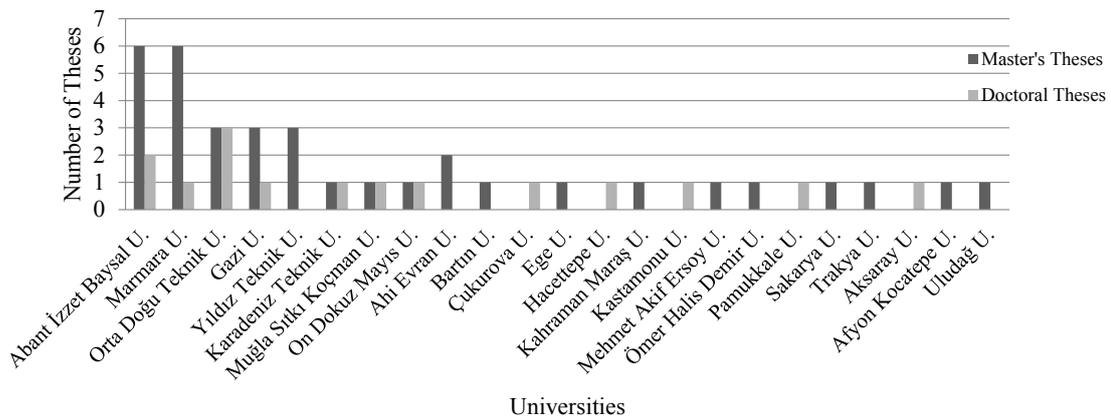


**Figure 1. Distribution of doctoral and master's theses by year**

As can be seen in Figure 1, the first thesis written on socio-scientific issues was a doctoral thesis by Topçu (2008). There was no doctoral thesis done on socio-scientific issues in 2009, 2010, 2011, 2012 and 2017. A significant increase was observed in the number of master's theses as of 2009 and in the number of doctoral theses as of 2013. The highest number of theses was completed in 2018.

### Distribution of the Thesis Studies across Universities

The distribution of the theses done in the period between 2008 and 2018 on socio-scientific issues across universities in Turkey is given in Figure 2.



**Figure 2. Distribution of the doctoral and master's theses across universities**

According to the 2017-2018 statistics issued by the Higher Education Council, there are 172 state universities and 72 foundation universities; thus, a total of 244 universities in Turkey. As can be seen in Figure 2, in 23% of the universities (9.4%), thesis studies on socio-scientific issues were done. The highest number of master's theses was completed in Abant İzzet Baysal University located in the Black Sea Region and Marmara University located in the Marmara Region and the highest number of doctoral theses was completed in Middle East Technical University located in the Central Anatolia Region.

### Distribution of the Thesis Studies according to their Research Methods and Designs

The distribution of the themes, sub-themes and codes related to research methods preferred in the theses on socio-scientific issues is given in Table 1.

**Table 1 Research methods and designs preferred in the theses on socio-scientific issues**

Theme	Sub-theme	Code	f
Quantitative Research Methods	Experimental Designs	Pretest-posttest control group design	7
		Pretest-posttest without control group design	2
	Survey Models	Not specified	1
		Correlational survey method	2
		Descriptive survey method	2
		Causal-comparative method	1
		Not specified	4
Total		19	
Qualitative Research Method	Case Studies	Multiple case study	4
		Exploratory case study	1
		Not specified	5
	Not specified		4
	Total		14
Mixed Research Method	Mixed models	Explanatory design	3
		Convergent parallel design	1
		Embedded mixed design	1
	Not specified		7
	Total		12
Action Research			3
Design Based Research			1
Not Specified			1
TOTAL			50

As can be seen in Table 1, in the thesis studies conducted on socio-scientific issues in Turkey, the researchers more tended to use quantitative research methods ( $f = 19$ ). The most preferred quantitative research method is the quasi-experimental pretest-posttest control group design ( $f = 7$ ). The second most commonly preferred research methods are qualitative research methods ( $f = 14$ ), followed by the mixed research methods ( $f = 12$ ). The least preferred research methods are the action research and design-based research approaches. In addition to this, the research design was not specified in 20 thesis studies. In many of the studies in which the research design was not specified, the mixed method was used ( $f = 7$ ).

### Distribution of the Thesis according to Study Group and its Size

The findings related to the distribution of the thesis studies conducted on socio-scientific issues in the period between 2008 and 2018 according to study group are presented in Table 2. It was determined that the study groups preferred in the thesis studies conducted on socio-scientific issues could be classified into three themes (students, teachers and others).

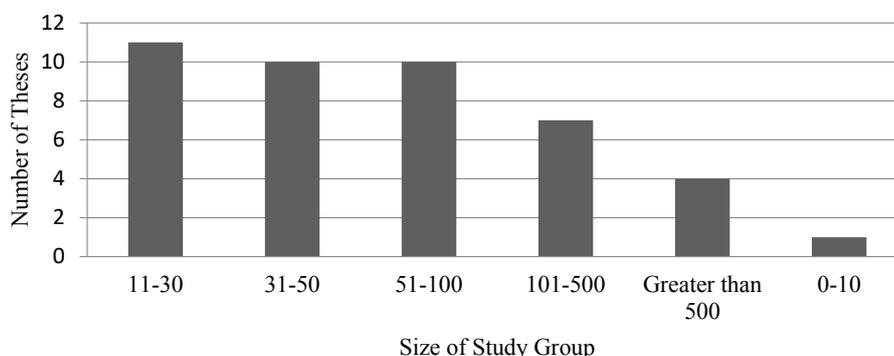
**Table 2. Distribution of the theses on socio-scientific issues according to study group**

Theme	Sub-theme	Code	f
Students	Pre-service teachers	Pre-service science teachers	17
		Pre-service biology teachers	2
		Pre-service classroom teachers	3
		Pre-service pre-school teachers	2
		Pre-service social studies teachers	1
		Not specified	1
	Total		26
K12 Students	K12 Students	Elementary school students	4
		Middle school students	17
		High school students	3
	Total		24

Teachers		Science teachers	3
		Biology teachers	1
		Unassigned science teachers	1
	Total		5
Others		Administrators -Members of non-governmental organizations-local people-Public.	1
	Total		1
TOTAL			56*

\*Since more than one study group were included in some theses, the total number of the study group types is different from the total number of theses (50).

As can be seen in Table 2, the most preferred study group is pre-service science teachers ( $f = 17$ ). The other pre-service teachers (biology, pre-school and social studies) were preferred as the study groups in few of the thesis studies. The second most preferred study group after pre-service science teachers is middle school students. However, elementary and high school students were preferred in a limited number of the thesis studies. The least preferred study group is teachers. Only five of the 50 theses used teachers as the study group. The findings related to the size of the study groups of the thesis studies conducted on socio-scientific issues in the period between 2008 and 2018 are presented in Figure 4.



**Figure 4. Distribution of the thesis studies according to the size of the study group**

As can be seen in Figure 4, in the thesis studies conducted on socio-scientific issues, the most preferred number of participants is in the range of 11-30. On the other hand, study groups consisted of 0-10 participants were preferred very little in the thesis studies conducted on socio-scientific issues in Turkey.

### **Categorical Analysis of the Thesis Studies according to the Data Collection Tools Used**

Findings related to the data collection tools used in the thesis studies conducted on socio-scientific issues in the period between 2008 and 2018 are given in Table 3.

**Table 3. Data collection tools used in the thesis studies on socio-scientific issues**

Theme	Codes (f)	f
Documents	Open-ended questions (f:8), scenarios (f:8), teacher or/and student dairies (f:5), argumentation worksheets/forms/reports (f:3), activity worksheets (f:2), arguments (f:3), argument quality rubric (f:1), laboratory guidelines (f:1), socio-scientific texts (f:1), individual documents (f:1), semi-structured discussion questions (f:1), unit plan activities (f:1), academic achievement assessment paper (f:1), reports (f:1), reflection reports (f:1), researcher notes (f:1), draw a scientist test checklist (DAST-C) (f:1)	40

Interview	semi-structured interview (f:12), focus group interview (f:4), interview protocol (f:3), interviews (f:3), interview form for the teaching of socio-scientific issues (f:2), interview for the evaluation of socio-scientific issues (f:1), interview related to the nature of socio-scientific issues (f:1), interview about science teaching (f:1), interview about the constructivist teaching (f:1), field dependent-field independent interview (f:1), interview form about socio-scientific issues (f:1), Structured interview (f: 1),	31
Scales/Questionnaires	Epistemological beliefs (f:4), attitude towards socio-scientific issues (f:4), argumentation quality evaluation (f:2), self-efficacy (f:2), metacognitive awareness (f:1), sensitivity to scientific-social problems (f:1) attitude towards human rights (f:1), environmental attitude (f:1), attitude towards environmental problems (f:1), self-efficacy for socio-scientific issues (f:1), motivation to learn science (f:1), attitude towards science (f:1), perception of socio-scientific issues (f:1), discussion in socio-scientific issues (f:1), making decisions about socio-scientific issues (f:1)	23
Skill Tests	Critical thinking test (f:2), decision-making skills test (f:3), basic science/technology literacy test (f:3), nature of science (f:2) science learning skill scale (f:1), determination of argumentation skills (f:1), scientific thinking skills (f:1), scientific thinking habits scale (f:1), problem solving (f:1), argumentation (f:1), basic skills scale (f:1), reflective thinking scale (f:1), critical thinking skill (f:1), socio-scientific reasoning skill (f:1)	19
Subject-area tests	Achievement test (f:2), renewable energy test (f:2), energy content area questions (f:1), achievement test with on energy subjects (f:1), content knowledge test (f:1), health awareness test (f:1), conceptual understanding test (f:1), biotechnology knowledge test (f:1), knowledge test on genetically modified foods (f:1), environmental achievement test (f:1), mid-terms (f:1), proximal and distal content knowledge tests (f:1), pedagogical content knowledge test on socio-scientific issues (f:1), test on the subjects of genetics (f:1)	16
Observation/audio and/or video recording	Observation (f:3), tape recordings of classroom discussions (f:2), class video recordings (f:2), classroom observation (f:1), tape recordings (f:1), in-class video recordings (f:1), discourse observation form (f:1), science teaching observation form (f:1)	12
<b>TOTAL</b>		<b>141</b>

As can be seen in Table 3, the data collection tools used in the thesis studies conducted on socio-scientific issues were collected under six themes. These are documents, interviews, observations, scales, skill tests and subject-area tests. The most frequently preferred data collection tool was found to be documents, one of the qualitative data collection tools, followed by interviews. The least preferred data collection tool was found to be observations.

### **Categorical Analysis of the Thesis Studies according to the Type of the Socio-scientific Issue Addressed**

Findings related to the socio-scientific issue selected to be investigated in the theses done in the period between 2008 and 2018 on socio-scientific issues are given in Table 4.

**Table 4. Samples to socio-scientific issues addressed in the theses**

Theme	Code (f)	f
Genetics studies and genetically modified products	Cloning/genetic duplication (f:5), genetically modified organisms (f:4), genetically modified foods (f:4), stem cell technology (f:2), human genome project (f:1), genetic studies (f:1), genetic tests (f:1), gene therapy (f:1), PGD (preimplantation genetic diagnosis) (f:1), CRISPR/Cas9 (f:1), bio-technology (f:1), use of golden rice (f:1), cell division and heredity (f:1)	24

Energy	Nuclear energy (f: 7), hydroelectric plants (f:6), alternative/renewable energy sources (f: 3), solar energy (f:1), power plants (f:1), Chernobyl accident (f:1), Bio-fuel production (f:1), energy issues (f:1), living things and energy relationships (f:1), heat insulation (f:1)	23
Human and environment relations	Global warming and climate change (f:8), human and environment relationships (f:2), environmental problems (f:1), air pollution (f:1), waste problem (f:1), cutting trees to build roads (f:1), depletion of ozone layer (f:1), development of medicine and cosmetic products and their effects on nature (f:1), Kyoto protocol (f:1), environment protection (f:1), the use of micro-organisms in the elimination of substances harmful to environment (f:1), nature and technology (f:1)	20
Local socio-scientific issues	Seben Taşlıyayla irrigation lake (f:1), chicken coops (f:1), leather production (f:1), disinfection of mosquitoes in Akyaka (f:1), food chain in Seyfe Lake (f:1), flamingos in Seyfe Lake (f:1), Köprübaşı gap and hydroelectric plant (f:1)	7
Eating	Balanced diet (f:1), food additives (f:1), synthetic meat production (f:1), use of convenient food (f:1), weight loss pills and supplements (f:1), is natural always healthy? (f:1),	6
Nutrition	Organ donation and transplantation (f: 4), health awareness (f:1), cholesterol (f:1), are mobile phones a threat to human life? (f:1), shot grip (f:1), health effects of organisms in our immediate environment (f:1),	5
Waste control	Wastes and recycling (f:1), plastic waste control (f:1)	2
Agriculture	Alternative agriculture suggestions (f:1), destruction of bees in colonies and use of pesticides in agriculture (f:1)	2
Use of animals for experiments and fun	Laboratory animals (f:2), dolphinariums (f:1)	2
Others	Bio-diversity (f:4), base stations (f:2), manufacturing of electric cars (f:1), scientists are discussing (f:1), illegal use of electricity (f:1).	9
TOTAL		100

As can be seen in Table 4, the researchers used social-scientific issues that can be collected under 10 different themes including genetics studies and genetically modified products, energy, human and environment relations, local socio-scientific issues, eating, health, waste control, agriculture, use of animals for experiments and fun and others in their theses. The most frequently preferred socio-scientific issues were found to be gathered under the themes of “genetics studies and genetically modified products” and “energy”. When the issues collected under these themes were examined, it was found that global warming and climate change ( $f=8$ ), nuclear energy ( $f=7$ ), hydroelectric plants ( $f=6$ ), genetic duplication/cloning ( $f=5$ ), organ donation and transplantation ( $f=4$ ) are the most popular issues addressed in the theses. On the other hand, agriculture, waste control and recycling, use of animals for experiments and fun were found to be the least preferred socio-scientific issues by the researchers.

### Categorical Analysis of the Purposes of the Thesis Studies

When the purposes of the thesis studies conducted on socio-scientific issues were categorically analysed, a total of four different themes were obtained. These themes are named as “Determining the effect of socio-scientific issues instructed through different instructional methods/activities on certain variables”, “Discovering the states of different study groups depending on different variables in relation to socio-scientific issues”, “Determining the relationships between different variables related to socio-scientific issues”, “Development and evaluation of an instructional module directed to socio-scientific issues”. It is seen that in the great majority of the thesis studies conducted on socio-scientific issues in Turkey, there is some kind of intervention and the effect of this intervention on different variables has been investigated. In these thesis studies collected under the theme “Determination of the effect of socio-scientific issues instructed through different instructional methods/activities on different variables”, the effect on a total of 23 different variables was found to have been examined. The codes (variables) found for the Theme 1 are given in Table 5.

**Table 5. Determination of the effect of socio-scientific issues instructed through different instructional methods/activities on different variables**

Codes	f
Argumentation quality/skill/ability	7
Decision making skills/tendencies	5
Academic achievement	4
Content knowledge	3
Informal reasoning/ reflective judgment	3
Scientific thinking skills/abilities	3
Perception of nature of science	2
Scientific discussion qualifications/tendencies	2
Science literacy	2
Critical thinking skills	2
Epistemological beliefs	1
Concept teaching	1
Sensitivity to scientific-social problems	1
Higher order question production	1
Attitude towards environment/environmental problems	1
Science-technology-society interactions	1
Attitude towards socio-scientific issues	1
Motivation to learn science	1
Belief in the nature of socio-scientific issues	1
Perceptions of socio-scientific issues	1
Reflective thinking skills	1
Problem solving skills	1
Attitude towards science	1
<b>TOTAL</b>	<b>46</b>

The most frequently investigated subject is the effect of socio-scientific issues instructed through different instructional methods/activities on argumentation skills ( $f=7$ ), decision-making skills/tendencies ( $f=5$ ), academic achievement ( $f=4$ ), informal thinking/reflective judgement ( $f=3$ ), scientific thinking skills ( $f=3$ ).

Another theme obtained as a result of the categorical analysis of the purposes of theses is “*Discovering the states of different study groups depending on different variables in relation to socio-scientific issues*”. Codes and frequency distributions found in relation to this theme are presented in Table 6.

**Table 6. The states of different study groups depending on different variables in relation to socio-scientific issues**

Codes	f
Opinions/perceptions/approaches regarding socio-scientific issues	8
Argumentation quality/skill/ability	6
Informal reasoning skills	3
Self-efficacy beliefs/levels	3
Epistemological beliefs	3
Attitude towards socio-scientific issues	3
Ways of teaching socio-scientific issues	2
Content knowledge	1
Scientific thinking habits	1
Pedagogical content knowledge	1
Supportive reasons	1
Conception of nature of science	1
Knowledge levels	1
Cognitive structures	1
Decisions and factors affecting them	1
Reflections on their works	1
<b>TOTAL</b>	<b>37</b>

As can be seen in Table 6, in the theses aiming to discover the states of different study groups depending on different variables in relation to socio-scientific issues, the researchers most preferred to

discover opinions/perceptions/approaches regarding socio-scientific issues ( $f = 8$ ), followed by argumentation quality/skill/ability ( $f = 6$ ), critical thinking abilities/ways of analysis/informal thinking skills ( $f = 3$ ), self-efficacy beliefs/levels ( $f = 3$ ), epistemological beliefs ( $f = 3$ ), attitude towards socio-scientific issues ( $f = 3$ ).

Another theme obtained as a result of the categorical analysis of the purposes of theses is “*Determining the relationships between different variables related to socio-scientific issues*”. A total of 6 codes were obtained in this theme. Codes and frequency distributions found in relation to this theme are presented in Table 7.

**Table 7. Relationships between different variables related to socio-scientific issues**

Codes	f
Content knowledge * argumentation quality	2
Informal reasoning * epistemological belief * metacognitive awareness	1
Self-efficacy belief * epistemological belief	1
Epistemological belief * ways of instruction in socio-scientific issues	1
Science learning skill * science literacy * attitude towards socio-scientific issues	1
Reasoning * conception of nature of science	1
TOTAL	7

As can be seen in Table 7, the number of the theses investigating the relationships between different variables related to socio-scientific issues was found to be limited. The most frequently investigated relationship is the relationship between content knowledge and argumentation quality. The epistemological belief is the variable whose relationship with different variables was investigated the most.

Another theme obtained as a result of the categorical analysis of the purposes of theses is “*Development and evaluation of an instructional module directed to socio-scientific issues*”. Codes and frequency distributions found in relation to this theme are presented in Table 8.

**Table 8. Development and evaluation of an instructional module directed to socio-scientific issues**

Codes	f
Development of content knowledge * argumentation quality	2
Development of argumentation and attitude towards human rights	1
Development of a unit	1
TOTAL	4

As can be seen, a limited number of researchers have been interested in the development and evaluation of an instructional module directed to socio-scientific issues in Turkey. These researchers mostly focused on the development of content knowledge \* argumentation quality.

## CONCLUSION AND DISCUSSION

The purpose of the current study was to determine the trends in the thesis studies conducted on socio-scientific issues in Turkey. To this end, thesis studies completed between 2008 and 2018 on socio-scientific issues were analyzed in terms of the year of thesis study and publication type, the university where the thesis is done, the purpose of the thesis, research methods and designs, study groups and their size, data collection tools and the socio-scientific issues preferred for investigation. One of the findings obtained from these analyses is that the first thesis study conducted on socio-scientific issues is a doctoral thesis by Topçu (2008). Moreover, the findings of the current study have revealed that a significant increase was observed in the number of master’s theses as of 2009 and in the number of doctoral theses as of 2013. These findings concur with the findings of Topçu et al. (2014) and Tekin, Aslan and Yılmaz (2016) arguing that the number of the studies on socio-scientific issues gradually increased over time. This might be because socio-scientific issues have gained greater importance both in the world and in Turkey. The rapid developments in the scientific and

technological fields and the increasing number of controversial issues brought about by these developments may have attracted more attention to socio-scientific issues and may have made it necessary to investigate these issues. Another reason can be the high increase seen in the number of master's and doctoral theses done on science and technology subjects since 2006 (72%, 71%, respectively) (Doğru et al., 2012). Doğru et al. (2012) associated this increase with the emergence of new research areas due to changes in science curricula since 2005 and rapid scientific and technological developments. Therefore, the increase in the studies conducted in the field of science education in general may have supported the increase in the studies on socio-scientific issues in particular. The increase seen in the number of doctoral theses on socio-scientific issues in Turkey as of 2013 can be attributed to the inclusion of these issues in the formal education curriculum prepared by the Ministry of National Education. It is possible that researchers and educators might have gained awareness of these new subjects that were incorporated into the curriculum and might have wanted to explore the effects of their inclusion of these issues in the curriculum.

Another finding obtained in the current study is that in only 23 of a total of 244 universities in Turkey (9.4%), thesis studies were conducted on socio-scientific issues. According to the findings of the current study, the highest number of master's theses was completed in Abant İzzet Baysal University located in the Black Sea Region and Marmara University located in the Marmara Region and the highest number of doctoral theses was completed in Orta Doğu Teknik University located in the Central Anatolia Region. This finding is parallel to the finding of Değirmenci and Doğru (2017) stating that socio-scientific issues have been most intensely studied in the Black Sea Region and Central Anatolian Region. One of the reasons for this situation can be attributed to the presence of researchers / academicians who are investigating socio-scientific issues in these universities. The panels organized by Marmara University and Orta Doğu Teknik University with the title of Socio-Scientific Issues in Science Education in 2012 can be considered as an indicator of the importance given to socio-scientific issues in these universities.

In the current study, it was determined that the researchers more tended to use quantitative research methods ( $f = 19$ ) in the thesis studies conducted on socio-scientific issues. This finding concurs with Genç and Genç (2017), Değirmenci and Doğru (2017) and Topçu et al. (2014) demonstrating that quantitative research methods were preferred more in articles and theses written on socio-scientific issues in Turkey. In fact, it can be said that more use of quantitative methods does not only apply to the analysis of socio-scientific issues because in their studies, Çalık et al. (2008), Doğru et al. (2012), Kula Wassink and Sadi (2016) and Varışoğlu and Göktaş (2013) found that experimental and survey designs were used the most in science education studies. It can therefore be stated that researchers working in science education prefer quantitative methods. Çalık et al. (2008) brought a different interpretation to the more widespread use of qualitative research in Turkey. They argued that the majority of the researchers researching science education in Turkey had been studying pure science at first and then they got directed to science education; thus, they could not get rid of their past habits. This argument proposed by Çalık et al. (2008) can be viewed as the reason for the findings of the current study. In addition, the fact that qualitative research requires the investigation of events as they are and more in-depth analyzes, whereas in quantitative research, data can be collected more easily and in a shorter time span through data collection tools such as questionnaires and tests, and data can be analyzed quickly with statistical programs may have directed researchers to quantitative studies. Another finding obtained in the current study is that the research method and / or design was not specified in 20 thesis studies and that the majority of these studies are mixed method studies. This finding may be explained by the lack of information about research methods and designs or the lack of care in writing scientific publications.

The results of the current study showed that the least preferred research methods are action research and design-based research approaches. This finding is in compliance with the study carried out by Çalışkan and Serçe (2018) reporting that only in 80 of 3087 articles published in journals with a Turkish address in ULAKBİM and SSCI databases used the action research method, revealing that action research is much less preferred in Turkey. Similarly, Ergun and Çelik (2011) revealed that action research is one of the least preferred methods in science education research, which supports the

findings of the current study. Action research, which is used to develop and implement educational practices in a better way (Calhoun, 2002), may require the generation of a new idea of implementation and the development of different perspectives in this regard. The implementation of the proposed innovation in the process and its evaluation with multiple data collection tools at different intervals (Yıldırım & Şimşek, 2008) may make the process long-term and difficult to control. This may have led the researchers to conduct quantitative research in which they could more easily reach the conclusion. The reason why design-based research is less preferred in the investigation of socio-scientific issues might be associated with its being relatively new to Turkey. In fact, the first thesis focusing on the implementation of design-based instructions was published in Turkey in 2014 (<https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp>).

The findings of the current research revealed that the most preferred study group in the theses on socio-scientific issues was pre-service science teachers, followed by middle school students. This finding is consistent with Kula Wassink and Sadi (2016) finding that in the articles published in the four basic educational sciences journals in Turkey in the period between 2005 and 2014, the most used study group was pre-service teachers, followed by middle school students. In addition, these findings are consistent with the results of Tekin et al. (2016), which revealed that one of the most preferred study groups in studies conducted on socio-scientific issues in international journals is middle school students. Genç and Genç (2017) determined that in the articles published between the years 2000 and 2014 on socio-scientific issues in Turkey, the most studied study groups were comprised of undergraduate students. Given that Genç and Genç (2017) did not divide the study groups into disciplines and that the pre-service science teachers are also undergraduate students, it can be stated that the results of their study support the results of the current study. Similarly, the results of the study conducted by Topçu et al. (2014) revealing that most of the study groups in the studies carried out on socio-scientific issues between 2002 and 2012 in Turkey were consisted of pre-service teachers are consistent with the results of the current study. This might be partially because of the fact that pre-service science teachers are easily accessible. Another reason may be that, as socio-scientific issues entered the Ministry of National Education science curriculum in 2013, researchers working in the field of science might have attached greater importance to the development of pre-service science teachers on socio-scientific issues and determination of their related competences. In addition, selection of middle school students to be included in study groups of the studies on socio-scientific issues might be the desire to evaluate the functionality and outcomes of these issues newly entering the science curriculum. Moreover, Kula Wassink and Sadi (2016) noted that most of the authors of the articles published in four educational sciences journals between 2005 and 2014 are researchers from the field of elementary school science teaching. Therefore, it can be stated that it is not surprising that the researchers working in the field of science teaching choose pre-service science teachers and middle school students as their samples. Another finding of the current study is that teachers are the least studied sample group in the investigation of socio-scientific issues. Parallel to this finding of the current study, Dođru et al. (2012) and Genç and Genç (2017) have also revealed that one of the least studied groups in Turkey is teachers. One of the reasons for this may be attributed to the fact that teachers do not volunteer to participate in such studies due to different reasons (such as concerns about national exams and keeping up with the curriculum). Moreover, as pre-service teachers are more easily accessible than teachers and these two groups have similar characteristics, pre-service teachers might have been preferred more than teachers.

Another finding of the current study is that in the thesis studies conducted on socio-scientific issues, the most preferred sampling size for these studies was between 11 and 30 participants and the sampling size including participants ranging from 0 to 10 was much less preferred. In the current study, it has also been shown that quantitative research is preferred more than qualitative research. Thus, given that it is possible to conduct a qualitative study with the participation of 0-10 people, it can be said that the research method preferred in the study seems to have affected the sampling size.

Another finding of the current study is that the most frequently used data collection tool in the thesis studies conducted on socio-scientific issues is documents, a qualitative data collection tool (open-ended questions, worksheets, assessment forms, written argumentation activities, reports,

researcher notes), followed by interviews and scales. This finding concurs with the study of Varışoğlu and Göktaş (2013) reporting that one of the data collection tools used the most in educational studies in Turkey is documents. The fact that documents are suitable for collective evaluations and many techniques may be one of the reasons why they are more preferred (Varışoğlu and Göktaş, 2013). In fact, open-ended questions also considered to be documents are one of the most preferred measurement tools in education (Güler, 2014). In addition, students who are dealing with socio-scientific issues are expected to be able to put forward their own stance on the issue, make benefit and risk analyzes, and defend their stance with appropriate and sufficient evidence and reasoning (Author, 2016). Therefore, the use of open-ended questions, written forms and worksheets that allow students to express their thoughts may be a requirement of the nature of socio-scientific issues. Another finding obtained in the current study is that in the thesis studies conducted on socio-scientific issues in Turkey, the least preferred data collection tool is observations. This finding of the current study is in compliance with the studies by Kula-Wassinki and Sadi (2016) and Dođru et al. (2012) stating that the least preferred data collection tools in theses and articles in Turkey is observations. This might be because researchers in Turkey generally tend to prefer quantitative research methods because observation is defined as a data collection tool mostly used in qualitative research (Yıldırım, 1999).

Another finding of the current study is that the most preferred socio-scientific issues to be studied in the thesis studies conducted in Turkey include global warming and climate change, nuclear energy, hydroelectric, genetic duplication / cloning, organ donation and transplantation. This finding is similar to the findings reported by Genç and Genç (2017) analyzing the articles written on socio-scientific issues between 2000 and 2014 and stating that the most studied issue is global warming and by Değirmenci and Dođru (2017) stating that one of the most studied issues between 2011 and 2015 is nuclear energy. Moreover, this finding is also supported by Genç and Genç (2017) as they found that after global warming, nuclear energy and cloning are the most studied subjects. This finding can be explained by the fact that initially more emphasis was put on global socio-scientific issues in Turkey; thus, more research was focused on the investigation of global warming and climate change affecting the whole world. As the establishment of nuclear power plants is a relatively new development in Turkey and the establishment of these plants is still continuing, the issue of nuclear energy might have turned out to be a popular subject of research. Similarly, news about the plans for the establishment of new hydroelectric plants in the media and public reaction against these new attempts might have fostered researchers' desire to investigate these issues. The use of animals in tests and for fun, agriculture, waste control and recycling were found to be less preferred socio-scientific issues and this might be because these issues have not been much discussed in media in Turkey.

Another finding in the current study is that the highest number of thesis studies analyzed focused on the investigation of the effect of socio-scientific issues on argumentation skills and decision-making skills / tendencies. This finding concurs with the study by Tekin et al. (2016) stating that socio-scientific issues were studied most together with argumentation and decision-making skills in the articles published in five journals having high impact factors. This finding may be related to the necessity of using argumentation and decision-making processes while dealing with socio-scientific issues due to their nature because socio-scientific issues are controversial issues and they do not have definite solutions. Therefore, socio-scientific issues may require individuals to express their own thoughts and to make a decision by defending their thoughts with evidence and reasoning. Therefore, it is natural to investigate the use of argumentation and individuals' decision-making processes while discussing socio-scientific issues in classrooms. On the other hand, the change in the perspective of science education over time may also be a reason for the finding. Nowadays, science teaching is seen from a perspective going beyond the learning of theories and laws or scientific knowledge. Recent approaches in educational research give importance to discursive practices in science learning and emphasize that argumentation; as one of these practices, plays a central role in the development of theories and explanations in science education (Erduran, Osborne and Simon, 2005). Therefore, argumentation has become one of the most emphasized issues in science education for the last 15 years (Tekin et al., 2016). Thus, the finding of the current study showing that socio-scientific issues are mostly studied together with argumentation may be the result of using socio-scientific issues as a suitable content for argumentation.

Another finding of the current study is that in the studies in which correlational analyses were conducted in relation to socio-scientific issues, the correlation most investigated was the one between content knowledge and argumentation quality. The reasons why argumentation is a preferred variable in socio-scientific issues are discussed above. On the other hand, the selection of content knowledge for investigation may be linked to the objectives of science education because although the perspective of science education has changed over time, it is stated that science literate individuals should understand basic science concepts in order to understand the world we live in (Halpern, 2000). Therefore, the objectives of science education can be shown as a reason for examining content knowledge in science education research. The results reported by Topçu et al. (2014) and Genç and Genç (2017) indicating that level of knowledge is one of the most studied variables in studies conducted on socio-scientific issues in Turkey support this finding of the current study. However, while arguing the finding that the correlation between content knowledge and argumentation is one of the most studied subjects in research on socio-scientific issues, it should be kept in mind that only 2 of the theses done in 2008-2018 investigated this correlation. Therefore, we can state that correlation studies are not very common among the studies investigating socio-scientific issues. The finding of Değirmenci and Dođru (2017) that only one of the articles and theses written on socio-scientific issues in Turkey in the period between 2011 and 2015 is a correlation study supports this finding of the current study.

In the current study, it was also found that a limited number of studies were engaged in the development and evaluation of an instructional module in socio-scientific issues from among the thesis studies investigated. In fact, it was found that only one thesis focused on the development of a unit. This might be because of the fact that quantitative methods are preferred more in studies investigating socio-scientific issues in Turkey yet developing a unit and evaluating its functionality may require the use of qualitative processes. On the other hand, these processes may necessitate the cooperation of science education experts and science teachers in the development stage of the unit and that of measurement and evaluation experts in the evaluation of the unit. Accordingly, the fact that the researchers preferred research methods that can reach the results more easily may be a reason for the relevant finding of the current study.

### *Suggestions*

- It is seen that the studies conducted on socio-scientific issues preferred quantitative research methods more. Given that the preferred research method will affect the content of the subject to be investigated, variables or data collection tools, future research to be conducted by using different research methods (quantitative, mixed, correlational, design-based, action research) is believed to make different and important contributions to the socio-scientific issues literature.
- In the considerable number of thesis studies, the research method and/or design of the research was not specified. For this reason, the variety and number of research methods and designs courses offered to especially master and doctoral students can be increased.
- It was determined that a very limited number of studies were conducted on socio-scientific issues with the participation of teachers in Turkey. Considering the importance of teachers in the implementation of instructional activities in the classroom, it can be stated that there is a need for studies to be done on teachers. Thus, the findings to be obtained from such studies will support the development of socio-scientific subject-based instruction and allocation of more time to such instruction in classrooms. Therefore, organization of in-service training seminars and projects to inform teachers on socio-scientific issues may also contribute to attachment of greater importance to these issues in the class.

- It is seen that socio-scientific issues have been studied in a very few universities in Turkey. More widespread exploration of these issues can be supported through projects to be realized in cooperation with universities both at national and international level.
- It was found that a considerably small number of studies were conducted to develop socio-scientific issues-based units in Turkey. Research oriented to developing units is believed to serve as an example for educators in terms of including socio-scientific issues in classrooms not only as content but also as a teaching model (socio-scientific issue based teaching).
- Issues such as pesticide use in agriculture and alternative agriculture are the least studied socio-scientific issues in Turkey. Investigation of such issues in an agriculture country like Turkey is of great importance for people to produce their agricultural products more consciously.

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