A Synthesis Study of National and International Graduate Theses on Writing for Learning in Science Education

Kevser Arslan [1], Elif Benzer [2]

Abstract

The aim of this study is to examine and analyse the postgraduate thesis studies published in the national and international fields for writing for learning purposes in science education in the context of the determined criteria. For this purpose, national and international postgraduate theses prepared for writing in science education between 2010-2020 were reached and 37 national and 36 international thesis studies included in the study were examined. This study, which examines the theses prepared for writing in the field of science education, was carried out as a synthesis study and in this direction, 73 postgraduate theses were examined with a comprehensive and critical approach. As a result of the examination; In most of the national and international postgraduate theses, writing themes related to science achievement, science attitude, conceptual learning and scientific skills are preferred, theses are mostly carried out with experimental methods from quantitative research methods, mostly secondary school samples are studied, and academic achievement test is generally used as a data collection tool and t-test analyses were used in the analysis process. In addition, within the framework of the thesis studies analysed, it was revealed that writing activities had a positive effect on academic achievement, attitude, writing skills, writing proficiency, and creative writing levels. International theses; It has been determined that it differs from national theses with the themes of science news, professional development, technology-integrated writing, and information transformation. Based on the results of the study, it is suggested that the postgraduate theses, especially in the national field, conducted for writing for learning purposes in science education, are enriched from different aspects (scientific method, approach, subject, etc.) to fill the gap in this subject with studies.

[1] Yıldız Technical University, Faculty of Education, Dept. of Mathematics and Science Education, Turkey, arslankevser96@gmail.com

[2] Marmara University, Atatürk Faculty of Education, Dept. of Mathematics and Science Education, Turkey, elif.benzer@marmara.edu.tr

Introduction

Each education system has goals that are shaped according to the characteristics of the period. Today, these goals are called 21st century skills, which include skills such as critical thinking, problem solving, and decision making, and individuals who make up the society are expected to have these skills. These skills can be based on the potential of individuals to access information, to distinguish between true and false information, to follow up information, or to use information. At this point, the question of what the teaching process can be, which can respond to today's needs in education, shows itself in order for individuals to acquire these gains. In response to this question; it can be said that there is a need for an active process in which students are involved in the process of acquiring, criticizing, using, producing and sharing information. Therefore, it can be deduced that basic language skills proficiency is more important than content.

There are four basic language skills: listening, speaking, reading and writing. Two of them are used for acquiring information (reading and listening) and the other two for sharing information (speaking and writing). Although these skills seem to belong to the Turkish course, they are common tools to be used in many courses, including science, to understand and transform knowledge into skills, because throughout history, knowledge has been created with language and transferred to future generations with language. "Word flies; the text remains." The expression reveals the importance of writing in the history of science, especially within the scope of science lessons, in reaching the present day. It is possible to come across many studies emphasizing that language skills in science education support the use of scientific language and learning science (Djudin, 2018; Miller, Scott, & McTigue, 2018; Prain & Hand, 2016; Wellington & Osborne, 2001).

The ineffective use of language is an obstacle to learning science and writing practices for learning are important in overcoming this obstacle (Wellington & Osborne, 2001). Writing is a complex skill that requires high-level thinking skills and is related to cognitive, affective and psycho-motor development levels (Okur, Demirtaş, & Keskin, 2013), a process that evokes cognitive processes and structures, creates information and facilitates learning (Galbraith & Baaijen, 2018) is described as a method of focusing, organizing, interpreting, making decisions, discovering and imagining any study (Akar, 2007) and an activity that associates and categorizes information in long-term memory and organizes information (Silva & Limongi, 2019).

The use of writing activities with different applications has increased the importance of writing in science education and its role on students' learning (Prain & Hand, 2016). Özbek (2020) listed different writing styles used in science as learning science by writing, argumentation writing, reflective writing, informative writing, persuasive writing, imagined experience writing, expressive writing, etc. Martin and Miller (1988) classified the main ways used in science as reports, explanations, experimental explanations and argument explanations and stated that these would also support students' writing and learning by writing and could be used as a writing framework for learning (Figure 1) (Wellington & Osborne, 2001).
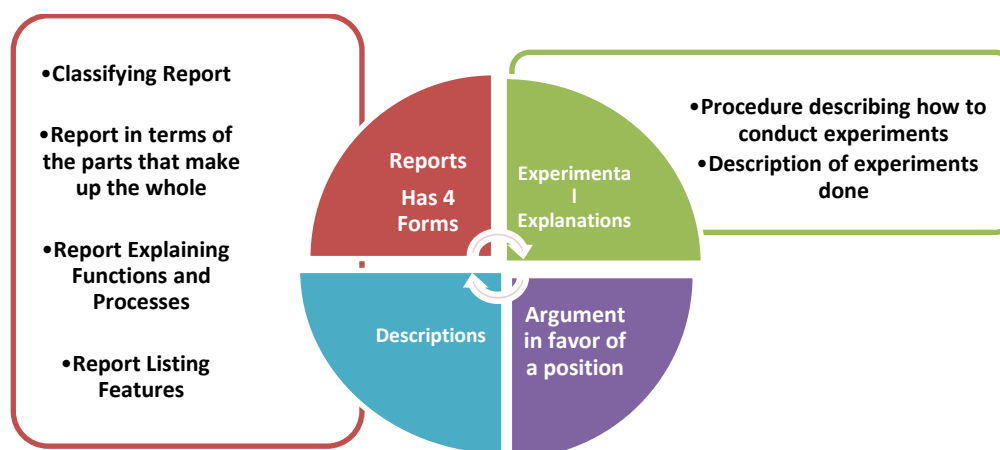
Figure 1. Types of Writing Used in Science

The approaches to writing for learning used in science education can be handled under two categories: One of the categories, traditionally defined, is writing, which is the process of copying based on the student taking notes, making a summary, and filling out the ready-made laboratory sheets. The other is writing activities such as stories, letters, diaries, posters, brochures, poems and concept maps, which are explained as writing types other than traditional writing (Uzoğlu, 2014). These applications, which are used to support learning and different acquisitions in science classes, can be enriched by emphasizing the act of writing. There are also studies that benefit from these writing-supported applications in which students can actively participate (Aksoy & Doymuş, 2011; Uc, 2019; Uysal & Sidekli, 2020).

Writing, which is integrated into science education with different applications, is one of the methods that should be used during science teaching (Erol, Akçay, Bayram, & Kapıcı, 2016; Lamb, Etopio, Hand, & Yoon, 2019), and it is possible that the different literacy and high-level thinking skills expected from individuals in the 21st century can be achieved in science. Science courses (Bozat & Yıldız, 2014; Wright, Hodges, Dismuke, & Boedeker, 2020; Wright, Hodges, Zimmer, & McTigue, 2019). On the other hand, it has an important epistemic value in encouraging students to learn (Prain & Hand, 2016) and is an important tool in revealing their conceptual understanding and strengthening their thoughts (Chen, Hand, & McDowell, 2013). In addition, writing activities used in science play a very important role in ensuring success and conceptual understanding (Akçay & Baltacı, 2017; Gere, Limlamai, Wilson, MacDougall Saylor, & Pugh, 2019; Pınar & Yıldız, 2020; Miller et al., 2018; Seven, Köksal, & Koçak, 2017; Uzoğlu & Gürbüz, 2013).

Through writing, students can plan and organize their ideas and moods and realize their own learning. They can acquire the skills of ordering, clarifying, comparing, scrutinizing and reviewing their thoughts through writing (Prain & Hand, 2016). At the same time, writing allows students to express their own ideas, thus allowing individuals to know themselves (Aktepe, 2020). It gives students interest and understanding in learning, increases their communication and questioning skills in their own discipline, and improves their self-confidence (Otfinowski & Silva-Opps, 2015). It can motivate students to advance their careers in science (Daniels & Goegan, 2019). In addition, writing plays an effective role in gaining literacy skills for the field and creating an identity of their own (Bazerman, 2009) by providing students with a unique perspective in science learning and the ability to turn each life experience into a learning opportunity (Dunya, 2019). While supporting the development of individuals' sense of identity, it also provides critical thinking skills (Williford, 2019), opens the door for students to get away from clichés and produce ideas that will make a sound (Topçuoğlu Ünal & Sever, 2012), and helps them to put forward different interpretations (Günel, Uzoğlu, & Büyükkasap, 2009). Thanks to scientific writing, it is inevitable for individuals to gain reasoning and reasoning skills and to offer solutions to the problems they encounter, so they are intertwined with scientific process skills (Otfinowski & Silva-

Opps, 2015; Ulu & Bayram, 2015). Writing activities used in science education improve students' epistemological beliefs and awareness (Atasoy & Küçük, 2020). It should be emphasized here that the writing activities in science are different from the symbolizing activities alone. However, the development of the activity based on writing will help the student to routinely include many high-level thinking skills such as giving his feelings and thoughts in a certain flow, questioning, and running it to work.

In addition to its various contributions to the importance of writing in science education, as in every approach, some deficiencies can be encountered in applications. İncirci (2016) stated that the use of writing in teaching is more difficult compared to other skills, and it is difficult for students and adults to perform it. In the study, primarily writing was seen by students and teachers as a way of taking notes or storing information in memory. At this point, when the point of view towards writing used in science education is examined, it would not be wrong to say that writing is seen as limited writing processes in the form of writing, summarizing, and completing an experiment report in class. Therefore, first of all, there is a need to change the existing perceptions of writing in the minds of both teachers and learners and to explain that writing is a tool that can be used in functions that will serve many purposes. As a matter of fact, Aktepe (2020) also stated that writing is individuals' expressing their own thoughts within a plan and within a period of time, but with such a writing content, it will be different, original and important as a means of reflecting the students' own thoughts. Although how writing is used is an important question, students' attitudes towards writing is another obstacle encountered in science teaching. Ungan (2007) states that students prefer to stay away from writing activities in education. Tağa and Ünlü (2013) revealed that students have difficulties in creating rich thoughts and writing their thoughts due to their lack of self-control skills. In addition, it has been determined that they are reluctant to write and do not use the ways of developing thinking effectively. Çömen (2018) states that writing activities used in science teaching for this purpose can cause boredom and sometimes reluctance for students due to the difficulty. Uc (2019) stated in his study that students were aware that they gained a lot from writing activities, but they stated that they were very tired from writing. It is also seen in the studies stated that students can exhibit an anxious and shy attitude towards writing, thinking that they will make mistakes in writing and that they do not have sufficient skills in performing the act of writing. At this point, the necessity of creating a motivational rich learning context in order to carry out writing activities reveals itself (Hand & Prain, 2002). In this sense, it is possible to state that students may have an even more uneasy attitude when scientific concepts are included in the writing process, especially in science education. The idea that students should write more carefully, because science comes to the fore in science lessons, may increase this uneasiness. At this point, Gunel, Hand, and Prain (2007) argue that it can be easier to involve students in the work by reflecting the daily life in the sciences to the language and writing. He suggests that teachers' feedback to students' writing activities in this process will be a source of motivation for them and they should have provided more interaction with each other during the writing process in science education. On the other hand, some teachers, like students, do not show a warm attitude towards writing activities. It was revealed by Ray, Graham, Houston, and Harris (2016) that teachers need support in applying writing activities for learning purposes that they will use in science lessons, and they do not use them very often. Daşdemir, Cengiz, and Uzoğlu (2015), on the other hand, would have provided a justification for this situation, as teachers related the writing process only as a note-taking process and thought that it causes a waste of time. Erduran Avcı and Akçay (2013) found that although science teachers saw writing as a valuable activity, they did not have enough experience in using time and using it. On the other hand, writing activities used in order to make writing skills more effective in the classroom environment may be important. It is necessary to determine the most appropriate writing activities used in the learning process. Graham, Kiuhara, and MacKay (2020) recommend that teachers match the course content with writing objectives and consider classroom conditions when applying writing activities in science classrooms. In addition, it should be checked that the writing activities applied in the classrooms reach the desired results and support should be provided for the successful completion of the deficiencies, if any. Hand and Prain (2002) emphasize the selection of a writing activity conducive to teachers' learning process. Teachers should be given the necessary

experience in terms of both practice and knowledge about using writing processes in their classrooms (Daşdemir et al., 2015; Whitacre, 2019). Therefore, considering the contributions of learning-oriented writing activities in science teaching, as Graham (2020) suggests, students should be taught how to plan and organize their writing steps, and this process should be supported by the determined objectives. It is possible to see many national and international studies on the importance of writing in the formation of science and science education. However, Wright et al. (2019) state that although there are studies on writing for learning in science, there is still a gap in the literature on this subject. Therefore, it is understood that the literature needs writing studies in science learning. Two studies conducted by Uzoğlu (2018) and İspir and Yıldız (2021) on writing for learning purposes in science education were found in the literature. When the studies were examined, it was seen that both of them included only scientific studies published in the national area. It is thought that the present study differs from other studies as it covers both national and international scientific publications. Another study, using a different subject area, is the study by Akkuş and Darendeli (2020) in which scientific publications on writing for learning purposes in the field of mathematics are examined. On the one hand, the aim of this study has been shaped by considering the contribution that it will provide to educators and researchers, on the other hand, there is no study that examines the scientific writing researches on national and international science education in depth and synthesizes the situation in depth. It is obvious that the first step that can be taken to fill the gap in the literature for writing in science is to examine the studies in the literature. By examining the studies in detail and making a thematic content analysis, we will have the opportunity to see many pictures together, such as what should be understood by the term "writing for learning in science", what are the trends in the world and in Turkey, how it has been studied, what scientific method has been used, and what has been taken to the focal point. In addition, it is aimed to reveal the current deficiencies and to guide the studies to be carried out in the future. In addition to all these, the comparison of both national and international postgraduate studies on writing in science education within the framework of the study also provides the opportunity to reveal the differences and similarities of Turkish and foreign theses. Theses based on writing practices for learning purposes written abroad are expected to be a source of ideas for researchers who will work on this subject in our country. Thus, it will be able to guide the researchers who aim to study on this subject and facilitate their ability to limit the subject. On the other hand, the study can serve as a guide for science educators to have information about the positive or negative effects of using writing activities in their lessons on student achievement, attitudes and skills. It is thought that the practices carried out in the classrooms for writing, especially in thesis studies, can greatly contribute to the educators who want to benefit from writing in science. However, it is anticipated that the results of the study will contribute to the literature in terms of guiding how writing in science can be carried to a more effective point by revealing the importance, effectiveness, advantages and disadvantages of writing in science education and drawing a descriptive framework in terms of giving individuals different perspectives. From this point of view, within the framework of the reasons expressed, in this study, it is aimed to synthesize the current situation in terms of the targeted criteria by reaching the national and international theses on writing for learning purposes in science education between 2010-2020. According to this purpose; In line with the main themes determined in the field of science education and writing for learning purposes, answers to the following questions were sought:

1. Which thematic codes (purpose, keyword, sample group, method, data collection tool, data analysis) do national and international thesis studies reveal?

2. What kind of results do the thesis studies published nationally and internationally produce?

Method

Research Design and Process

This research is a synthesis study, which is a type of qualitative research approach. The research critically and systematically synthesizes theses on writing for learning in science education. Synthesis studies can be explained as a systematic approach that aims to collect and analyse studies in the literature and to reveal new findings (Brown, 2017). This synthesis process allows for the construction of great meanings about the focused subject area (Erwin, Brotherson, & Summers, 2011). Synthesizing and interpreting the studies carried out on a determined subject in a critical way based on a theme or template is explained as the process of qualitatively comparing and analyzing the differences and similarities of the studies conducted on a field from an objective perspective (Au, 2007; Çalık & Sözbilir, 2014). In the study, a synthesis study was preferred as it allows to present the theses made within the scope of the subject in the literature in a certain framework and guides the research to be done. In addition, the synthesis method was used because it can be a source for both researchers and teachers who want to improve in their field and aims to reveal common tendencies comprehensively by examining the studies on writing in science education (Bağ & Çalık, 2017; Çalık, Ayas, & Ebenezer, 2005). Therefore, in the current study, it was decided to use a synthesis study in order to create a general picture of quantitative and qualitative studies. Based on the studies of Brown (2017), Esfijani (2018), Suri and Clarke (2009), Çalık and Wiyarsi (2021), the synthesis steps followed in this study are given in Figure 2 in general terms.
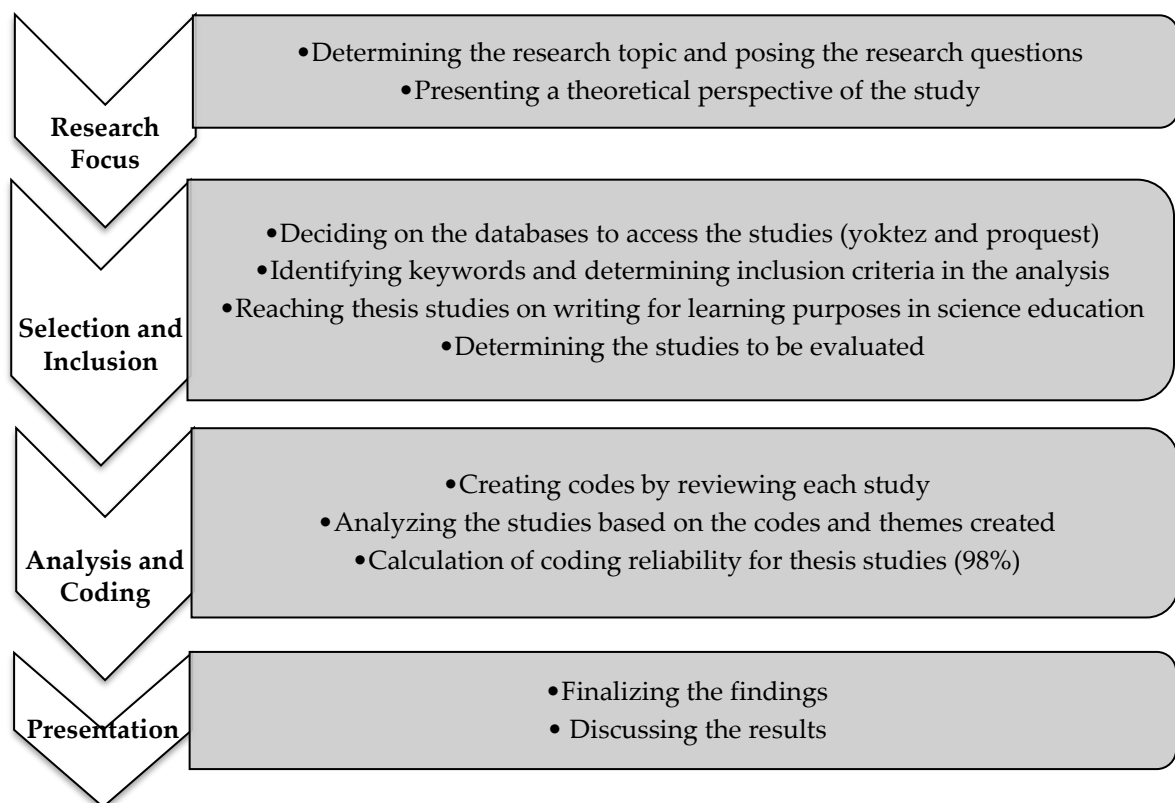

Research Focus
- Determining the research topic and posing the research questions
- Presenting a theoretical perspective of the study

Selection and Inclusion
- Deciding on the databases to access the studies (yoktez and proquest)
- Identifying keywords and determining inclusion criteria in the analysis
- Reaching thesis studies on writing for learning purposes in science education
- Determining the studies to be evaluated

Analysis and Coding
- Creating codes by reviewing each study
- Analyzing the studies based on the codes and themes created
- Calculation of coding reliability for thesis studies (98%)

Presentation
- Finalizing the findings
- Discussing the results

Figure 2. Synthesis Steps Followed in Their Studies

When Figure 2 is examined, the synthesis research process stages carried out in the current research are seen. Within the scope of the research question determined in the context of the research purpose, the synthesis process of writing studies in science education was carried out in line with the critical and systematically determined steps. The findings, which were revealed after the synthesis process, were concluded. Based on these results, comments were made and suggestions were made.

Research Sample and Data Collection

Studies identified in synthesis studies serve as samples (Dunst, Hamby, Howse, Wilkie, & Annas, 2019). In the beginning, it was thought that national and international theses and articles would be considered in the study, but it was deemed appropriate to include only theses in the study due to the large number of publications available, and the article studies may have been produced from theses in general, and therefore the data might be duplicated. Thus, theses written in national and international fields within the framework of the subject included in the study were determined as the research sample. Although writing activities for learning purposes have been used in science teaching in previous years, it can be stated that it has gained popularity in the recent past. It is thought that the synthesis of theses made within the scope of the subject in recent years will provide an opportunity to see the trend in today's studies and guide science educators more accurately. In this context, in the data collection step, it was decided to examine the national and international thesis studies conducted between 2010-2020 on writing for learning purposes in science education. In line with this goal, it was first checked that there are sufficient number of theses. While deciding on the database to be researched, the YÖK database was used because all the theses written in our country were uploaded to the YÖK National Thesis Center, and for international theses, Proquest was used because it is a database that includes most of the foreign theses. Approximately 2000 theses were encountered in the specified databases. While creating the data sets of the study; firstly "*Writing in Science Education*" and "*Writing in Science*"; secondly, "*Writing Activity*" and "*Writing for Learning*"; finally, the keywords "*Multiple Writing*" and "*Creative Writing*" were used. Searching was carried out by typing each keyword and the number of studies to be examined was limited. The theses that did not meet the criteria determined as a result of the screening were subjected to the elimination process and 153 theses, 81 of the Turkish theses and 72 of the foreign theses, were reached. When it was seen that there was a sufficient number of studies for the synthesis study, inclusion and exclusion criteria were established to determine the data most suitable for the purpose of the study (Thorne, 2012). In science education, the evaluation process was started in line with the parameters determined for writing, and the studies included in the research were evaluated by filtering them according to four criteria, respectively. First of all, it was taken into account that the studies were published in 2010-2020. In the second step, it was checked whether the studies within the determined years were national and international theses. In the next step, it was sought that the writing activities were writing for learning purposes. In this sense, manuscripts such as compositions and books, whose sole purpose is language and expression, have been eliminated. On the other hand, following this step, only writing theses for learning purposes, which were carried out within the scope of biology, physics, chemistry and science education and training, were included in the study. With the elimination process carried out in four stages, the data set to be analysed, which includes studies that fit the purpose, was given its final form. After these stages, 51 Turkish and 47 Foreign theses were obtained. In addition, the theses written abroad, despite being Turkish nationals, are included in the scope of international theses. On the other hand, those who collected their data abroad and wrote their thesis in our country, those who obtained their national data from Turkey or abroad and wrote their thesis abroad, were included in the scope of international theses. The contents of the 98 theses reached were examined one by one and subjected to the re-screening process. Thesis studies, where writing is not at the centre of the thesis and are used as an auxiliary tool in the methods used, are excluded from the scope. In addition, theses in which argumentation and writing are used together and writing is emphasized are included in the scope of the study. It is justified that the argumentation method is based on writing studies. Thesis studies in which writing styles such as digital stories, diary writing, and letter writing are used as a stand-alone method were also included in the research. Multimodal descriptive studies using writing were also analysed. Thesis studies, which are included under the title of reading and writing method and where writing is in the background, are not included in the scope of the study. At the last stage, it was seen that there were a total of 73 theses, 37 national and 36 international, which were decided to be included in the research. While each foreign thesis included in the research was coded as YT1, YT2, YT3… respectively, each Turkish thesis was coded as TT1, TT2, TT3…. "YT" foreign thesis; "TT" stands for Turkish thesis words. Information on the codes

and tags of the thesis studies in the national field to be analysed within the scope of the research is given in Appendix 1, and information on the codes and tags of the theses in the international field is given in Appendix 2. Each thesis work included in the research was analysed in depth and presented in the findings section. In addition, the distribution of the postgraduate theses examined within the scope of the study according to their types and years was also examined. Table 1 shows the distribution of theses written in national and international fields, which were carried out within the scope of writing for learning purposes in science education, according to genres and years.

Table 1. Distribution of Thesis Studies Performed in the Scope of Writing for Learning in Science Education by Type and Years

Study Years	National		International	
	Master	**PhD**	**Master**	**PhD**
2010	1	1	-	4
2011	4	2	-	1
2012	2	-	1	3
2013	2	-	2	2
2014	2	-	1	2
2015	2	-	1	3
2016	1	-	2	3
2017	5	-	-	3
2018	4	1	2	1
2019	8	-	-	3
2020	1	1	1	1
Toplam	**32**	**5**	**10**	**26**

When Table 1 is examined, the distribution of theses written in national and international fields in the last ten years in science education according to years is seen. As can be seen from the table, although master's theses in the national field are more than doctoral theses; in the international arena, there are more doctoral theses than master's theses. In the last ten years, while 37 theses were reached in the national field that met the analysis criteria, 36 theses written in the international field were found. While at least one thesis in the national field was written in 2016 with one master's thesis; it is seen that the most theses were written in 2011 and 2019. In the international arena, it is seen that the most thesis was published in 2016, with at least one thesis in 2011.

Coding and Analysis of Data

The studies that were decided to be evaluated in line with the criteria determined during the data collection process constitute the data set of the research. In synthesis studies, the process of analysing data may be important in order to transfer data accurately and effectively. Studies were evaluated based on research themes and codes. Afterwards, the keywords were scanned in the database and the studies were limited in line with the criteria taken as basis. The studies determined to be evaluated were analysed and the findings were concluded.

After the data scanning process, all the studies that were evaluated were read and examined by the researchers. After the first examination, it was realized that some of the thesis studies were directly related to writing for learning purposes, some of them were related to reading and writing, and some of them were studies in which writing activities were integrated with other methods. Thus, it has been understood that the thesis studies are basically divided into three groups. In the next step, it was decided which of the grouped studies would be included. After the general examination of the studies, the studies to be analyzed according to the inclusion criteria were determined. The identified studies were reviewed and coding was created. The purpose, process, method and analysis methods of each study were followed. In line with the studies examined, codes covering each of them were created. The code template of the first analysis was revealed through the noted similarities and differences between studies. The general evaluation was finalized and the theme and code template were determined to

facilitate the secondary coding process. Efforts were made to examine the codes and themes on the basis of research questions in order to categorize the studies in a better quality. After the primary coding process, the coding phase was repeated and the themes and codes were detailed within the framework of the code template. The codes were re-examined to verify the compatibility and applicability of the generated primary codes. In order to present a detailed and comprehensive systematic, first of all, secondary codes were created for the studies that were decided to be included in the study. Secondary codes were generated for each theme by inductively reviewing the data. Codes and themes were developed by adding the codes that were overlooked or noticed during this placement process to the template. Themes and codes were changed again according to the need and content of the study. The studies were re-read and placed under the appropriate codes and themes. During the placement of the appropriate code, data suitable for more than one code in the code template created from the analyzed studies were found (Au, 2007; Ayotte-Beaudet, Potvin, Lapierre, & Glackin, 2017; Brown, 2017; Çalık & Wiyarsi, 2021). The dominance of these studies in terms of content was examined and placed in the most appropriate code. Çalık and Sözbilir (2014) stated that the codes and themes determined in the synthesis studies should be displayed on graphs and diagrams in an appropriate manner. From this point of view, it was decided to present the themes and codes created within the scope of the research in tabular form, with the aim of both providing visuality and allowing the researchers to give an idea at first glance and to be more understandable. The stages of the analysis and coding process of thesis studies are given below, respectively:

1. The theses written in the last ten years are listed from the past to the present, and the distribution of the master's and doctoral theses written in each year is presented in tables.

2. The purpose and subject themes that the thesis studies focused on were written one by one. Then, subject themes that remind each other were combined. For example, studies on concept learning and misconceptions are given under the same theme.

3. The research methods used in the thesis studies are written one after the other. It was then separated into qualitative and quantitative research methods. In addition, sub-methods placed in quantitative and qualitative research methods were rearranged. Longitudinal and panel studies were organized by including them in survey studies. Case studies and multiple case studies were directly included in the case studies. Single-subject experimental and quasi-experimental studies were also compiled under the title of experimental studies. Studies in which both quantitative and qualitative research methods are used together are placed under the theme of mixed studies. Studies carried out in accordance with the mixed methodology are included in whichever mixed study type they belong to. However, some studies that were not specified to which mixed research type although they were conducted with mixed method were placed in the appropriate mixed method category by reading the research process.

4. While analyzing the sample size in the thesis studies, the sample group determined in each study was separated step by step. Document-based samples without any sample group were placed under a separate theme. Some of the reviewed studies have both pilot and main application samples. The sample analysis of such studies was determined on the basis of the main application group participants. On the other hand, in some thesis studies, it was seen that both teachers and students worked together as participants. In such studies, both teachers and students were included in the analysis table. In addition, while analysing the thesis studies in which students from all levels of secondary or high school levels were included in the sample group, a frequency table was created by taking each level in the levels.

5. The data collection tools used in the thesis studies were similarly coded as qualitative and quantitative data collection tools. Frequency values were calculated by including performance-based evaluation tests, district evaluation tests based on science achievements, teacher-made subject tests and end-of-unit tests, student term performance tests, science tests, science evaluation tests, learning performance questionnaires under the code of academic achievement

test. On the other hand, writing worksheets and papers containing classical questions were placed in the worksheets category, while papers filled by students, complex papers containing questions and homework were placed in the student assignments category. Focus group interviews, teacher and student opinions, audio recordings were included in the interview data collection tool. Many data collection tools such as the beginning and end of the term writing form, the explanatory writing task form, the genetic science dictionary scale, which could not be included in any specified data collection tool, were gathered under the other theme.

6. The analysis techniques used in the studies are divided into qualitative and quantitative analysis techniques. Demographic analyses, frequency analyses, standard deviation and mean data analyses are placed under the title of descriptive analysis. Dependent and independent t-test analyses were collected under the t-test. Coding and theme analyses were included in the content analysis method. Quantitative analysis such as multiple comparison test, skewness and kurtosis, effect size, cluster analysis, conditional concept analysis, z-score analysis are included in the other category.

7. While analysing the results of the experimental studies, the effects of which were investigated in line with the purpose of the studies, the variables that did not make a significant difference even though they increased the score on the variable were included in the category of no effect. If it made a significant difference on the variable, it was placed in the category with effect. When examining the results of the study analysed qualitatively, the positive theme of advantage, appropriate, effective and useful in learning; the views that are disadvantage, not useful, and have no effect on learning are included in the negative theme.

An example of the way in which the studies examined in the context of the criteria determined by following the steps above are analysed is given in Table 2.

Table 2. An Example of the Investigation Criteria and Analysis Process of the Studies Examined within the Scope of the Research

Review Criteria	Research Purpose	Keywords	Research Method	Target group	Data Collection Tools	Data Analysis Methods	Research Results
Qualifications of the Study	Effect on Academic Achievement	Keywords for the Concept of "Writing"	Quantitative	Middle School Level	Quantitative Data Analysis	Quantitative Data Collection Tools	Having influence
	The Effect of Writing Activities on Academic Achievement	Learning by Writing by Doing Scientific Writing Activities	Experimental	6th grade	Dependent T-Test Independent T-Test	Academic Achievement Test	+

When Table 2 is examined, an example of the analysis criteria and analysis process of the studies examined within the scope of the research is seen. When analysing the studies included in the research, if a study belongs to more than one attribute under the examined criterion, that study was placed in more than one attribute under the same criterion. For example, both an attitude scale and an academic achievement test can be used as data collection tools in a study. In this case, when analysing the study, it was coded under both the achievement test and the attitude test under the data collection tool criterion. Therefore, in the frequency table created in the findings section, the total frequency value calculated for the examined criterion is higher than the number of studies examined. Themes used in each criterion content analysis; each attribute represents codes. Each study was examined in the context of the determined criteria, and each of them was placed in the qualifications in the criteria to which it belongs, by following the eight steps described above. Thus, the evaluation of the thesis studies, which were subjected to the analysis process, was completed. The findings of the studies evaluated according

to the analysis steps taken into consideration were tabulated and their frequency values were calculated. In the tables, only the frequency values are given statistically. In the next step, necessary explanations were made under each table.

Research Validity and Reliability

In order to ensure the validity of the research, each step followed in the data analysis section is clearly stated. The validity of the study results was increased by making repeated checks during the analysis phase. The consistency of each theme within itself was evaluated among themselves. The results of each study are given in the findings section and tabulated. A common consensus of the two researchers was achieved in the coding of the qualitative and quantitative studies included in the scope of the research and the creation of the main themes. In this context, the studies included in the research were examined separately by the researchers, and themes and codes were created. 10 national and 10 international studies randomly selected by two researchers from each of the themes and codes created were examined individually. As a result of the category evaluations of the researchers, it was revealed that there was 98% compatibility between the researchers.

Results

Within the scope of the research, national and international theses written on writing in science education were analysed in the context of different criteria. The research findings obtained in line with the analysis carried out are presented in this section.

The distribution of national and international theses on writing for learning purposes in science education according to their themes and purposes is given in Table 3.

Table 3. Distribution of Thesis Studies According to Themes and Purposes

Study Themes	National		International	
	Master	**PhD**	**Master**	**PhD**
Effect on Academic Achievement	19	2	3	11
Science Attitude Effect	6	-	1	6
Creative Writing and Activities	3	-	4	6
Writing Self-Efficacy and Skills	4	-	3	5
Scientific Process - Metacognitive Skills and Scientific Literacy	3	1	1	5
Write-Aided Argumentation Practices	4	1	1	3
Multiple Representation and Modal Description	6	-	-	3
Concept Learning and Misconceptions	2	2	2	2
Lab Report Writing	-	1	1	4
Material and Application Development	1	1	1	2
Epistemological Beliefs	1	-	-	2
Affective Variables	1	-	1	-
Peer Interaction-Collaborative	-	-	1	1
Tutorial and Student Mediation	-	-	1	1
Student Feedback	2	-	-	-
Permanence	2	-	-	-
Technology Integrated Writing	-	-	1	1
Attitude Towards Writing	1	1	-	-
The Effect of Written Expression on Attitude	1	-	-	1
Transforming Information	-	-	-	1
Finding Method	-	-	1	-
Professional Development	-	-	-	1
Science News	-	-	-	1
Generating Analogies	1	-	-	-
Nature of Science	-	-	1	-
Book Review	1	-	-	-
Critical Thinking	-	-	-	1
Total	**80**	**14**	**33**	**80**

Table 3 shows the distribution of national and international theses on writing for learning in science education in the last ten years, according to their themes and purposes. When the national and international theses are examined, it is seen that in both fields, it is seen that the effects of writing on academic success, attitude, scientific process skills and scientific literacy have been studied mostly. It is seen that studies have been carried out in both national and international theses on topics that can be integrated into writing, such as writing-supported argumentation practices, multiple representation and modal description, concept learning and misconceptions, writing in the laboratory. On the other hand, when the subject themes of the theses are examined, it is understood that the international theses differ with the study themes on subjects such as science news, professional development, technology integrated writing, knowledge transformation, peer interaction, instructor and student mediation.

Table 4 shows the distribution of research methods used in theses written in national and international fields for writing for learning purposes in science education.

Table 4. Distribution of Thesis Studies According to the Research Methods Used

Research Method	Thesis Type	National		International	
		Master	**PhD**	**Master**	**PhD**
Quantitative Research Method	Experimental	21	4	5	10
	Descriptive Research	2	-	-	-
	Scanning	-	-	-	1
	Meta analysis	-	-	-	1
	Correlation	-	-	-	1
Qualitative Research Method	Situation	1	-	3	4
	Document Review	3	-	-	-
	Phenomenology	-	-	-	2
	Case study	-	-	-	2
Mixed Research Method	Integrated Pattern	2	1	-	4
	Descriptive Pattern	2	-	-	2
	Converging Parallel Pattern	2	-	-	1
Total		**33**	**5**	**8**	**28**

Table 4 shows the distribution of research methods used in national and international theses on writing for learning purposes in science education. As can be seen from the table, the majority of both national and international postgraduate theses were conducted in an experimental design based on the quantitative research method. Then, mixed method designs were used frequently, and at least qualitative research methods were used. It has been observed that the case study is frequently used after the experimental design in international theses, and only one master's thesis is carried out according to the case study in national theses. A thesis study based on meta-analysis, correlation, scanning and narrative methods has not been carried out in the national area. It can be said that there are no document analysis and descriptive analysis studies in international theses.

Table 5 shows the distribution of target audience levels determined in national and international theses written for writing for learning purposes in science education.

Table 5. Distribution of Thesis Studies According to the Determined Target Audience Levels

Target Audience	Thesis type	National		International	
		Master	**PhD**	**Master**	**PhD**
Primary School	4th grade	3	-	-	3
Level	Pre-school	-	-	1	-
Middle School	8th grade	4	-	2	11
Level	7th grade	8	1	1	4
	6th grade	4	1	-	7
	5th grade	5	1	-	3
High School	9th grade	4	-	-	5
Level	10th grade	1	1	-	2
	11th grade	1	-	-	2
	12th grade	1	-	-	2
Undergraduate	Science Students	3	1	-	1
Level	Chemistry Students	-	-	-	4
	Biology Students	-	-	2	-
Academician	Science Teachers	2	1	2	6
	High School Teachers	-	-	1	-
Document	Science, Science and Writing Studies	-	-	-	2
	Middle School Science Book	1	-	-	-
Total		**34**	**6**	**9**	**56**

Table 5 shows the distribution of the target audience in national and international theses on writing for learning purposes in science education. It is seen that both national and international theses are mostly carried out with secondary school students. Secondly, the group studied is high school students. Then, it worked with undergraduate students. While science teacher candidates constitute the undergraduate level participants in the national area, chemistry and biology students in the international arena. In addition, in some studies, no target audience was studied, and documents and sources were taken as samples.

Table 6 shows the distribution of data collection tools used in national and international theses on writing for learning purposes in science education.

Table 6. Distribution of Thesis Studies by Data Collection Tools Used

Data Collection Tools	Thesis Type	National		International	
		Master	**PhD**	**Master**	**PhD**
Quantitative	Achievement Tests	22	4	7	17
Data	Attitude Scales (Science Class, Written	12	-	1	3
Collection	Expression, Writing, etc.)				
Tools	Questionnaires (Student Perception,	2	1	3	9
	Teacher, Metacognitive Awareness, etc.)				
	Evaluation Scales and Rubrics (Creative	4	-	1	5
	Writing, Scientific Writing,				
	Argumentation Rubric, etc.)				
	Concept Tests	5	1	-	1
	Self-Efficacy Scales (Writing, Science,	2	-	-	2
	etc.)				
	Scientific Process Skills Test	3	1	-	-

Table 6. Continued

Data Collection Tools	Thesis Type	National		International	
		Master	**PhD**	**Master**	**PhD**
Quantitative Data Collection Tools	Inventories (Metacognitive Awareness, Self-Writing Activity Inventory, etc.)	1	1	-	1
	Motivation Scales (Learning Science, Writing Activity Motivation, etc.)	1	-	-	2
	Critical Thinking Scale	1	-	-	1
	Other (Metacognitive, anxiety, epistemology...)	1	-	-	6
Qualitative Data Collection Tools	Interview	10	3	9	14
	Observation	-	2	5	2
	Open-Ended Questions	5	-	-	-
	Field Notes (Teacher, Student, etc.)	-	-	2	3
	Lesson Plans	1	-	-	1
	Modal Descriptive Forms	2	-	-	-
	Textbooks	1	-	-	-
	Academic Journals	-	-	-	1
Student Products	Worksheets	5	2	6	3
	Laboratory Reports	2	1	1	3
	Student Works (homework, prepared inventories, etc.)	2	-	2	2
	Daily (Teacher, Student, etc.)	2	-	1	2
	Letter	2	-	-	-
	Stories	1	-	-	-
	Portfolio	-	-	-	1
	ÖABT Text Form	1	-	-	-
	Concept Cartoons	1	-	-	-
Total		**89**	**16**	**38**	**79**

Table 6 shows the distribution of tools used in data collection in national and international theses on writing for learning purposes in science education. It is understood from the table that achievement tests and attitude scales were used as quantitative data collection tools in both national and international theses, and interviews were preferred as a qualitative data collection tool. It is seen that field notes are used as a data collection tool in theses written internationally, unlike national theses. In national theses, unlike international theses, data were collected by using open-ended questions. In the theses written in national and international fields, the work papers and laboratory reports prepared by the students on the subject were used as data collection tools. In national theses, data were collected by using writing types such as letters and stories, and portfolio files were used in international theses.

Table 7 shows the distribution of the analysis methods used in data analysis in theses written in national and international fields for writing for learning purposes in science education.

Table 7. Distribution of Thesis Studies According to Data Analysis

Data Analysis Methods	Thesis Type	National		International	
		Master	**PhD**	**Master**	**PhD**
Quantitative Data Analysis	Descriptive Statistics	8	4	7	16
	T-Test	13	3	4	9
	ANOVA	9	2	3	10
	Normality Test	13	2	-	3
	Wilcoxon Signed Rank Test	5	1	-	1
	Mann Whitney U Test	8	1	-	-
	Item Analysis	6	-	-	2
	Pearson(Chi-square)	-	1	-	7
	ANCOVA	2	1	1	1
	Correlation Analysis	2	-	-	-
	Factor Analysis	-	-	-	1
	Kruskal-Walls H Test	1	-	-	-
Qualitative Data Analysis	Content Analysis	9	4	7	13
	Descriptive Analysis	6	-	2	1
	Rubric	2	1	2	4
	Document Analysis	1	-	-	-
	Other	4	2	-	5
Total		**89**	**20**	**26**	**73**

Table 7 shows the distribution of analysis methods used in the analysis of data in national and international theses conducted for writing for learning purposes in science education. While the majority of quantitative data are analyzed in both national and international theses; It is seen that t-test, ANOVA, descriptive statistical analysis methods are used. Before the analysis of the data, it was determined that normality analysis was mostly used in national theses, and normality analysis was used very little in international theses despite statistical analysis. Depending on the normality analysis, the use of Wilcoxon, Mann Whitney U-Tests, which are non-parametric tests, is more common in national theses. It is seen that analyzes based on item analysis are used more in national theses than in international theses. While analyzing the qualitative data, content analysis based on coding was mostly used in national and international theses. Rubrics were used more in the analysis of data in international theses than in national theses.

Table 8 shows the distribution of research results obtained in national and international theses on writing for learning purposes in science education.

Table 8. Distribution of Thesis Studies According to the Obtained Results

The Variable Whose Effect is Measured	Thesis Type	National		International	
		Master	**PhD**	**Master**	**PhD**
Academic Achievment	Having Influence	19	4	5	15
	No Effect	3	-	2	-
Science Attitude	Having Influence	8	-	-	2
	No Effect	4	-	1	1
Writing Attitude	Having Influence	1	-	3	9
	No Effect	2		-	-
Concept Learning and Knowledge	Having Influence	5	1	2	3
	No Effect	-	-	-	-

Table 8. Continued

The Variable Whose Effect is Measured	Thesis Type	National		International	
		Master	PhD	Master	PhD
Writing Skill	Having Influence	2	2	2	3
	No Effect	-	-	-	-
Writing Self-Efficacy	Having Influence	-	-	-	3
	No Effect	1	-	-	-
Creative Writing	Having Influence	1	-	1	1
	No Effect	-	-	-	-
Permanence	Having Influence	3	-	-	-
	No Effect	1	-	-	-
Scientific Process Skills	Having Influence	2	1	-	1
	No Effect	-	-	-	-
Metacognitive Awareness	Having Influence	3	1	-	-
	No Effect	-	-	-	-
Critical Thinking Skills	Having Influence	1	-	1	1
	No Effect	-	-	-	-
Motivation	Having Influence	1	-	-	2
	No Effect	-	-	-	-
Scientific Discussion Skill	Having Influence	-	-	1	2
	No Effect	-	-	-	-
Epistemological Belief Level	Having Influence	1	-	-	1
	No Effect	-	-	-	-
Science Literacy	Having Influence	-	-	1	1
	No Effect	-	-	-	-
Professional Development	Having Influence	-	-	-	2
	No Effect	-	-	-	-
Skills in Recognizing and Using Modal Descriptions	Having Influence	1	-	-	-
	No Effect	1	-	-	
Other (Reasoning, Scientific Vocabulary, Risky writing, Understanding the Nature of Science, Inquiry Skill, Content Literacy)	Having Influence	-	-	2	4
	No Effect	-	-	-	-
Exhibitor Feedback	Positive	13	3	4	12
	Negative	-	-	2	2
Total		**73**	**12**	**24**	**67**

Table 8 shows the distribution of the results obtained after analyzing the data in national and international theses conducted for writing for learning purposes in science education. As can be seen from the table, it is seen that writing and writing activities used in science courses both in the national and international arena have a positive effect on academic achievement. Following this, it is understood that the attitude towards science and writing is generally increased through writing. However, there are more studies in the category that has no effect on attitudes towards science compared to other attitudes. In addition, it is reached from both national and international theses that the writing function is also effective on conceptual learning. On the other hand, it is concluded from the results of theses written in both fields that motivation, critical thinking, epistemological beliefs and scientific process skills can also be developed through writing. It has been determined that permanence and meta-cognitive awareness increase with writing in theses published in the national area. It is seen that international theses are effective on the professional development of science teachers at the desired level. In addition, it is reached that writing in international theses expands scientific vocabulary. Argumentation, questioning, scientific research, reasoning, and the positive effect of writing in risky

writing are other analysis results obtained from international theses. As a result of the interviews conducted in the studies, among the positive opinions in the theses written in both fields, writing and writing activities support science teaching in general, the effect of writing on learning is important, it supports learning and it is an effective approach compared to traditional writing practices. In addition, it is one of the opinions identified from the studies that writing can be used as a tool to detect misconceptions. Among the negative opinions reached are that writing approaches are not used frequently by educators and they are not aware of different practices for writing.

Discussion and Conclusion

From the results of the research, it is understood that the themes related to science achievement, science attitude, creative writing competencies, concept learning and scientific skills come to the fore in theses written in both national and international fields. This may be due to the fact that the instructors who are experts in the field of science education primarily value the performance and attitude of the students in the course. Therefore, it is an expected situation to examine the effects of methods or techniques used in the teaching process on academic achievement or attitude at the first stage. Similarly, Uzoğlu (2018) revealed that the themes of student achievement, student attitude and cognitive skills are predominant in writing activities for learning purposes in science education conducted at the national level. Therefore, it is understood that national and international theses overlap on themes such as science achievement, science attitude, creative writing competencies and concept learning. International theses differ from national theses with their study themes on science news, professional development, technology-integrated writing, knowledge transformation, peer interaction-collaboration, tutor and student mediation. Among these themes, the themes of peer interaction and mediation stand out. The lack of theses on these subjects in our country may be associated with the inability of the classroom layout and physical conditions to provide an adequate environment for interaction. The fact that there is no professional development theme in the national area brings to mind the judgments of choosing a profession based on the score obtained in the central exams instead of the targeted profession at an early age in our country, or providing professional development in the business life phase. On the other hand, it is thought that the technology-integrated writing theme, which is included in foreign theses, is not included in national theses, due to the fact that writing activities are carried out more physically in our country and technology integration is not fully established. These results can be interpreted as the subject areas related to writing in science education focus on different contents in national and international theses.

It has been found that quantitative research methods are in the majority in national and international theses and qualitative studies are conducted in less number than quantitative studies. It can be stated that the data obtained in qualitative studies require in-depth evaluation or the researchers' inability to obtain generalizable results such as quantitative researches pushes them to conduct quantitative research. As a matter of fact, Çepni and Ormancı (2018) confirm the concerns of postgraduate students to conduct qualitative research and state that postgraduate theses made in the national field are generally quantitative studies. Similarly, in the study conducted by İspir and Yıldız (2021), it was determined that quantitative research methods are used more than qualitative methods in writing for learning studies, which is in line with our study findings. The fact that experimental studies, one of the quantitative research methods, are at the forefront in theses can be related to the fact that the study themes generally aim to measure the effect of writing activities on a variable. On the other hand, the aim of revealing the effect of using writing as a tool in science teaching on independent variables and determining the contribution of writing in science teaching may have increased the tendency to carry out experimental studies. However, the fact that the experimental method is the most prominent in Akkuş and Darendeli's (2020) writing studies in the field of mathematics and Uzoğlu (2018)'s writing studies in science coincides with the results of the current study. In the theses in the national field, a thesis study based on meta-analysis, scanning and narrative methods has not been carried out. It is thought that the reason for this is that some designs may have been used less or not at all due to the widespread use of writing activities for learning purposes in the national area in the recent

past. However, the fact that it is very difficult to come across individuals who are science educators who are trained in writing for learning purposes, who can fully master the writing and its process, may have caused some patterns such as storytelling to not be used. It is possible to explain the reason why there are no document review and descriptive analysis studies in the international arena by considering the use of richer patterns in international studies. Supporting this interpretation can only be shown by examining the studies before 2010. Since writing activities for learning purposes started at an earlier date in the international arena, these patterns, which enable to describe the existing situation, may have been studied before 2010. However, what is surprising is that although learning writing activities require more practice than theory, there is no thesis conducted within the scope of action work and embedded theory work in both national and international fields. Defining action research as a systematic intervention based on taking action for change (Costello, 2007), the fact that writing activities are based on practice and action research overlaps, and the lack of writing-oriented action research in science education emerges as a shortcoming. The lack of theory building and action research in order to develop writing and writing activities and to create a new framework may be a gap that needs to be filled. In this sense, it would not be wrong to state that there is a need for writing-based action and embedded theory studies in both national and international science education. It has been revealed that although theses are written in phenomenology patterns in international theses, they are not included in theses in the national field. It is obvious that revealing student or teacher experiences regarding writing studies will be beneficial in terms of directing writing studies and writing-based science teaching. For this reason, it is anticipated that conducting such studies in Turkish theses, as in foreign theses, can bring a different perspective to the literature. It has been determined that case studies have been made in the theses published in both fields. However, case studies have been used more in international theses. In these theses, it was revealed that the data collection tools varied (student worksheets, teacher opinions, observation, etc.). At this point, it is clear that the studies in the national literature should be enriched in order to catch up with the writing studies for learning purposes in the international literature. In addition to the theses written with both qualitative and quantitative methods, the theses based on mixed design in which quantitative and qualitative studies were made together were also accessed. Although it is believed that quantitative studies provide clearer data in numerical terms, qualitative studies in which the thoughts of individuals are revealed can take place in the position of explanatory, supportive and exploratory element. Therefore, in the context of this view, it can be deduced that researchers can benefit from mixed methods in studies where they think that answers cannot be sought only with quantitative and qualitative methods.

It has been determined that writing studies in national and international science education are mostly studied with secondary school students. The fact that there are very few writing activities in primary or pre-school periods may be due to the thought that students' level of readiness is not yet sufficient for writing activities. The possibility comes to mind that they may have difficulties in the application phase in lower grade classes, since they believe that the writing process may be more difficult to implement compared to other teaching methods. In the study (Akkuş & Darendeli, 2020) in which research trends on writing for learning purposes conducted in the national field between 2005 and 2020 were revealed, it was revealed that writing studies in mathematics education focused on the second level of primary education. Therefore, the research shows one-to-one correspondence with the result of the current study, which is mostly done at secondary school level. The finding in the research of İspir and Yıldız (2021) that writing activities are mostly carried out at the secondary school level also coincides with our study findings. In the study in which Uzoğlu (2018) examined national articles on writing for learning purposes in science, it was found that the largest sample was conducted on the sixth grade of secondary school. Although the majority of the studies were conducted with secondary school students, it was determined that more studies were conducted with 8th grade students in this study. It can be thought that the difference in grade level may be due to the fact that the articles in the study of Uzoğlu (2018) and the theses in this study were examined and some current theses were not converted into articles. No thesis has been encountered in the national area for pre-school students. There is only one study in the international arena. This situation brings to mind that researchers who

do writing work may think that writing cannot be done without knowing how to read. The fact that they have worked with 9th grade students at high school level in both fields can be associated with the fact that the ninth grade level may not have any exam anxiety yet and they are not focused on the professional field. The ninth grade may have been preferred because it is the first year of transition from middle school to high school and because they do not have test anxiety, they can be more interested in writing activities. Although there are studies in both fields in the theses conducted with pre-service science and science teachers at the undergraduate level, it has been observed that there are more studies in the international arena. This may be due to the fact that writing for learning purposes was included in the programs much earlier in science education in foreign literature. E.g; In the United States of America, it is seen that basic language skills, especially writing skills, are included and integrated into the program in the (National Research Council, 2013). National Research Council (2014) made suggestions on how pre-service science teachers can use these skills in education. While these studies were carried out in international education programs about 10 years ago, there are no courses in the content of writing practices for learning in national science education undergraduate programs yet. This situation is thought to be the reason why fewer studies are conducted in the thesis studies, especially with pre-service and in-service science educators, compared to the international field.

It was determined that quantitative data collection tools were used more than qualitative data collection tools in both areas. It can be said that the researchers thought that quantitative tools were easier or more practical in terms of data collection in writing studies. Researchers may have thought that there may be more difficulty in collecting and evaluating the writing and writing process in the form of qualitative data than quantitative ones. It has been determined that attitude scales and questionnaires, especially achievement tests, are used as quantitative data collection tools in the national and international arena. The fact that academic success is seen as a symbol of reaching the goal in education and training and the efforts of individuals (Sıral, 2020) is seen as an important indicator of the effectiveness of the teaching process carried out by educators and students. Therefore, it is not surprising that achievement tests are the data collection tool of studies in both fields. Moreover, it is possible to state that the achievement tests used in thesis studies are examined, and the achievement tests are differentiated at the national and international level. It is seen that the achievement tests used in national theses are tests developed by researchers in general terms and can directly measure the achievements within the framework of the unit or subject. It should also be noted that almost all of them are multiple choice. On the other hand, it is noteworthy that in the achievement tests used in international theses, there is a general exam, evaluation and exams approved on a country basis. In addition to this, being of a complex type and classical structure are other features that distinguish it from national achievement tests. Questionnaires can be multiple choice, open-ended, short answer, etc. It is thought that the fact that it contains questions can be a source for its use after achievement and attitude tests. The fact that concept tests are used as a data collection tool in both areas may be due to the fact that researchers or educators have the judgment that while performing writing activities for learning purposes, it is a process in which the scientific concepts existing in the minds of individuals are put into writing format. Therefore, during the writing process, the aim of the students to reveal the concepts that took place in their minds and to get rid of the existing concept confusion may have caused the use of concept tests. The statement by Aktepe (2020) that "writing activities used in science education are a tool that provides an experience of strengthening students' conceptual understanding by revealing existing prior knowledge and integrating it with new knowledge" supports the reason presented in the framework of the study. It can be stated that the fulfillment of an effective writing process in science can be achieved by the appropriate and correct use of concepts. From this point of view, it is expected that concept tests will be used as a data collection tool in writing studies. Likewise, the use of interviews as a qualitative data collection tool in theses written in both fields may be due to the fact that it is a flexible data collection tool that allows in-depth data collection and verification of writing activities and writing process (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2012). On the other hand, the fact that observation is used more in international theses compared to national theses may be a result of the observations taking a long time and strict permission procedures. Less use of observations in

national theses can also be associated with fewer studies for teachers compared to foreign theses. The fact that observations are required to be used mostly in studies with teachers in the classroom environment may have caused the use of observations less than other qualitative data collection tools. As a result of making use of the least observations in the writing articles on science in Turkey put forward by Uzoğlu (2018), it supports the current research result. In addition, it is another striking result that data is collected in national theses using open-ended questions, unlike international theses. Another striking difference is that in national theses, direct data collection was carried out by using writing types such as letters, stories, and diaries. However, the situation of obtaining data by using only one of the writing activities in foreign theses was not encountered in the studies examined. At this point, due to the wide range of writing activities, it may be a shortcoming for some theses in the national field to obtain data by using only these activities.

It has been determined that quantitative data analyses are generally used in the analysis of the theses written in the national and international field for writing in science education. This result is also related to the fact that the studies examined are carried out with experimental design rather than quantitative methods. It has been determined that the most used analysis method in quantitative data analysis is dependent and independent t-test. When the research methods and purposes of the theses were examined, it was found that the experimental design of the designs and the effects of writing activities on a dependent variable in the framework of science were investigated in general. It is expected that the t-test is preferred in studies where the effect of any method or technique on the variable desired to be investigated is determined. In the research of Uzoğlu (2018), which examines writing studies in science published in Turkey, it is revealed that t-test-based analysis methods are used in the majority of the study data. In another study, in which writing studies were analyzed, it was revealed that t-test analyzes were performed the most, and this constitutes a supporting element for the results of the study (İspir & Yıldız, 2021). On the other hand, although the t-test is widely used in both fields, it is understood that non-parametric tests such as ANOVA, Wilcoxon Signed Rank Test, Mann Whitney U-Test are used only in national theses. In national theses, item analyzes are used more than in international theses. It is thought that item analyzes may not have been needed due to the availability of achievement tests in international theses. While analyzing the qualitative data, it has been determined that content analysis based on coding is mostly used in national and international theses.

In both national and international theses, it was determined that writing activities had positive effects on academic success in science courses. Regardless of the unit or subject covered in the theses, it is an expected situation to experience an increase in academic achievement after writing for learning purposes. The expectation of this result can be explained by many sources in the literature about the effect of writing on learning (Akçay & Baltacı, 2017; Galbraith & Baaijen, 2018; Prain & Hand, 2016; Pınar & Yıldız, 2020; Miller et al., 2018). The result that scientific concepts are more effectively understood by students and misconceptions in students are eliminated with learning-oriented writing activities may be due to the fact that students perform the writing process by revealing the key concepts in their minds. The fact that writing is a process in which the scientific concepts that exist in the minds of individuals are put into writing format allows students to express the words that have existed in their minds from the past to the present. This situation provides educators with the opportunity to correct scientific concepts that are misunderstood in students. As a matter of fact, the present study also reveals that writing activities can be used as a useful tool in detecting students' misconceptions. In the study carried out by İspir and Yıldız (2021), the result that writing for learning has a positive effect on academic achievement, permanence in learning and misconceptions supports the findings of our study. While the majority of studies have found that writing for learning has a positive effect on attitudes towards science, there are also thesis that writing does not have a positive effect on attitudes towards science. This situation can be associated with the fact that the change of attitude in individuals requires a longer time, so the attitude did not change immediately. However, another reason is thought to be due to the fact that students are very tired in the writing process, as Uc (2019) states. On the other hand, it is understood that writing activities have a positive effect on writing skills, writing proficiency, and creative writing levels. On the other hand, the result that critical thinking skills, epistemological beliefs

and scientific process skills in Turkish and foreign theses can be developed through writing brings to mind the expectation of individuals to discuss and make sense of the reasons for the arguments in science through writing. Finding out from international theses that writing for learning improves the skills of making arguments, questioning, scientific research and reasoning; It can be shown as proof that writing can make important contributions to the development of critical skills beyond academic progress. In addition, it has been determined that the permanence, the skills of recognizing and using modal descriptions, and meta-cognitive awareness have increased in theses written in the national field. It can be said that the science course, which is carried out with learning-oriented writing activities, contributes to the development of high-level skills because it makes students the subject of the scientific process. The view that learning-oriented writing activities can provide students with the opportunity to learn by gaining understanding, questioning, research and critical skills (Doğan & İlhan, 2016) shows parallelism with the results of this study. In international theses, results have been obtained that writing on the professional development of science teachers is effective at the desired level. In this sense, using writing in professional development training or in-service training can be very effective in achieving the desired goal. In summary, it is concluded from the national and international theses that writing in science has a positive effect on many variables. In some thesis studies, it has been determined that teachers see writing as a very useful teaching tool that can be used in science lessons. However, it has been revealed that writing activities are not used intensively by teachers in science because they have some disadvantages. In the article studies carried out, there are findings regarding this result (Erduran Avcı & Akçay, 2013; Koçak & Seven, 2016). Some of the disadvantages are that writing causes a loss of time in the course process, cannot be used at every student level, some students find the writing process boring and they are not aware of how to write. The reason why teachers see writing activities in science as a waste of time may be the fact that teachers cannot effectively apply writing activities during the lesson and that they do not receive adequate education in undergraduate. On the other hand, it is one of the findings obtained as a result of the analysis that although the students exhibit a generally positive perspective towards the writing activities used in science, some students did not find writing interested and attracted attention.

Suggestions

1. It is recommended to carry out different studies in which the writing process is used in the classroom environment by providing the integration of writing activities with technology.

2. It is recommended to conduct research on the implementation of writing by creating a collaborative environment, with the justification that writing activities are suitable for group work.

3. Since writing studies used in the field of science include scientific concepts, applications integrated with science news will make writing activities more effective.

4. The absence of an action research for science education in writing activities and the fact that writing is practical indicates the necessity of using the achievements of action research on this subject.

5. During the implementation of writing activities in the classroom environment, it is recommended to obtain data through observation in order to identify the deficiencies.

6. As a result of the experimental researches carried out in the theses, it is recommended that educators who want to increase success and/or develop attitudes in science teaching should benefit from it in their classrooms, based on the effect of writing on success and attitude.

7. It is recommended that science educators use writing activities, which have a positive effect on concept teaching and scientific process skills, in order to provide effective concept teaching in classroom practices.

8. With the aim of making the applicability of the writing activities of the studies more effective in the classroom environment, research on prospective science teachers and teachers should be increased.

9. It may be important to carry out studies based on the search for solutions on the basis of questions such as how writing activities can reach a sufficient level for both teachers and students in the education process, how to improve their writing skills, and how they can be more productive.

10. Necessary training opportunities should be provided to teachers in order to eliminate the negative judgments created by some teachers about writing and to ensure that writing is effectively applied in science teaching.

11. For pre-service science teacher candidates, the benefits of writing for learning activities in science education, how they can be integrated into science education, designing application examples, and microteaching of design should be added to the undergraduate programs of writing for learning course.

12. With a more detailed compilation, studies on this subject should be enriched in terms of recommendations, learning, teaching, practice, policy and future studies.

References

Akar, M. S. (2007). *The effect of creating and main use of writing texts on academic achievement in laboratory lessons* (Unpublished master's thesis). Atatürk University, Erzurum.

Akçay, H., & Baltacı, A. (2017). Evaluation of multiple writing activities for learning purposes in teaching astronomy. *Journal of Mersin University Faculty of Education, 13*(1), 138-151. doi:10.17860/mersinefd.305773

Akkuş, R., & Darendeli, D. (2020). Research trends on writing for learning purposes in mathematics in Turkey: Between 2005 and 2020. *International Journal of Educational Studies in Mathematics, 7*(1), 1-13.

Aksoy, G., & Doymuş, K. (2011). The effect of cooperative literacy-practice technique in science and technology lesson applications. *Gazi University Journal of Gazi Educational Faculty, 31*(2), 381-397.

Aktepe, T. (2020). *Investigation of the effect of learning writing activities on academic achievement in the fourth grade "Let's get to know the substance" unit* (Unpublished doctoral dissertation). Atatürk University, Erzurum.

Atasoy, S., & Küçük, O. (2020). Development of eighth grade students' epistemological beliefs through writing-to-learn activities. *Journal of Science Learning, 3*(2), 57-66. doi:10.17509/jsl.v3i2.20573

Au, W. (2007). High-stakes testing and curricular control: A qualitative metasynthesis. *Educational Researcher, 36*(5), 258-267. doi:10.3102%2F0013189X07306523

Ayotte-Beaudet, J. P., Potvin, P., Lapierre, H. G., & Glackin, M. (2017). Teaching and learning science outdoors in schools' immediate surroundings at k-12 levels: A meta-synthesis. *EURASIA Journal of Mathematics, Science and Technology Education, 13*(8), 5343-5363. doi:10.12973/eurasia.2017.00833a

Bağ, H., & Çalık, M. (2017). Thematic content analysis for argumentation studies at primary education level. *Education and Science, 42*(190), 281-303. doi:10.15390/EB.2017.6845

Bazerman, C. (2009). Genre and cognitive development: Beyond writing to learn. In C. Bazerman, A. Bonini, & D. Figueiredo (Eds.), *Genre in a changing world* (pp. 283-298). Fort Collins, CO: The WAC Clearinghouse.

Bozat, O., & Yıldız, A. (2014). The effect of the letter, one of the learning-oriented writing activities, on the success of the 5th grade "electricity in our lives" unit. *Education Sciences, 10*(4), 291-304.

Brown, J. C. (2017). A metasynthesis of the complementarity of culturally responsive and ınquiry-based science education in k-12 settings: Implications for advancing equitable science teaching and learning. *Journal of Research in Science Teaching, 54*(9), 1143-1173. doi:10.1002/tea.21401

Büyüköztürk, Ş., Çakmak, E., Akgün, Ö., Karadeniz, Ş., & Demirel, F. (2012). *Scientific research methods in education*. Ankara: Pegem Academy Publications.

Chen, Y. C., Hand, B., & McDowell, L. E. A. H. (2013). The effects of writing-to-learn activities on elementary students' conceptual understanding: Learning about force and motion through writing to older peers. *Science Education, 97*(5), 745-771. doi:10.1002/sce.21067

Costello, P. J. M. (2007). *Action research.* London: Continuum Books.

Çalık, M., & Sözbilir, M. (2014). Parameters of content analysis. *Education and Science, 39*(174), 33-38. doi:10.15390/EB.2014.3412

Çalık, M., & Wiyarsi, A. (2021). A systematic review of the research papers on chemistry-focused socio-scientific issues. *Journal of Baltic Science Education, 20*(3), 360-372. doi:10.33225/jbse/21.20.360

Çalık, M., Ayas, A., & Ebenezer, J. V. (2005). A review of solution chemistry studies: Insights into students' conceptions. *Journal of Science Education and Technology, 14*(1), 29-50. doi:10.1007/s10956-005-2732-3

Çepni, S., & Ormancı, Ü. (2018). Concerns of doctoral students towards qualitative research. *Kastamonu Journal of Education, 26*(3), 875-886. doi:10.24106/kefdergi.413385

Çömen, H. (2018). *Investigation of the effects of the hybrid book developed based on writing activities for learning purposes within the scope of the 7th grade "electrical energy" unit of science* (Unpublished master's thesis). Uşak University, Uşak.

Daniels, L. M., & Goegan, L. D. (2019). Applying utility-value writing prompts to science education. *Alberta Science Education Journal, 46*(1), 22-27.

Daşdemir, İ., Cengiz, E., & Uzoğlu, M. (2015). The effect of letter writing, one of the learning-oriented writing activities, on the academic achievement and scientific attitudes of the students in the 7th grade "light" unit. *ODU Journal of Social Sciences Research, 5*(11), 89-103.

Djudin, T. (2018, December). *Revitalizing students activities in reading and writing in science: An investment in educational improvement*. International Conference on Mathematics and Science Education, Universitas Pendidikan Indonesia, Bandung.

Dunst, C. J., Hamby, D. W., Howse, R. B., Wilkie, H., & Annas, K. (2019). Metasynthesis of preservice professional preparation and teacher education research studies. *Education Sciences, 9*(1), 50.

Doğan, Y., & İlhan, N. (2016). Opinions of pre-service teachers on the use of learning-oriented writing activities in "science and technology teaching" course. *Adıyaman University Journal of Educational Sciences, 6*(1), 1-22. doi:10.17984/adyuebd.30690

Dunya, S. M. (2019). *The effect of reflective journal writing on science learning* (Doctoral dissertation). Notre Dame University, Louaize.

Erduran Avcı, D., & Akçay, T. (2013). Teachers' views on writing activities in science and technology course. *Journal of Turkish Science Education, 10*(2), 48-65.

Erol, G., Akçay, H., Bayram, H., & Kapıcı, H. Ö. (2016). Evaluation of teaching the subject of "acid and base" using multiple writing activities for learning purposes. *Journal of Educational Science and Technology Research, 1*(2), 94-102.

Erwin, E. J., Brotherson, M. J., & Summers, J. A. (2011). Understanding qualitative meta synthesis: Issues and opportunities in early childhood intervention research. *Journal of Early Intervention, 33*(3), 186-200. doi:10.1177%2F1053815111425493

Esfijani, A. (2018). Measuring quality in online education: A meta-synthesis. *American Journal of Distance Education, 32*(1), 57-73. doi:10.1080/08923647.2018.1417658

Galbraith, D., & Baaijen, V. M. (2018). The work of writing: Raiding the in articulate. *Educational Psychologist, 53*(4), 238-257. doi:10.1080/00461520.2018.1505515

Gere, A. R., Limlamai, N., Wilson, E., MacDougall Saylor, K., & Pugh, R. (2019). Writing and conceptual learning in science: An analysis of assignments. *Written Communication, 36*(1), 99-135. doi:10.1177%2F0741088318804820

Graham, S. (2020). The sciences of reading and writing must become more fully integrated. *Reading Research Quarterly, 55*(S1), 35-44. doi.10.1002/rrq.332

Graham, S., Kiuhara, S. A., & MacKay, M. (2020). The effects of writing on learning in science, social studies, and mathematics: A meta-analysis. *Review of Educational Research, 90*(2), 179-226. doi:10.3102/0034654320914744

Gunel, M., Hand, B., & Prain, V. (2007). Writing for learning in science: A secondary analysis of six studies. *International Journal of Science and Mathematics Education, 5*(4), 615-637. doi:10.1007/s10763-007-9082-y

Günel, M., Uzoğlu, M., & Büyükkasap, E. (2009). The effect of using writing activities for learning purposes on learning the subject of "force" at primary level. *Gazi University Journal of Gazi Educational Faculty, 29*(2), 379-399.

Hand, B., & Prain, V. (2002). Teachers implementing writing-to-learn strategies in junior secondary science: A case study. *Science Education, 86*(6), 737-755. doi:10.1002/sce.10016

İncirci, A. (2016). *The effect of "letter writing activity" for learning purposes on academic achievement, attitude towards the course and metacognition level in English course* (Unpublished master's thesis). Bülent Ecevit University, Zonguldak.

İspir, B., & Yıldız, A. (2021). Analysis of research on writing for learning in Turkey: A meta-synthesis study. *OPUS International Journal of Society Studies, 18*(41), 3396-3447. doi:10.26466/opus.906264

Koçak, G., & Seven, S. (2016). Views of pre-service science teachers about writing activities for learning: An example of one-dimensional movement. *Ekev Academy Journal, 65*, 253-268. doi:10.17753/Ekev557

Lamb, R. L., Etopio, E., Hand, B., & Yoon, S. Y. (2019). Virtual reality simulation: Effects on academic performance within two domains of writing in science. *Journal of Science Education and Technology, 28*(4), 371-381. doi:10.1007/s10956-019-09774-y

Martin, K., & Miller, E. (1988). Storytelling and science. *Language Arts, 65*(3), 255-259.

Miller, D. M., Scott, C. E., & McTigue, E. M. (2018). Writing in the secondary-level disciplines: A systematic review of context, cognition and content. *Educational Psychology Review, 30*(1), 83-120. doi:10.1007/s10648-016-9393-z

National Research Council. (2013). Next generation science standards: For states, by states. Washington, DC: The National Academies Press. doi:10.17226/18290

National Research Council. (2014). Literacy for science: Exploring the intersection of the next generation science standards and common core for ELA standards: A workshop summary. Washington, DC: The National Academies Press. doi:10.17226/18803

Okur, A., Demirtaş, T., & Keskin, F. (2013). A model review on the latest practices in writing education: A portfolio of Australian native language curriculum. *Ondokuz Mayıs University Journal of Education, 32*(1), 297-319.

Otfinowski, R., & Silva-Opps, M. (2015). Writing toward a scientific identity: Shifting from prescriptive to reflective writing in undergraduate biology. *Journal of College Science Teaching, 45*(2), 19-23. doi:10.2505/4/jcst15_045_02_19

Özbek, E. (2020). *The effect of scientific writing activities on primary school 6th grade students' academic achievement in the unit "reproduction, growth and development in plants and animals", their attitudes towards science lesson and written expression* (Unpublished master's thesis). Marmara University, Istanbul.

Pınar, E., & Yıldız, A. (2020). The effect of journal writing, one of the" writing to learn" activities, on achievement and science attitude in the fourth grade science course. *Online Submission, 10*(1), 179-196. doi:10.26579/jocress.354

Prain, V., & Hand, B. (2016). Coming to know more through and from writing. *Educational Researcher, 45*(7), 430-434. doi:10.3102%2F0013189X16672642

Ray, A. B., Graham, S., Houston, J. D., & Harris, K. R. (2016). Teachers use of writing to support students' learning in middle school: A national survey in the united states. *Reading and Writing, 29*(5), 1039-1068. doi:10.1007/s11145-015-9602-z

Seven, S., Koksal, A. P., & Koçak, G. (2017). The effect of carrying out writing to learn activities on academic success of fifth grade students in secondary school on the subject of" force and motion". *Universal Journal of Educational Research, 5*(5), 744-749. doi:10.13189/ujer.2017.050506

Sıral, C. (2020). *Examining the relationship between secondary school students' attitudes towards physical education lessons and sports and academic achievement* (Unpublished master's thesis). Gelişim University, İstanbul.

Silva, A. M., & Limongi, R. (2019). Writing to learn increases long-term memory consolidation: A mental-chronometry and computational modeling study of" epistemic writing". *Journal of Writing Research, 11*(1), 211-243. doi:10.17239/jowr-2019.11.01.07

Suri, H., & Clarke, D. (2009). Advancements in research synthesis methods: From a methodologically inclusive perspective. *Review of Educational Research, 79*(1), 395-430. doi:10.3102/0034654308326349

Tağa, T., & Ünlü, S. (2013). A review on the problems encountered in writing education. *Turkish Studies, 8*(8), 1285-1299.

Thorne, S. E. (2012). Metasynthesis. In M. Lisa (Ed.), *Nitel araştırma yöntemlerinin SAGE ansiklopedisi* (pp. 511 - 513). Thousand Oaks, CA: SAGE Publications, Inc.

Topçuoğlu Ünal, F., & Sever, A. (2012). The influence of music in creative writing. *Turkish Studies - International Periodical for the Languages, Literature and History of Turkish or Turkic, 7*(4), 2907-2918.

Uc, F. B. (2019). *Investigation of the effects of writing-assisted argumentation practices on 7th grade students' writing self-efficacy, creative writing and concept learning* (Unpublished master's thesis). Marmara University, İstanbul.

Ulu, C., & Bayram, H. (2015). The effect of teaching method based on science learning approach by doing and writing on scientific process skills. *Hacettepe University Faculty of Education Journal, 30*(1), 282-298.

Ungan, S. (2007). Developing and importance of writing skill. *Erciyes University Journal of Social Sciences Institute, 1*(23), 461-472.

Uysal, H., & Sidekli, S. (2020). Developing the story writing skills of primary school 4th grade students with the mind map method. *Education and Science, 45*(204), 1-22. doi:10.15390/EB.2020.8848

Uzoğlu, M. (2014). The effects of different learning-oriented writing activities on the academic achievement, laboratory attitudes and critical thinking skills of pre-service science teachers: The case of Giresun Faculty of Education [Special issue]. *Black Sea Journal of Social Sciences*, 195-209.

Uzoğlu, M. (2018). Investigation of the studies related to writing activities for learning purposes in science education environments in Turkey. *European Journal of Education Studies, 5*(4), 54-66. doi:10.5281/zenodo.1464020

Uzoğlu, M., & Gurbuz, F. (2013). The use of letter writing activity for learning purposes in determining the misconceptions of science and technology teacher candidates about "heat and temperature". *International Journal of Social Science, 4*(6), 501-517. doi:10.9761/JASSS838

Wellington, J., & Osborne, J. (2001). *Language and literacy in science education*. Buckingham: Open University Press.

Whitacre, M. P. (2019). The importance of teacher self-efficacy in the implementation of a middle and high school science writing initiative. Teaching/Writing: *The Journal of Writing Teacher Education, 7*(1), 78-111.

Williford, Y. (2019). *How to develop a daily writing habit.* Retrieved from https://www.lifehack.org/articles/productivity/how-develop-daily-writing-habit.html

Wright, K. L., Hodges, T. S., Dismuke, S., & Boedeker, P. (2020). Writing motivation and middle school: An examination of changes in students' motivation for writing. *Literacy Research and Instruction, 59*(2), 148-168. doi:10.1080/19388071.2020.1720048

Wright, K. L., Hodges, T. S., Zimmer, W. K., & McTigue, E. M. (2019). Writing-to-learn in secondary science classes: For whom is it effective?. *Reading & Writing Quarterly, 35*(4), 289-304. doi:10.1080/10573569.2018.1541769

Appendix 1. Information on the Codes and Tags of Thesis Studies in the National Field

Thesis Code	Thesis Year	Thesis Type	Thesis Author	Thesis Title	Thesis Advisor	University Name
TT-1	2020	Master Thesis	Emine Özbek	The Effect of Scientific Writing Activities on the Attitudes of 6th Grade Primary School Students towards Academic Achievement, Science Lesson and Written Expression in the unit "Reproduction, Growth and Development in Plants and Animals"	Prof. Fatma Şahin	Marmara University
TT-2	2020	PhD Thesis	Zeynep Tuba Aktepe	Investigation of the Effect of Learning Writing Activities on Academic Achievement in the Fourth Grade "Let's Get to Know the Matter" Unit	Prof. Ali Yıldız	Atatürk University
TT-3	2019	Master Thesis	Fatma Betül Uc	Investigation of the Effects of Writing Assisted Argumentation Practices on 7th Grade Students' Writing Self-Efficacy, Creative Writing and Concept Learning	Assoc. Prof. Elif Benzer	Marmara University
TT-4	2019	Master Thesis	Emine Pınar	The Effect of Diary, one of the Learning Purpose Writing Activities, on Achievement and Science Attitude in the Fourth Grade Science Lesson	Prof. Ali Yıldız	Atatürk University
TT-5	2019	Master Thesis	Ahmet Polat Yazıcıoğlu	The Effect of Letter Writing Activity in Science Lesson on Students' Achievement in the 5th Grade "The Radiation of Light and Physical Events" Unit and Determination of Student Opinions on Letter Writing Activity	Assoc. Prof. Eser Ültay	Giresun University
TT-6	2019	Master Thesis	Miraç Tarikdaroğlu	The Effect of Learning Writing on AcademicAchievement and Determination of Students' AttitudestowardsWriting	Dr. Muhammed Said Akar	Erzincan Binali Yıldırım University
TT-7	2019	Master Thesis	Asiye Pınar Köksal	The Effects of Learning Writing Activities on Fifth Grade Students' Academic Achievement, Persistence and Attitudes towards Science Lesson on "Electricity"	Prof. Sabriye Seven	Atatürk University
TT-8	2019	Master Thesis	Naci Han Takaç	Determining the Effect of Using Different Writing Activities on Student Achievement and Attitudes on 8th Grade Simple Machines	Assoc. Prof. Mustafa Uzoğlu	Giresun University
TT-9	2019	Master Thesis	Murat Bayer	Determining High School Students' Views on Physics Using Some Creative Writing Techniques	Prof. Hüseyin Küçüközer	Balıkesir University
TT-10	2019	Master Thesis	Dursun Yalçın	Investigation of the Development of Multiple Representations and Modal Descriptions in Written Arguments of Pre-service Science Teachers	Dr. Fatma Yaman	Yozgat Bozok University
TT-11	2018	Master Thesis	Ahmet Aydın	The Effect of Multiple Writing Activities on Secondary School Students' Academic Achievement and Attitudes Towards Science Lesson	Prof. Mutlu Nisa Ünaldı Coral	Mersin University
TT-12	2018	Master Thesis	Fatih Aktürk	Using Letter Writing Activities in Identifying the Misconceptions of Secondary School 5th and 8th Grade Students about "Heat and Temperature"	Assoc. Prof. Mustafa Uzoğlu	Giresun University

TT-13	2018	Master Thesis	Hakan Çömen	Investigation of the Effects of the Hybrid Book Developed Based on Writing Activities for Learning Purposes within the Scope of the 7th Grade Electrical Energy Unit of Science	Dr. Salih Uzun	Uşak University
TT-14	2018	Master Thesis	Zafer Külekçi	Investigation of the Effect of Story Writing on the Academic Achievement and Attitudes of 8th Grade Students in the Unit of the Structure and Properties of Matter	Assoc. Prof. Mustafa Uzoğlu	Giresun University
TT-15	2018	PhD Thesis	Ebru Altun	Development of Written and Verbal Argument Making Skills of Pre-service Science Teachers	Prof. Tuncay Özsevgeç	Karadeniz Teknik University
TT-16	2017	Master Thesis	Sümeyye Erenler	Investigation of the Effect of Argument-Based Inquiry Research Practices on Pre-service Science Teachers' Metacognitive Awareness Levels and Writing Skills	Assoc. Prof. Pınar Seda Çetin	Abant İzzet Baysal University
TT-17	2017	Master Thesis	Emel Ulum	Digital Story Preparation Experiences of Seventh Grade Students on Science Subjects	Asst. Prof. Feride Ercan Yalman	Mersin University
TT-18	2017	Master Thesis	Osman Küçük	Using Writing Activities to Develop Eighth Grade Students' Epistemological Beliefs	Assoc. Prof. Şengül Atasoy	Recep Tayyip Erdoğan University
TT-19	2017	Master Thesis	Nursemen Yılmaz	Change in Secondary School Fifth Grade Students' Skills in Using Modal Descriptions	Asst. Prof. Funda Hasançebi	Giresun University
TT-20	2017	Master Thesis	Havva Kübra Santaş	An Investigation of the Use of Multimodal Descriptions for 5th, 6th, 7th, and 8th Grade Science Textbooks for Physics and Biology Topics	Asst. Prof. Ayşe Gül Nasırcılar	Akdeniz University
TT-21	2016	Master Thesis	Mustafa Kavaklı	Evaluation of Teaching Human and Environmental Relations Unit Using Multiple Writing Activities	Asst. Prof. Mehmet Mutlu	Ömer Halisdemir University
TT-22	2015	Master Thesis	Emine Çavuş	The Effect of Science Diary Use in Science and Technology Class on Primary School Students' Metacognitive Awareness and Academic Achievement	Assoc. Prof. Mustafa Özden	Adıyaman University
TT-23	2015	Master Thesis	Nurseda Özdemir	The Effect of Reflective Writing Activities on Students' Metacognitive Skills and Affective Variables in Science Teaching	Prof. Ömer Ergin	Dokuz Eylül University
TT-24	2014	Master Thesis	Ömer Bozat	The Effect of Letter from Learning Purpose Writing Activities on Success in the "Electricity" Unit in Our 5th Grade Life	Prof. Ali Yıldız	Atatürk University
TT-25	2014	Master Thesis	Sadık Öztürk	The Effect of Recognizing Modal Descriptions and Using them in Writing for Learning Purposes on Academic Achievement in the Physics Course Waves Unit by First Year High School Students	Assoc. Prof. Refik Dilber	Atatürk University
TT-26	2013	Master Thesis	Ayşe Baltacı	Evaluation of Teaching Astronomy Subject by Using Multiple Writing Activities and Science Learning Method by Doing and Writing	Assoc. Prof. Hakan Akçay	Marmara University
TT-27	2013	Master Thesis	Gülşen Koçak	The Effect of Implementation of Learning-Aimed Writing Activities on the Subject of "One-Dimensional Movement" on Academic Success and Permanence of First Year Science Education Students	Prof. Sabriye Seven	Atatürk University

TT-28	2012	Master Thesis	Bilge Biber	Science and Technology Teachers' Perceptions of Writing and Application Levels of Writing Activities for Learning	Assoc. Prof. Murat Günel	Atatürk University
TT-29	2012	Master Thesis	Elif Bektaş Esen	Reading and Writing Strategies Used by Students in Science and Technology Lesson	Asst. Prof. Nevzat Yiğit	Karadeniz Teknik University
TT-30	2011	Master Thesis	Nuray Duymaz	Using Writing Activities for Learning in Learning Cell Subject and Generating Analogies	Asst. Prof. Melike Özer Keskin	Gazi University
TT-31	2011	Master Thesis	Mehmet Demirbağ	The Effect of Modal Description Education on Students' Science Achievement and Writing Skills in Science Classes Using Argumentation-Based Science Learning Approach	Assoc. Prof. Murat Günel	Ahi Evran University
TT-32	2011	Master Thesis	Ayşegül Öğdük	The Effect of Modal Descriptions Used in Writing Activities for Learning Purposes on Academic Achievement in Science and Technology Lessons in Primary Education Second Level	Assoc. Prof. Murat Günel	Atatürk University
TT-33	2011	Master Thesis	Büşra Başak Özyurt	Evaluation of Teaching the Unit "Reproduction, Growth and Development in Living Things" Using Multiple Writing Activities	Assoc. Prof. Hakan Akçay	Marmara University
TT-34	2011	PhD Thesis	Cüneyt Ulu	The Effect of Using Inquiry-Based Science Writing Tool on Conceptual Understanding, Scientific Process and Metacognition Skills in Science Teaching	Prof. Hale Bayram	Marmara University
TT-35	2011	PhD Thesis	Salih Uzun	The Effect of Learning Environments Enriched with Reading-Writing Activities on Physics Learning: An Application in the "Energy" Unit	Asst. Prof. Nedim Alev	Karadeniz Teknik University
TT-36	2010	Master Thesis	Gamze Erol	Evaluation of Teaching "Acid-Base" Subject Using Multiple Writing Activities and Science Learning Method by Doing and Writing	Prof. Hale Bayram Dr. Hakan Akçay	Marmara University
TT-37	2010	PhD Thesis	Mustafa Uzoğlu	Investigation of the Effect of Use of Learning Writing Activities on Learning Force and Substance Units at Primary School Level	Assoc. Prof. Sabriye Seven	Atatürk University

Appendix 2. Information on the Codes and Tags of Thesis Studies in the International Field

Thesis Code	Thesis Year	Thesis Type	Thesis Author	Thesis Title	Thesis Advisor	University Name
YT-1	2020	Master Thesis	Carina Perez	The Effect of Collaborative Writing of Scientific Arguments on Content Learning and Student Attitudes in Science	Dr. Alan Colburn	California State University
YT-2	2020	PhD Thesis	Stephanie Higgins Selvaggio	The Effects of the *Claim, Evidence, Reasoning* Format of Argument Writing on Urban Middle School Science Students' Performance	Dr. Chahine Iman	University of Massachusetts Lowell
YT-3	2019	PhD Thesis	Dulani Samarasekara	The Impact of Utilizing Peer Mentoring Interactions, New Laboratory Experiments, and Writing-to-Learn Practices İn Undergraduate Chemistry Education	Dr. Debra A. Mlsna	Mississippi State University
YT-4	2019	PhD Thesis	Julie Valentine Mcgough	Tales of Wonder: A Narrative Inquiry of Elementary Girls' Science Stories	Dr. Julie Thomas	University of Nebraska
YT-5	2019	PhD Thesis	Yewon Lee	Exploring the Use of Cognitive Apprenticeship for Teachers and Students in Science Classrooms	Prof. Susan De La Paz	University of Maryland
YT-6	2018	Master Thesis	Mckenna Lucille Maguet	Identifying Elements of Voice and Fostering Voice Development in First-Grade Science Writing	Dr. Timothy Morrison	Brigham Young University
YT-7	2018	PhD Thesis	Anna Karin Roo	Exploring Science Literacy of English Learners in K - 16 Learning Environments	Dr. Salsbury Thomas L. Dr. Ardasheva Yuliya	Washington State University
YT-8	2018	Master Thesis	Rutherford Erica	Mixed Methods Study of Kindergarten Students' Explanation Writing and Vocabulary Acquisition	Coleman, Julianne	The University of Alabama
YT-9	2017	PhD Thesis	Manning, TarshaRena	A Correlation of Postsecondary Biochemistry Student Writing With Perception of Elementary Science Engagement	Dr. Brocato Kay D.	Mississippi State University
YT-10	2017	PhD Thesis	Justin Michael Atwell	In This Together: Consubstantial Ethos in Writing in the Sciences Classrooms	Dr. Miriam Mara	North Dakota State University
YT-11	2017	PhD Thesis	Denae Nurnberg	Writing-to-Learn in High-School Chemistry: The Effects of Using the Science Writing Heuristic to Increase Scientific Literacy	Dr. Patricia Busk	The University of San Francisco
YT-12	2016	PhD Thesis	Nurcan Keleş	Investigating the Effect of Science Writing Heuristic Approach on Students' Learning of Multimodal Representations across 4th to 8th Grade Levels	Prof. Brian Hand	The University of Iowa
YT-13	2016	PhD Thesis	Xochitl Anabel Rocha	The Impact of Reading and Writing in Science for Fifth Grade Students in a Dual Language Classroom	Dr. Roberto Torres	The University of Texas-Pan American

YT-14	2016	PhD Thesis	Katherine Elizabeth Landau Wright	Methods and Measures for Using Writing to Transform Knowledge in Science Classes	Dr. Erin Mctigue	Texas A&M University
YT-15	2015	Master Thesis	Tamara Drobitsky	Using Science Writing Heuristics to Increase Conceptual Understanding of Properties of Matter and Property Changes with 8th Grade Students	Dr. Julie Luft	Arizona State University
YT-16	2015	PhD Thesis	Âmânda M Knıght	Students' Abilities to Critique Scientific Evidence When Reading and Writing Scientific Arguments	Dr. Kate Mcneill	Boston College
YT-17	2015	Master Thesis	Yang Qı	Learning to Write in Science: A Study of English Language Learners' Writing Experience in Sixth-Grade Science Classrooms	Dr. Zhihui Fang	University of Florida
YT-18	2015	PhD Thesis	Deborah A. Kravchuk	The Effectiveness of Professional Development in Teaching Writing-to-Learn Strategies for Science: an Evaluative Case Study	Dr. Sherry Lowrance	Northcentral University
YT-19	2015	PhD Thesis	Kathryn A. Lichon	"*If* I Write Like a Scientist, *Then* Soy Un Científico": Differentiated Writing Supports and the Effects on Fourth-Grade English Proficient Students' and English Language Learners' Science Content Knowledge and Explanatory Writing about Magnetism and Electricity	Dr. Paige Ware	Southern Methodist University
YT-20	2014	PhD Thesis	Angela K. Leffler	Writing in the Elementary Science Classroom: Teacher Beliefs and Practices within a Narrowing Curriculum	Ancy Melser	Ball State University
YT-21	2014	PhD Thesis	Alma Shaw Greer	Perception of Science Engagement in Secondary 7-12 Classrooms: A Correlation of Postsecondary Biochemistry Students' Scientific Writing and Their Ratings of Science Instruction	Brocato Donna K.	Mississippi State University
YT-22	2014	Master Thesis	Amy Gillespie	Writing to Learn in Science: Effects on Fourth-Grade Students' Understanding of Balance	Dr. Donald L. Compton,	Vanderbilt University
YT-23	2014	PhD Thesis	Ching-Mei Tseng	The Effects of the Science Writing Heuristic (SWH) Approach Versus Traditional Instruction on Yearly Critical Thinking Gain Scores in Grade 5-8 Classrooms	Prof. Brian M. Hand Prof. Walter Vispoel	University of Iowa
YT-24	2013	PhD Thesis	Atiya Parson	Writing for Understanding: The Effect of Using Informational Writing on Student Science Achievement	Dr. Amy Kuo-Newhouse	Capella University
YT-25	2013	Master Thesis	Anthony Bacaoat Kalaskas	Science Lab Report Writing in Postsecondary Education: Mediating Teaching and Learning Strategies Between Students and Instructors	Dr. Paul Michael Rogers	George Mason University
YT-26	2013	Master Thesis	Tina Vo	A Middle School Science Teacher's Integration of Technology with the Science Writing Heuristic: A Case Study	Professor Brian Hand	The University of Iowa
YT-27	2013	PhD Thesis	Niphon Chanlen	Longitudinal Analysis of Standardized Test Scores of Students in The Science Writing Heuristic Approach	Professor Brian Hand	The University of Iowa

YT-28	2012	Master Thesis	Caroline E. Hickerson	Science Writing Heuristic Effects on Students' Understanding of The Nature of Science	Dr. Leslie Rush	University of Wyoming:
YT-29	2012	Master Thesis	Shannon Marie Chamberlin	Writing for Science Literacy	Rachel Millstone	University of California
YT-30	2012	PhD Thesis	Angela M. Kohnen	A New Look at Genre and Authenticity: Making Sense of Reading and Writing Science News in High School Classrooms	Dr. Saul E. Wendy	University of Missouri - Saint Louis
YT-31	2012	Master Thesis	Lori Fulton	Writing in Science: Influences of Professional Development on Teachers' Beliefs, Practices, and Student Performance	Dr. Jian Wang	University of Nevada
YT-32	2011	PhD Thesis	Joi Phelps Walker	Argumentation in Undergraduate Chemistry Laboratories	Dr. Victor Sampson	The Florida State University
YT-33	2010	PhD Thesis	Nancy S. Caukin	Science Writing Heuristic: A Writing-To-Learn Strategy and Its Effect on Students' Science Achievement, Science Self-Efficacy, and Scientific Epistemological View	Dr. John Mark Hunter	Tennessee State University
YT-34	2010	PhD Thesis	Pamela R. Nagasawa	Writing in Scientific Inquiry: Epistemic Practices Afforded Through Multiple Genre Engagement in a Sixth -Grade Classroom	Associate Prof. Mark A. Windschitl	University of Washington
YT-35	2010	PhD Thesis	Kathleen J. Deakin	Student Perception of Writing in the Science Classroom	Dr. James Blasingame	Arizona State University
YT-36	2010	PhD Thesis	Diane K. Erıckson	The Effects of Blogs Versus Dialogue Journals on Open-Response Writing Scores and Attitudes of Grade Eight Science Students	Dr. Jay Simmons	University of Massachusetts Lowell