General Trends in National Research on Web-Based Instruction in Science Education: A Meta-Synthesis Study*

Rumeysa Karaca[**a], Canan Dilek Eren[b]

[a](ORCID ID: 0009-0004-8470-049X), Atatürk Middle School, Gaziantep, Turkey, rumeysakaracaa.14@gmail.com
[b](ORCID ID: 0000-0002-7004-5066), Kocaeli University, Faculty of Education, Physics, Turkey, canandilek@kocaeli.edu.tr
[**]Corresponding author

ABSTRACT

This study analyzes Turkish studies on web-based instruction in the field of science education using the meta-synthesis method with the aim of determining the general trends of the analyzed studies. A total of 20 studies published between 2006 and 2022, including 7 doctoral dissertations, 11 master theses, and 2 journal articles, were analyzed with a qualitative research design. These studies were identified using the databases of the YÖK National Thesis Center, EBSCO, Google Scholar, and ProQuest. The studies were analyzed using a coding form that included ten categories: year of publication, type of publication, purpose of the research, method, data collection tools, data analysis method, grade level, sample size, learning domain, and outcome of the research. The obtained data were interpreted according to the specified categories. It was concluded that a significant portion of the analyzed studies were conducted with the aim of examining web-based instruction and Web 2.0 tools, mixed research designs and semi-structured interview forms were most often used, most studies were conducted with students in the 6th and 7th grades, and web-based instruction was generally found to be more effective than traditional instruction. This study provides an overview of research on web-based instruction in the field of science education, serves as a resource for future research, and offers new ideas and suggestions for researchers in this field.

INTRODUCTION

Due to the rapid developments in information technologies, the speed of the production and distribution of information is steadily increasing. These developments have significantly affected the way of life of individuals (Çetin & Günay, 2010; Özgen, 2017). With the integration of technology into individual lives, societies that have achieved the interconnection of technology and information aim to find new ways to access information using technology and improve old approaches to accessing information (Karagöz, 2010; Koruk, 2021). This new form of society has been characterized as "information society" and information technologies are seen as the main factor in transitioning to an information society.

Modern information societies seek alternative methods rather than relying on preexisting methods for structuring knowledge and using it in daily life (Karakırık & Durmuş, 2005; Yurdabakan, 2011; Akgündüz, 2013). The internet has been an important technological development in this regard as it allows individuals to access alternative teaching methods (Taşkıran et al., 2003; Bacanak, 2008). The development and diffusion of the internet over time has enabled the use of new internet-based methods and applications in the field of education (Lam & Khalifa, 2002; Ateşkan & Çataloğlu, 2014). The World Wide Web, as one of the most important internet tools used in the field of education, is a system that provides access to information through the internet (Taş, 2006; Kırıkkaya & Dağ, 2012). Web applications provide access to information with various formats including text, pictures, animation, and audio or video files (Karaman, 2007; Oral & Kenanoğlu, 2012). Web-based teaching applications are increasingly being used to improve existing methods for education and teaching, to support lifelong learning, and to increase the quality of education and student success, and its use is increasing day by day (Melis et al., 2001).

Graduate theses play a guiding role in shaping the field of education, facilitating students' academic achievement, fostering positive attitudes towards specific courses, and improving interest and motivation (Tarman, Yüksel, & Acun, 2010). When the meta-synthesis method is used together with graduate research, it becomes possible to determine the need for new research on specific problem situations. In the present study, the meta-synthesis method is used in the analysis of research on web-based instruction in science education to answer questions such as what web-based instruction in science education entails, the current trends in Turkey in this field, and the most popular scientific methods being applied. This study also provides information about positive or negative effects on students' academic achievement, attitudes towards their courses, and relevant skills. The studies examined here in detail with the meta-synthesis method provide ideas and guidance to researchers exploring web-based instruction in science education. The results obtained from this meta-synthesis study are expected to highlight the importance of web-based instruction in science education and contribute to the literature by providing information about the advantages, disadvantages, and effectiveness of web-

*This study was derived from the first author's master's thesis, under the supervision of the second author.

based instruction in in science education. With those aims, this study synthesizes recently published work on web-based instruction in science education in Turkey.

Web-based instruction constitutes an internet-supported approach to teaching. Therefore, it differs from traditional educational methods in several important ways. These differences are listed in Table 1.

Table 1. Comparison of web-based instruction and traditional educational methods (Oral & Kenanoğlu, 2012)

Web-based Instruction	Traditional Teaching
Students can work individually.	Students work in a group in a classroom environment.
Instruction can be applied anywhere and anytime.	Education is carried out in a specific place at a specific time.
All desired data can be accessed.	Data are limited to those described in the course curriculum.
Students can learn using methods appropriate to their own pace and individual differences.	All students in the class learn in the same way.
Instruction can be simultaneous or asynchronous.	Instruction can only be simultaneous.
The teacher's workload may be decreased.	The teacher's workload may be increased.
Updated information is immediately available.	Updated information may not be immediately available.

Purpose of the study

The purpose of this study is to analyze research conducted in Turkey on web-based instruction in the field of science education using the meta-synthesis method and to determine the general trends of the studies included in the analyzed studies.

Research Questions

To determine the general trends of the analyzed studies using the meta-synthesis method, the following research questions were prepared:

1. What is the distribution of studies on Web-based instruction according to years?
2. What is the distribution of studies on web-based instruction according to their purposes?
3. What is the distribution of studies on Web-based instruction according to types of publication?
4. What is the distribution of the designs used in studies on Web-based instruction?
5. What is the distribution of the data collection tools used in studies on Web-based instruction?
6. What is the distribution of the data analysis methods applied in studies on Web-based instruction?
7. What is the distribution of sample sizes in studies on web-based instruction?
8. What is the distribution of applications in studies on Web-based instruction according to grade levels?
9. What is the distribution of applications in studies on web-based instruction according to science learning areas?
10. What is the distribution of the results of studies on Web-based instruction?

METHOD

Study Model

In this study, meta-synthesis, a type of content analysis, was used. Meta-synthesis is a method for the in-depth examination of studies in which qualitative designs are applied and qualitative findings are presented in the form of mixed-methods research. This approach supports the detailed interpretation and grouping of findings according to themes (Rhodes & Dewitt-Brinks, 1992; Gümüş, 2018). Meta-synthesis studies focus on relatively limited numbers of studies to examine, interpret, and analyze the selected studies in more detail (Weed, 2005; Polat & Ay, 2016). The most important feature of the meta-synthesis method is that all relevant research on a selected topic is collected within a single study (Koran, 2022). This allows researchers who want to conduct research on the selected topic to access all previous publications via a single meta-synthesis study instead of reviewing the entire body of literature. This saves time for researchers (Çalık & Ültay, 2012).

Meta-Synthesis Process Steps

The steps applied in the process of conducting meta-synthesis research are presented in Figure 1.
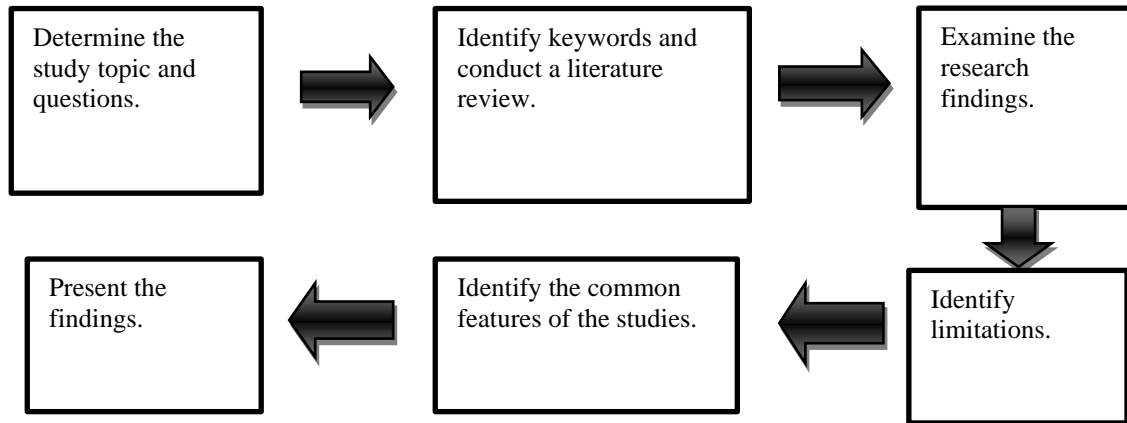

Figure 1. Meta-synthesis process steps (Ay and Polat, 2016)

The meta-synthesis steps applied in the present study may be described in more detail as follows:
1. Determining the study topic and appropriate research questions.
2. Selecting keywords related to the study topic and searching the literature for these keywords.
3. Examining the studies found in the literature as a result of the previous step.
4. Determining the inclusion and exclusion criteria for studies to be included in the analysis.
5. Determining the common and non-common characteristics of the studies that met the inclusion criteria.
6. Identifying the research findings in light of the common characteristics of the analyzed studies.
7. Explaining the findings in detail with the support of the obtained data.

Data Collection

As the first step of this meta-synthesis study, the study topic was determined. Accordingly, the research focused on studies conducted in Turkey on the topic of web-based instruction in the field of science education. After the study topic was determined, relevant keywords were identified. These keywords included "science education," "internet," and "web-based instruction." Subsequently, a literature review was conducted using the database of the YÖK National Thesis Center, EBSCO, Google Scholar, and ProQuest. Twenty studies conducted in Turkey on web-based instruction in the field of science education between 2006 and 2022 with elementary and middle school students based on qualitative and mixed research designs were found. These studies included 7 doctoral dissertations, 11 master theses, and 2 journal articles.

Studies conducted between 2006 and 2022 were included in the analysis because the earliest available Turkish study on web-based instruction in science education was published in 2006. After 2006, no further Turkish studies on this topic were published until 2010. After 2010, there was at least one study published annually on web-based instruction until 2022, excluding 2012 and 2017. Overall, more than 20 studies on web-based instruction in science education between 2006 and 2022 were found. However, in line with the exclusion criteria of the present study, publications entailing quantitative designs, research conducted among high school or university students and teachers, and studies not conducted in Turkey were not analyzed.

DATA ANALYSIS

Data analysis was conducted for the 20 selected studies using the thematic synthesis technique developed by Harden and Thomas (2008) in three stages (Koyuncu, 2022). These stages are presented in Figure 2.
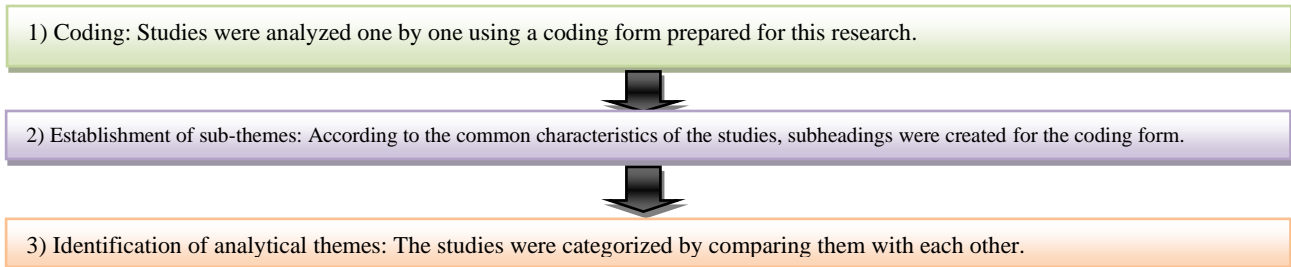

Figure 2. Data analysis stages adapted from Koyuncu (2022)

The data analysis stages applied in the present study may be described in more detail as follows:
1. Before analyzing the selected studies, research questions appropriate for the aims of the meta-synthesis were determined. Studies were analyzed with a coding form created based on the determined research questions.
2. Sub-headings were created for the coding form according to the common and non-common characteristics of the analyzed studies. As a result, the following information was collected with the coding form: the code number assigned to each study, the name of the study, the year of publication, the type of publication, the purpose of the research, the method of the research, data collection tools, data analysis methods, the sample size, the grade level of participants, the learning area, and the results of the study.
3. Based on the established sub-headings of the coding form, studies were classified by comparing them with each other.

Validity and reliability

To determine the reliability of the present study, the full texts of the 20 studies to be analyzed were reviewed and the coding form was completed for each study according to the predetermined research questions. Evaluations of the 20 studies were performed separately by two researchers in line with the sub-headings of the coding form. Their evaluation results were checked for consistency according to the reliability formula developed by Huberman and Miles (1994). The coder reliability of the present study was found to be 95%. Reliability values of ≥70% can be accepted as sufficient.

FINDINGS

Findings Related to the Year of Publication of National Studies on Web-Based Instruction in Science Education

The majority of analyzed studies were published in 2021 or 2022. No works published in 2007, 2008, 2009, 2012, or 2017 met the inclusion criteria of this meta-synthesis study.

The first relevant study on web-based instruction in the field of science education was published in 2006, but there were no further publications on web-based instruction until 2010. After 2010, at least one study on web-based instruction was published annually until 2022, excluding 2012 and 2017.
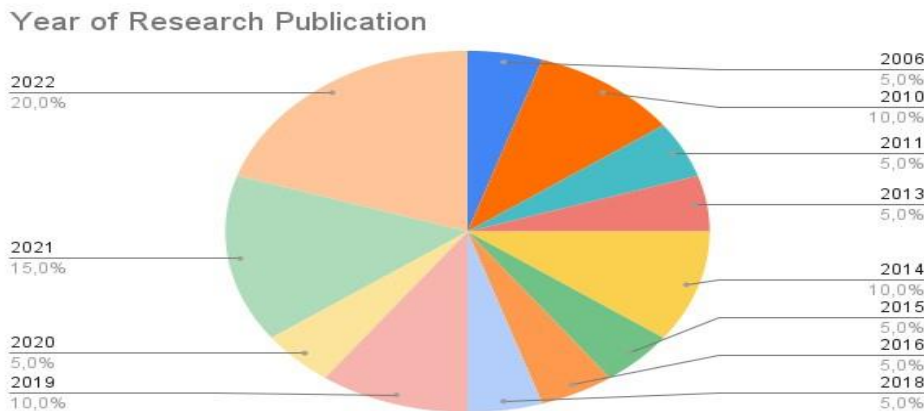

Figure 3. Publication Year of the Studies

Findings Related to the Objectives of National Studies on Web-Based Instruction in Science Education

As seen in Table 2, the majority of the analyzed studies addressed the effects of Web 2.0 tools and web-based teaching. In contrast, the least frequent research objectives were respectively evaluations of the effects of technology-supported instruction, computer-supported instruction, a web-based Moodle application, web-based graphic organizer software, and a web-based artificial intelligence application.

One aspect of life heavily affected by the COVID-19 pandemic has been the field of education (Kaçaroğlu, 2022). With the pandemic, the education sector experienced a transition to web-based teaching models, computer-aided instruction, and distance education (Başaran et al., 2021). This transition in education was a driving factor in the increase in graduate theses and journal articles addressing web-based teaching or web-based tools as major research objectives (Küçük & Küçük, 2021).

Table 2. Objectives of the Analyzed Studies

Research Objectives	Frequency
To examine the impact of web-based teaching	4
To examine the impact of Web 2.0 tools	4
To examine the effect of web-based portfolio applications	2
To examine the effect of Turkey's Education Information Network (EBA)	2
To examine the impact of social media-supported teaching	2
To examine the effect of digital game-supported practice	2
To examine the effect of technology-supported instruction	1
To examine the effect of computer-assisted instruction	1
To examine the impact of a web-based Moodle application	1
To examine the impact of web-based graphic organizer software	1
To examine the impact the Impact of a web-based artificial intelligence application	1

Findings Related to Publication's Type of National Studies on Web-Based Instruction in Science Education

As seen in Figure 4, the majority of analyzed studies were conducted as master theses.

In Turkey, universities providing master-level education are more prevalent compared to universities providing doctoral education (Kıldan & Ahi, 2013). Accordingly, more students receive education at the master level compared to the doctoral level (Kaya, İşcan, Aydın, & İşkol, 2019). This explains the high percentage of master theses analyzed in this meta-synthesis study.
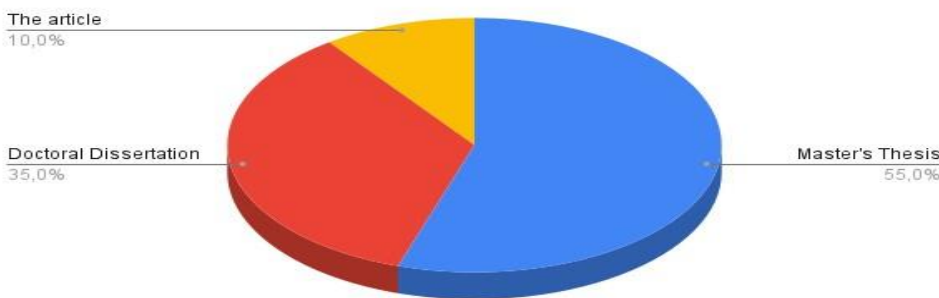
Figure 4. Publication Types of Studies

Findings Related to the Design of National Studies on Web-Based Instruction in Science Education

Figure 5 reveals that the majority of analyzed studies were conducted with mixed research designs.

In 17 of the 20 analyzed studies, mixed designs incorporating both qualitative and quantitative research was conducted. Among these various mixed design models, the special case study approach, multimedia modeling, nested approach, convergent parallel approach, and sequential explanatory approach were utilized. Special case studies constitute a mixed design model in which more than one data collection tool is used and students are examined in their natural environments (Ahmed & Williams, 1997). Multimedia models are based on the constructivist approach, which allows students to learn on their own (Gündüz & Şendağ, 2007). Nested designs are mixed design models that allow data to be collected at the same time or at different times as a result of research conducted with both quantitative and qualitative designs (Ekemen, 2022). Convergent parallel designs are a type of mixed design model for collecting, examining, and analyzing qualitative and quantitative data separately and comparing the results (Toraman, 2021; Gül, 2022). Sequential explanatory designs are a type of mixed design model in which quantitative findings are obtained first and then qualitative findings are obtained to support those quantitative findings (Creswell et al., 2003; Baki & Gökçek, 2012). In the remaining three analyzed studies, the naturalistic inquiry approach or multiple case study approach was used. These are types of qualitative designs. The naturalistic approach offers a method for examining students in their natural environments without any intervention (Aktay, 2015).
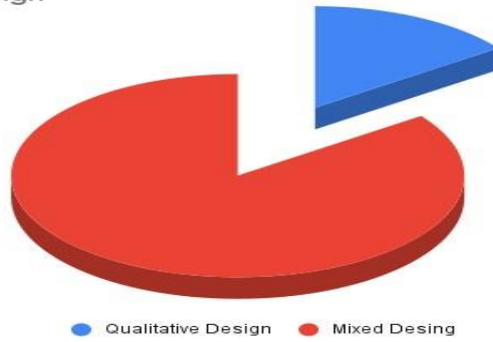
Research Design

Figure 5. Research Design

Findings Related to Data Collection Tools Used in National Studies on Web-Based Instruction in Science Education

Figure 6 presents the types of data collection tools used in the analyzed studies. Semi-structured interview forms were used most often and questionnaire surveys were used least often.

In studies using qualitative designs, interview forms are preferred most often as the data collection tool (Şimşek & Yıldırım, 2011; Aybek & Aslan, 2018). In particular, interview forms are used most often as the data collection tool in studies based on mixed designs (Gülen & Dönmez, 2021). Semi-structured forms are more open to change than structured forms (Akgündüz, 2013), and structured forms are prepared before the research begins and are applied without any changes (Yıldırım & Şimşek, 2011). Semi-structured forms are also prepared before the research begins, but adaptations can be made to these forms while administering them by customizing certain questions in accordance with the purpose of the research (Türnüklü, 2000). For this reason, semi-structured interview forms were used most often in the studies included in this meta-synthesis.
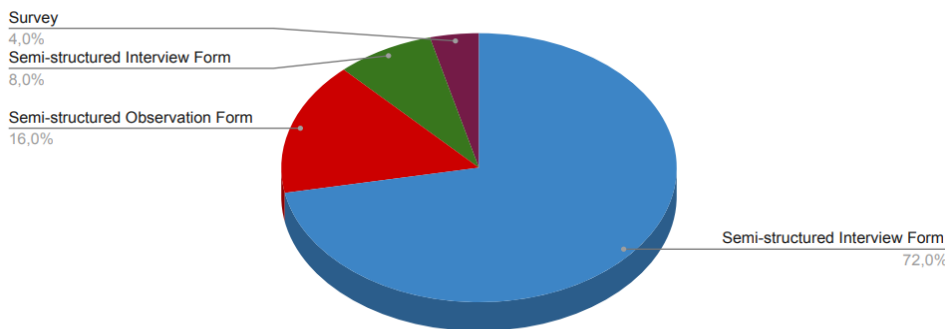

Figure 6. Data Collection Tools

Findings Related to Data Analysis Methods Used in National Studies on Web-Based Instruction in Science Education

Details about the sample sizes of the analyzed studies are provided in Figure 8. The most common sample size among these studies was 31-100, while small sample sizes of 1-10 were least common. No studies with sample sizes above 300 met the inclusion criteria for this meta-synthesis.

The descriptive method of data analysis, which is most commonly used in the research considered here, examines obtained data more superficially than other analysis methods (Şimşek & Yıldırım, 2011). Document analysis is a data analysis method that allows for the in-depth and systematic examination of written and digital documents (Wach & Ward, 2013; Kıral, 2020). Coding analysis is a data analysis method that enables the examination of obtained data using coding forms.
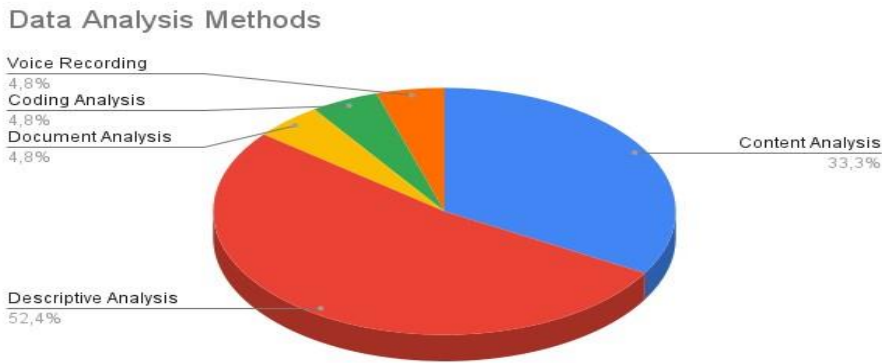
Data Analysis Methods

Figure 7. Data Analysis Methods

Findings Related to the Sample Sizes of National Studies on Web-Based Instruction in Science Education

Details about the sample sizes of the analyzed studies are provided in Figure 8. The most common sample size among these studies was 31-100, while small sample sizes of 1-10 were least common. No studies with sample sizes above 300 met the inclusion criteria for this meta-synthesis.

The sample sizes of the analyzed studies were relatively small. This finding may be attributed to the use of qualitative research designs. In studies based on qualitative designs, the research questions are explored in depth (Karataş, 2017). Accordingly, smaller sample sizes are advantageous in studies using qualitative designs to conduct a more detailed examination of relatively limited data (Weed, 2005; Ay & Polat, 2016).

None of the analyzed studies had sample sizes above 300. Studies with larger sample sizes are typically designed as more comprehensive quantitative research than that conducted in the scope of the qualitative designs considered in this meta-synthesis. Comprehensive studies may also have disadvantages in terms of the time required and the complexity of the analysis of the results.
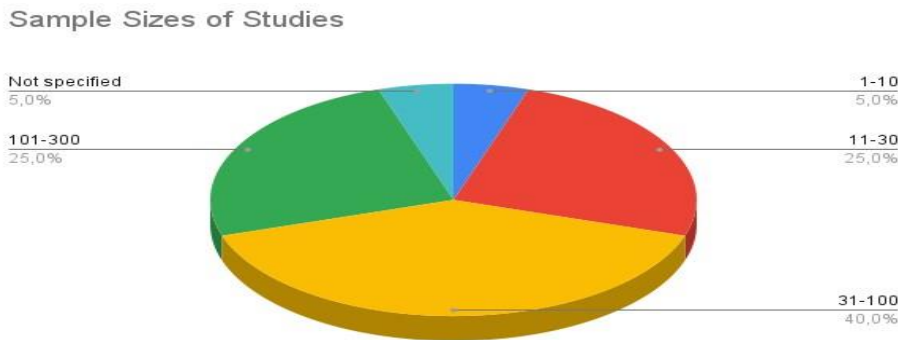
Sample Sizes of Studies

Figure 8. Sample Sizes of the Studies

Findings Related to the Grade Levels of Participants in National Studies on Web-Based Instruction in Science Education

As seen in Figure 9, most of the analyzed studies were conducted with students in the 6th and 7th grades. Research conducted with students in the 4th grade was found to be rare.

Students in the 4th grade are younger compared to most other students in the age range considered here. Therefore, they are less likely to be considered as research participants due to challenges that may arise as a result of their developmental levels in the process of data collection (Gülen & Dönmez, 2021). In contrast, students in the 6th and 7th grades are more likely to be well adapted to the educational system and easier for researchers to work with.
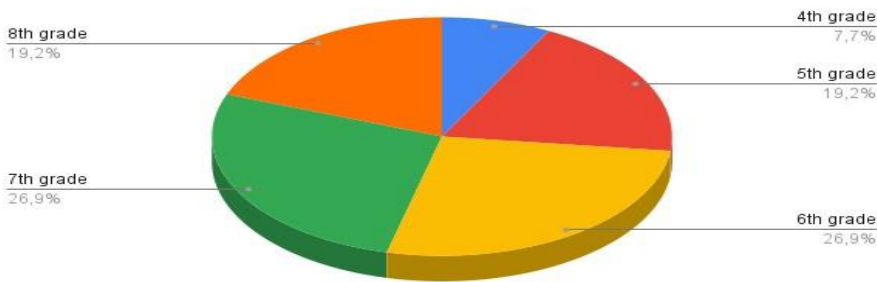
Class Levels at which the Research was Conducted

Figure 9. Class Levels at which the Studies were Conducted

Findings Related to the Areas of Science Learning Considered in National Studies on Web-Based Instruction in Science Education

Figure 10 illustrates the distribution of areas of science learning considered in the analyzed studies. The analyzed studies were most likely to address biological topics within the scope of "Living Things and Life," while studies within the scope of "Matter and Nature" were rare.

The higher number of studies addressing educational topics related to "Living Things and Life" may be attributed to the fact that abstract concepts and subjects are considered in this learning domain. Fewer studies addressed "Matter and Nature," which may be attributed to the fact that this learning domain includes experiment-intensive subjects. Schools may lack the necessary laboratories or materials to conduct such experiments in the classroom environment, and the experiments may also pose safety hazards, particularly for younger students (Erdoğan, 2022).
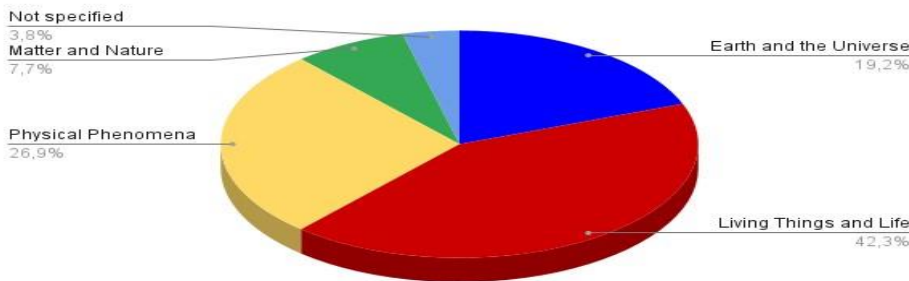

Figure 10. Areas of Science Learning Considered in the Studies

Findings Related to the Results of National Studies on Web-Based Instruction in Science Education

As seen in Table 3, a majority of the analyzed studies found that web-based instruction positively affected students' academic achievement. These studies also commonly reported improvements in science process skills, attitudes, and interest and motivation in science courses. Other results, such as increased digital literacy levels, increased critical thinking or creativity skills, a lack of effect on academic achievement, a lack of effect on attitudes towards science courses, and a lack of effect on digital literacy levels, were each reported by only one study.

Table 3. Results of the analyzed studies

Conclusions drawn regarding web-based science instruction	Frequency
Positive impact on academic success	13
Positive attitudes towards the science course	6
Positive interest in the sciences course	4
Positive motivation in the science course	3
Positive impact of electronic portfolio application on students	2
Positive impact on science process skills	1
Positive impact of graphic organizer software application on students	1
Positive impact on digital literacy levels	1
Positive impact on thinking skills	1
Positive impact on critical thinking skills	1
Positive impact on creativity skills	1
No impact on academic achievement	1
No effect on attitudes towards the science course	1
No impact on digital literacy levels	1

DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Results Regarding the Year of Publication of National Research on Web-Based Instruction in Science Education

The majority of studies analyzed in this meta-synthesis were conducted in 2021 and 2022. No publications on web-based instruction in science education from 2007, 2008, 2009, 2012, or 2017 met the relevant inclusion criteria.

The increase in research being conducted on web-based teaching in the field of science education in 2021 and 2022 may be attributed to the COVID-19 pandemic, which started in 2020. Because of the pandemic, transitions were made to web-based teaching models, computer-aided instruction, and distance education (Başaran et al., 2021). In line with those transitions in education, the most common subject of graduate theses and articles in this field has been web-based teaching or web-based tools since 2021 (Küçük & Küçük, 2021). Fewer studies on web-based teaching in the field of science education were conducted in 2020 as the efforts of teachers and students to adapt to distance education were still relatively new at that time (Kaçaroğlu, 2022). The number of studies addressing web-based teaching and tools increased in 2021 and 2022 as adaptation to pandemic-related changes in education progressed (Kaçaroğlu, 2022).

Results Regarding the Objectives of National Research on Web-Based Instruction in Science Education

The majority of studies analyzed in this meta-synthesis were conducted to examine the effects of Web 2.0 tools and web-based instruction. In contrast, very few studies were conducted to examine the effects of technology-supported instruction, computer-supported instruction, web-based Moodle applications, web-based graphic organizer software, or web-based artificial intelligence applications.

The prevalence of research addressing web-based teaching and Web 2.0 tools in the field of science education may be attributed to the fact that distance education, internet-based educational programs, web-based teaching, and applications prepared with web tools entered our lives with the COVID-19 pandemic and continue to maintain their importance even as other effects of the pandemic begin to fade.

Similar studies investigating the effects of web-based instruction and Web 2.0 tools in science education on students' academic achievement and attitudes are available in the literature. For example, Uzunboylu (2002) examined the effect of web-based instruction on students' academic achievement. Biber Köse (2009) evaluated the effect of web-based instruction on attitudes towards the course and academic achievement among students in the 7th grade. Günay and Çetin (2010) explored the effect of web-based instruction on students' attitudes towards the course and their academic achievement. Ayvacı and Sevim (2016) addressed the effect of web-based instruction on students' academic achievement in the 6th grade within the learning domain of "Physical Phenomena." Yapıcı (2019) considered the effect of an educational information network application as a Web 2.0 tool on the academic achievement of students in the 8th grade. Pürbudak (2020) studied the effect of Web 2.0 tools on students' academic achievement and attitudes toward the course.

Results Regarding the Publication's Type of National Studies on Web-Based Instruction in Science Education

The majority of studies analyzed in this meta-synthesis were conducted as research for master theses, while journal articles constituted the least common publication type.

In Turkey, universities providing master-level education are in the majority compared to universities providing doctoral education (Kıldan & Ahi, 2013). Thus, research conducted for master theses is particularly prevalent compared to other potential publication types (Kaya, İşcan, Aydın, & İşkol, 2019).

In this context, a review of the YÖK National Thesis Center database revealed a total of 824 studies conducted as master theses in the field of science education during the time period considered in this meta-synthesis in contrast to 182 studies conducted as doctoral dissertations in the field of science education.

Results Regarding the Design of National Research on Web-Based Instruction in Science Education

The majority of studies analyzed in this meta-synthesis were conducted with mixed research designs.

Mixed-design research combines qualitative and quantitative research methods to provide a holistic approach to the research questions and a better understanding of the topic (Greene, 2007). The combination of qualitative and quantitative designs increases the validity, reliability, and objectivity of the research and ensures that the results are more accurate, precise, and consistent (Glesne, 2013; Creswell, 2013). In mixed-design studies, if one method is relatively weak for the specific research being conducted, those weaknesses can be addressed by the other method. In addition, in research conducted with mixed designs, the research topics are explored more comprehensively (Baki & Gökçek, 2012; Onwuegbuzie & Johnson, 2004). As a result of these advantages, mixed research designs are most common in research conducted in the field of education (Tanoba, Tonyalı, Özdemir, & Karaokur, 2021; Gülen & Dönmez, 2021).

Results Regarding the Data Collection Tools of National Studies on Web-Based Instruction in Science Education

Semi-structured interview forms were used in the majority of studies analyzed in this meta-synthesis, while questionnaires were the least common data collection tool.

For research conducted with qualitative and mixed designs, interview forms are most often preferred as data collection tools (Şimşek & Yıldırım, 2011; Aybek & Aslan, 2018; Gülen & Dönmez, 2021). The use of interview forms in such research enables students' relevant thoughts, attitudes, interests, and experiences to be revealed. As a result, detailed information about the research topic can be obtained (Şimşek & Yıldırım, 2011).

Semi-structured interview forms are more open to change than structured forms (Akgündüz, 2013). This is because structured forms are prepared before the research is conducted and are then administered without any changes (Yıldırım & Şimşek, 2011). Semi-structured forms are also prepared before the research begins, but these forms can be customized during the course of the study by adjusting some questions in accordance with the purpose of the research (Türnüklü, 2000). As a result of these advantages, semi-structured interview forms were used in most of the studies analyzed in this meta-synthesis. Questionnaires were less common as data collection tools because they are more appropriate in studies involving larger sample sizes.

Results Regarding the Data Analysis Methods of National Studies on Web-Based Instruction in Science Education

Descriptive analysis was the most common data analysis method used in the studies analyzed in this meta-synthesis, while document analysis, coding analysis, and voice recording methods were the least common approaches to data analysis.

The popularity of descriptive data analysis methods in the analyzed studies may be attributed to the fact that descriptive analysis methods permit a more superficial analysis of data compared to other data analysis methods, making them appropriate for the qualitative or mixed designs evaluated in this meta-synthesis (Şimşek & Yıldırım, 2011). Document analysis is used to analyze data obtained from documents and coding analysis is used to analyze data obtained based on coding forms. Therefore, these analysis methods were less appropriate for the studies evaluated in this meta-synthesis.

Results Regarding the Sample Sizes of National Studies on Web-Based Instruction in Science Education

Among the studies analyzed in this meta-synthesis, sample sizes of 31-100 were most common and sample sizes of 1-10 were least common. None of the analyzed studies included more than 300 participants in their samples.

The prevalence of sample sizes of 31-100 in the analyzed studies may be attributed to the fact that these studies were planned with mixed research designs. The sample sizes of studies with mixed designs are generally larger than those of studies with purely qualitative designs (Küçüközer, 2016; Büyükalan & Yaylacı, 2020). In contrast, studies involving sample sizes of only 1-10

participants are generally based on qualitative designs. The limited sample size in studies using qualitative designs enables more in-depth examination of the research subject (Weed, 2005; Ay & Polat, 2016; Karataş, 2017).

Results Regarding the Grade Levels of National Research on Web-Based Instruction in Science Education

The majority of analyzed studies were conducted with students in the 6th and 7th grades, while research conducted among students in the 4th grade was least common.

Gülen and Dönmez (2021) concluded that, in 2020, research conducted in the field of science education in Turkey was most often conducted with students in the 7th grade and least often with students in the 5th grade. Students enrolled in lower grade levels are younger; therefore, they are less likely to answer research questions in a thorough way and fewer of the analyzed studies included 4th grade students in the analysis (Gülen and Dönmez, 2021).

Results Regarding the Learning Areas of National Research on Web-Based Instruction in Science Education

The majority of studies analyzed in this meta-synthesis addressed topics related to "Living Things and Life," while studies addressing "Matter and Nature" were least common.

Some subjects and concepts in science courses are abstract, which poses comprehension challenges for students in science courses (Bayrak, 2011; Aktaş, 2013). Köse (2022) stated that there are more abstract concepts and topics in the field of "Living Things and Life" in contrast to other educational topics; thus, analogies can be used to concretize these abstract concepts and topics. Çelik (2017) concluded that the concepts and topics related to the educational theme of "Systems in Our Body" were abstract and students struggled to concretize them. In that study, students had difficulty learning about the muscular system, respiratory system, circulatory system, and skeleton in the "Systems in Our Body" unit. Web-based instruction can help concretize abstract concepts and subjects, create permanent learning, and improve students' attitudes and interests towards their courses (Aktaş, 2013).

Results Regarding the Overall Findings of National Studies on Web-Based Instruction in Science Education

Considering the final conclusions of the Turkish studies on web-based instruction in science education evaluated in this meta-synthesis, a majority of the studies concluded that web-based instruction had a positive effect on students. In contrast, very few studies reported a lack of effect. Web-based instruction applied in science courses was generally found to be more effective than traditional science curricula (Can, 2008; Biber Köse, 2009; Karacak Deren & Altıparmak, 2010; Karagöz, 2010; Ballıel, 2014; Durak Men, 2018)

Recommendations

1. Only studies conducted in Turkey were included in this meta-synthesis study. The scope of this study could be expanded with international studies on web-based instruction in science education.
2. As the number of qualitative studies on web-based instruction in science education increases, the results of the present study could be compared with those new results and further studies on this topic could be conducted in the future.
3. In this meta-synthesis study, studies conducted with elementary and middle school students were evaluated. By including studies conducted with high school and university students, the broader general trends in web-based instruction in science education can be identified. The results obtained in future studies encompassing more diverse age groups would be helpful in building upon the results of the present study.

Ethics and Consent: Ethics committee approval for this study was received from the Ethics Committee of Kocaeli University-(Date:26/6/2024; Decision Number:2024/10, Number: E-20189260-050.04-614027).

REFERENCES

Ahi, B. & Kıldan, A. O. (2013). Investigation of Postgraduate Theses in the Field of Preschool Education in Turkey (2002-2011). *Mehmet Akif Ersoy University Journal of Faculty of Education, 1*(27), 23-46.

Ahmed, A., & Williams, H. (1997). Numeracy Project: A Catalyst for Teacher Development and Teachers Researching. *Teacher Development, 1*(3), 357-374.

Akgündüz, D. (2013). The Effect of Blended Learning in Science Education and social media Supported Learning on Students' Achievement, Motivation, Attitude and Self-Learning Skills. *Doctoral Dissertation*, Marmara University, Turkey.

Aktaş, M. (2013). The Effect of Web Based Distance Education on Students' Academic Achievement and Attitudes in Science and Technology Course. *Unpublished Master's Thesis*, Bülent Ecevit University, Zonguldak.

Aktay, S. (2015). Web-Based Portfolio (Webfolio) Application in Primary Education. *Doctoral Dissertation*, Anadolu University, Turkey.

Altıparmak, M., & Deren, Ş. (2010). Technology Supported Collaborative Group Research Methods Based on Constructivist Approach in Science Teaching. *Turkish Journal of Educational Sciences, 8*(3), 697-717.

Aslan, S. S., & Aybek, B. (2018). Investigation of Primary School Fourth Grade Students' Perceptions of Tolerance Value: A Phenomenological Study. *Journal of National Education, 47*(217), 97-110.

Aydın, İ. E., Kaya, S., İşkol, S., & İşcan, A. (2019). Content Analysis of Master's and Doctoral Theses Published in Anadolu University Distance Education Department. *Journal of Higher Education and Science*, *3*, 430-441.

Bacanak, A. (2008). Investigation of the Effectiveness of the Web-Based Program Created for Science and Technology Course Performance Evaluation Forms. *Doctoral thesis*, Institute of Science and Technology, Karadeniz Technical University, Trabzon, 2008.

Baki, A. & Gökçek, T. (2012). An Overview of Mixed Method Research. *Electronic Journal of Social Sciences, 11*(42), 1-21.

Ballıel, B. (2014). The Effect of Webquest Supported Cooperative Learning Approach on Learning Products. *Unpublished master thesis.* Gazi University Institute of Educational Sciences*:* Ankara.

Başaran, M., Ülger, I. G., Demirtaş, M., Kara, E., Geyik, C., & Vural, Ö. F. (2021). Investigation of Teachers' Technology Use in Distance Education Process. *OPUS International Journal of Society Research, 17*(37), 4619- 4645.

Bayrak, B. (2011). The Effect of Science and Technology Teaching Supported by Problem-Based Instruction in Web Environment on Eighth Grade Students' Academic Achievement, Conceptual Understanding and Scientific Process Skills: Acid Base Issue. *Doctoral Dissertation*, Marmara University, Turkey.

Can, Ş. (2008). Web Based İnstruction in Science Teaching. *Master thesis*, Celal Bayar University, Manisa.

Creswell, J.W. (2013). *Qualitative Research Methods (Trans. Ed.: Whole, M., & Demir, S.B.).* Ankara: Political Publications Distribution.

Çataloğlu, E., & Ateşkan, A. (2014). Exemplifying the Use of QR (Quick Response) Code in Education and Training. *Ilkogretim Online*, *13*(1), 5-14.

Çelik, Ö. (2017). Evaluation of Secondary School Science Course Sixth Grade Curriculum in Terms of the Theme of Systems in Our Body: The Case of Konya City Center. *Doctoral Dissertation*, Necmettin Erbakan University, Turkey.

Çetin, O., & Günay, Y. (2010). The Effect of Web-Based Instruction in Science Education on Students' Academic Achievement and Attitudes. *Çukurova University Journal of Faculty of Education, 3*(38), 19-34.

Dağ, F. & Kırıkkaya, E. B. (2012). Preparation of Eighth Grade Web-Based Teaching Material for Natural Processes Unit: Opinions of Different Field Experts about the Material. *Education Sciences, 7*(1), 212-229.

Dewitt-Brinks, D., & Rhodes, S. C. (1992). *Listening Instruction: A Qualitative Meta analysis of Twenty-Four Selected Studies (ED351721).* ERIC. https://files.eric.ed.gov/fulltext/ED351721.pdf

Durak Men, D. (2018). The Effect of Web-Based Instruction on Science Achievement and Attitude Towards Science Lesson: A Metaanalysis Study. *Master's Thesis*, Cumhuriyet University Institute of Educational Sciences, Sivas.

Durmuş, S., & Karakırık, E. (2005). A Computer Assessment Tool for a Structural Communication Grid. *Turkish Online Journal of Educational Technology/ TOJET, 4*(4), 3-6.

Dönmez, İ., & Gülen, S. (2021). Current Research Trends in Science Education in Turkey: An Examination of 2020 Graduate Theses. *Journal of Ahi Evran University Kırşehir Faculty of Education, 22*(3), 1884-1924.

Ekemen, M.(2022). Social Media Supported Science Enriched with Web 2.0 Tools Instruction on 6th Grade Students' Social Media Use, Digital Effects on Literacy Levels and Critical Thinking Skills Review. *Master's Thesis*, Marmara University, Educational Sciences Institute, Istanbul, 743028.

Erdoğan, A. (2022). Evaluation of a Training for Using Web 2.0 Tools in the Teaching Process of Pre-service Science Teachers. Tools in the Teaching Process to Prospective Science Teachers. *Master Thesis*, Recep Tayyip Erdoğan University, Institute of Science and Technology, Rize, 725541.

Glesne, C. (2013). *Introduction to Qualitative Research (Trans. Ed.: Ersoy, A., & Yalcinoglu, P.).* Ankara: Anı Publishing.

Greene, J. C. (2007). *Mixed Methods in Social Inquiry*. Jossey-Bass, San Francisco, CA.

Gül, R. (2022). The Effect of Online Education Supported by Web 2.0 Tools on the Conceptual Achievement, Attitudes and SelfRegulation Perceptions of 5th Grade Middle School Students in the Sun, Earth and Moon Unit. *Master Thesis.* Yıldız Technical University, Institute of Science and Technology, Istanbul, 722173.

Gümüş, S. (2018). Systematic Review of Qualitative Research: Meta synthesis. In *Research in Educational Administration (pp. 533-550),* Ankara: Pegem A.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm whose Time Has Come. *Educational Researcher, 33*(7), 14-26.

Kaçaroğlu, A. (2022). A Content Analysis of Master's Theses in the Field of Education During the COVID-19 Pandemic (2020-2021). *Master Thesis*. Pamukkale University, Denizli.

Karagöz, F. (2010). The Effectiveness of Web Assisted Instruction Method in Elementary Science and Technology Course. *Master's Thesis*, Eskişehir Osmangazi University, Institute of Educational Sciences.

Karaman, S. (2007). Course Web Pages: Characteristics, Preparation, Use and Attitudes of Instructors. *Journal of Inonu University Faculty of Education, 7*(13), 47-68.

Karataş, Z. (2017). Paradigm Shift in Social Science Research: The Rise of Qualitative Approach. *Turkish Journal of Social Work Research, 1*(1), 68-86.

Khalifa, M., & Lam, R. (2002). Web-based learning: Effects on learning process and outcome. *IEEE Transactions on Education, 45*(4), 350-356.

Kıral, B. (2020). Document Analysis as a Qualitative Data Analysis Method. *Siirt University Journal of Institute of Social Sciences, 8*(15), 170-189.

Koran, Ç. (2022). Meta-Synthesis of Design-Based Learning Studies in Turkey. *Master's Thesis*, Atatürk University, Institute of Educational Sciences, Erzurum, 748737.

Koruk, S. Ş. (2021). Investigation of the Effect of the Topic of Cell Divisions Integrated with Computational Thinking Skills in an Online Learning Environment on the Computational Thinking Skills, Creativity and Academic Achievement of Middle School 7th grade students (*Doctoral Dissertation*, Marmara University (Turkey)).

Koyuncu, İ. (2022). Research on Culture in Turkish as a Second/Foreign Language Textbooks: A Meta-Synthesis Study. *Master's Thesis.* Hacettepe University, Ankara.

Köse Biber, S. (2009). The Effect of Web Supported Science Teaching on the Performance Level and Academic Achievement of Primary School seventh Grade Students in Inclusive Education *(Master's Thesis*, Graduate School of Science and Technology).

Köse, M. (2022). Evaluation of Analogies in Science Textbooks. *Cumhuriyet International Journal of Education, 11*(1), 112-126.

Küçük, A., & Küçük, M., (2021). A Descriptive Content Analysis of COVID-19 Outbreak Research on Pre-School Education in Turkey. In *IV. International COVID-19 and Current Issues Congress (ss. 93-104)*. İstanbul, Türkiye.

Küçüközer, A. (2016). An Overview of Doctoral Theses in the Field of Science Education. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 10*(1), https://doi.org/10.17522/nefefmed.54132

Melis, E., Andres, E., Budenbender, J., Frischauf, A., Goduadze, G., Libbrecht, P., ... & Ullrich, C. (2001). ActiveMath: A generic and adaptive web-based learning environment. *International Journal of Artificial Intelligence in Education (IJAIED), 12*, 385-407.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook. (2nd ed.).* Sage Publications Inc.

Oral, B., & Kenanoğlu, R. (2012). The Effect of Web-Based Distance Education Systems on Student Achievement and Attitudes Towards Computers. *Electronic Journal of Educational Sciences, 1*(2), 58-67.

Özdemir, A., Tanoba, T., Karaokur, Ş., & Tonyalı, Ö. (2021). Typological and Methodological Trends in Mixed Method Theses in Educational Sciences in Turkey. *Marmara University Atatürk Faculty of Education Journal of Educational Sciences, 54(*54), 23-53.

Özgen, Y. (2017). The Effect of Web Supported Instruction in Plant and Animal Reproduction, Growth and Development Unit on 6th Grade Students' Academic Achievement, Remembrance and Attitudes Towards Science (*Doctoral Dissertation*, Marmara University (Turkey)).

Polat, S., & Ay, O. (2016). Meta-synthesis: A conceptual analysis. *Journal of Qualitative Research in Education, 4*(2), 52-64.

Pürbudak, A. (2020). Experimental Investigation of Web 2.0 Based Collaborative Group Activities in the Context of Learning Styles. *Unpublished Master's Thesis*. Necmettin Erbakan University, Konya.

Sevim, S., & Ayvacı, H. Ş. (2016). The Effect of Web-Based Instruction on Science and Technology Course. *Bayburt Education Faculty Journal, 7*(2), 1-19.

Şendağ, S., & Gündüz, Ş. (2007). Prospective Teachers' Web-Based Learning Opinions on the Usability and Effectiveness of the Material. Mehmet Akif Ersoy University Journal of Faculty of Education, 8(14),137-149.

Tarman, B., Acun, İ., & Yüksel, Z. (2010). Theses in the Field of Social Studies Education Evaluation. *Gaziantep University-Journal of Social Sciences, 9*(3), 725-746.

Taşkıran, Y., Sertbaş, K., Gönener, A., & Atalı, L. (2003). Investigation of Computer Use Status of Kocaeli University School of Physical Education and Sports Students. *Spormetre Journal of Physical Education and Sport Sciences*, 2(1), 129-132.

Taş, E. (2006). Developing, İmplementing and Evaluating of a Web Designed Science Material. *Unpublished Doctoral Thesis*, Karadeniz Technical University, Trabzon.

Thomas, J., & Harden, A. (2008). Methods for the Thematic Synthesis of Qualitative Research in Systematic Reviews. *BMC Medical Research Methodology, 8*(1), 1- 10.

Toraman, S. (2021). Mixed Methods Research: Short History, Definition, Perspectives and Basic Concepts/Mixed Methods Research: A Brief History, Definitions, Perspectives, and Key Elements. *Qualitative Social Sciences, 3*(1), 1-29.

Türnüklü, A. (2000). A Qualitative Research Technique that can be Used Effectively in Educational Science Research: Interview. *Educational Administration in Theory and Practice, 24*(24), 543-559.

Uzunboylu, H. (2004). *The effectiveness of web-assisted English language teaching on students' achievement and attitude (pp. 727-733).* Association for the Advancement of Computers in Education (AACE).

Ültay, N., & Çalık, M. (2012). A Thematic Review of Studies on the Effectiveness of Context-Based Chemistry Curricula. *Journal of Science Education and Technology, 21,* 686-701.

Wach, E., & Ward, R. (2013). Learning About Qualitative Document Analysis. IDS Practice Paper in Brief, ILT Brief 13 August 2013.

Weed, M. (2005). "Meta Interpretation": A Method for the Interpretive Synthesis of Qualitative Research. In *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, *6*(1). https://doi.org/10.17169/fqs-6.1.508

Yapıcı, B. (2019). The Effect of Educational Informatics Network on Students' Academic Success in the Teaching of Living Things and Energy Relationships Unit (*Master's Thesis*, Graduate School of Natural and Applied Sciences).

Yaylacı, Z., & Büyükalan, S. (2020). Thematic Analysis of Theses Referred to Teacher Opinion in Social Studies Education (2005-2017). *Abant İzzet Baysal University Journal of Faculty of Education, 20*(1), 1-19.

Yıldırım, A., & Şimşek, H. (2011). *Qualitative Research Methods in Social Sciences*. Seçkin Publishing, Ankara, 446.

Yurdabakan, İ. (2011). View of Constructivist Theory on Assessment: Alternative Assessment Methods in Education. *Ankara University Journal of Faculty of Educational Sciences (JFES), 44*(1), 51-78.