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Bilimsel Muhakeme Becerileri ile İlgili Ulusal Lisansüstü Tezlerin Tematik İçerik Analizi[1]

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ÖZET

Bilimsel muhakeme becerileri hakkında yapılan çalışmaların derinlemesine incelenmesinin ve bu incelemeler sonucunda yol gösterici bir haritanın oluşturulmasının gerekliliği düşünülmektedir. Bu çalışmada, bilimsel muhakeme becerisi ile ilgili ulusal lisansüstü tezler incelenerek genel bir çerçeve oluşturulması amaçlanmıştır. Araştırmanın örneklemini Yükseköğretim Kurulu (YÖK) Ulusal Tez Merkezi veri tabanından erişilebilen Türkiye genelindeki 74 ulusal lisansüstü tez oluşturmaktadır. Bu tezler, nitel araştırma yöntemlerinden tematik içerik analizi kullanılarak analiz edilmiştir. İncelenen ulusal lisansüstü tezler 13 tema altında analiz edilmiştir: "yıl", "tez türü", "eğitim alanı", "araştırma tasarımı/yöntem modeli", "deneysel araştırma türü", "öğrenme yöntemi", "örneklem türü", "örneklem büyüklüğü", "veri toplama yöntemleri/araçları", "veri analiz tekniği", "araştırmaya dâhil edilen bilimsel muhakeme becerileri", "sonuçlar" ve "öneriler". Bulgular, tezlerin çoğunun 2019 yılında yazıldığını ortaya koymuştur. Tez türlerinin çoğunluğu yüksek lisans tezi, eğitim alanlarının en sık matematik eğitimi olduğu görülmüştür. En sık araştırma tasarımı/yöntem modeli deneysel, en sık yarı deneysel tasarım ise deneysel araştırma türüdür. Ortaokul öğrencileri en sık kullanılan örneklem türüydü ve örneklem büyüklükleri çoğunlukla 0-25 arasındadır. Testler en sık kullanılan veri toplama yöntemleri/araçlarıydı ve geçerlilik en çok kullanılan veri analiz tekniğiydi. Argümantasyona dayalı öğrenme en çok tercih edilen öğrenme yöntemiydi. Araştırmada en sık ele alınan bilimsel muhakeme becerisi, özellikle matematiksel muhakeme becerilerine odaklanan matematiksel muhakemedir. Sonuçlar ve tartışmalar, öğrencilerin bilimsel muhakeme becerilerindeki gelişmeleri sıklıkla vurguladı. Önerilerde, araştırmacılara genellikle bilimsel muhakeme becerilerini geliştirmeyi amaçlayan uygulamalar geliştirmeleri tavsiye edilmektedir.

Anahtar Kelimeler: Bilimsel Muhakeme Becerileri, Tematik Analiz, Ulusal Lisansüstü Tezler

Etik Kurul İzni Tarih / Sayı: Bu çalışma yazar tarafından etik kurul onayı gerektirmeyen bir çalışma olarak beyan edilmiştir.

UZUN ÖZET

Amaç ve Önem

Bilimsel muhakeme becerileri, uluslararası eğitim alanında yaygın olarak karşılaşılan önemli bir konu olarak kabul edilmektedir (Abate ve diğerleri, 2024; Getahun, 2023; Krell ve diğerleri, 2020; Osborne, 2013). İlgili ulusal alanyazın incelendiğinde fen eğitiminde bilimsel muhakeme becerileri ile ilgili yapılan çalışmaların az sayıda ve amaçlarının ise muhakeme becerilerinin tespit edilmesi ve geliştirilmesi yönünde gerçekleştirildiği görülmüştür (Aydın ve Kaptan, 2014; Ceylan ve Bozkurt, 2017; Doğru Oral ve Bozkurt, 2021; Fettahlıoğlu, 2018; Gökçe ve Saraçoğlu, 2018; Kara ve Kefeli, 2018; Kocagül Sağlam ve Ünal Çoban, 2020; Kocagül ve Ünal Çoban 2022a, 2022b, 2023; Özdeniz ve diğerleri, 2023; Polat ve Emre, 2020; Sert Çıbık ve Emrahoğlu, 2008; Şaşmaz Ören ve Tezcan, 2008; Yaman, 2005; Yüksel, 2019;

[1] Bu çalışma, birinci yazarın ikinci yazar danışmanlığında yürüttüğü "Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin tematik içerik analizi" başlıklı yüksek lisans tezinden üretilmiştir.

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Yüksel ve Ateş, 2017; Yüksel ve Ateş, 2019; Yüzüak ve Dökme, 2019). Bu alana gösterilen ilginin artışı göz önüne alındığında, bu çalışmanın bulguları araştırmacılar ve eğitimciler açısından karşılaştırmalı analizlere ve uluslararası düzeyde yapılacak tartışmalara değerli bir katkı sunabilir. Ayrıca bu çalışma, Türkiye'deki bilimsel muhakeme araştırmalarını derinlemesine analiz ederek uluslararası literatürde görece eksik olan bölgesel bağlamlara ışık tutmayı amaçlamaktadır. Dolayısıyla taşıdığı önem kapsamında, bilimsel muhakeme becerileri hakkında yapılan çalışmaların derinlemesine incelenmesinin ve bu incelemeler sonucunda yol gösterici bir haritanın oluşturulmasının gerekliliği düşünülmektedir. Bu doğrultuda gerçekleştirilen bu çalışmada "Bilimsel Muhakeme Becerileri" içeriğini sunan ulusal lisansüstü tezlerin güncel bir bakış açısı ile değerlendirilmesi yapılarak var olan araştırmaların tek bir kaynak altında toplanması sağlanmıştır. Ayrıca bu çalışmada amaçların ortaya konması için tematik içerik analizi yöntemi kullanılmış ve bu sayede yapılan çalışmaların kapsam çeşitliliğinin artması, yeni ölçeklerin ve alternatif değerlendirme araçlarının tasarlanması, program, ders kitapları ve etkinliklerde dolaylı olarak değil doğrudan bilimsel muhakeme becerilerine vurgu yapılmasının sağlanması hedeflenmiştir. Bu araştırmanın amacı, bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin tematik içerik analizi yoluyla incelenmesidir. Bu doğrultuda gerçekleştirilen bu çalışmada bilimsel muhakeme becerileri ile ilgili yazılmış ulusal lisansüstü tezlerin incelemesinde aşağıda verilen araştırma soruları ele alınmıştır:

- Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin yıl, tez türü ve eğitim alanlarına göre dağılımı nasıldır?
- Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin araştırma desen/yöntem modeli, deneysel araştırma türü, örneklem türü, örneklem büyüklüğü, veri toplama yöntemi/aracı, veri analiz tekniklerine göre dağılımı nasıldır?
- Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü öğrenme yöntemi ve araştırmaya dahil edilen bilimsel muhakeme becerilerine göre dağılımı nasıldır?
- Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin sonuç ve tartışma ve önerilerine göre dağılımı nasıldır?

Yöntem

Bu araştırmada nitel araştırma yaklaşımı olan tematik analiz yöntemi kullanılmıştır. Araştırmada tezlere YÖK Ulusal Tez Merkezi veri tabanı aracılığıyla ulaşılmıştır. "Bilimsel muhakeme becerileri", "bilimsel muhakeme", "muhakeme becerileri", "muhakeme yeteneği", "orantısal düşünme becerileri", "nedensel muhakeme", "korelasyonel düşünme", "olasılıklı düşünme", "orantısal düşünme" ve "ilişkisel düşünme" arama kelimeleri tercih edilmiştir. Araştırmada 74 lisansüstü tezi üzerinde inceleme yapılmıştır. Tematik içerik analizi yapılmak üzere bazı ölçütlere karar verilmiştir. Bu ölçütler "yıl", "tez türü", "eğitim alanı", "araştırmanın desen/yöntemi", "deneysel araştırma türü", "öğrenme yöntemleri", "örneklem türü", "örneklem sayısı", "veri toplama yöntemleri/araçları", "verilerin analizi", "araştırmaya dâhil edilen bilimsel muhakeme becerileri", "sonuç-tartışma" ve "öneriler" olmak üzere 14 tanedir. Temalar uzman görüşüne sunulmuştur. Temaların belirlenmesinde iki uzman (Fen Eğitimi Alanında Öğretim Üyesi) görüşü alınmıştır. Uzman görüşlerinde uyuşmayan kısımlar tespit edilmiş ve ortak karara başvurularak tutarlılık sağlanmıştır.

Sonuç ve Tarıtşma

Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin yıllara göre dağılımı incelendiğinde, ilk tez çalışmasının 2007 yılında yapıldığı ve en fazla tezin ise 2019 yılında yazıldığı elde edilmiştir. Bunun sebebi Türkiye'de 2018 yılında fen öğretim programında değişikliklere gidilmiş olması, farklı tema ve becerilerin müfredata dâhil edilmiş olması olabilir (MEB, 2018). Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin tez türüne göre dağılımı incelendiğinde 49 çalışmanın yüksek lisans, 25 çalışmanın ise doktora düzeyinde olduğu tespit edilmiştir. YÖK ulusal tez merkezinde yer alan yüksek lisans tezleri doktora tezlerine göre daha fazladır (Yükseköğretim Kurulu Başkanlığı [YÖK] Ulusal Tez Merkezi, 2024). Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin eğitim alanına göre dağılımı incelendiğinde matematik eğitimi alanında yapılan çalışma sayısının en fazla olduğu, onu takip eden eğitim alanının ise fen bilgisi eğitimi olduğu elde edilmiştir. Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin araştırma desen/yöntem modeline göre dağılımı incelendiğinde en fazla kullanılan araştırma desen/yöntem modelinin deneysel olduğu, onu takip eden araştırma desen/yöntem modellerinin sırasıyla tarama, durum, karma ve ilişkisel olduğu sonucuna ulaşılmıştır. Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin örneklem türüne göre dağılımı incelendiğinde en fazla çalışmanın ortaokul öğrencileri ile yapıldığı tespit edilmiştir. Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin örneklem büyüklüğüne göre dağılımı incelendiğinde en fazla çalışmanın 0-25 kişi aralığında, ikinci en fazla çalışmanın 51-75 kişi aralığında yapıldığı elde edilmiştir. Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin veri toplama yöntemlerine/araçlarına göre dağılımı incelendiğinde en fazla kullanılan test, en az ise anket olduğu tespit edilmiştir. Daha sonra sırasıyla doküman, görüşme/mülakat, gözlem ve ölçek kullanıldığı görülmüştür. Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin veri analiz tekniğine göre dağılımı incelendiğinde en fazla kullanılan veri analiz tekniğinin geçerlik ve güvenirlik olduğu daha sonra ise betimsel istatistik ve normallik testlerinin kullanıldığı elde edilmiştir. Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin öğrenme yöntemlerine göre dağılımı incelendiğinde 29 farklı

öğrenme yönteminin kullanıldığı ve en fazla argümantasyona dayalı öğrenme yönteminin kullanıldığı tespit edilmiştir. Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin araştırmaya dâhil edilen bilimsel muhakeme becerilerine göre dağılımı incelendiğinde sırasıyla en fazla matematiksel muhakeme becerileri ve Lawson bilimsel muhakeme becerilerinin tercih edildiği elde edilmiştir. Daha sonra sırasıyla informal muhakeme becerileri, Lohman ve Hagen bilimsel muhakeme becerileri ve sözel muhakeme becerilerinin kullanıldığı tespit edilmiştir. Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin sonuç ve tartışmalarına göre dağılımı incelendiğinde en fazla ulaşılan sonuç ve tartışma öğrencilere yönelik temasındaki "bilimsel muhakeme becerilerinin geliştiği" olmuştur. Bilimsel muhakeme becerileri ile ilgili ulusal lisansüstü tezlerin önerilerine göre dağılımı incelendiğinde en fazla öneri araştırmacılara yönelik temasındaki "bilimsel muhakeme becerilerini geliştirmeye yönelik uygulamaların hazırlanması" olmuştur.

Thematic Content Analysis of National Postgraduate theses on Scientific Reasoning Skills[1]

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ABSTRACT

Given its importance, there is a perceived necessity to conduct an in-depth examination of studies on scientific reasoning skills and to create a guided map based on these examinations. This study aims to establish a general framework by examining national postgraduate theses related to scientific reasoning skills, revealing their current state, and updating any hidden or misunderstood skills. The research sample includes 74 national postgraduate theses from Türkiye, which are accessible through the National Thesis Center database of the Council of Higher Education (CoHE). These theses were analyzed in-depth using thematic content analysis, a qualitative research method. The examined national postgraduate theses were analyzed across 13 themes: "year", "thesis type", "field of education", "research design/method model", "type of experimental research", "learning method", "sample type", "sample size", "data collection methods/tools", "data analysis technique", "scientific reasoning skills included in the research", "results" and discussions", and "recommendations". The findings revealed that most of these were written in 2019. The predominant thesis type was a master's thesis, and the most common field of education was mathematics education. The most frequent research design/method model was experimental, with quasi-experimental design being the most common type of experimental research. Middle school students were the most frequent sample type, with sample sizes most commonly ranging from 0-25. Tests were the most frequently used data collection methods/tools, and validity was the most employed data analysis technique. Argumentation-based learning was the preferred learning method. The most addressed scientific reasoning skill in the research was mathematical reasoning, specifically focused on mathematical reasoning skills. The results and discussions frequently highlighted improvements in students' scientific reasoning skills. The recommendations often advised researchers to develop applications aimed at enhancing scientific reasoning skills.

Keywords: National Graduate Theses, Scientific Reasoning Skills, Thematic Content Analysis

Ethical Committee Date / Number: This study was declared by the author as a study that does not require ethics committee approval.

1. Introduction

The word "reasoning" means making impartial decisions by considering the existing information (Erdem, 2011). Altıparmak and Öziş (2005) define reasoning, a fundamental ability, as the process of drawing conclusions from judgments, facts, or propositions. This process involves examining events comprehensively, generating various options, and making decisions based on logical evaluation (Hardman & Macchi, 2003). To logically assess the current situation, it is crucial to question it with an understanding of "what and why did I do" in terms of cause and effect (Öz & Işık, 2017). In this context, Zimmerman (2000) refers to the skills used in the inquiry process as reasoning skills. Reasoning is the process of "seeking a way to solve a problem (Türk Dil Kurumu (Turkish Language Society) [TDK], 2024)." Therefore, reasoning skills can also be referred to as scientific reasoning skills.

Scientific reasoning skills are recognized as "a tool for engaging in discussions aimed at drawing logical conclusions" (Sperber, 2000) and as "mental skills that enhance students' capacity for critical thinking" (Dökme, 2019). In essence, they denote the abilities required to solve problems scientifically and to express students' inquiries accordingly (Bruckermann et al., 2022; Hadi et al., 2021; Reith & Nehring, 2020; Wulandari et al., 2025). Researchers have articulated the attributes of scientific reasoning skills through diverse perspectives in their studies, resulting in various categorizations (Kocagül Sağlam, 2019). Various researchers have developed different classifications of scientific reasoning skills (Figure 1).

[1] This study was derived from the master's thesis entitled "Thematic content analysis of national graduate thesis related to scientific reasoning skills", conducted by the first author under the supervision of the second authors.

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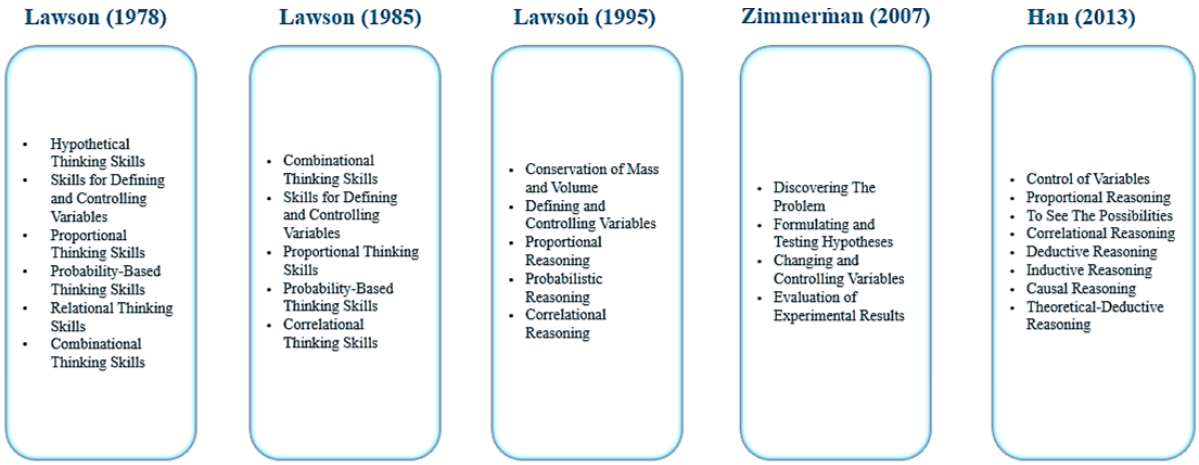


Figure 1. Classifications of scientific reasoning skills

From 1978 to 2013, these skills represent essential and tangible components of broadly defined scientific reasoning abilities. Lawson's studies (1978, 1985, 1995) emphasize cognitive development through reasoning types such as hypothetical, proportional, and correlational thinking, with a gradual expansion to include conservation principles. Zimmerman (2007) focuses on the procedural and metacognitive aspects of scientific reasoning, including hypothesis testing, variable control, and evaluation of results. Han (2013) integrates both cognitive and logical reasoning processes—such as inductive, deductive, and causal reasoning—highlighting the complexity and interconnection of these skills in scientific inquiry. Zimmerman (2007) and Han (2013) have delineated the current dimensions of skills assessed by Lawson. There are also scientific reasoning skills classified with different sub-dimensions in the literature. Lohman and Hagen (2003) formed these skills from three sub-components: numerical, which refers to understanding the relationships between numbers and solving patterns; verbal, which refers to drawing conclusions and establishing relationships between concepts; and spatial reasoning, which refers to visualizing and analyzing the direction, location, and relationships of shapes. Ateş (2019) mentioned four sub-components: abductive, which is to suggest a possible cause based on observation, inductive, which is to reach a general conclusion from specific observations, deductive, which is to deduce a special case from a general rule, and deductive and inductive reasoning, which is to use deduction and induction together. These skills encompass reasoning abilities such as hypothetical, proportional, probabilistic, correlational, inductive, and deductive thinking, as well as the control of variables, understanding of conservation principles, and combinational reasoning—all fundamental to scientific inquiry and problem-solving (Dökme, 2019).

Science education programs published between 2018 and TCEM (Türkiye Century Education Model) have emphasized the cultivation of life skills such as problem-solving, analytical thinking, creative thinking, critical thinking, and decision-making (Kartal & Öztürk, 2023). When reviewing pertinent studies, it becomes clear that scientific reasoning skills are pivotal to the core objectives of science education. Science courses serve as crucial platforms for developing these skills (Diola et al., 2025; Rantong & Sarnkong, 2025; Varlı, 2018). Consequently, in science instruction, there is an emphasis on processes that involve structuring knowledge and applying reasoning through activities such as research, inquiry, and exploration. Laboratory practices are particularly conducive to exploring socio-scientific issues, interdisciplinary concepts, projects, and designs (Baba, Zorlu & Zorlu, 2022; Dinç Bilgin & Zorlu, 2023; Özdeniz, 2021; Zorlu & Sezek, 2019, 2020; Zorlu & Zorlu, 2022). The 2018 Science Curriculum also advocates for a research and inquiry-based learning approach with an interdisciplinary focus. The curriculum's specific goals emphasize adopting a scientific research methodology, understanding the creation and evolution of scientific knowledge, and its application in new research. Socioscientific issues are used to enhance reasoning abilities, foster scientific thinking habits, and develop decision-making skills (MoNE, 2018). However, the curriculum does not explicitly highlight scientific reasoning skills within the life skills category. This underscores the importance of explicitly incorporating targeted skill instruction to promote awareness and

understanding of expected scientific reasoning abilities (Kocagül Sağlam, 2019). The 2024 The Century of Türkiye Education Model has integrated reasoning skills into its framework of learning outcomes (MoNE, 2024a). These skills are viewed as integral components of broader competencies, encompassing abilities such as inductive, deductive, and analogical reasoning. Specifically within the domain of science, the curriculum emphasizes the development of skills like inductive and deductive reasoning (MoNE, 2024b).

Research based on inquiry-based science education has been observed to enhance scientific reasoning skills (Beck & Blumer, 2012; Benford & Lawson, 2001; Choowong & Worapun, 2021; Erlina et al., 2018; Gerber et al., 2001; Zimbardi et al., 2013). However, upon reviewing relevant national literature, it has been noted that studies focusing on scientific reasoning skills in science education are limited in number, and their objectives mainly revolve around identifying and developing these skills (Aydın & Kaptan, 2014; Ceylan & Bozkurt, 2017; Doğru Oral & Bozkurt, 2021; Fettahlıoğlu, 2018; Gökçe & Saraçoğlu, 2018; Kara & Kefeli, 2018; Kocagül Sağlam & Ünal Çoban, 2020; Kocagül & Ünal Çoban 2022a; Kocagül & Ünal Çoban, 2022b; Özdeniz vd., 2023; Polat & Emre, 2020; Sert Çıbık & Emrahoğlu, 2008; Şaşmaz Ören & Tezcan, 2008; Yaman, 2005; Yüksel, 2019; Yüksel & Ateş, 2017; Yüksel & Ateş, 2019; Yüzüak & Dökme, 2019). Therefore, given its importance, there is a perceived necessity to conduct an in-depth examination of studies on scientific reasoning skills and to create a guiding map based on these examinations. In this study, national postgraduate theses are evaluated to consolidate contemporary research on "Scientific Reasoning Skills" into a comprehensive source. Thematic content analysis was employed to elucidate the objectives and broaden the scope of these studies. In this context, the evaluation of scientific reasoning skills usage and the critical assessment of research outcomes are expected to make a substantial contribution to the relevant literature. Furthermore, this assessment is anticipated to serve as a guiding framework for future studies, offering direction to researchers in the field. Ergün et al. (2023) examined studies focusing on scientific reasoning skills with a similar method. However, this study provided depth analysis by revealing the sub-dimensions of different scientific reasoning skills in detail with the thematic analysis method from qualitative research approaches. Scientific reasoning skills are widely accepted as an important issue encountered in the field of international education (Abate et al., 2024; Getahun, 2023; Krell et al., 2020; Osborne, 2013). Considering the increasing interest in this field, the findings of this study can make a valuable contribution to comparative analyses and international discussions for researchers and educators. In this study, the examination of national postgraduate theses related to scientific reasoning skills addresses the following research questions:

1. What is the distribution of national postgraduate theses related to scientific reasoning skills by year, thesis type, and field of education?

2. What is the distribution of national postgraduate theses related to scientific reasoning skills by research design/method model, type of experimental research, sample type, sample size, data collection method/tool and data analysis technique?

3. What is the distribution of national postgraduate theses related to scientific reasoning skills by learning method and scientific reasoning skills included in the research?

4. What is the distribution of national postgraduate theses related to scientific reasoning skills by results, discussions, and recommendations?

2. Method

2.1. Ethics Committee Approval

The sample of research consists of documents, not humans or living beings. Ethics committee approval is not required for research involving document review.

2.2. Research Design

In the study that investigated national postgraduate theses focusing on scientific reasoning skills, the researchers employed thematic analysis, a qualitative research method. Thematic content analysis aims to enhance comprehension of research conducted within a particular field by conducting detailed examinations within predefined themes and frameworks. This method involves critically evaluating

studies, addressing gaps in the literature, consolidating information from existing studies into a cohesive analysis, and identifying trends based on the findings (Au, 2007; Çalık & Sözbilir, 2014; Doğankollu, 2022). Thematic content analysis was selected for this study to explore the effective utilization of scientific reasoning skills. The data collection and analysis process in the study is structured into three stages (Figure 2). The first stage involves defining the research questions and selecting the relevant graduate theses. The second stage includes reading and analyzing the theses to identify themes and codes. The third stage focuses on presenting the findings and drawing conclusions.

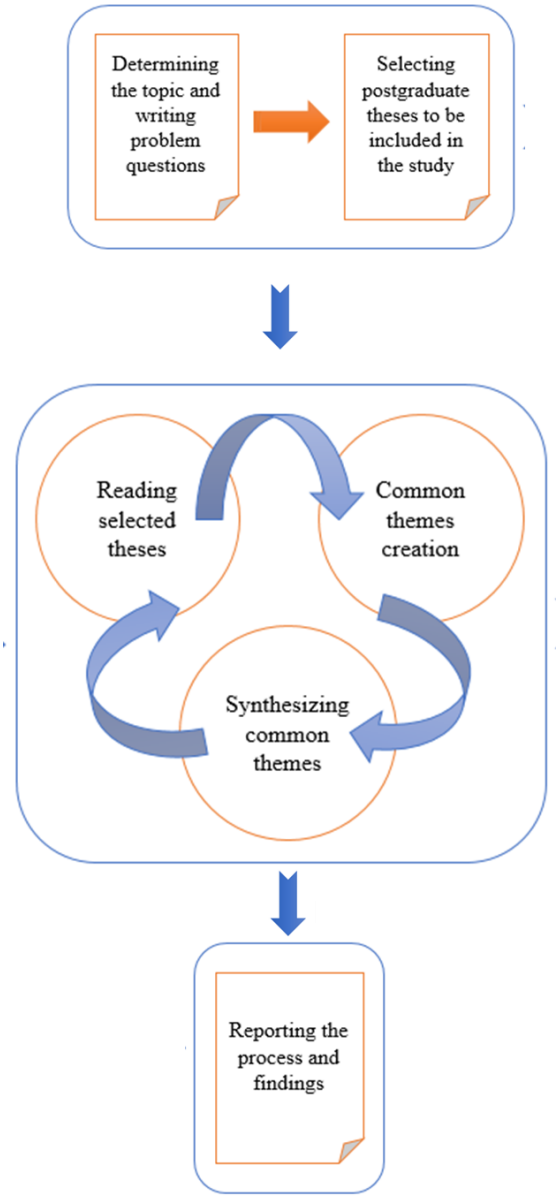


Figure 2. Stages followed in thematic content analysis (Polat & Ay, 2016).

2.3. Data Collection Process

Access to national postgraduate theses focusing on scientific reasoning skills was facilitated through Database of the National Thesis Center of the Council of Higher Education (CoHE). The most recent access date for these theses was 11.11.2023. Theses not aligned with thematic integrity were excluded based on specific search keywords related to scientific reasoning skills (f = 9), scientific reasoning (f = 5), reasoning skills (f = 37), reasoning ability (f = 14), proportional reasoning skills (f = 2), causal reasoning (f = 2), correlational reasoning (f = 1), probabilistic reasoning (f = 2), proportional reasoning (f = 1), and relational reasoning (f = 1). Theses retrieved through these keywords were further validated to ensure relevance to the field of education and teaching. A total of 74 postgraduate theses were thoroughly reviewed.

2.4. Data Analysis

Criteria were established for conducting thematic content analysis, encompassing 14 specific aspects including search keywords, year of publication, thesis type, educational field, research design/methodology, type of experimental research, learning methods, sample type, sample size, data collection methods/tools, data analysis techniques, scientific reasoning skills studied, results-discussion, and recommendations. Data from the reviewed studies were organized and summarized using Microsoft Excel. To establish themes such as "Research Design/Methodology," "Type of Experimental Research," "Learning Methods," "Sample Type," "Sample Size," "Data Collection Methods/Tools," and "Data Analysis," a comprehensive review of various sources was conducted, and a pool was created (Büyüköztürk et al., 2020; Cresswell, 2017; McMillan & Schumacher, 2010; Tanrıöğen, 2021). The theme regarding the "Inclusion of Scientific Reasoning Skills in Research" was derived from multiple sources, and a pool was created (Han, 2013; Lawson, 1978, 1985, 1995; Zimmerman, 2007). Themes related to "Results" and "Recommendations" were formulated based on the analysis of the theses. These themes were presented to experts for their evaluation and feedback. Two experts, both faculty members specializing in Science Education, were consulted to finalize and validate the themes. In the experts' views, inconsistent parts were determined and consistency was ensured by applying a common decision. In order to determine the reliability in determining the themes and codes, the formula "Reliability = Consensus / (Consensus + Disagreement) x 100" was applied (Miles & Huberman, 1994). The similarity between the two coders for two experts was calculated as 1853 / (185 + 1853) × 100 = 90.90%. According to this value, reliability was ensured in determining the themes and codes.

3. Results

3.1. Findings for Research Question "What is the distribution of national postgraduate theses related to scientific reasoning skills by year, thesis type, and field of education?"

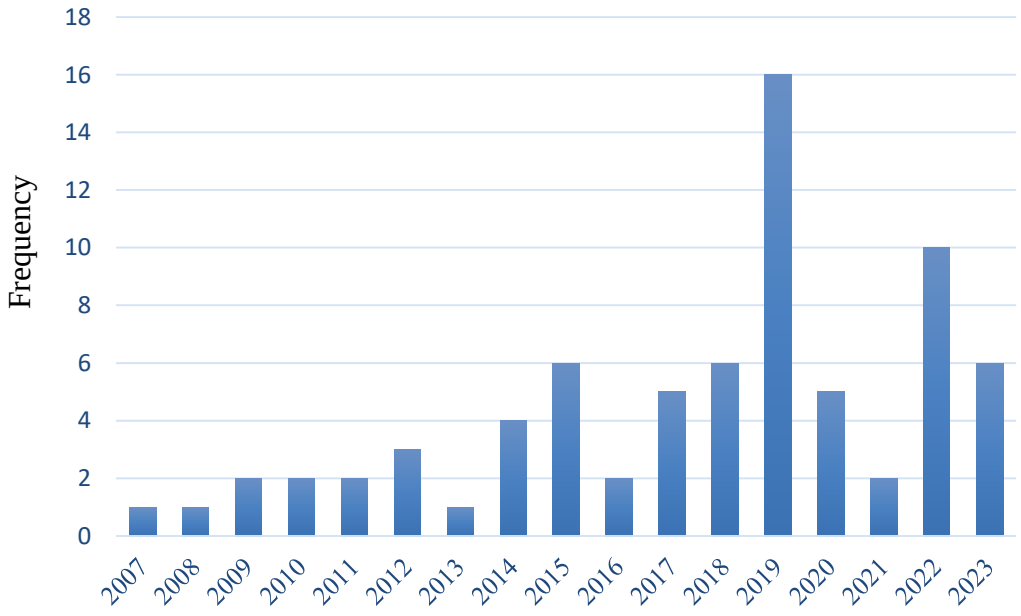


Figure 3. Distribution of theses according to "Publication Year"

When Figure 3 is examined, the highest number of studies were conducted in 2019 (16), while the fewest were conducted in 2007, 2008, and 2013 (1 each).

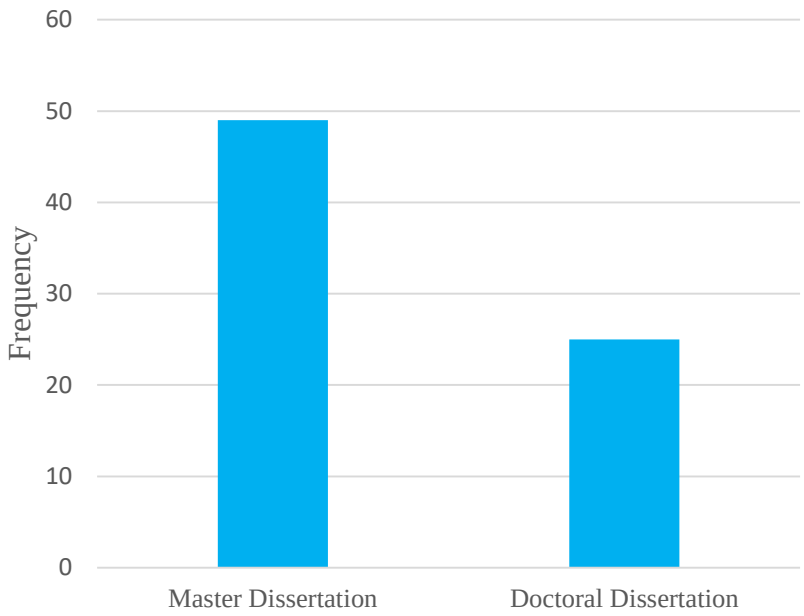


Figure 4. Distribution of theses according to "Publication Type"

When Figure 4 is examined, 49 were master dissertations and 25 were doctoral dissertations.

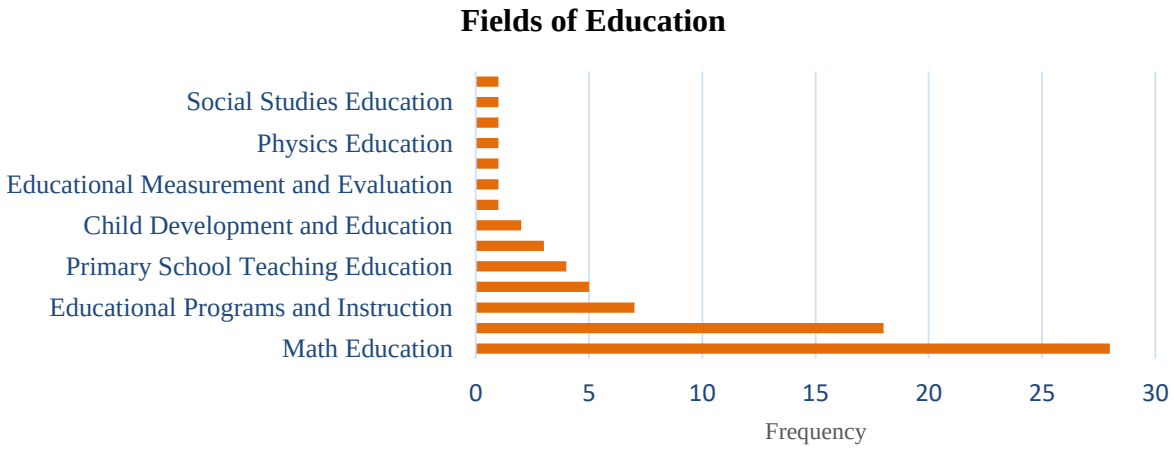


Figure 5. Distribution of theses according to "Fields of Education"

When Figure 5 is examined, within the doctoral dissertations, the highest number were in the field of mathematics education (10), followed by science education (5), educational programs and instruction and primary school teaching education (3 each), preschool education (2), and physics education and social studies education (1 each). The highest number were conducted in mathematics education (28), while the fewest were conducted in biology education, educational measurement and evaluation, educational program development, physics education, special education, social studies education, and Turkish education (1 each).

3.2. Findings for Research Question "What is the distribution of national postgraduate theses related to scientific reasoning skills by research design/method model, type of experimental research, sample type, sample size, data collection method/tool and data analysis technique?"

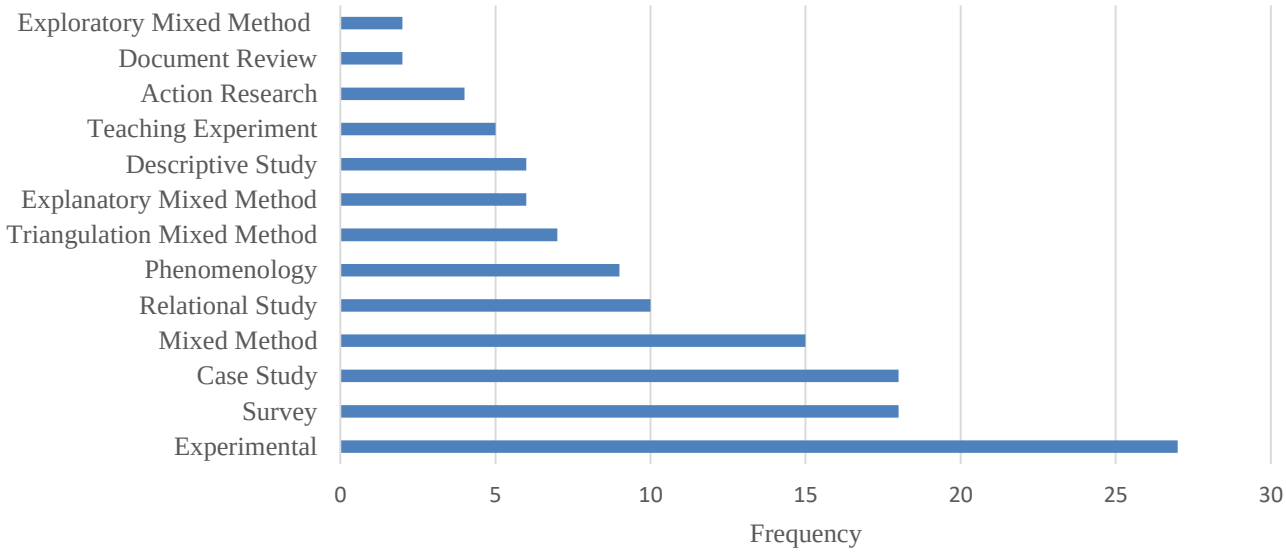


Figure 6. Distribution of theses according to themes "Research Method"

When Figure 6 is examined, the most frequently used method was the experimental method (27), while the least used was the document review and exploratory mixed method (2). Additionally, within the mixed research design/method, the mixed research method was the most utilized (7). The quasi-experimental design was the most used (21), while the true experimental design was the least used (1).

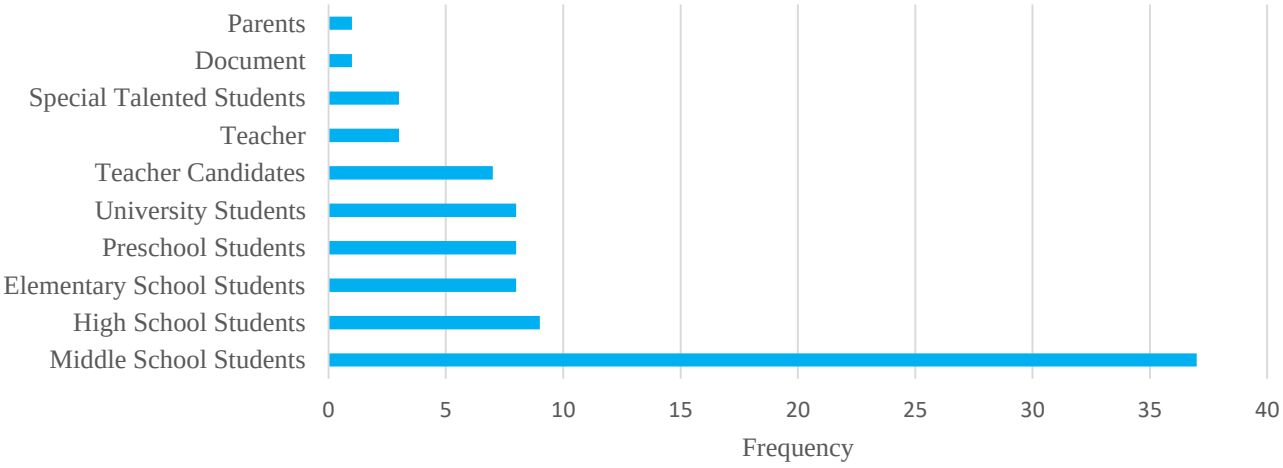


Figure 7. Distribution of theses according to themes "Sample Type"

When Figure 7 is examined, the most frequent sample type was middle school students (37), while the least frequent sample types were parents (1) and documents (1). The discrepancy between the number of studies reviewed and the total frequency arises from the fact that five studies were coded for both elementary and middle school, and another five studies used more than one sample type.

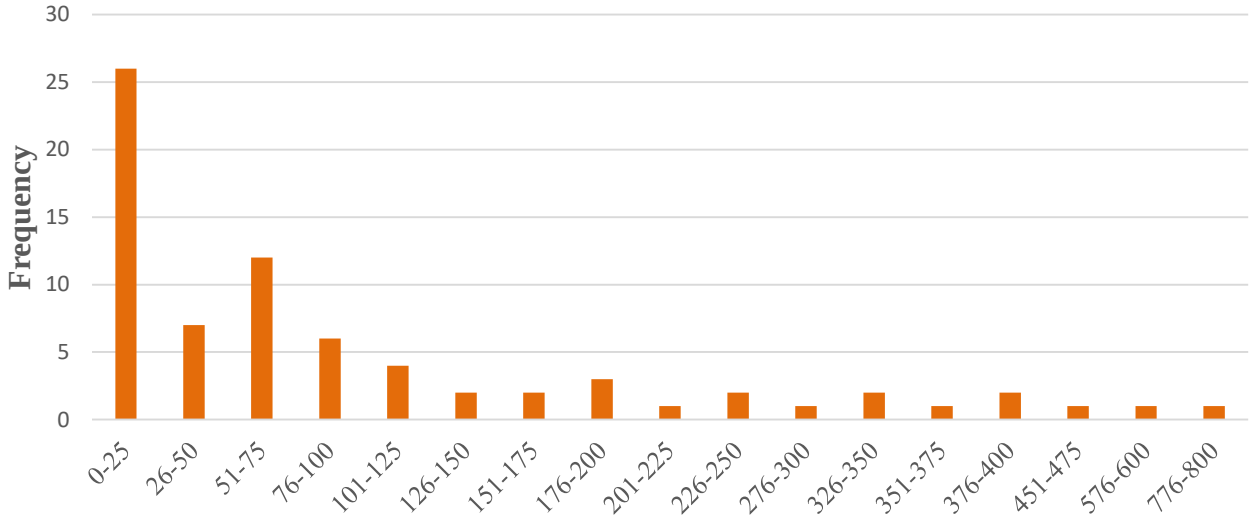


Figure 8. Distribution of theses according to themes "Sample Size"

When Figure 8 is examined, the most frequent sample size was in the range of 0-25 individuals (26), while the least frequent sample sizes were in the ranges of 201-225, 276-300, 351-375, 451-475, 576-600, and 776-800 individuals (1 each).

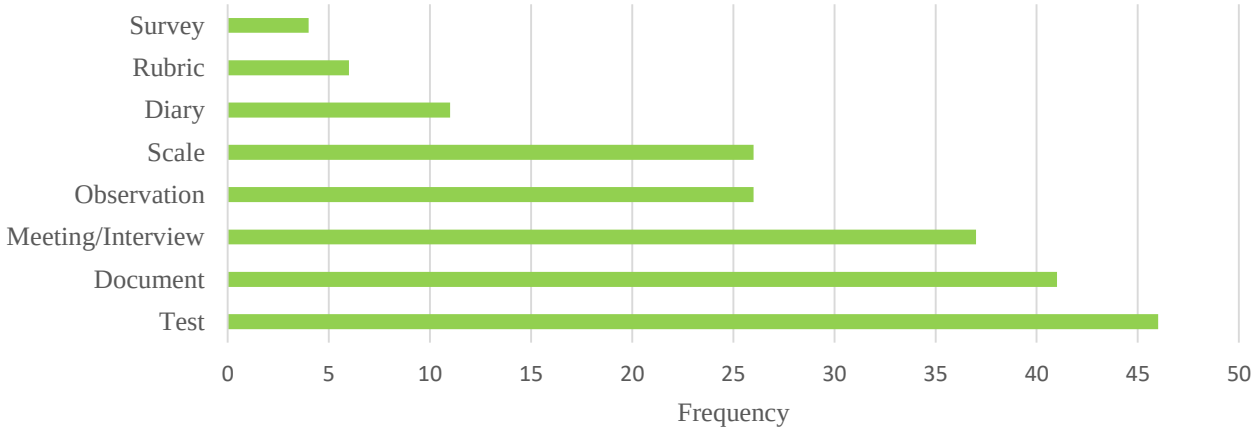


Figure 9. Distribution of theses according to themes "Data Collection Methods/Tools"

When Figure 9 is examined, the most frequent data collection method/tool was tests (46), while the least frequent was surveys (4).

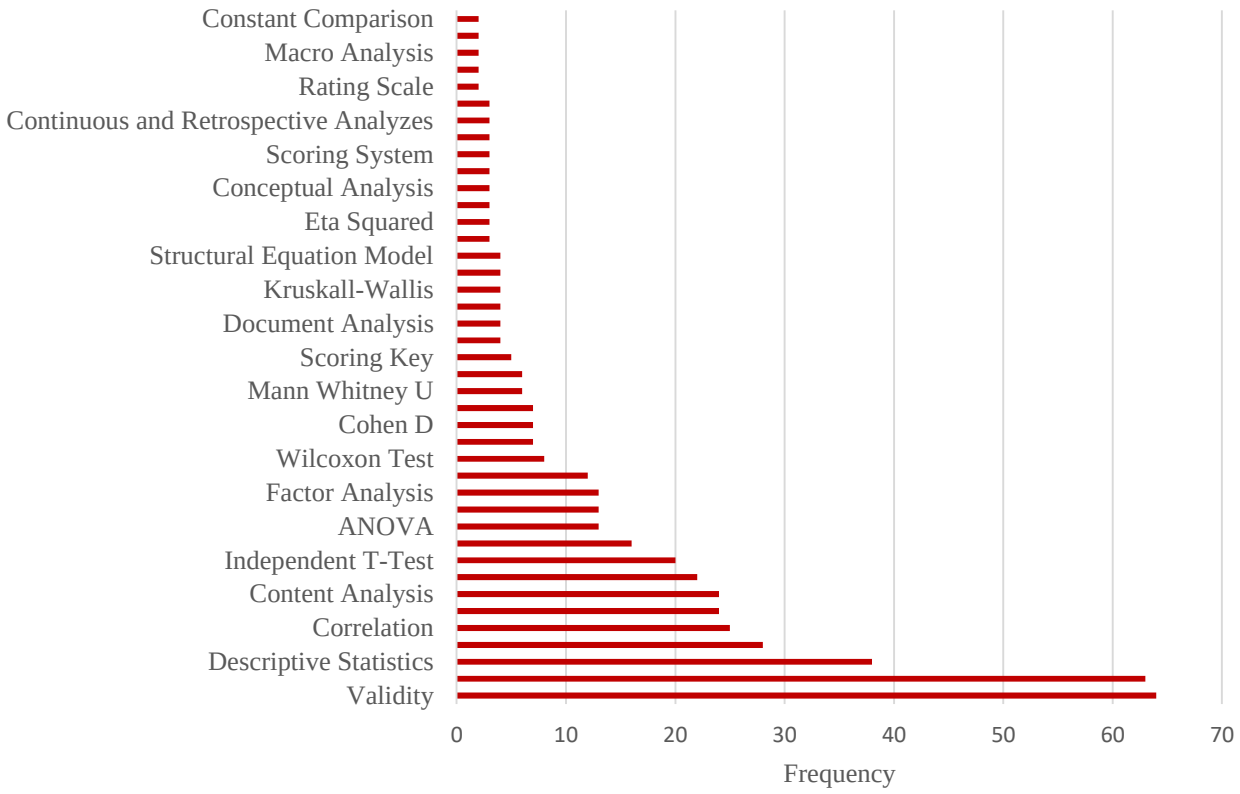


Figure 10. Distribution of theses according to themes "Data Analysis"

When Figure 10 is examined, forty-nine different codes were created under the "Data Analysis" theme. Among the 74 studies reviewed, the most frequently used data analysis method was validity (64). Given the necessity for studies to be valid and reliable, 10 of the reviewed studies did not include validity and reliability data analysis techniques. Following validity and reliability codes, the most frequent data analysis techniques were descriptive statistics (38) and normality tests (28).

3.3. Findings for Research Question "What is the distribution of national postgraduate theses related to scientific reasoning skills by learning method and scientific reasoning skills included in the research?"

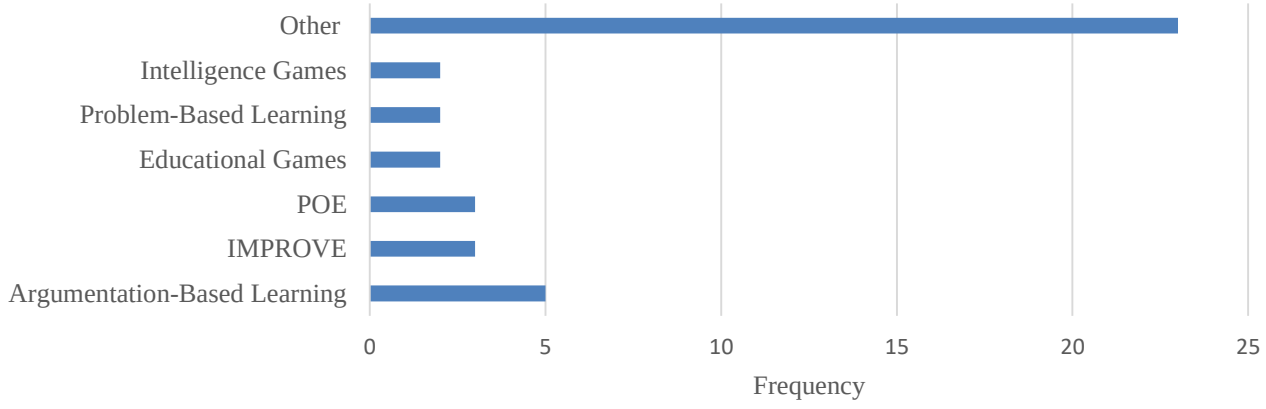
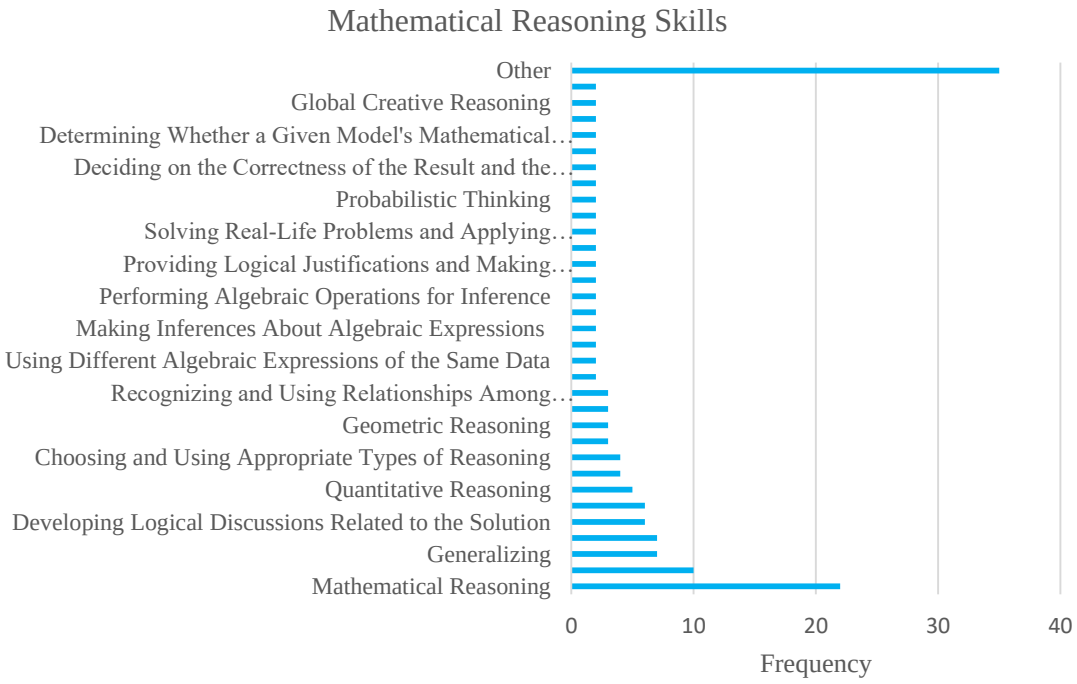
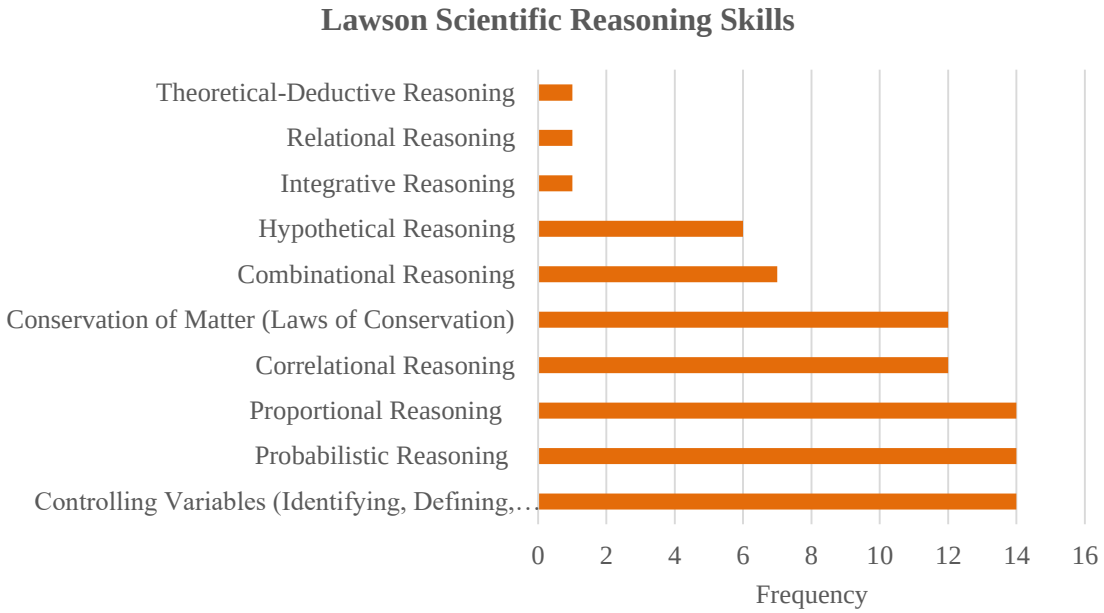
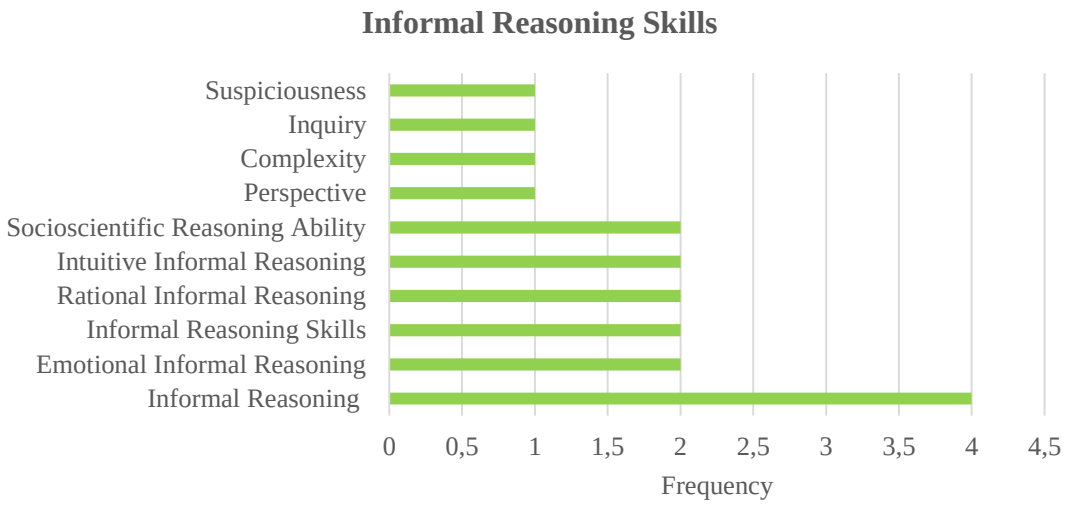


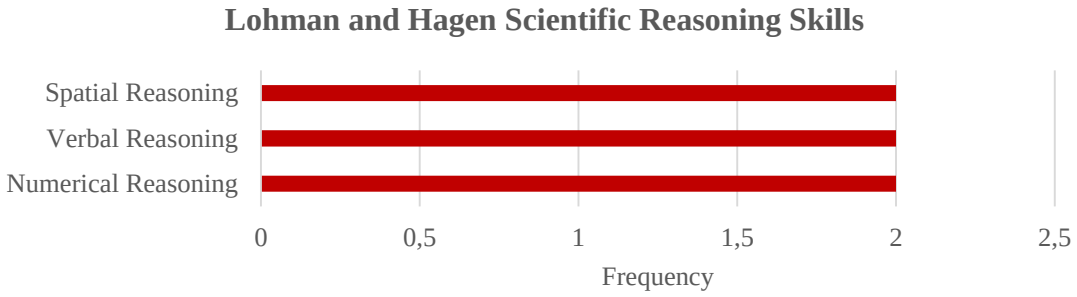
Figure 11. Distribution of theses according to "learning method" theme

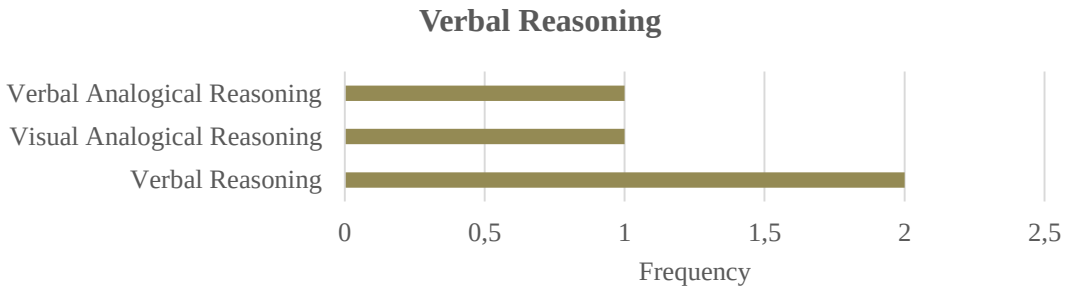
When Figure 11 is examined, the most frequently used learning methods were argumentation-based learning (5), IMPROVE (3), POE (3), educational games (2), problem-based learning (2), and intelligence games (2). Twenty-three other learning methods were each used in only one study.

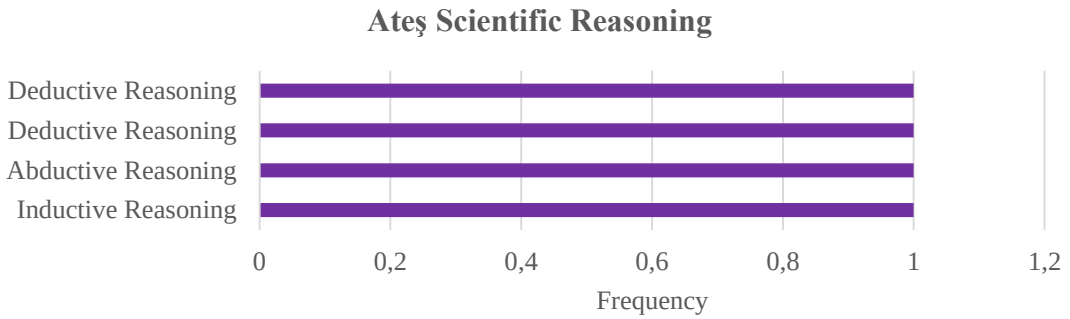





Informal Reasoning Skills
Suspiciousness
Inquiry
Complexity
Perspective
Socioscientific Reasoning Ability
Intuitive Informal Reasoning
Rational Informal Reasoning
Informal Reasoning Skills
Emotional Informal Reasoning
Informal Reasoning
0 0,5 1 1,5 2 2,5 3 3,5 4 4,5
Frequency


Lohman and Hagen Scientific Reasoning Skills
Spatial Reasoning
Verbal Reasoning
Numerical Reasoning
0 0,5 1 1,5 2 2,5
Frequency


Verbal Reasoning
Verbal Analogical Reasoning
Visual Analogical Reasoning
Verbal Reasoning
0 0,5 1 1,5 2 2,5
Frequency


Ateş Scientific Reasoning
Deductive Reasoning
Deductive Reasoning
Abductive Reasoning
Inductive Reasoning
0 0,2 0,4 0,6 0,8 1 1,2
Frequency

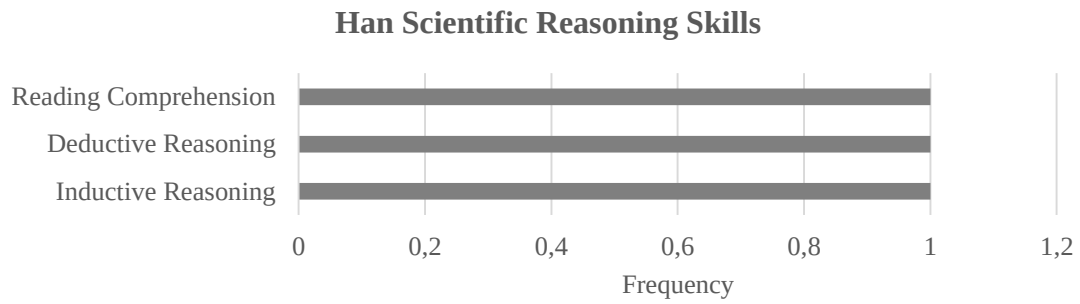


Figure 12. Distribution of theses according to "Scientific Reasoning Skills Included in the Study" theme

When Figure 12 is examined, the most frequently utilized mathematical reasoning skill was mathematical reasoning itself, appearing in 22 studies, while each of the remaining 35 sub-codes was employed once. The most used skills from Lawson's framework were control of variables (identifying, defining, and controlling variables), probabilistic reasoning, and proportional reasoning, each appearing in 14 studies. In contrast, combinatory reasoning, relational reasoning, and theoretical-deductive reasoning were each employed in only one study. Under the category of Han's scientific reasoning skills, three sub-codes were identified. It was found that Han's scientific reasoning skills were used in conjunction with Lawson's scientific reasoning skills in one study. Under the category of Ateş's scientific reasoning skills, four sub-codes were identified and utilized in one study. Lohman and Hagen's scientific reasoning skills category comprises three sub-codes, observed in a total of two studies. Complexity, perspective, inquiry, and skepticism were each employed in one study. Verbal reasoning was the most frequently used skill, appearing in two studies, while verbal analogical reasoning and visual analogical reasoning were each utilized once. Under the category of other reasoning skills, three different sub-codes were created (Figure 3).

3.4. Findings for Research Question "What is the distribution of national postgraduate theses related to scientific reasoning skills by results, discussions, and recommendations?"

Table 1. Distribution of theses according to "Results" theme

Code	Sub-code	Frequency
Students	Scientific reasoning skills have developed.	41
	Prominent scientific reasoning skills have been identified in students.	15
	Scientific reasoning skills are at a low level (insufficient).	9
	Students utilize scientific reasoning skills to varying degrees.	9
	Students encounter challenges in their scientific reasoning processes.	6
	Scientific reasoning skills have not developed.	5
	Scientific reasoning skills are not at the desired level of success.	4
	Gender differences in scientific reasoning skills levels have been observed.	3
	Similarities in scientific reasoning skills levels by gender have been observed.	3
	Scientific reasoning skills were found to be at a moderate level.	3
	Students' scientific reasoning skills levels differ by grade.	3
	Students make observations regarding scientific reasoning skills.	3
	Students' scientific reasoning skills levels are similar across grades.	2
	Other	16
Skills and Strategies	Positive relationships were observed between scientific reasoning skills.	2
	There is a relationship between metacognitive learning strategies and scientific reasoning skills.	2
	There is a relationship between mathematical self-efficacy resources and reasoning skills.	2
	Other	3
Learning Environment	Designed activities and learning environments need to be suitable for the formation and development of scientific reasoning skills.	7
	STEM activities have been observed to create a suitable instructional environment for reasoning skills.	1

Teachers and Prospective Teachers	Alongside conceptual knowledge and strategic information, epistemological knowledge also influences prospective teachers' reasoning actions interactively.	2
	Prospective teachers' scientific reasoning skills levels differ by department.	2
	Various deficiencies and shortcomings (such as material and time inadequacies, internet, pandemic) experienced by prospective teachers in activity processes have an impact on results.	1
	There is a relationship between teachers' beliefs about questioning and erotetic reasoning.	1
Documents and Data Collection Tools	A valid and reliable test has been developed in sub-dimensions of scientific reasoning types.	1
	Textbooks do not sufficiently consider the development of proportional thinking.	1
	The scale successfully distinguishes students in terms of mathematical reasoning skills.	1
Total		148

Table 1 presents an analysis of 74 studies focused on the theme of results and discussion, identifying 5 different codes and 44 sub-codes. The data are categorized into codes related to "students," "skills and strategies," "learning environment," "teachers and prospective teachers," and "documents and data collection tools." Upon examination, the highest number of results and discussions are directed towards students (122), followed by skills and strategies (9), learning environment (8), teachers and prospective teachers (6), and documents and data collection tools (3). The most frequently discussed result relates to the development of scientific reasoning skills (41).

Table 2. Distribution of theses according to "Recommendations" theme

Code	**Sub-code**	**Frequency**
Researchers	Preparation of practices to enhance scientific reasoning skills is recommended.	41
	Establishment of relationships between scientific reasoning skills and other variables is recommended.	28
	Designing studies with different research methods is recommended.	9
	Conducting studies targeting students with different characteristics/grade levels is recommended.	8
	Conducting studies targeting teachers and prospective teachers is recommended.	7
	Examination of different scientific reasoning skills is recommended.	5
	Designing long-term studies is recommended.	5
	Designing research that forms a theoretical basis for scientific reasoning skills is recommended.	4
	Other	2
Program Development	Emphasizing the processes and development of scientific reasoning skills in educational programs is recommended.	12
	Integrating mandatory/elective/applied courses into teacher training programs to develop scientific reasoning skills and pedagogical approaches is recommended.	6
	Preparing successful reasoning education programs/activities in formal and informal education is recommended.	3
	It is recommended to conduct applied courses and to integrate these courses into all levels starting from elementary school.	1
Teachers and Academicians	Providing information and education on scientific reasoning skills is recommended.	10
	Others	3
Course Materials	It is recommended that course materials, including teaching tools and books, be developed with consideration given to enhancing students' scientific reasoning skills.	9
Measurement and Evaluation	It is recommended to develop/use new assessment tools for evaluating scientific reasoning skills.	3
	Others	2
Parents	Providing information and education on scientific reasoning skills is recommended.	2

Students	Introducing different skills to develop scientific reasoning skills is recommended.	1
No Recommendation	No recommendation was made for scientific reasoning skills.	10
Total		171

When examining Table 2, it is noted that there are 8 different codes and 23 different sub-codes related to the theme of recommendations across 74 studies. The data is categorized into codes targeting "researchers," "program development," "teachers/academicians," "course materials," "measurement and evaluation," "parents," and "students." Upon review, the majority of recommendations are directed towards researchers (109 mentions), followed by program development (22), teachers/academicians (13), course materials (9), measurement and evaluation (5), parents (2), and students (1). Additionally, it is highlighted that scientific reasoning skills were not the subject of recommendations in 10 of the studies. The most prevalent recommendation is to prepare practices aimed at enhancing scientific reasoning skills (41 mentions).

4. Discussion and Conclusions

4.1. Discussion and Conclusions for Research Question "What is the distribution of national postgraduate theses related to scientific reasoning skills by year, thesis type, and field of education?"

The analysis of the distribution of theses by year reveals that the first thesis was conducted in 2007, with the highest number of theses written in 2019. Ergün et al. also noted in their study of theses on scientific reasoning that the first thesis was written in 2007, with the number of theses peaking in 2019. It was observed that the number of national postgraduate theses on scientific reasoning skills generally increased after 2018, reaching its peak in 2019. This increase could be linked to the changes introduced in the science curriculum in Türkiye in 2018, which incorporated new themes and skills (MoNE, 2018). Deveci (2018) emphasized in their study that the 2018 science curriculum emphasized scientific reasoning skills, enabling students to apply these skills to generate alternative solutions to everyday problems, make informed inferences, select the optimal solutions, and translate them into practical outcomes. When examining the distribution of national postgraduate theses on scientific reasoning skills by thesis type, it was observed that 49 studies were at the master's level and 25 studies were at the doctoral level (refer to Table 2). The lower number of doctoral studies can be attributed to factors such as the more rigorous demands of doctoral education in terms of both financial investment and personal commitment compared to master's education. Additionally, it is noted that the number of master's theses generally exceeds that of doctoral theses in the CoHE National Thesis Center (Council of Higher Education [CoHE] Thesis Center, 2024). Among the 25 doctoral-level studies identified in the study, it was found that they span across 7 different educational fields, with mathematics education having the highest number of studies (10), followed by science education with 5 studies.

Upon examining the distribution of theses across different fields of education, it is evident that the highest number of studies are concentrated in mathematics education, followed by science education. Interestingly, there is only one national graduate thesis each in the fields of biology education, measurement and evaluation in education, curriculum development in education, physics education, special education, social studies education, and Turkish language education (Aslan Sürek, 2023; Bağcı, 2015; Büyükbayraktar Ersoy, 2015; Danişman, 2011; Kılıçarslan, 2019; Tüzüngüç, 2019; Yüceer, 2020). A notable finding is the greater number of studies in preschool education compared to the subfields of physics, chemistry, and biology education, which are branches of natural sciences. This observation is surprising given the perceived relevance of natural sciences subfields to the development of scientific reasoning skills through their connections with acquisition, application, and mathematics domains. However, the findings do not align with this expectation. The prominence of studies in mathematics education can be attributed to its explicit and direct integration of scientific reasoning skills within its curriculum objectives (MoNE, 2018), aligning closely with the goals of mathematics education. Similarly, the relatively higher number of studies in science education can be explained by the ample opportunities these subjects afford for the application of scientific reasoning skills. Uyanık (2023) also supports this view, noting that science subjects provide favorable conditions for the cultivation of scientific reasoning skills.

4.2. Discussion and Conclusions for Research Question "What is the distribution of national postgraduate theses related to scientific reasoning skills by research design/method model, type of experimental research, sample type, sample size, data collection method/tool and data analysis technique?"

Upon analyzing the distribution of theses by research design/method model, it is evident that the most employed model is experimental, followed by survey, case study, mixed methods, and correlational models. Notably, the case study method/model was utilized in only one national graduate thesis (Karlı, 2019). Ergün et al. (2023) have similarly observed a predominance of experimental and survey designs/methods in studies investigating scientific reasoning skills, with case studies and mixed research methods also being represented, corroborating these findings. Given that a significant number of studies are concentrated in mathematics and science education, it follows that the experimental method is frequently chosen as the research design/method model in these fields. Indeed, within studies conducted in mathematics and science education, the predominant research design/method model is experimental (Karamustafaoğlu & Değirmenci, 2018; Karamustafaoğlu et al., 2020; Ulutaş & Ubuz, 2008). Further examination reveals that among experimental studies, quasi-experimental research emerges as the most frequently employed type, with true experimental research being utilized in only one instance (Akay, 2017). This finding is consistent with the findings of Inam and Güven (2019), Er and Biber (2020), and Karamustafaoğlu et al. (2020). The reason for this may be the difficulty of unbiased assignment in sample selection in educational research, and generally, selection is made from existing classes to create experimental and control groups. Upon reviewing the distribution of national postgraduate theses focusing on scientific reasoning skills according to sample type, it is apparent that the majority of studies involve middle school students (refer to Table 3). Interestingly, the use of parent and document samples was limited to one national graduate thesis each (Gül, 2015; Memiş, 2022). Ergün et al. (2023) also noted a prevalence of studies involving middle school students when examining sample types in theses related to scientific reasoning skills, corroborating these findings. Similarly, Köseoğlu and Eroğlu Doğan (2020), Dönmez and Gülen (2021), and Kiras and Bahar (2021) have reported similar conclusions in their respective studies, highlighting middle school students as the most commonly selected sample type. This preference can be attributed to several factors. Given that experimental research is the predominant research design/method model (MoNE, 2018) in these studies, middle school students are frequently chosen due to the relevance of their curricula and the focus on developing scientific reasoning skills.

Upon examining the distribution of theses according to sample size, it has been observed that the highest number of studies involved 0-25 participants, followed by the range of 51-75 participants. Yalcin et al. (2015) have previously highlighted that studies conducted in Türkiye generally exhibit low sample sizes. Ergün et al. (2023), in contrast, found that the most frequent sample sizes in theses related to scientific reasoning skills were between 31-100 participants. The predominance of sample sizes ranging from 0-75 can be attributed to the prevalent use of experimental and case study research methods. In experimental research, sample sizes are influenced by factors such as the implementation of instructional methods, class sizes, and the practical constraints faced by researchers. Similarly, the case study method, being qualitative in nature (Büyüköztürk et al., 2020; Cresswell, 2017; McMillan & Schumacher, 2010; Tanrıöğen, 2021), typically involves smaller sample sizes due to its focus on in-depth analysis of specific cases. Akaydın and Çeçen (2015) have also suggested that the reason behind the low sample sizes could be the widespread adoption of experimental research methodologies in Turkish educational settings. When analyzing the distribution of national postgraduate theses focused on scientific reasoning skills by data collection methods/tools, it is evident that tests are the most frequently employed, with surveys being the least utilized. Following tests, document analysis, interviews, observations, and scales were employed in descending order. Many studies employed multiple data collection methods/tools, reflecting a trend towards diversifying data sources and considering different perspectives. Ergün et al. (2023) also noted the preference for multiple collection methods and found that tests are commonly used in theses related to scientific reasoning skills, alongside interviews, surveys/scales, and document analysis. This observation aligns with the prevalent use of experimental and survey designs/methods in the examined national graduate thesis studies, where the inclusion of test and scale data collection methods/tools is expected. When analyzing the distribution of national postgraduate theses focused on scientific reasoning skills according to data analysis techniques, it is evident that the most used technique is validity and reliability analysis, followed by descriptive statistics and tests for normality. Many studies utilized multiple data analysis techniques. Ergün et al. (2023), however, found different trends in the data analysis techniques used in theses related to scientific reasoning skills. According to their findings, content analysis is the most

frequently employed technique, followed by descriptive analysis and t-tests. Interestingly, they noted a notable absence of analysis for reliability and validity techniques. Köseoğlu and Eroğlu Doğan (2020) also observed instances in their review of postgraduate theses where reliability and validity techniques were not mentioned, highlighting variability in reporting across different studies. Considering the foundational principles of research, it is crucial to emphasize that reliability and validity are integral aspects included in the majority of examined national graduate theses. Şencan (2005) also emphasizes that reliability and validity are important factors determining the quality of research, stating that reliability refers to the degree to which measurement results are free from random errors, and validity refers to the degree to which measurement results serve the intended purpose (Büyüköztürk et al., 2020); in qualitative research, reliability ensures the credibility of research results, while validity ensures unbiased presentation of research results (Yıldırım & Şimşek, 2021).

4.3. Discussion and Conclusions for Research Question "What is the distribution of national postgraduate theses related to scientific reasoning skills by learning method and scientific reasoning skills included in the research?"

When examining the distribution of theses according to learning methods, it has been found that a total of 29 different learning methods were utilized, with argumentation-based methods being the most frequently employed. Argumentation is defined as engaging in reasoning activities by scientifically addressing a debated topic (İnam & Güven, 2019); evaluating alternative perspectives and solutions, judging data to reach conclusions (Çınar, 2013); allowing students to formulate claims based on concrete evidence during the reasoning process, and using scientific evidence to justify or refute these claims (Demircioğlu & Uçar, 2014). So, students engage in scientific reasoning during argumentation practices (Demirel & Özcan, 2021). Since argumentation-based learning methods consist of processes that enable students to utilize their reasoning skills, this method may be preferred the most.

When analyzing the distribution of scientific reasoning skills included in theses, it was observed that mathematical reasoning skills and Lawson's scientific reasoning skills were predominantly favored. Following these, informal reasoning skills, Lohman and Hagen's scientific reasoning skills, and verbal reasoning skills were also utilized. Specific skills such as "Han scientific reasoning skills," "Ateş scientific reasoning skills," " erotetic reasoning skills," and "reasoning skills" were each employed in only one national graduate thesis (Gülmez Güngörmez, 2018; Kabaoğlu, 2023; Yılmaz, 2017; Yüceer, 2020). Among these, Han, Ateş, and erotetic reasoning skills were studied within the field of science education, while reasoning skills were explored in social studies education. Considering the highest concentration of studies in mathematics education, it is evident that skills encompassed by mathematical reasoning were the most frequently applied. Indeed, Sevencan (2019) emphasized that problem-solving and reasoning skills are extensively employed in mathematics education, focusing on cognitive dimensions, skills, and abilities. İnci (2023) highlighted that following mathematical proficiency categories indexed in ERIC, ESCI, and SSCI fields, mathematical skills were prominently featured, with a strong emphasis on reasoning skills. Examining the educational fields where Lawson's scientific reasoning skills were integrated, it was found that out of 14 studies, 10 were in science education, 3 in chemistry education, and 1 in physics education. These findings suggest that Lawson's scientific reasoning skills can be effectively applied within the context of science education. Furthermore, Gülmez Güngörmez (2018) and Özdeniz (2021) underscored its significant integration into the curriculum and its pivotal role in enhancing science learning.

4.4. Discussion and Conclusions for Research Question "What is the distribution of national postgraduate theses related to scientific reasoning skills by results, discussions, and recommendations?"

Regarding the conclusions and discussions of theses, it was found that the most frequently reached conclusion and discussion centered on "the development of students' scientific reasoning skills". This emphasis on student development aligns with the patterns observed in sample selection and is an expected outcome. Ergün et al. (2023) summarized findings from the examined theses, indicating that activities, learning models, or approaches aimed at enhancing reasoning skills had a positive impact on students' abilities. Similarly, multiple studies have reported improvements in students' reasoning skills (Abdullah & Shariff, 2008; Eşkin, 2008; Houssart & Sams, 2006; Othman et al., 2010; Ramirez & Monterola, 2022; Remigo et al., 2014). Looking at other results and discussions aimed at students, it was found that there is no significant difference between them, and a similar number of studies have been conducted. Another prominent conclusion and discussion focused on "the necessity for designing activities and learning

environments conducive to the formation and development of scientific reasoning skills". When considering the majority of studies on the impact of specific learning methods or activities on scientific reasoning skills are predominantly quantitative and experimental, it can be considered necessary to take this into account in order to identify differences between experimental and control groups.

In examining the distribution of theses, the highest number of recommendations pertained to the theme of "preparing practices aimed at enhancing scientific reasoning skills for researchers". This supports the findings and discussion outcomes. Ergün et al. (2023) have corroborated these findings. Recommendations were made in only one thesis for students and in two theses for parents (Çoban, 2010; Er, 2012; İnal, 2010). Considering that the majority of samples in the examined graduate thesis studies consisted of students, the presence of only one recommendation specifically aimed at students represents a noteworthy discrepancy. The recommendation aimed at parents is to provide "information and training on scientific reasoning skills." It has been noted that studies making these recommendations focused on children in the preschool education period.

- Due to the scarcity of theses addressing scientific reasoning skills, it is recommended to conduct more detailed studies in this area.
- Given that the reviewed studies were predominantly conducted in the fields of mathematics and science education, it is recommended to conduct new studies in different educational fields to contribute fresh insights to literature.
- Given that tests were the most used data collection tool to assess scientific reasoning skills, it is recommended that future studies develop new and refined data collection tools aimed specifically at measuring these skills.
- It is recommended to conduct studies focusing on scientific reasoning skills as included in international exams (PISA and TIMSS) and national exams (LGS, YKS, KPSS) to align educational practices with global standards and national assessments.

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Researchers' Contribution Rate Statement:

The authors contributed equally.