Kalem Eğitim ve İnsan Bilimleri Dergisi 2024, 14(1), 129-153, doi: 10.23863/kalem.2023.267

Development of the Reasoning Ways Scale: Validity and Reliability Study

Doç. Dr. Meltem YALIN-UÇAR*

Aydın Adnan Menderes Üniversitesi, Eğitim Fakültesi, Eğitim Bilimleri Bölümü, Aydın / Türkiye,
myalinuc@gmail.com, ORCID: 0000-0002-9922-0905

Dr. Tuba BAĞATARHAN

Millî Eğitim Bakanlığı, İstiklal Anaokulu, Aydın / Türkiye,
tuba.bagatarhan@gmail.com, ORCID: 0000-0002-7885-6496

Gülin YAKIT

Millî Eğitim Bakanlığı, Söke Hilmi Fırat Anadolu Lisesi, Aydın / Türkiye,
gulinyakit@gmail.com, ORCID: 0000-0003-2853-092X

Murat Berkant EKİCİ

Aydın Adnan Menderes Üniversitesi, Eğitim Fakültesi, Eğitim Bilimleri Bölümü, Aydın / Türkiye,
muratxdrmx@gmail.com, ORCID: 0000-0002-8359-534X

Aslı EROL

Millî Eğitim Bakanlığı, Bozdoğan Fatih Ortaokulu, Aydın / Türkiye,
aslierol09@gmail.com, ORCID: 0000-0003-2479-6835

Hakime Nihan KIZILASLAN

Aydın Adnan Menderes Üniversitesi, Eğitim Fakültesi, Eğitim Bilimleri Bölümü, Aydın / Türkiye
hakimenihan@gmail.com, ORCID: 0000-0001-9201-3068

*Sorumlu Yazar. Tel: +90 505 588 71 55 | Araştırma Makalesi.
Makale Tarih Bilgisi. Gönderim: 21.09.2022, Kabûl: 04.11.2022, Erken Görünüm: Ekim, 2023, Basım: Haziran, 2024

 ISSN: 2146-5606, e-ISSN: 2687-6574

Abstract

The aim of this study was to develop a valid and reliable measurement tool to determine the reasoning ways of university students. The study was carried out in two separate stages consisting of the pilot and main application in the 2020-2021 academic year. In the main application, the analysis was made on the data obtained from 378 university students. Exploratory and Confirmatory Factor Analysis was performed for the construct validity of the scale; Average Explained Variance [Average Variance Extracted (AVE)], square root of AVE, Composite Reliability [CR], Maximum Shared Variance [Maximum Squared Variance (MSV)], Average Squared Shared Variance [(Average Shared Square Variance (ASV)] and inter-construct correlations were calculated for convergent and divergent validities. The Cronbach's alpha internal consistency and CR coefficients were calculated to examine the reliability. The Exploratory and Confirmatory Factor Analysis results showed that the scale had a seven-factor structure (deductive, inductive, analogical, heuristic, algebraic, historical, and verbal) and consisted of 21 items. Convergent and divergent validity of the scale was proved by examining AVE, square root of AVE, CR, MSV, ASV values, and inter-construct correlation coefficients. Cronbach's alpha and composite reliability coefficients which were calculated for the whole scale and each sub-dimension indicated that the scale was reliable. The results reveal that the Reasoning Ways Scale is a valid and reliable measurement tool.

Keywords: Reasoning; Reasoning ways; Scale development validity; Reliability.

Akıl Yürütme Yolları Ölçeği'nin Geliştirilmesi: Geçerlik ve Güvenirlik Çalışması

Öz

Bu araştırmanın amacı üniversite öğrencilerinin akıl yürütme yollarını belirlemek için geçerli ve güvenilir bir ölçme aracı geliştirmektir. Araştırma, 2020-2021 eğitim-öğretim yılında pilot ve asıl uygulamadan oluşan iki ayrı aşamada gerçekleştirilmiştir. Asıl uygulamada 378 üniversite öğrencisinden elde edilen veriler üzerinden analiz yapılmıştır. Ölçeğin yapı geçerliği için Açımlayıcı ve Doğrulayıcı Faktör Analizi yapılmış; yakınsak ve ıraksak geçerlik için Ortalama Açıklanan Varyans [Average Variance Extracted (AVE)], AVE'nin karekökü, Kompozit Güvenirlik [Composite Reliability (CR)], Maksimum Paylaşılan Varyans [Maximum Squared Variance (MSV)], Paylaşılan Varyansın Karesinin Ortalaması [(Average Shared Square Variance (ASV)] ve alt boyutlar arasındaki korelasyon katsayıları hesaplanmıştır. Güvenirliği incelemek için ise Cronbach alfa iç tutarlık ve CR katsayıları hesaplanmıştır. Açımlayıcı ve Doğrulayıcı Faktör Analizi bulguları, ölçme aracının yedi faktörlü (tümdengelimsel, tümevarımsal, analojik, sezgisel, cebirsel, tarihsel, sözel) bir yapıya sahip olduğunu ve 21 maddeden oluştuğunu göstermiştir. AVE, AVE'nin karekökü, CR, MSV

ve ASV değerleri ile alt boyutlar arasındaki korelasyon katsayıları incelenerek ölçeğin yakınsak ve ıraksak geçerliğinin sağlandığı tespit edilmiştir. Ölçme aracının geneli ve her bir alt boyutu için hesaplanan Cronbach Alfa ve kompozit güvenirlik katsayıları, ölçeğin güvenilir olduğunu göstermiştir. Bulgular, Akıl Yürütme Yolları Ölçeği'nin geçerli ve güvenilir bir ölçme aracı olduğunu ortaya koymaktadır.
Anahtar Kelimeler: Akıl yürütme; Akıl yürütme yolları; Ölçek geliştirme; Geçerlik; Güvenirlik.

Introduction

Reasoning ways, which are within the scope of the study of science, are an important mental experience that should be gained in formal learning environments. In the last quarter-century, "reasoning" ways, especially in the United States, Europe and other developed countries, is an important variable that is handled within the scope of social-emotional learning, which includes the acquisitions of "responsible decision making". Within the scope of affective learning outcomes, emotional competencies are tried to be gained by developing programs related to a wide social and emotional skill set such as self-awareness (for example, the ability to recognize one's emotions), social awareness (for example, the ability to take the perspective of others), self-management (for example, the ability to regulate their emotions), relationship skills (for example, the ability to form rewarding relationships), and the ability to make responsible decisions (for example, the ability to make constructive choices) (Goodman, Joshi and Hyson, 2004; Sharp, 2001; Taylor, Oberle, Durlak and Weissberg, 2017). In this context, it is necessary for individuals to identify problems, analyze situations, solve problems, evaluate, reflect and take ethical responsibility in the decision-making process (Casel, 2021). Therefore, at the mentioned stages, each individual (regardless of the age range) must use the reasoning process because reasoning is an important variable that ensures survival. In this process, individuals need to use "reasoning" ways so that they can make constructive choices in the process of ethical standards, safety concerns, personal behaviors, and social interactions based on social norms.

So "What is mind?". Is it a calculation job, creativity, awareness, agnostic physicalism, dualist interaction, or functionalism? As can be seen, there are many theories, approaches, and definitions describing the mind in the literature. However, the definition of mind within the limits of this study is related to cognition. Because, in the psychological framework, cognition includes all mental activities including thinking, feeling, and willing (Paul and

Elder, 2008) as well as numerous parameters such as speaking, problem-solving, and decision making. In addition, reasoning in Greek ancient literature is to make syllogism by creating chain links between one proposition and another. Therefore, it requires reaching the final decision from the results, judgments, facts, and propositions or drawing a conclusion from the direction of thought and way of thinking (Altıparmak and Öziş, 2005; Bergqvist, Lithner and Sumpter, 2004). Thus, reasoning leaves a trace in almost every part of the life flow, in the sense that it requires reaching a conclusion. When we learn, criticize, judge, infer, evaluate, apply, explore, design and create, we draw conclusions from the information obtained and form our own beliefs (Leighton and Sternberg, 2004). According to Amsterlaw (2004), reasoning is a fundamental part of our lives, which enables us to make choices and preferences, shapes our ideas, and enables us to solve problems.

As for reasoning, a subject that originated in antiquity and has been studied since ancient Greek history, Foucault said that education cannot change society, but it can probably change a person's reasoning style, and he mentioned that changing a person's reasoning style depends on revealing one's own legitimacy, foresight, and limit (as cited in Zhao, 2018). Since reasoning is an acquired behavior depending on cultural characteristics, it can be transformed into a systematic form of the thinking process in educational settings. Because thinking, feeling, and willing behaviors are three different parameters that form "cognition". Thinking behavior is transformed into "reasoning" in educational processes; the behavior of feeling is transformed into "intuition" and the behavior of desire is transformed into "will" (Paul and Elder, 2008).

For this reason, the ways of reasoning should be considered an important subject of formal learning processes, as they can be taught, changed, and developed. Ultimately, the preferred ways of reasoning show the feature of being an important parameter that determines the existence of individuals as a quality because reasoning is a widely known reality not only for researchers but also for making informed decisions in daily life and without reasoning, previously acquired knowledge, and experiences cannot be applied to new situations (Bhat, 2019). In fact, many researchers carried out studies showing the effect of reasoning ability on academic achievement (Abdu, 1998; Cavallo, 1996; Duran and Mertol, 2019; Ertepmar, 1995; Gupta, 2012; Johnson and Lawson, 1998; Kanchan and Sharma, 2013; Nnorom, 2013; Oloyede, 2012;

Sungur, Tekkay and Geban, 2001; Tekkaya and Yenilmez, 2006) and concluded that individuals who are successful in the reasoning process are more successful than other individuals because they make more accurate and effective decisions in their lives (Erdem and Gürbüz, 2015). In addition, there are studies showing that the product should be focused on rather than focusing on the process during in-class activities that support reasoning (Umay and Kaf, 2005). Especially, many studies by Heit (2007), trying to understand experimentally the relationship between the effects of inductive reasoning on memory and decision making and the ways of inductive and deductive reasoning take place in the literature.

When the studies on the reasoning process are examined, Kind and Osborn (2017) stated that this feature is not an innate quality, but rather a built-in feature shaped by language, belief systems, and worldview. They justified it with a quote from Vygotsky (1978): Every individual has reasoning preferences that are assimilated according to the interpersonal interaction that arises simply from being in that culture.

So, if the ways of reasoning are learnable and teachable, the primary goal of this study is to reveal what the reasoning ways of individuals have, not how these ways emerge and what is achieved. Thanks to this tool, which was developed to serve a purely educational purpose, "way of reasoning" will be a tool for evaluating scientific, intellectual, and cultural development because it is important to "emphasize/care about what we want", otherwise we will get "what we don't want" (Hill, 2008, p.9).

As stated above, reasoning ways that have the characteristics of learning and teaching in educational environments are learned at all education levels from preschool to higher education. In this context, teachers need to use very different ways of reasoning for every situation, event and phenomenon. Mentioned that teachers with multiple reasoning skills will increase the possibility of learning different ways of reasoning for their students.

Because of all the explanations, it is very important to teach different ways of reasoning to teacher candidates during their education. In order to increase the multiplier effect of education, teacher candidates; need to use different ways of reasoning in their processes such as identifying problems, analyzing the situation, solving problems, reflecting, taking ethical responsibility, evaluating, and making decisions. The more different ways of reasoning are used, the more cognitive and social-emotional abilities are gained. Because it

is necessary for creativity. For the aforementioned reasons, the "Reasoning Ways Scale" was developed in this study to be used in the processes of identifying, developing, and evaluating the reasoning paths of the pre-service teachers. The sub-dimensions of the Reasoning Ways Scale developed in this study are as follows:

The word "analogy" is included as "similarity-resemblance" in the Dictionary of the Turkish Language Association and is defined as obtaining a result or information by comparing pre-existing information with new information among similar objects (Amir-Mofidi, Amiripour and Bijan-Zadeh, 2012). "Deductive" reasoning involves making a general assumption that is known or believed to be true and then analytically arriving at a particular conclusion based on that assumption. Again, deductive reasoning gives information about what is particular by making the premises clear rather than giving new information. Thus, it requires making rational inferences about what we do not know based on what we know and reasoning based on certain facts and observations, as it requires heuristic processes that make use of relational information about context and similarities (Heit and Rotello, 2010).

On the other hand, "Inductive" reasoning requires making rational inferences about what we do not know based on what we know, and heuristic processes that make use of relational information about context and similarities (Heit and Rotello, 2010). At the same time, inductive reasoning plays an important role in advancing intellectual development processes such as intelligence and reasoning strategies (Hayes, Heit and Swendsen, 2010; Klauer and Phye, 2008; Klauer, Willmes and Phye, 2002; Mousa, 2017).

"Algebraic" reasoning, which is another way of reasoning in the measurement tool, consists of various thinking and symbolism understandings such as arithmetic generalization, understanding the structure of the number system and patterns, and mathematical modeling (Kaput, 1999). The "intuitive" reasoning process, on the other hand, is the reasoning we do with our instincts and acting or not acting as a result, completely outside of conventional wisdom or data-based reasoning.

"Verbal" reasoning is the ability to logically understand concepts and problems expressed in words. Behaviors of speaking fluently, accessing vocabulary, expressing oneself in a meaningful way, and using reasoning skills to help understand the environment are elements of verbal reasoning.

"Historical" reasoning emphasizes the mental activities in which an individual acquires knowledge of the past and uses this knowledge to interpret events and phenomena of the past and present. This process includes basic concepts, meta-concepts, asking historical questions, using resources, contextualization, and discussion (Drie and Boxtel, 2008).

In the domestic and foreign literature review on reasoning-related measurement tools, there are generally "reasoning" measurement tools developed depending on a certain discipline or subject area such as mathematics, engineering, science, and health sciences. On the other hand, in the field of social sciences, there are tools such as "intercultural thinking and reasoning or reasoning power that were developed related or specific to a field, age or occupational group. For example, there are tools developed specifically for a specific field, such as "Early Mathematical Reasoning Skills Assessment Tool" (Ergül, 2014), "Korean Version of Nurse Clinical Reasoning Competence Scale" (Jiyoung and Narae, 2017), "Two-Tier Proportional Reasoning Skill Test" (Açıkgül, 2021) and "Statistical Reasoning Assessment" (Garfield, 2003). Although the "Hypothetical-Creative Reasoning Skills Scale" developed by Duran (2019) is suitable for use in the field of social sciences and has parallels with some of the reasoning ways in the scale, it still shows significant differences from the aforementioned instrument in terms of theory and structure.

The aim of the present study to develop the "Reasoning Ways Scale" was developed in this study for the reasons mentioned. Because reasoning behavior can be learned and taught, it is should be a remarkable target in the curriculum. It is thought that the developed measurement tool will contribute to the description, evaluation, and development of the level and ways of reasoning.

Method

This research was conducted using the quantitative method. Descriptive statistics, construct validity, convergent validity, divergent validity, Cronbach's Alpha internal consistency, and composite reliability analyses were performed to examine the psychometric properties of the Reasoning Ways Scale.

Participants

The participants of the study consisted of 378 university students of the

faculty of education in Turkey. The sample of the study was selected by convenient sampling method, one of the non-probability sampling methods. The sample of this study was determined by convenient sampling method, which accelerates the study (Kılıç, 2013). Participants of the study were included in the study on a voluntary basis. The sample group consisted of 378 university students from different cities and different grade levels and in different departments. A total of 378 education faculty students, 296 female (78.3%) and 82 male (21.7%) participated in the study. The sample included 296 female (78.3%) and 82 male (21.7%); 42 were in 1st, 77 were in 2nd, 150 were in 3rd and 109 were in 4th grade.

Procedures

The ethics committee approval of this study was obtained with the decision number V at the 24th meeting of the Aydın Adnan Menderes University Educational Research Ethics Committee on 22.10.2021. All the participants were recruited via online survey tools. Participation in the study was completely voluntary. The purpose of the study was explained, and voluntary participant consent was provided before conducting the data collection instruments to participants.

Data Collection

In this study, the measurement tool was developed in two stages. This process is explained as follows.

In the first stage, the process of creating the item pool and writing the items was carried out. In this process, ten different ways of reasoning that can be used in the field of social sciences were agreed upon by the researchers. As a result of the literature review, an item pool related to 10 reasoning ways was created. Because these 10 ways of reasoning were mostly used in the education processes in the literature. For this reason, it was decided to include 10 reasoning ways in the draft measurement tool.

In the process of creating the item pool of the study, 11 researchers took part and 350 draft items were created. These ways of reasoning were “deductive”, “inductive”, “intuitive”, “hypothetical”, “reversible”, “analogical”, “algebraic”, “hepatic”, “verbal” and “historical” reasoning. A total of 350 items were created from 35 items for each sub-dimension. Thus, a large number of items were obtained in an appropriate format that could reveal the characteristics determined for the dimensions to be measured. Then, the item pool was examined by the researchers and the number of items was reduced to 100.

Again, these items were reduced to 50 within the framework of expert opinions in philosophy and psychology. In addition, expert opinion was requested for the confirmation of the correctness of the items' conceptual framework, language, expression, and punctuation marks. Thus, the draft of the Reasoning Ways Scale, which included 10 different ways of reasoning and in which five items expressing these ways was created in the five-point likert type (evolving from 1=Strongly Disagree to 5=Strongly Agree).

The pilot application of the measurement tool was carried out with 406 teacher candidates. Different participants were reached during the pre-testing of measurement tool. The pre-test group consisted of 101 female and 305 male education faculty students.

As a result of the analysis, it was determined that 25 items were collected in 7 sub-dimensions (deductive, inductive, analogical, intuitive, algebraic, historical, verbal). The items written for the hepatic, reversible, and hypothetical sub-dimensions were not collected in the desired sub-dimensions.

In the second stage of the scale development, the 25-item scale consisting of 7 sub-dimensions was tested. It briefly stated a priori factor structure was determined.

Data Analysis

Prior to analysis, assumptions for the factor analysis including univariate and multivariate normality were investigated. Skewness and kurtosis values were used to check the univariate normality. Skewness and kurtosis values for the normal distribution were accepted as values between -3 and +3 as suggested by Coakes and Steed (2003). Multivariate outliers were identified by using a $p<0.001$ criteria with Mahalanobis distance (Tabachnick and Fidell, 2013).

Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were used to examine the construct validity of the Reasoning Ways Scale. The Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity Test results were calculated in order to examine the suitability of the data for factor analyses. The normality test of the whole scale and sub-dimensions were conducted. The variances explained by the whole scale and sub-dimensions were calculated. The factors, factor loadings, and items in the factors were determined as a result of the exploratory factor analysis. The factor structure ob-

tained by exploratory factor analysis was tested by confirmatory factor analysis. To evaluate the goodness-of-fit of CFA, Chi-Square Goodness (χ^2/degrees of freedom (df)), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), Comparative Fit Index (CFI), Goodness of fit index (GFI), Adjusted Goodness of Fit Index (AGFI), Incremental fit index (IFI), Tucker-Lewis Index (TLI) and Normed Fit Index (NFI) were used.

The Average Extracted (AVE), the square root of the AVE, Maximum Shared Variance Variance (MSV) and the Average Shared Squared Variance (ASV), inter-construct correlations, and composite reliability (CR) were calculated for the convergent and discriminant validity. Cronbach Alpha coefficient for the whole scale and sub-dimensions were calculated in order to examine the internal consistency reliability of the scale. All analyses were performed using IBM SPSS 23 and AMOS 24.

Results

In this section, findings related to the validity and reliability of the Reasoning Ways Scale have been included. Prior to analysis, univariate and multivariate normality were examined. Skewness values of the items ranged from -1.338 to 1.601 and kurtosis values from -1.405 to 1.930. The skewness and kurtosis values are recommended between -3 and +3 for the data to show normal distribution (Coakes and Steed, 2003). According to these criteria, the univariate normality was met. Multivariate outliers were identified by using a $p<0.001$ criteria with Mahalanobis distance (Tabachnick and Fidell, 2013).

Construct Validity

Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) were conducted to analyze the construct validity of the scale.

Exploratory Factor Analysis (EFA)

Exploratory factor analysis was performed in order to determine the factor structure of the scale. The principal component analysis and the varimax rotation method were used for the exploratory factor analysis. The principal component analysis is used to reveal the basic dimensions of an equally spaced scale developed on a theoretical basis. This method is also preferred in cases where a high correlation is not expected between the factors, that is, the factors are independent of each other (Çokluk, Şekercioğlu and Büyüköztürk, 2016). The sub-dimensions of the Reasoning Ways Scale are theoretically independent of each other. The correlations between the factors were also examined in

the pilot application and it was determined that the correlation coefficients among the sub-factors were low. For this reason, the principal component analysis method was used in this study. In addition, the varimax method, one of the orthogonal rotation methods, was preferred in the analysis. Because orthogonal rotation methods are used when there is no relationship between the factors. In addition, the varimax method is used in cases where more than one independent and generalizable dimension is expected to be obtained from the scale, as expected in the Reasoning Ways Scale (Çokluk et al., 2016; Şencan, 2005). The factor loadings above 0.30 were determined as acceptable levels to include a particular item into a factor (Tabachnick and Fidell, 2013).

Exploratory factor analysis was carried out according to some criteria. The criteria for an item to be included in a factor were that the factor load should be 0.30 and above and that the difference between the load values in the factors should be 0.10 or more in case the items were in more than one factor (Büyüköztürk, 2002). In addition, it was taken into account that the eigenvalue of each factor should be at least 1 (Büyüköztürk, 2002). In the first phase of the analysis, four items (item 1 and item 5 written for deduction sub-dimension; item 9 and item 10 written for induction sub-dimension) that did not meet these criteria were removed from the scale one by one.

Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity Test results were assessed to examine data suitability for factor analysis (see Table 1).

Table 1. Reasoning Ways Scale KMO and Bartlett's Test Statistics

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.732
Bartlett's Test of Sphericity	χ^2	2638.915
	df	210
	p	*0.000*

The Kaiser-Meyer-Olkin (KMO) value was 0.732, exceeding the recommended value (0.60) (Tabachnick and Fidell, 2001). This value indicates that the correlation structures are integrated, and factor analysis will provide reliable factors (Pallant, 2001). Bartlett's Test of Sphericity found statistically significant (χ^2=2638.915; *p=.000*), supporting the factorability of the correlation matrix. KMO values and Bartlett's Test of Sphericity results show that the research data is suitable for exploratory factor analysis and confirmatory factor analysis.

As seen in Table 2 and Figure 1, as a result of repeated exploratory factor analyses, it is understood that 21-item scale exhibited a seven-factor

structure with an eigenvalue above 1.00.

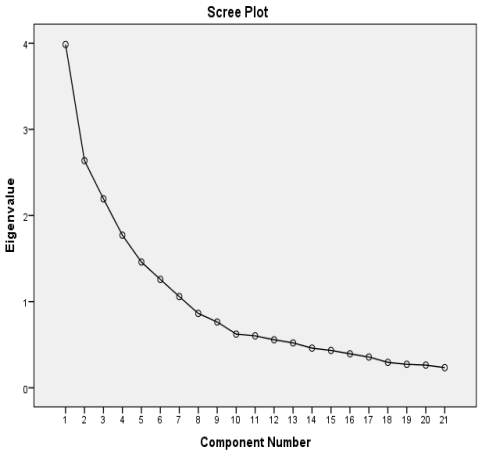

Figure 1. Scree plot for the exploratory factor analysis (EFA) of the Reasoning Ways Scale

Table 2. Eigenvalues, Percentages of Variance and Cumulative Percentages of Factors for the Reasoning Ways Scale Items

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cum. %	Total	% of Variance	Cum. %	Total	% of Variance	Cum. %
1	3.986	18.979	18.979	3.986	18.979	18.979	2.375	11.310	11.310
2	2.637	12.557	31.536	2.637	12.557	31.536	2.220	10.572	21.882
3	2.193	10.443	41.979	2.193	10.443	41.979	2.137	10.175	32.056
4	1.771	8.434	50.413	1.771	8.434	50.413	2.061	9.816	41.872
5	1.460	6.951	57.364	1.460	6.951	57.364	1.972	9.389	51.261
6	1.258	5.990	63.354	1.258	5.990	63.354	1.858	8.850	60.111
7	1.058	5.039	68.393	1.058	5.039	68.393	1.739	8.282	68.393
8	.863	4.108	72.501						
9	.763	3.635	76.136						
10	.623	2.967	79.103						
11	.603	2.872	81.975						
12	.557	2.653	84.628						
13	.521	2.479	87.106						
14	.460	2.190	89.296						
15	.433	2.064	91.360						
16	.394	1.877	93.237						
17	.357	1.698	94.935						
18	.295	1.403	96.338						
19	.272	1.297	97.634						
20	.263	1.253	98.888						
21	.234	1.112	100.000						

In the scree plot graph, it was determined that the graph curve decreased rapidly, the curve took a horizontal shape after the seventh factor and the eigenvalues were very close to each other. Accordingly, it can be said that the

scale has a seven-factor structure. Eigenvalues and cumulative variance percentages for seven factors are shown in Table 2.

The 21-item scale exhibited a seven-factor structure with an eigenvalue above 1.00. Eigenvalues of scale sub-dimensions are 2.375 for factor 1, 2.220 for factor 2, 2.137 for factor 3 and 2.061 for factor 4, 1.972 for factor 5, 1.858 for factor 6 and 1.739 for factor 7. The variance explained by the first factor was 18.979%, the variance explained by the second factor was 12.557%, the variance explained by the third factor was 10.443%, the variance explained by the fourth factor was 8.434%, the variance explained by the fifth factor was 6.951%, the variance explained by the sixth factor was 5.990% and the variance explained by the seventh factor was 5.039%. The total variance explained by the seven-factor structure obtained after the excluded items was 68.39%. This value is at an acceptable level (Kline, 2005). Items in the factors and factor loadings are presented in Table 3.

Table 3. Items in Factors and Factor Loading Distributions

Items	Factors						
	1	2	3	4	5	6	7
Item 17	.858						
Item 19	.840						
Item 18	.824						
Item 21		.833					
Item 20		.805					
Item 22		.784					
Item 24			.899				
Item 23			.874				
Item 25			.641				
Item 15				.888			
Item 14				.839			
Item 16				.709			
Item 11					.837		
Item 13					.770		
Item 12					.738		
Item 6						.813	
Item 7						.776	
Item 8						.689	
Item 3							.822
Item 4							.761
Item 2							.602

According to the results of the exploratory factor analysis, each factor consisted of three items. As a result, in the Reasoning Ways Scale, items 2, 3, 4 belong to the “deductive” sub-dimension; items 6, 7, 8 belong to the “induc-

tive" sub-dimension; items 11, 12, 13 belong to the "analogical" sub-dimension; items 14, 15, 16 belong to the "intuitive" sub-dimension; items 17, 18, 19 belong to the "verbal" sub-dimension; items 20, 21, 22 belong to the "historical" sub-dimension; items 23, 24, 25 belong to the "algebraic" sub-dimension.

Confirmatory Factor Analysis (CFA)

CFA was conducted to confirm the EFA results. Assumptions for the factor analysis including univariate and multivariate normality were examined before the analysis.

Skewness and kurtosis values were calculated to check the univariate normality of the data. Reasoning Ways Scale item means, standard deviations, skewness, and kurtosis values were provided in Table 4.

Table 4. Descriptive Statistics for Reasoning Ways Scale Items

	Mean	SD	Skewness	Kurtosis
Item 2	3.22	1.420	-0.212	-1.235
Item 3	3.35	1.547	-0.369	-1.405
Item 4	3.69	1.371	-0.757	-0.710
Item 6	2.31	1.316	0.608	-0.842
Item 7	1.68	1.033	1.601	1.930
Item 8	2.70	1.374	0.235	-1.186
Item 11	4.07	1.163	-1.142	0.368
Item 12	4.33	0.864	-1.338	1.545
Item 13	3.71	1.177	-0.630	-0.501
Item 14	3.37	1.131	-0.206	-0.749
Item 15	3.46	1.174	-0.374	-0.757
Item 16	2.69	1.087	0.340	-0.523
Item 17	4.41	0.763	-1.128	0.600
Item 18	4.36	0.816	-1.073	0.289
Item 19	4.47	0.732	-1.316	1.287
Item 20	4.01	1.054	-0.740	-0.543
Item 21	3.82	1.071	-0.490	-0.711
Item 22	3.46	1.144	-0.248	-0.783
Item 23	3.04	1.177	0.070	-0.807
Item 24	3.28	1.262	-0.188	-0.977
Item 25	3.57	1.164	-0.521	-0.475

N=378

The skewness values of the items were between -1.338 to 1.601 and the kurtosis values were between -1.405 to 1.930. Findings suggest that the items provide univariate normality according to the criteria of Coakes and Steed (2003).

Multivariate outliers were identified by using a $p<0.001$ criteria with Mahalanobis distance (Tabachnick and Fidell, 2013). As a result, the items

conform to the assumptions of confirmatory factor analysis. The maximum-likelihood method was used as an estimation method. The CFA result of the 21-item scale consisting of a seven-factor structure is shown in Figure 2.

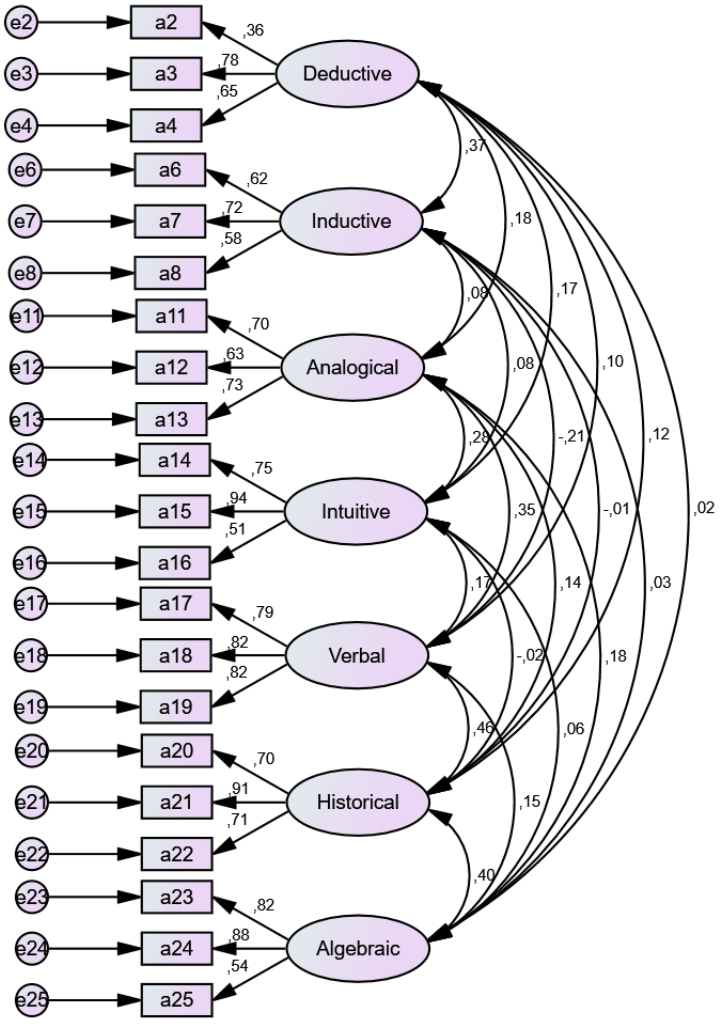

Figure 2. Confirmatory Factor Analysis Model of Scale Items

As a result of the confirmatory factor analysis, goodness of fit indices of seven-factors scale were as follows: χ^2=281.213, df=168, χ^2/df=1.67, *p<.001*, RMSEA=0.04, SRMR=0.05, CFI=0.95, GFI=0.93, AGFI=0.91, IFI=0.96, TLI=0.94, and NFI=0.90. χ^2/df ratio is below 3 shows perfect fit (Kline, 2005; Sümer, 2000). RMSEA and SRMR values are 0.05 or below

0.05 indicate perfect fit (Pallant, 2001). CFI, GFI, AGFI, IFI, TLI, NFI values which are greater than 0.90 constitute a good fit (Hu and Bentler, 1999; Kline, 2005; Tabachnick and Fidell, 2000). According to these criteria, the seven factors Reasoning Ways Scale displayed satisfactory fit indexes.

Composite Reliability, Convergent Validity and Discriminant Validity

The composite reliability (CR) of each factor was calculated. Convergent and discriminant validities were determined by examining the Average Variance Extracted (AVE), the square root of the AVE, Maximum Shared Variance (MSV) the Average Shared Squared Variance (ASV), inter-construct correlations and CR. The results were presented in Table 5.

Table 5. CR, AVE, the Square Root of the AVE, MSV, ASV, and Inter-Construct Correlations

Factor	CR	AVE	MSV	ASV	1	2	3	4	5	6	7
1. Deductive	.635	.387	.133	.036	**0.622**						
2. Inductive	.677	.413	.133	.032	.260**	**0.642**					
3. Analogical	.728	.473	.123	.048	.127*	.081	**0.687**				
4. Intuitive	.789	.569	.079	.024	.124*	.120*	.228**	**0.754**			
5. Verbal	.656	.851	.213	.074	.090	-.123*	.278**	.117*	**0.922**		
6. Historical	.820	.607	.213	.068	.096	-.004	.121*	-.055	.393**	**0.779**	
7. Algebraic	.799	.579	.162	.037	.056	.022	.152**	.046	.152**	.372	**0.760**

**p<.05, **p<.01, ***p<.001.*
Note: The bold values are the square root of the AVE values in the same row.

The CR higher than 0.60 shows composite reliability (Hair, Hult, Ringle and Sarstedt, 2017). Since the CR was higher than 0.60 for each factor, the composite reliability confirmed for the Reasoning Ways Scale.

For convergent validity, AVE should be equal or higher than 0.50 but lower than CR, and CR higher than 0.60 show convergent validity (Fornell and Larcker, 1981; Huang, Wang, Wu and Wang, 2013; Netemeyer, Bearden and Sharma, 2003). Although AVE was less than 0.50 for the factors of deductive, inductive and analogical, AVE is lower than CR for each factor. In addition, CR is higher than 0.60 for each factor in this study. According to Fornell and Larcker (1981) criterion, if AVE is less than 0.50 but CR is higher than 0.60, it is adequate for the convergent validity. In addition, to evaluate the convergent validity, the AVE of each construct was evaluated against its correlation with the other constructs. If AVE is higher than the correlation coefficients of the construct with other constructs, the convergent validity was considered to be confirmed (Gefen, Straub and Boudreau, 2000). Since it is

provided for each construct in this study, the convergent validity was confirmed for the Reasoning Ways Scale.

According to Fornell and Larcker Criterion, discriminant validity is established by comparing the square root of the average variance extracted (AVE) with the correlation of constructs. The square root of the AVE of each construct should be higher than the correlations of its with other constructs (Gefen et al., 2000). It was provided for each construct of the Reasoning Ways Scale. In addition, the MSV and the ASV should be less than the AVE for all the constructs for discriminant validity (Hair, Black, Babin and Anderson, 2010). The square root of the AVE of each construct was higher than its correlations with other constructs of the Reasoning Ways Scale. The MSV and ASV values for all the constructs were less than the AVE. Thus, the discriminant validity of the scale was confirmed.

Internal Consistency and Descriptive Statistics

Cronbach Alpha coefficient for the whole scale and sub-dimensions were calculated in order to examine the internal consistency of the Reasoning Ways Scale. The Cronbach's Alpha coefficient of the whole scale was calculated as 0.74. The main descriptive statistics and standardized Cronbach's Alpha coefficients for the sub-dimensions of the scale were given in Table 6.

Table 6. Descriptive Statistics and Internal Consistency of the Sub-dimensions of the Reasoning Ways Scale

	M	SD	Skewness	Kurtosis	Cronbach's Alpha
Deductive	10.27	3.25	-0.358	-0.674	0.605
Inductive	6.69	2.90	0.650	-0.084	0.666
Analogical	12.11	2.59	-0.722	-0.165	0.720
Intuitive	9.51	2.79	-0.240	-0.441	0.765
Verbal	13.23	2.03	-1.082	0.720	0.778
Historical	11.28	2.79	-0.430	-0.571	0.810
Algebraic	9.89	3.00	-0.099	-0.697	0.850

Hinton, Brownlow, McMurray and Cozens (2004) suggest that Cronbach's Alpha value between 0.70 and 0.90 indicates high reliability, and a value of Cronbach's Alpha between 0.50 and 0.70 indicates moderate reliability. According to the results, the Reasoning Ways Scale and all seven sub-dimensions were reliable and displayed normal distribution.

Following the validity and reliability studies, the final form of the Reasoning Ways Scale consists of 21 items with seven sub-dimensions: verbal,

historical, algebraic, intuitive, analogical, inductive and deductive. The equivalents of the scale items in the trial form (25 items form) in the Reasoning Ways Scale were given in Table 7.

Table 7. Equivalents of the Items in the Trial Form on the Scale

Trial Form	Scale	Trial Form	Scale	Trial Form	Scale
Item 2	Item 1	Item 12	Item 8	Item 19	Item 15
Item 3	Item 2	Item 13	Item 9	Item 20	Item 16
Item 4	Item 3	Item 14	Item 10	Item 21	Item 17
Item 6	Item 4	Item 15	Item 11	Item 22	Item 18
Item 7	Item 5	Item 16	Item 12	Item 23	Item 19
Item 8	Item 6	Item 17	Item 13	Item 24	Item 20
Item 11	Item 7	Item 18	Item 14	Item 25	Item 21

In the final form of the Reasoning Ways Scale, the items in the sub-dimensions were presented in Table 8.

Table 8. Items in the Sub-dimensions of the Reasoning Ways Scale

	Sub-dimensions	Items
Reasoning Ways Scale	Deductive	1-2-3
	Inductive	4-5-6
	Analogical	7-8-9
	Intuitive	10-11-12
	Algebraic	13-14-15
	Historical	16-17-18
	Verbal	19-20-21

Discussion and Conclusion

The aim of the present study was to develop the Reasoning Ways Scale and to evaluate the validity and reliability scale. The findings showed that the Reasoning Ways Scale is a valid and reliable measurement tool. The results are summarized as follows.

Confirmatory factor analysis findings were evaluated considering the criteria of χ^2/df ratio of 3 or less (Kline, 2005; Sümer, 2000) and CFI, GFI, AGFI, IFI, TLI and NFI values of 0.90 or higher (Hu and Bentler, 1999; Kline, 2005; Tabachnick and Fidell, 2000). According to these criteria, the seven factors of the Reasoning Ways Scale displayed satisfactory fit indexes. These results showed that the seven-factor structure of the Reasoning Ways Scale fitted the data set at the desired level. In addition, the factor loadings obtained from the confirmatory factor analysis of the scale were at acceptable levels.

It was determined that the Reasoning Ways Scale included seven different sub-dimensions, each consisting of three items, differing from each other in terms of features. Researchers have suggested varying numbers of items per factor ranging from three to five for representing each factor (Raubenheimer, 2004; MacCallum, Widaman, Zhang and Hong, 1999). This criterion was met as each sub-dimension of the scale consisted of three items. In addition to these, since each sub-dimension consisted of three items, it was thought that the total score would not be appropriate for this measurement tool. Therefore, the measuring tool has no cutoff point.

Convergent and discriminant validities of the Reasoning Ways Scale was tested in this study. Findings have shown that the Reasoning Ways Scale has adequate convergent and discriminant validities. However, since there are no tests with a similar structure, the correlation between similar tests could not be calculated.

Cronbach's Alpha reliability coefficient of the whole scale was calculated as 0.74 and all seven sub-dimensions were reliable and displayed normal distribution: verbal, 0.85; historical, 0.81; algebraic, 0.78; intuitive, 0.77; analogical, 0.72; inductive,0.67; deductive, 0.61. According to this, while the verbal, historical, algebraic, intuitive and analogical sub-dimensions show high, the inductive and deductive sub-dimensions indicate moderate reliability. In addition, a composite reliability value higher than 0.60 shows adequate composite reliability (CR) (Hair, Hult, Ringle and Sarstedt, 2017). Since the composite reliability coefficient for each sub-dimension of the Reasoning Ways Scale was higher than 0.60, the composite reliability of the scale was confirmed. As a result, the reliability of the Reasoning Scale has been proven.

The sample of the Reasoning Ways Scale consisted of education faculty students. However, since the scale items are related to daily life and not to the teaching profession, this scale can be used for all adult groups. In addition, the truth value of a proposition considered alone is related to the relevant field, attention was paid to ensure that the propositions included in the measurement tool are for the routine of daily life. Considering the participants of this study, the developed measurement tool is suitable for all individuals between the ages of 18 and 25 who are in the undergraduate education process.

"Reasoning" skills and preferred ways of reasoning are important parameters that determine the individual existence in decision-making, thinking, and problem-solving processes. This measurement tool has been developed

with the idea that reasoning ways, which are a cognitive ability and behavior that can be taught, should be included in formal learning processes because the way of producing science and technology occurs as a result of reasoning processes. In addition, the fact that the items in the measurement tool consisted of propositions made the preferences more understandable within the framework of logic. Dennett (1999), who defines all entities from simple to complex as directed systems, explained propositions as the basic form of mental states, and propositions as theoretical entities in which beliefs are specialized or measured. These theoretical entities indicate a judgment, and the reasons for choosing these judgments vary depending on different variables such as people's knowledge, expectations, needs, curiosity, passion, habits, experiences, or beliefs (Dennett, 1999). The rules of reasoning (deduction) are used while making a decision, exactly in the process of reaching a conclusion. This deduction process also requires multiple ways of reasoning when characterized from a post-modern perspective. Because in addition to the inductive and deductive ways of reasoning required by the positivist tradition, single or multiple ways of reasoning can vary according to individual preferences, depending on variables such as a person, situation, condition, expectation, readiness and mental ability. For this reason, the Reasoning ways Scale will be useful in terms of including seven different ways of reasoning.

Although the present study provides an important contribution to the literature, it contains some limitations. One of the limitations of this scale is that it measures only seven ways of reasoning. In addition, this scale cannot be evaluated according to a total score. Each sub-dimension is scored and evaluated within itself. Another limitation of the study is the inability to make comparisons since no measurement tool with a similar structure to the Reasoning Ways Scale has been encountered in the literature. In addition to these, the validity and reliability of the scale were evaluated only according to the data obtained from the students attending the education faculties. For this reason, it would be useful to test the psychometric properties of the scale in groups with participants from different faculties and departments in future studies.

References

Abdu, S. (1998). *Relationship between reasoning ability, self-efficacy and achievement in chemistry among pre-degree chemistry students*. Master Thesis in Education Ahmadu Bello University, Zaria.
http://worldwidescience.org/topicpages/n/Nigerian +university+libraries.html

Açıkgül, K. (2021). Developing a two-tier proportional reasoning skill test: Validity

and reliability studies. *International Journal of Assessment Tools in Education, 8*(2), 357-375.

Altıparmak, K. and Öziş, T. (2005). An investigation upon mathematical proof and development of mathematical reasoning. *Ege Journal of Education, 6,* 25-37.

Amir-Mofidi, S., Amiripour, P. and Bijan-Zadeh, M. H. (2012). Instruction of mathematical concepts through analogical reasoning skills. *Indian Journal of Science and Technology, 5*(6), 2916-2922.

Amsterlaw, J. A. (2004). Development of children's beliefs about everyday reasoning. University of Michigan.

Bergqvist, T., Lithner, J. and Sumpter, L. (2004). Reasoning characteristics in upper secondary school students' task solving. Mathematics and Language, 71-77.

Bhat, M. A. (2019). Learning styles in the context of reasoning and problem solving ability: An approach based on multivariate analysis of variance. *International Journal of Psychology and Educational Studies, 6*(1), 10-20.

Büyüköztürk, Ş. (2002). *Sosyal bilimler için veri analizi el kitabı istatistik araştırma deseni-SPSS uygulamaları ve yorum.* Ankara: Pegem Yayıncılık.

Casel. (2021). *Collaboration of Academics for Social Emotional Learning* (CASEL). https://casel.org.

Cavallo, A. M. L. (1996). Meaningful learning, reasoning ability and students' understanding and problem solving topics in genetics. *Journal of Research in Science Education, 33*, 625-656.

Coakes, J. S. and Steed, G. L. (2003). *SPSS analysis without anguish: Version 11.0 for windows.* Australia: John Wiley & Sons.

Çokluk, Ö., Şekercioğlu, G. and Büyüköztürk, Ş. (2016). *Sosyal bilimler için çok değişkenli istatistik: SPSS ve LISREL uygulamaları* (4. baskı). Ankara: Pegem Akademi.

Dennett, D. C. (1999). *Aklın türleri*. (H. Balkara, Trans.). Varlık Yayınları.

Drie, J. V. and Boxtel, C. V. (2007). *Historical reasoning: Towards a framework for analyzing students' reasoning about the past.* Published Online: 3 October 2007, Educ Psychol Rev. (2008) 20:87-110.

Duran, V. and Mertol, H. (2019). Investigation of the reasoning styles of the teacher candidates in terms of decision making styles, learning modalities and gender (Süleyman Demirel University Education Faculty Case). *European Journal of Contemporary Education, 8*(3), 489-505.

Erdem, E. and Gürbüz, R. (2015). An analysis of seventh-grade students' mathematical reasoning. *Çukurova University Faculty of Education Journal, 45*(1), 123-142.

Ergül, A. (2014). *Erken matematiksel akıl yürütme becerileri değerlendirme aracı geliştirilmesi*. Unpublished doctoral thesis, Hacettepe Üniversitesi Sağlık Bilimleri Enstitüsü.

Ertepmar, H. (1995). The relationship between formal reasoning ability, computer assisted instruction, and chemistry achievement. *Hacettepe University Journal of Education, 11*, 21-24.

Fornell, C. and Larcker, D. (1981). Structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39-50.

Garfield, J. B. (2003*). The 16 scales represent only a small subset of reasoning skills and strategies and attempts to establish the reliability and validity have raised*

new issues and yielded incomplete results. Retrieved from e-web.org

Gefen, D., Straub, D. W. and Boudreau, M. C. (2000). Structural equation modelling and regression: Guidelines for research practice. *Communications of the Association for Information Systems, 4*, 1-79.

Goodman, A., Joshi, H., Nasim, B. and Tyler, C. (2015). *Social and emotional skills in childhood and their long term effects on adult life.* UCL, Institute of Education.
http://www.eif.org.uk/wp-content/uploads/2015/03/EIF-Strand-1-Report-FINAL1.pdf

Gupta, S. (2012). A study of reasoning ability among high school students of Jammu district in relation to sex and academic achievement. *Review of Research Journal, 2*(2), 1-7.

Hair, J. F., Black, W. C., Babin, B. J. and Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Upper Saddle River, NJ: Prentice Hall.

Hair, J., Hult, G. T. M., Ringle, C. and Sarstedt, M. (2017). *A Primer on partial least squares structural equation modeling (PLS-SEM)* (2nd ed.). Los Angeles: Sage.

Hayes, B. K., Heit, E. and Swendsen, H. (2010). Inductive reasoning. *Wiley Interdisciplinary Reviews: Cognitive Science, 1*(2), 278-292.
Doi: 10.1002/wcs.44.

Heit, E. (2007). What is induction and why study it? In A. Feeney and E. Heit, (Eds.), *Inductive reasoning: Experimental, developmental, and computational approaches* (1-24). Cambridge University Press.
Doi: 10.1017/CBO9780511619304.002

Heit, E. and Rotello, C. M. (2010). Relations between inductive reasoning and deductive reasoning. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *36*(3), 805-812.

Hill, C. (2008). The post-scientific society. *Issues in Science and Technology on Line*, *24*(1), 78-84.

Hinton, P. R., Brownlow, C., McMurray, I. and Cozens, B. (2004). *SPSS explained.* East Sussex, England: Routledge Inc.

Hu, L. T. and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1-55.
Doi: 10.1080/10705519909540118

Huang, C. C., Wang, Y. M., Wu, T. W. and Wang, P. A. (2013). An empirical analysis of the antecedents and performance consequences of using the moodle platform. *International Journal of Information and Education Technology, 3*(2), 217-221.

Hyson, M. (2004). *The emotional development of young children* (2nd ed.). New York: Teachers College Press.

Jiyoung, K. and Narae, H. (2017). Validity and reliability of a Korean version of nurse clinical reasoning competence scale. *Journal of the Korea Academia-Industrial cooperation Society, 18*(4), 304-310.
Doi: 10.5762/KAIS.2017.18.4.304

Johnson, M. A. and Lawson, A. E. (1998). What are the relative effects of reasoning ability and prior knowledge on biology achievement on expository and inquiry classes? *Journal of Research in Science Teaching, 35*, 89-103.

Kanchan, K. and Sharma, S. (2013). Academic achievement of senior secondary

school students in relation to their gender and differential levels of reasoning ability. *International Educational E-Journal*, *2*(1), 16-20.

Kaput, J. (1999). Teaching and learning a new algebra. In E. Fennema and T. Romberg, (Eds.), *Mathematics classrooms that promote understanding* (133-155). Erlbaum: Mahwah, NJ.

Kind, P. and Osborne, J. (2016). Styles of scientific reasoning: A cultural rationale for science education? *Science Education, 101*(1), 8-31. Doi: 10.1002/sce.21251

Kılıç, S. (2013). Örnekleme yöntemleri. *Journal of Mood Disorders, 3*(1), 44-46.

Klauer, K. J., Willmes, K. and Phye, G. D. (2002). Inducing inductive reasoning: does it transfer to fluid intelligence. *Contemporary Educational Psychology*, *27*(1), 1-22.

Klauer, K. J. and Phye, G. D. (2008). Inductive reasoning: A training approach. *Review of Educational Research, 78*(1), 85-123. Doi: 10.3102/0034654308327416

Kline, R. B. (2005). *Principles and practice of structural equation modeling.* New York: The Guilford Press.

Leighton, P. J. and Sternberg, J. R. (2004). *The nature of reasoning*. The Edinburg Building Cambridge, CB2, Cambridge University Press.

MacCallum, R. C., Widaman, K. F., Zhang, S. and Hong, S. (1999). Sample size in factor analysis*. Psychological Methods, 4*(1), 84-99. Doi: 10.1037/1082-989X.4.1.84

Mousa, M. (2017). The influence of inductive reasoning thinking skill on enhancing performance. *International Humanities Studies, 4*(3), 37-48.

Netemeyer, R. G., Bearden, W. O. and Sharma, S. (2003). *Scaling procedures: Issues and applications.* Thousand Oaks, CA: Sage Publications.

Nnorom, N. R. (2013). The effect of reasoning skills on students achievement in biology in Anambra State. *International Journal of Scientific & Engineering Research, 4*(12), 2102-2104.

Oloyede, O. I. (2012). The relationship between acquisitions of science process skills, formal reasoning ability and chemistry achievement. *International Journal of African and African American Studies, 8*(1), 1-4.

Pallant, J. (2001). *SPSS survival manual.* Maidenhead, PA: Open University.

Paul, R. and Elder, L. (2008). *The miniature guide to critical thinking: Concepts and tools* (5th ed.). Tomales, CA: Foundation for Critical Thinking Press.

Raubenheimer, J. (2004). An item selection procedure to maximise scale reliability and validity. *SA Journal of Industrial Psychology, 30*(4), 59-64. http://www.sajip.co.za/index.php/sajip/article/viewArticle/168

Sharp, P. (2001). *Nurturing emotional literacy*. London: David Fulton.

Sungur, S., Tekkay, C. and Geban, O. (2001). The effect of gender differences and reasoning ability on the learning of human circulatory system concepts. *Hacettepe University Journal of Education, 20*, 126 -130.

Sümer, N. (2000). Yapısal eşitlik modelleri: Temel kavramlar ve örnek uygulamalar. *Turkish Psychological Articles, 3*(6), 49-74.

Şencan, H. (2005). *Sosyal ve davranışsal ölçümlerde güvenirlik ve geçerlik.* Ankara: Seçkin Yayıncılık.

Tabachnick, B. G. and Fidell, L. S. (2013). *Using multivariate statistics*. Boston: Allyn and Bacon.

Taylor, R. D., Oberle, E., Durlak, J. A. and Weissberg, R. P. (2017). Promoting positive youth development through school-based social and emotional learning interventions: A meta-analysis of follow-up effects. *Child Development, 88*(4), 1156-1171.

Tekkaya, C. and Yenilmez, A. (2006). Relationships among measures of learning orientation, reasoning ability, and conceptual understanding of photosynthesis and respiration in plants for grade 8th males and females. *Journal of Elementary Science Education, 18*(1), 1-14.

Umay, A. and Kaf, Y. (2005). A study on flawed reasoning in mathematics. *Hacettepe University Journal of Education, 28*, 188-195.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Zhao, W. (2018). Cultural lessons learned when a U.S.-trained Chinese professor meets home-grown Chinese pre/in-service teachers in a Hong Kong teacher education classroom. *Issues in Teacher Education, 27*(1), 28-40.

AKIL YÜRÜTME YOLLARI ÖLÇEĞİ

	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Ege bölgesinde zeytin yetiştiğine göre, Balıkesir'de de zeytin yetişir.					
2. Tüm çocuklar meraklı olduğuna göre, üç yaşındaki Deniz de meraklıdır.					
3. El dokuması halılar pahalıdır. Seyhan'ın evindeki halı el dokuması olduğuna göre, Seyhan'ın halısı da pahalıdır.					
4. Petrol rezervi yüksek olan Katar, zengin bir ülke olduğuna göre, petrol rezervleri iyi olan tüm ülkeler zengindir.					
5. Yüksek öğrenime sahip olan Evren zeki olduğuna göre, yüksek öğrenime sahip olan tüm insanlar zekidir.					
6. Yazar, şair ve ressamlar yaratıcı insanlar olduklarına göre, tüm sanatçılar yaratıcı insanlardır.					
7. Bir çiftçi fidanlarını nasıl yetiştirirse, öğretmen de öğrencilerini öyle yetiştirir.					
8. Beyin, bilgisayarlardaki hard disk gibi verileri saklayarak işler.					
9. Bir eleştirmen bir romanı nasıl analiz ederse, bir polis de suçları benzer şekilde çözer.					
10. Birçok konuda, genellikle sezgilerime dayanarak karar veririm.					
11. Önemli durumlarda, genellikle iç sesime kulak veririm.					
12. Çoğu durumda, aklımı bir kenara bırakır, kalbimin sesini dinlerim.					
13. Paragraf içerisinde, anlam bütünlüğünü bozan cümleyi bulurum.					
14. Karışık olay örgüsü cümlelerini sıralarım.					
15. Paragraftaki boşlukları uygun cümlelerle doldururum.					
16. Tarihsel bir olayı, farklı görüş içeren kaynaklardan araştırırım.					
17. Bir problemle karşılaştığımda, problemi anlamak için tarihsel gelişimine bakarım.					
18. Geleceğimi inşa ederken, tarihi bilgilerden yararlanırım.					
19. Çoğu bilgiyi, sayısal değerler vererek kolayca öğrenirim.					
20. Günlük hayatımda, sayısal ifadeleri kullanmak hayatımı kolaylaştırır.					
21. Günlük hayattaki problemlerimi çözmek için kendi formüllerimi oluştururum.					