www.ijte.net

Development and Validation of the Metacognitive Awareness Scale for Learning with Multimedia

Adem Koç
Mersin University, Türkiye

Mutlu Nisa Ünaldı Coral
Mersin University, Türkiye

To cite this article:

Koç, A. & Ünaldı Coral, M.N. (2024). Development and validation of the Metacognitive Awareness Scale for learning with multimedia. *International Journal of Technology in Education (IJTE), 7*(3), 513-534. https://doi.org/10.46328/ijte.740

International Journal of Technology in Education

2024, Vol. 7, No. 3, 513-534 https://doi.org/10.46328/ijte.740

Development and Validation of the Metacognitive Awareness Scale for Learning with Multimedia

Adem Koç, Mutlu Nisa Ünaldı Coral

Article Info

Article History

Received:
26 December 2023

Accepted:
10 May 2024

Keywords

Multimedia
Metacognitive awareness
Scale development
University students

Abstract

Technology has become increasingly prevalent in the field of education. Alongside the growing presence of technology in educational environments, the importance of learning with multimedia tools has also increased. It is believed that individuals need to be aware of how to learn most effectively in these environments for effective learning to take place. This research aims to develop a valid and reliable scale to reveal university students' metacognitive awareness of learning processes with multimedia. To achieve this goal, the study was conducted in two phases. Firstly, a pool of items was created by reviewing the literature, and 407 data were obtained to explore this pool of items. Subsequently, to confirm the structure of the revealed 6-factor scale, 318 data were collected from a second study group. The confirmed scale consists of a total of 41 items under six factors, explaining 54% of the total variance. The reliability coefficients for internal consistency of the scale as a whole were calculated as ω = .90 and α = .85. The results of the study indicate that the developed scale is a valid, reliable, and effective tool for measuring university students' metacognitive awareness of learning with multimedia.

Introduction

Educational systems are widely acknowledged as indispensable for the development and progress of societies (Yurdakul, Kanaatkar, Irtegun, Calbay & Yildirim, 2023). Education, perceived as a fundamental tool for the transfer of knowledge and skills, self-improvement of individuals, and the establishment of knowledge societies, has undergone a significant transformation with technological advancements. Digital learning environments have replaced traditional classroom education, making the learning experiences of students more diverse (Uzunboylu, Bicen & Cavus, 2011). At the heart of this transformation, the role of multimedia in education is particularly noteworthy. Multimedia, by integrating text, images, video, sound, and interactive elements, has emerged as a tool that enriches learning experiences. Especially courses and educational materials delivered on digital platforms can provide students with different learning opportunities, making the learning process more effective (Andresen & Brink, 2002; Tudor, 2013).

However, the impact of multimedia in education is not limited solely to the use of technology. Multimedia also provides students with opportunities to use and enhance their metacognitive skills. Metacognition, as defined by

Flavell (1976), is the individual's knowledge about their cognitive processes, outputs, or anything related to them, such as the characteristics of learning knowledge or data. Similarly, Brown (1987) defines the same concept as individuals having knowledge and control over their own cognitive systems. Metacognition, in a broader sense, encompasses individuals recognizing basic knowledge about cognitive tasks, planning well when faced with new problems, offering alternative solutions, applying analysis, synthesis, and evaluation processes to complete various cognitive tasks (Tosun & Senocak, 2013). Metacognition involves individuals organizing and monitoring input, as well as the ability to store, search, and retrieve it from memory (Flavell, 1976). In this context, metacognitive skills include important abilities for the 21st century, such as directing one's own learning process, developing strategies, problem-solving, and critical thinking. Learning experiences with multimedia can enhance students' learning potential by providing opportunities to use these metacognitive skills (Antonietti et al., 2015; Lindner et al., 2021).

Metacognition consists of two fundamental components: metacognitive knowledge and metacognitive regulation (Flavell, 1979; Schraw, Crippen, & Hartley, 2006). Metacognitive knowledge is the hidden cognitive knowledge related to mental activities such as tasks, goals, behaviors, and experiences of individuals (Flavell, 1979). Metacognitive knowledge is further divided into three subcomponents by Flavell (1979): personal knowledge, task knowledge, and strategy knowledge; and by Schraw, Crippen, and Hartley (2006): declarative knowledge, procedural knowledge, and conditional knowledge. Although the definitions expressed for these different subcomponents overlap, the subcomponents adopted by Schraw, Crippen, and Hartley (2006) in the research have been taken into account. In this context, declarative knowledge includes information about learners themselves and factors influencing their performances. Procedural knowledge involves information about strategies and other procedures, while conditional knowledge encompasses information about when and how declarative and procedural knowledge should be used (Schraw, Crippen, & Hartley, 2006).

The metacognitive regulation component of metacognition is also divided into three subcomponents: planning, monitoring, and evaluation. Planning involves determining appropriate strategies and acquiring resources. Monitoring consists of the self-testing abilities necessary to control learning. Evaluation encompasses the assessment of the learning process (Schraw, Crippen, & Hartley, 2006). The visual representation of this classification is presented in Figure 1.

The concept of 'awareness' is defined as a phenomenon emerging in individuals' ways of experiencing situations and phenomena in their lives (Marton & Booth, 1997). Having the same structure as metacognition (Schraw & Dennisson, 1994), metacognitive awareness refers to individuals having the necessary knowledge about how they will think and control their learning. In this context, metacognitive awareness includes information about how to think, learning preferences, strengths and weaknesses, as well as knowledge about what information to acquire and the best way to acquire it (Niedringhaus, 2010). In summary, it can be stated that this concept can be expressed as individuals being aware of their metacognitive knowledge and skills. It is also believed that as the number of stimuli in the learning environment increases, this concept, which can be considered as individuals being aware of their own learning in learning environments and being able to decide on the most suitable learning methods and techniques for themselves, will become more complex. Particularly in technology-supported learning environments, it is observed, especially during the COVID-19 pandemic, that it is challenging for individuals to focus their attention on the learning process for an extended period. While various multimedia tools may serve as options to support students' remote learning during periods of mandatory transition to remote education, the density of learning materials can divert them from their previous learning objectives (Zhang & Zou, 2021). In this regard, it is believed that individuals' metacognitive awareness in learning processes with multimedia tools is crucial. Although there are many measurement tools related to metacognition in the literature, it is seen that these measurement tools, whether developed or adapted, are oriented towards traditional learning environments (Akin et al., 2007; Balcikanli, 2011; Esmer & Yorulmaz, 2017; Karakelle & Sarac, 2007; Sanium & Buaraphan, 2022; Schraw & Dennison, 1994; Song et al., 2021; Sperling et al., 2002; Tosun & Irak, 2008; Vandergrift et al., 2006; Zhang & Qin, 2018).

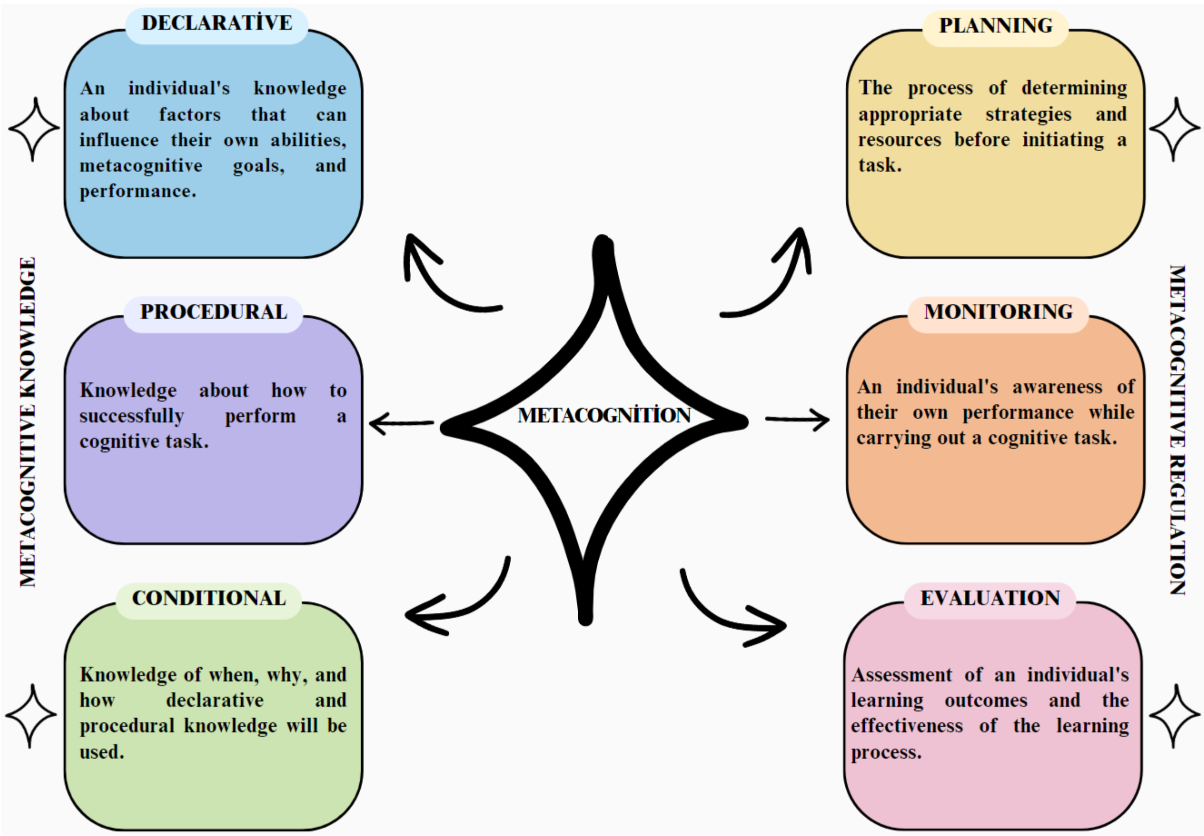


Figure 1. Subcomponents of Metacognition

Alongside debates regarding the generality or domain specificity of metacognition (Veenman et al., 2006), it is also closely related to self-regulated learning (Schraw & Dennison, 1994), which explains the relationship between cognition and metacognition (Frith, 2012). Additionally, metacognition is noted to be effective in multimedia environments (Azevedo et al., 2010). According to Flavell and Wellman, the taxonomy of metacognition fundamentally consists of three variable structures: person, task, and strategy. Accordingly, it is observed in the literature that various measurement tools considering different levels of the taxonomy have been developed for teachers (Kallio et al., 2017), teacher candidates (Sanium & Buaraphan, 2022), reading strategies (Ozturk, 2012), and piano learning (Askeri, 2021). It is thought that metacognition in technology-supported learning environments, expressed as multimedia, needs to be evaluated differently. It is believed that this concept, defined as individuals' awareness of their own learning, will become even more challenging in multimedia environments due to the increasing number of stimuli. In fact, the extent to which the effectiveness of multimedia learning is attributed to the presentation itself or to how students manage multimedia materials is still open to debate (Antonietti et al., 2015). In multimedia learning contexts, it is stated that metacognition significantly influences various learning outcomes (e.g., problem-solving, reasoning, and academic achievement) (Mayer, 2014). Additionally, metacognition is also acknowledged as a developable factor (Glaser et al., 1992; Schraw, 2001). However, it is observed that a significant challenge in enhancing students' metacognitive awareness is their tendency to recall previous knowledge and behaviors rather than questioning them (Rivers, 2020).

In this context, the importance of our study in developing the 'Metacognitive Awareness Scale for Multimedia Learning' becomes apparent. The developed scale aims to reveal individuals' metacognitive awareness in multimedia learning processes. Accordingly, the process of developing the scale is explained in detail in the study, information about the validity and reliability of the scale is presented, and discussions are made on how the results can contribute to educational practices. It is believed that the scale will be an important tool for guiding and enhancing metacognitive awareness in efforts aimed at making learning experiences with multimedia tools more efficient. This study also aims to contribute to researchers, educators, and policymakers in the education field by better understanding the role of multimedia in education and developing strategies to enhance students' metacognitive skills. In this context, a scale development study, called the 'Metacognitive Awareness Scale for Multimedia Learning,' was conducted by considering the theory of learning in multimedia and the concept of metacognitive learning. Accordingly, a literature review was conducted by considering the rules of scale development, and a pool of items was created to start the process. In this stage, in addition to the literature, expert opinions and possible item suggestions were obtained by consulting expert opinions and ChatGPT, a prototype artificial intelligence chat robot developed by OpenAI specializing in dialogue. The trial form created as a result of the literature review and expert opinions was presented to expert opinion, and validity ratios and validity index values were calculated.

Method

This section of the conducted research explains the study group and the process of developing the Metacognitive Awareness Scale for Multimedia Learning, along with the analysis of the data.

Research Design

The study was conducted following a survey design. In this design, through studies conducted on a sample selected from a specific population, trends, attitudes, or opinions across the population are quantitatively or numerically described (Creswell, 2014).

Study Group

In this research, to elucidate the structure of the developed measurement tool, exploratory factor analysis, and to confirm the established structure, confirmatory factor analyses were conducted through two separate independent study groups. Both groups consisted of undergraduate and postgraduate students who were engaged in online education systems during the spring semester of the academic year 2022-2023. Therefore, all participants in the study group have undergone learning with various multimedia tools during the period when remote education was mandatory. Data were collected both online and in-person. The trial form of the scale, created online, was sent to all individuals in the relevant study group, with necessary explanations provided. Participants were asked to respond to the form if they voluntarily committed to participate in the study. The printed form of the scale was also administered in person to individuals in the study group. Principal Component Analysis (PCA) and Exploratory Factor Analysis (EFA) factor extraction techniques were utilized in elucidating the structure of the developed measurement tool within the research framework. In this context, the results of two different factor extraction techniques were compared. Considering the results of PCA within the research scope, analyses were continued. Initially, 407 data were obtained to test the assumptions of EFA, and following preliminary analyses, the study continued with 371 data. The literature review indicated that 300 data were sufficient for EFA (Tabachnick & Fidel, 2015), demonstrating that this criterion was met. For testing the decided structure, confirmatory factor analyses were conducted with 318 data obtained from an independent study group with similar characteristics. After preliminary analyses, 23 observation data sets were excluded, and analyses were conducted with the remaining 295 data. In Table 1, the distribution of observations obtained through the data collection process for EFA and CFA based on various demographic characteristics is presented, and frequency and percentage values are calculated.

Table 1. EFA and CFA Study Groups

EFA						CFA					
		f	%	Total f	Total %			f	%	Total f	Total %
Age	18-22	196	48.2	407	100	Age	18-22	202	63.5	318	100
	23-27	122	29.9				23-27	71	22.3		
	28-32	77	18.9				28-32	37	11.7		
	33 and over	12	3.0				33 and over	8	2.5		
Sex	Male	124	30.5			Sex	Male	127	39.9		
	Female	283	69.5				Female	191	60.1		
Level of Education	Bachelor	305	74.9			Level of Education	Bachelor	232	72.9		
	Master's Degree	67	16.5				Master's Degree	69	21.7		
	Doctorate	35	8.6				Doctorate	17	5.4		

Scale Development Process

The scale development process began with an extensive literature review. In this context, a literature review on metacognition and metacognitive awareness was conducted to initiate the creation of the item pool and subsequent trial form for the developed measurement tool. In addition to the literature, expert opinions and ChatGPT, an artificial intelligence chat robot, were consulted to determine possible subfactors, make decisions on relevant demographic characteristics, and gather possible item suggestions. Following the evaluation of the literature review and expert opinions, a total of 60 items were written for the six factors expressed in the literature. While drawing upon the previously mentioned scales in the creation of the item pool, the characteristics of metacognition and metacognitive awareness, as well as the characteristics of multimedia learning environments, were taken into account. In this context, in order to enrich the item pool, support was sought from ChatGPT regarding the adaptability of certain items from previous scales to multimedia learning environments. The items written for the creation of the trial form were presented to a total of 5 experts, specializing in instructional design with multimedia tools, assessment and evaluation, and science education, who have experience in remote education. Accordingly: A total of 60 items were presented to expert opinions, and the views of five experts were collected. Within the framework of these opinions, content validity ratios and content validity index were calculated. The calculated content validity ratios vary between 0.11 and 1.00. In this case, the content validity index is calculated as 0.89. Considering the criteria of Veneziano and Hooper (1997), the appropriateness criterion for the relevant content validity ratio in the presence of five experts is 0.99. In this context, a total of 48 items with a content validity ratio of 0.99 and above were directly included in the trial form, or with minor adjustments according to expert opinions, while all items below this value were removed from the trial form. As a result, a trial form consisting of 48 items was created. Participants are expected to evaluate each item in the form using a 5-point Likert scale ranging from 'Strongly Disagree' to 'Strongly Agree'.

For the data obtained for EFA and CFA, initially, the dataset was checked for the assumptions of factor analysis, and the dataset was prepared for factor analysis. Preliminary analyses for both obtained datasets were conducted using SPSS 22. In this case, preliminary analyses were first conducted on the dataset obtained for EFA. While conducting EFA, principal component analysis was used as the factor extraction technique; however, the results of EFA were also presented to demonstrate that PCA and EFA yield similar results when the structure to be explained is known (Dogan & Aybek, 2021). Principal component analysis on the dataset was performed using SPSS 22, and EFA was performed using Jasp. The preliminary analyses for the suitability of the dataset for these analyses are as follows: After examining the 407 observations obtained after the application of the Multimedia with Metacognitive Awareness Scale (MMAS) trial form, it was concluded that there were no missing or erroneous data. The values of mode, median, and mean for each variable were generally close to each other, indicating that univariate normality was achieved. The scatter plot between the most distant pairs of items was examined. Although definitive evidence of linearity could not be obtained from this scatter plot, the analysis proceeded with the assumption that the correlation between item pairs was linear, as it is not very likely for linearity to exist between two different variables in nature. After calculating the standardized z-scores, it was observed that there were no univariate outliers outside the [4, -4] range (Tabachnick & Fidell, 2015). However, by calculating Mahalanobis distances, it was found that 30 observations exceeded the critical value (84.037) calculated for 48 degrees of freedom and a 0.001 error rate, indicating the presence of multivariate outliers, and a total of 36 observations were excluded from the dataset. All subsequent analyses were performed on the remaining 371 observations. The calculated Durbin-Watson statistic for all items was 1.91. Considering that this value is close to 2 (expected to be in the range of 2-2.5), it was concluded that there was no autocorrelation of errors and that the errors were independent. The multicollinearity problem among items was examined using Tolerance and VIF statistics. Tolerance values for the items range from 0.305 to 0.683, while VIF values range from 1.465 to 2.993. To avoid multicollinearity, Tolerance should be greater than 0.20, and VIF should be less than 5 (Tabachnick & Fidell, 2015). In this case, it was determined that none of the items showed a multicollinearity problem, and no item was removed from the trial form. The Durbin-Watson coefficient, which is expected to have values in the range of 2-2.50, was approximately 1.91, and it was interpreted as acceptable. Thus, it was concluded that the errors were independent. Additionally, to determine whether the data collected for the MMAS were suitable for EFA, the calculated Bartlett test result was found to be significant ($\chi 2 = 6753.041$, $p < 0.05$), and the KMO coefficient was 0.900. According to Tabachnick and Fidell (2015), as the KMO value approaches 1, the data are considered suitable for analysis. Therefore, based on the results of the preliminary analyses, it was concluded that the data were suitable for EFA.

In order to confirm the revealed structure of the scale, confirmatory factor analysis (CFA) was conducted. To conduct CFA, a total of 318 data were obtained from a different study group with similar characteristics to the group where EFA was performed. The mode, median, and mean values of the obtained 318 data were generally close to each other, indicating the achievement of univariate normality. The scatter plot between the most distant pairs of items was examined. Although definitive evidence of linearity could not be obtained from this scatter plot, the analysis proceeded with the assumption that the correlation between item pairs was linear, given that linearity is not very likely to exist between two different variables in nature. After calculating the standardized z-scores, it was observed that there were no univariate outliers outside the [-4, 4] range (Tabachnick & Fidell, 2015). However, by calculating Mahalanobis distances, it was found that 23 observations exceeded the critical value (74.74494) calculated for 41 degrees of freedom and a 0.001 error rate, indicating the presence of multivariate outliers, and a total of 23 observations were excluded from the dataset. All subsequent analyses were performed on the remaining 295 observations. The calculated Durbin-Watson statistic for all items was 2.091. Given that this value is in the range of 2-2.5, it was concluded that there was no autocorrelation of errors, and it was assumed that the errors were independent. The multicollinearity problem among items was examined using Tolerance and VIF statistics. Tolerance values for the items range from 0.316 to 0.696, while VIF values range from 1.431 to 3.164. Similar to the EFA dataset, it was determined that items did not exhibit a multicollinearity problem, and it was accepted that the dataset was ready for CFA.

Results

Results on EFA

After the preliminary analyses conducted on the dataset, EFA was performed to reveal the structure of the scale. Although the principal component analysis was used as the factor extraction technique, in cases where the structure to be explained is known, EFA was also conducted to demonstrate that this technique provides similar results to EFA. In cases where the comparison of the two factor extraction techniques is not mentioned within the scope of the study, the term EFA is generally used. EFA, a multivariate statistical technique, aims to combine a large number of interrelated variables to create a smaller number of conceptually meaningful variables (Buyukozturk, 2014). Factor analysis also provides insights into the functioning of the items (DeVellis, 2016). In the decision-making stage about the structure of the measurement tool, attention was paid to the common variance explained by the items being greater than 0.40, and the factor loadings of the items being greater than 0.45 (Köklü, 2002; Cokluk, Sekercioglu & Buyukozturk, 2018). Another consideration was whether an item loaded on two different factors with a difference of less than 0.10, in which case, those items had to be removed from the scale (Buyukozturk, 2014). In the item removal process, items were removed one by one from the scale, and after each removal, the analysis was conducted again. This is because after each removal, the factor loading of another problematic item may fall within acceptable limits, or the determination of which factor it belongs to may become more certain (Dogan & Aybek, 2021). In order to decide on the rotation technique to be applied after EFA, relationships between factor scores were examined. As the relationships between factors were not significant at the $p<0.05$ level, the varimax rotation technique, which is one of the orthogonal rotation techniques, was decided to be applied (Tabachnick & Fidell, 2015). Subsequently, the findings of the principal component analysis and exploratory factor analyses are as follows:

Initially, a principal component analysis was conducted using SPSS 22, and the explained common variances of the 48 items were examined, revealing that these values varied between 0.466 and 0.788. The factor loadings of the items in the scale were examined, and it was observed that 5 items did not obtain a value of 0.45 or higher under any factor, and 2 items loaded on different factors with a difference of less than 0.10; thus, they were removed from the scale. In the final state, it was observed that the remaining 41 items in the scale, distributed under six factors, each with more than 3 items, did not exhibit a factor loading difference of 0.10 or less under different factors (Tabachnick & Fidell, 2015). It is noted that the total 41 items distributed under six factors explain approximately 54.1% of the variance.

Afterward, CFA was conducted using Jasp, and similar results to principal component analysis were obtained. The only difference observed in CFA compared to principal component analysis is that the factor loadings of the items are smaller, resulting in a lower explained total variance. In CFA, it is noted that the factor loadings vary between 0.418 and 0.782, and the explained total variance is 46.5%. In this context, the total amount of explained variance, eigenvalues, and scree plot for both analyses were considered to determine the number of factors for the scale. The procedures related to these analyses are presented in Table 2 and Figure 2.

When examining Table 2, it is observed that, in the final stage, a total of 41 items on the scale are grouped under six factors. According to the eigenvalues from the principal component analysis, the eigenvalues for the six factors are as follows: the first factor is 9.932, the second factor is 4.922, the third factor is 2.207, the fourth factor is 2.134, the fifth factor is 1.636, and the sixth factor is 1.348. The total explained variance is calculated as 54.095%. Additionally, according to the CFA, the eigenvalues for the factors are as follows: the first factor is 9.417, the second factor is 4.426, the third factor is 1.668, the fourth factor is 1.631, the fifth factor is 1.088, and the sixth factor is 0.829. The total explained variance is calculated as 46.500%. In this case, CFA shows lower factor loadings and explains less variance compared to the principal component analysis. Moreover, in both factor extraction techniques, the total explained variance is found to be greater than 40%. Considering that in social sciences, it is generally accepted that an explained variance between 40% and 60% in multifactorial structures is sufficient, this value is deemed quite good (Scherer, Wiebe, Luther, & Adams, 1988). Given the higher explained variance for items and the previously established structure in the literature, the principal component analysis was adopted. The analysis results confirm that the six-factor structure is supported by Horn's parallel analysis (Horn, 1965). Horn's Parallel Analysis Method is based on generating random data to determine the number of factors. With the Monte Carlo simulation method, random data is generated to be parallel to the real data, and the expected eigenvalue of parallel data is calculated. The eigenvalue obtained from the parallel data is then compared with the eigenvalues estimated from the real data set. The point where the eigenvalue of the parallel data is greater than that of the real data set determines the significant number of factors (Ledesma & Valero-Mora, 2019). The simulated values created for the relevant data set are presented in Table 3.

Table 2. The Number of Factors in the 41-item form of the Scale, the Eigenvalues and Explained Variance Values of the Factors

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	Variance	Cumulative %	Total	Variance	Cumulative %	Total	Variance	Cumulative %
1	9.932 9.417*	24.225 23.000*	24.225 23.000*	9.932	24.225	24.225	4.510 4.040*	11.001 9.900*	11.001 9.900*
2	4.922 4.426*	12.004 10.800*	36.229 33.800*	4.922	12.004	36.229	4.351 4.033*	10.612 9.800*	21.613 19.700*
3	2.207 1.668*	5.383 4.100*	41.612 37.800*	2.207	5.383	41.612	4.054 3.631*	9.888 8.900*	31.501 28.500*
4	2.134 1.631*	5.205 4.000*	46.817 41.800*	2.134	5.205	46.817	3.970 3.520*	9.683 8.600*	41.184 37.100*
5	1.636 1.088*	3.990 2.700*	50.807 44.500*	1.636	3.990	50.807	2.695 2.038*	6.573 5.000*	47.757 42.100*
6	1.348 0.829*	3.288 2.000*	54.095 46.500*	1.348	3.288	54.095	2.599 1.798*	6.338 4.400*	54.095 46.500*

*: Values related to EFA.

Table 3. Horn Parallel Analysis Results

Component or Factor	Mean Eigenvalue	Percentile Eigenvalue	Component or Factor	Mean Eigenvalue	Percentile Eigenvalue
1	1.698512	1.771678	5	1.464665	1.503315
2	1.614778	1.666963	6	1.418131	1.457023
3	1.554677	1.602478	7	1.379700	1.419555
4	1.506592	1.557147	8	1.344283	1.384544

The decision on the number of factors is made by considering the case where the eigenvalue calculated from the actual data set is smaller than the eigenvalue calculated from the simulated data. Accordingly, parallel analysis supports a 7-factor structure (1.348 < 1.379). When the structure is forced into a 7-factor structure, it is observed that there is no item loading with a value greater than 0.45 under the seventh factor. Therefore, the decision is made to preserve the six-factor structure. Additionally, the slope gradient graph drawn for this structure is observed to be as shown in Figure 2.

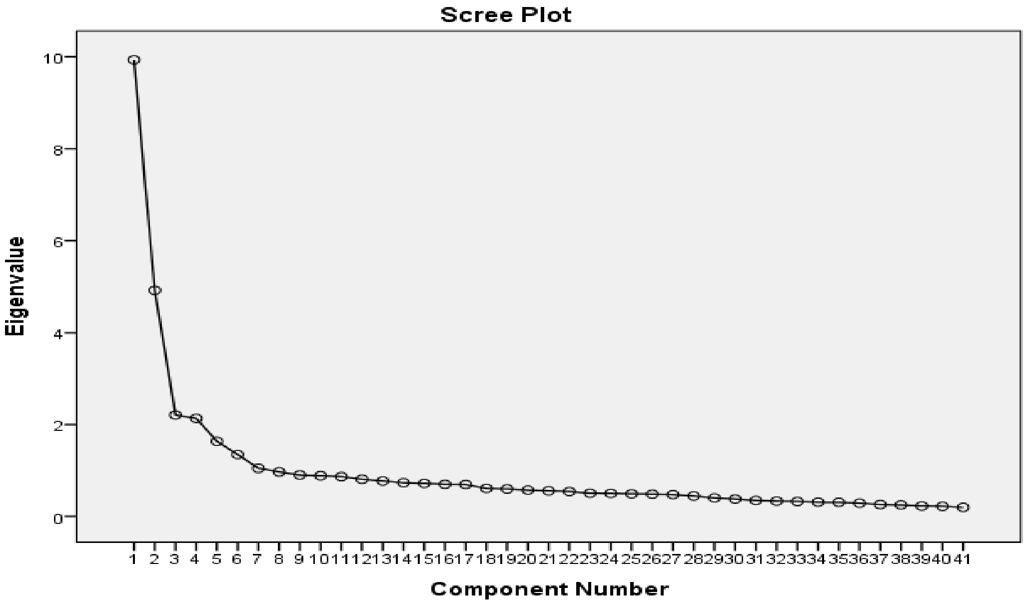


Figure 2. Results of Scree Test for the Scale Consisting of 41 Items

Upon examination of the slope gradient graph in Figure 2, it is evident that the slopes exhibit a noticeable break, supporting a six-factor structure. In this context, the slope gradient graph, by aligning with the eigenvalues and the explained total variance results, suggests that it would be appropriate for the items in the scale to be grouped under six factors. The factor loadings of the total 41 items distributed under six factors are presented in Table 4.

Table 4. The Factor Loadings of the Total 41 Items Distributed under Six Factors

Items	Subfactors					
	Metacognitive Knowledge			Metacognitive Regulation		
	Declarative	Procedural	Conditional	Planning	Monitoring	Evaluation
M1	.788					
M2	.765					
M3	.742					
M4	.727					
M5	.679					
M6	.667					
M7	.592					
M8	.543					
M9	.505					
M10		.691				
M11		.681				
M12		.651				

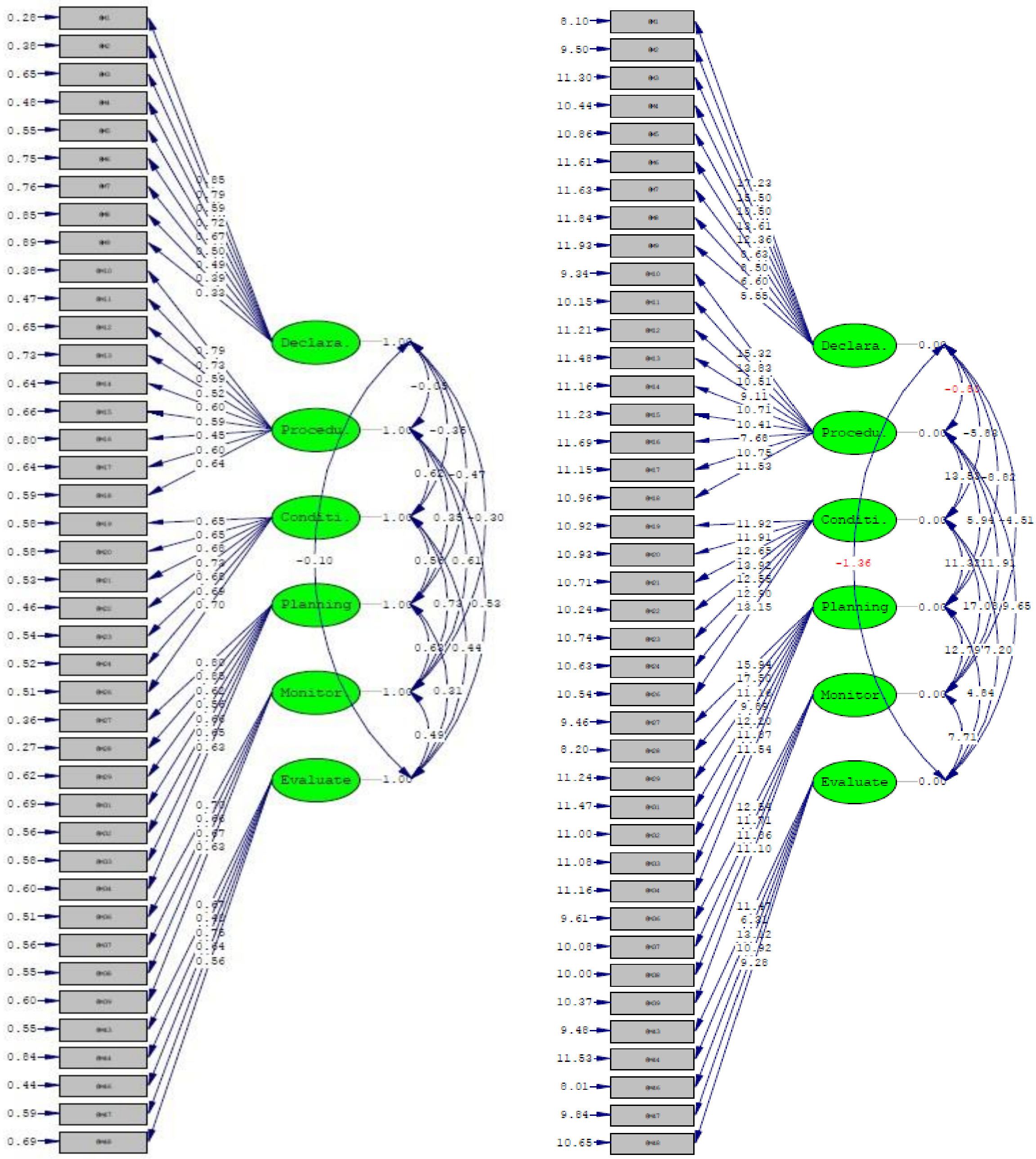
Items	Subfactors					
	Metacognitive Knowledge			Metacognitive Regulation		
	Declarative	Procedural	Conditional	Planning	Monitoring	Evaluation
M13		.625				
M14		.617				
M15		.604				
M16		.590				
M17		.577				
M18		.508				
M19			.771			
M20			.753			
M21			.700			
M22			.609			
M23			.602			
M24			.580			
M26			.530			
M27				.785		
M28				.777		
M29				.713		
M31				.695		
M32				.638		
M33				.522		
M34				.466		
M36					.693	
M37					.600	
M38					.578	
M39					.528	
M43						.753
M44						.654
M46						.599
M47						.585
M48						.557

*M: Multimedia

According to Table 4, it is observed that the factor loadings for the total of 41 items, distributed under six factors, vary between 0.466 and 0.788.

Results on CFA and Second Order CFA

After the EFA of the scale, a CFA was conducted using data obtained from a different study group with similar characteristics to confirm the revealed structure. In this context, the path diagram depicting standardized values and t-values for the conducted CFA is presented in Figure 3 (a) and Figure 3 (b).

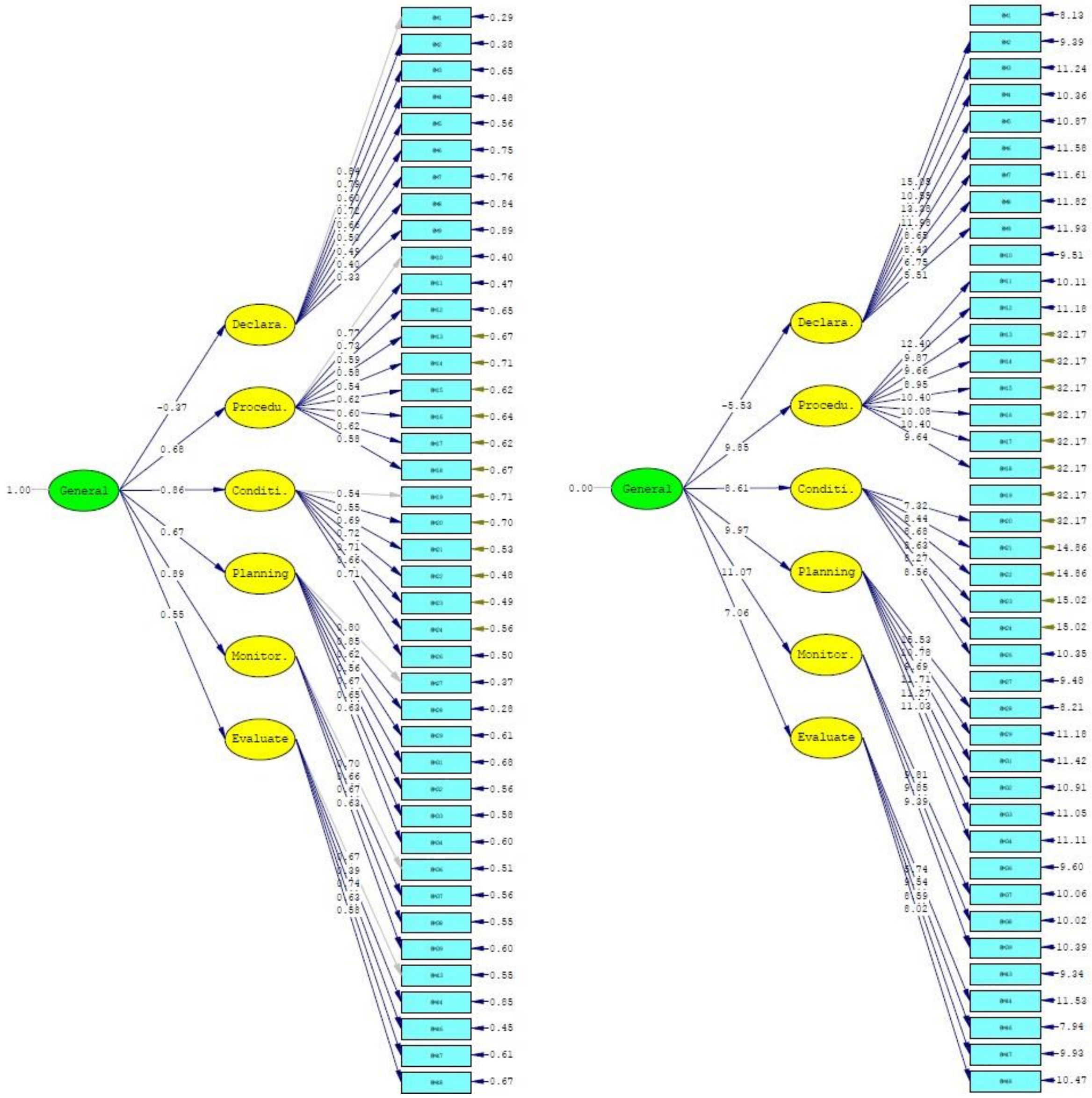


(a) (b)

Figure 3. First Level CFA Standardized Values (a) and t Values (b)

When examining Figure 3 (a), it is observed that standardized values vary between 0.33 and 0.85. In Figure 3 (b), all t-values between items and sub-factors are statistically significant ($p < 0.01$).

Furthermore, standardized values and t-values for the overall scale in the second-order CFA are presented in Figure 4 (a) and Figure 4 (b), while the goodness-of-fit values for both CFAs are provided in Table 5.



(a) (b)

Figure 4. Second Order CFA Standardized Values (a) and t Values (b)

Upon examination of Figure 4 (a), it is observed that the standardized score for the Declarative Information sub-factor is -0.37, and the standardized scores for other sub-factors range from 0.55 to 0.86. In Figure 4 (b), t-scores for sub-factors and the overall scale are displayed. Despite the negative t-score for the Declarative Information sub-factor, all t-values are statistically significant ($p < 0.01$).

Table 5. Goodness of Fit Values for both CFAs

CFA	$\chi2_{(1570,53)}/sd_{(764)}$	RMSEA	NFI	CFI	RFI	NNFI	SRMR
First Order	2.05	0.060	0.90	0.95	0.90	0.94	0.073
Second Order	2.17	0.065	0.89	0.94	0.89	0.93	0.083

The calculated fit indices for the tested measurement model are as seen in Table 5. When examining the values, it can be stated that the χ2(1570.53)/df(764) value being less than 5 indicates a very good fit. The other calculated fit indices, NFI, CFI, RFI, and NNFI, having values higher than 0.90, along with an SRMR value of 0.073, are interpreted as indicators that the measurement model has a good fit (Cokluk, Sekercioglu & Buyukozturk, 2018). Additionally, the calculated fit index RMSEA, being lower than 0.05, is considered desirable (Jöröskog & Sörbom, 1993), and although values below 0.10 are acceptable (Anderson & Gerbing, 1984), it is acknowledged as acceptable in this case. Therefore, it is concluded that the tested measurement model is confirmed.

In addition, using the values related to CFA data, an attempt was made to estimate the convergent and discriminant validity of the scale by calculating composite reliability and average variance extracted (AVE) values for each factor. In this context, the values of convergent reliability (CR), obtained by dividing the sum of the squares of the standard load values of the items under each factor by the sum of the actual load values (observed value + error variance), and Average Variance Extracted (AVE) values for each factor are presented in Table 6.

Table 6. CR and AVE of the Measurement Items

Subfactors	Composite reliability	Average variance extracted
Declarative Knowledge	0.88	0.46
Procedural Knowledge	0.85	0.38
Conditional Knowledge	0.84	0.43
Planning	0.84	0.44
Monitoring	0.69	0.36
Evaluation	0.77	0.40

When examining Table 6, it is observed that the CR values generally meet the condition of being greater than 0.70. AVE values are generally expected to be greater than 0.50 (Fornell & Larcker, 1981). However, none of the factors meet this condition, but the calculated values are very close to 0.50. Nevertheless, since all calculated CR values are greater than AVE values, it is considered an indicator that the developed scale meets the condition of convergent validity (Nunnally & Bernstein, 1994).

Results on Reliability

The calculated Cronbach's α reliability coefficient and McDonald's ω coefficient values for the final form of MEYPFO consisting of 41 items and six subscales, based on the CFA data, are presented in Table 7 for both subscales and the overall scale.

Table 7. Reliability Coefficient Values in terms of Internal Consistency

Subfactors	Declarative Knowledge	Procedural Knowledge	Conditional Knowledge	Planning	Monitoring	Evaluation
Cronbach α	0.83	0.84	0.86	0.86	0.76	0.74
Total	Cronbach α			McDonald´s ω		
	0.85			0.89		

When examining Table 7, it is observed that Cronbach's α reliability coefficient values range from 0.74 to 0.86 for individual subscales and are calculated as 0.85 for the overall scale. The calculated McDonald's ω coefficient for the overall scale is 0.89. In terms of internal consistency, a Cronbach's α coefficient above 0.70 is expected for reliability assessment (DeVellis, 2012). In this context, the calculated value for the MEYPFO trial form is considered an indicator of very high internal consistency for this form. Thus, the values calculated separately using AFA and CFA data demonstrate that the reliability of the scale is quite high in terms of both overall and subscale internal consistency.

Discussion and Conclusion

This study focuses on the development of a valid and reliable scale to reveal individuals' metacognitive awareness in multimedia learning processes. While there have been numerous studies on the development and adaptation of metacognitive awareness scales in the literature, these measurement tools are observed to be oriented towards learning processes in traditional learning environments (Akin et al., 2007; Balcikanli, 2011; Esmer & Yorulmaz, 2017; Karakelle & Sarac, 2007; Schraw & Dennison, 1994; Song et al., 2021; Sperling et al., 2002; Tosun & Irak, 2008; Vandergrift et al., 2006; Zhang & Qin, 2018). When examining the literature, it is evident that the use of technology in educational processes is increasing, and various reality technologies such as virtual, augmented, and mixed reality have become more widespread in recent times. Following the rapid development of multimedia tools in educational environments, there has arisen a need for metacognitive awareness scales specifically designed for their use. In this study, the developed scale is organized within the subcomponents of metacognition expressed by Schraw, Crippen, and Hartley (2006), namely metacognitive knowledge and metacognitive regulation. These subcomponents are further delineated into declarative knowledge, procedural knowledge, situational knowledge, planning, monitoring, and evaluation. Items under declarative knowledge encompass factors that relate to individuals' knowledge about themselves and the factors affecting their performance in the multimedia learning process. Items under procedural knowledge consist of information about strategies and other procedures that individuals can use in the multimedia learning process. Situational knowledge comprises information on when and how declarative and procedural knowledge should be applied. Planning involves determining appropriate strategies, securing resources in the metacognitive learning process; monitoring consists of controlling this learning process, and evaluation includes items for the overall evaluation of the learning process.

The six-factor structure of the scale appears to be similar to the concept of metacognition expressed by Schraw, Crippen, and Hartley (2006), as well as to some other previously developed scales in the literature (e.g., Balcikanli, 2011; Sanium & Buaraphan, 2022). The theoretical foundation of the concept and its alignment with similar scales in the literature, along with evidence of validity and reliability, indicate that the developed scale can be utilized to reveal metacognitive awareness in individuals engaging in learning with multimedia tools. However, it should be noted that the scale has certain assumptions and limitations. In this context, data were obtained online during the scale development process, and it is assumed that all individuals voluntarily participated in the study, reading and answering all items. The structure of the scale can be tested in different study groups.

The validation studies of MASML aimed to establish content and structural validity. To ensure content validity, opinions were sought from a total of 5 experts in measurement and evaluation and science education, and based on these opinions, content validity ratios and content validity indices were calculated. As mentioned in the development process of the scale, decisions about the items to be included in the trial form were made by comparing the calculated values with critical values. EFA was utilized to test the structural validity of the scale, and the analyses revealed that the form, consisting of 41 items, exhibited a six-factor structure.

The trial form created during the development process of the scale consists of 48 items. After the data collection process, analyses were conducted, resulting in the decision to retain 41 items in the scale, while excluding 7 items that did not meet the established criteria. Consequently, the remaining 41 items in the scale were grouped into 6 factors based on the slope gradient graph and item load values obtained through EFA. The first factor is labeled as 'Planning' and consists of a total of 9 items. The second factor is named 'Monitoring' and consists of a total of 9 items. The third factor is designated as 'Procedural Knowledge' and comprises a total of 7 items. The fourth factor is identified as 'Evaluation' and includes a total of 7 items. The fifth factor is termed 'Situational Knowledge' and encompasses 4 items. Finally, the sixth factor is named 'Declarative Knowledge' and comprises 5 items. This structure was tested with CFA, and the calculated standardized load values varied between 0.39 and 0.88, with all t-values being statistically significant. Additionally, the calculated fit indices were found to be excellent/acceptable. In this form, the 'Multimedia Learning Metacognitive Awareness Scale,' consisting of a total of 44 items under 6 factors and using a 5-point Likert scale, is considered a scientifically and psychometrically valid and reliable measurement tool. It is expected to validly and reliably reveal the metacognitive awareness scores of individuals benefiting from multimedia tools in the learning process.

Acknowledgements

This study was conducted within the scope of the doctoral dissertation supervised by Prof. Dr. Mutlu Nisa Ünaldı Coral and carried out by Adem Koç. The study received support from Mersin University Scientific Research Projects Unit under project number 2023-1-TP3-4840. Additionally, a part of the study was presented as an oral summary at the International Education Congress 2023.

References

Akin, A., Abaci, R., & Cetin, B. (2007). The validity and reliability study of the Turkish version of the Metacognitive Awareness Inventory. *Educational Science: Theory & Practice*, *7*(2), 655-680.

Anderson, J. C. ve Gerbing, D. W. (1984). The effect of sampling error on convergence, improper solutions, and goodness-of-fit indices for maximum likelihood confirmatory factor analysis. *Psychometrika*, *49*(2), 155-173.

Andresen, B. B., & van den Brink, K. (2002). Multimedia in education. In *Specialised training course*. Moscow: UNESCO Institute for Information Technologies in Education.

Antonietti, A., Colombo, B., & Di Nuzzo, C. (2015). Metacognition in self-regulated multimedia learning: Integrating behavioural, psychophysiological and introspective measures. *Learning, Media and*

Technology, 40(2), 187-209. https://doi.org/10.1080/17439884.2014.933112

Askeri, D. (2021). *Development of Metacognitive Awareness Scale for Piano Learning* (Publication No. 687779) [Master's thesis, Muğla Sıtkı Koçman University]. YÖK National Thesis Center.

Balcikanli, C. (2011). Metacognitive awareness inventory for teachers (MAIT). *Electronic Journal of Research in Educational Psychology, 9*(3), 1309–1332. https://doi.org/10.25115/ejrep.v9i25.1620

Brown, A. (1987). Metacognition, executive control, self-regulation, and other more mysterious mechanisms. In F. Reiner & R. Kluwe (Eds.), *Metacognition, motivation, and understanding* (pp. 65–116). Hillsdale, NJ: Lawrence Erlbaum.

Buyukozturk, S. (2014). *Manual of data analysis for social sciences*. Ankara: Pegem Academy.

Cokluk, O., Sekercioglu, G., & Buyukozturk, S. (2012). Multivariate statistics for social sciences: SPSS and LISREL applications (Vol. 5). Ankara: Pegem Academy.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th Edition). [Translated by Selcuk Besir Demir (Ed.)] Ankara: Eğiten Kitap.

DeVellis, R. F. (2016). *Scale development: Theory and applications*. London, UK: Sage.

Dogan, C. D., & Aybek, E. C. (2021). *Psychometrics and statistics applications with R Shiny*. Ankara: Pegem Academy.

Esmer, E., & Yorulmaz, A. (2017). Reliability and validity analysis of the metacognitive awareness scale teacher form. *Bartin University Journal of Faculty of Education, 6*(3), 955-966. https://doi.org/10.14686/buefad.306102

Flavell, J. H. (1976). Metacognitive aspects of problem-solving. In L. B. Resnick (Ed.), *The nature of intelligence* (pp. 231–236). Hillsdale, NJ: Erlbaum.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist*, *34*(10), 906-911.

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

Frith, C. D. (2012). The role of metacognition in human social interactions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*(1599), 2213-2223.

Glaser, R., Schauble, L., Raghavan, K., & Zeitz, C. (1992). Scientific reasoning across different domains. In De E. Corte, M. C. Linn, H. Mandl, L. Verschaffel, (Eds.), *Computer Based Learning Environments and Problem Solving* (pp. 345–371). Springer. https://doi.org/10.1007/978-3-642-77228-3_16

Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. Psychometrika, 30, 179-185.

Jöreskog, K. G., & Sörbom, D. (1993). *LISREL 8: Structural equation modeling with the SIMPLIS command language*. Scientific software international.

Kallio, H., Virta, K., Kallio, M., Virta, A., Hjardemaal, F. R., & Sandven, J. (2017). The utility of the metacognitive awareness inventory for teachers among in-service teachers. *Journal of Education and Learning*, *6*(4), 78-91.

Karakelle, S., & Sarac, S. (2007). Validity and Factor Structure of Turkish Versions of The Metacognitive Awareness Inventory for Children (Jr. MAI) - A and B Forms. *Turkish Psychological Articles, 10*(20), 87-103.

Koklu, N. (2002). *Annotated dictionary of statistics terms*. Ankara: Nobel Publishing.

Ledesma, R. D., & Valero-Mora, P. (2019). Determining the number of factors to retain in EFA: An easy-to-use computer program for carrying out parallel analysis. *Practical assessment, research, and evaluation, 12*(1), 2. https://doi.org/10.7275/wjnc-nm63

Lindner, M. A., Eitel, A., Barenthien, J., & Köller, O. (2021). An integrative study on learning and testing with multimedia: Effects on students' performance and metacognition. *Learning and Instruction*, *71*, 101100. https://doi.org/10.1016/j.learninstruc.2018.01.002

Marton, F., & Booth, S. A. (1997). *Learning and awareness*. Psychology Press.

Mayer, R. E. (2014). Multimedia instruction. *Handbook of research on educational communications and technology*, 385-399.

Niedringhaus, K. L. (2010). Teaching better research skills by teaching metacognitive ability. *Perspectives: Teaching Legal Research and Writing*, *18*, 113.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory*. New York, NY: McGraw-Hill, Inc.

Ozturk, E. (2012). The validity and reliability of the Turkish version of the metacognitive awareness of reading strategies inventory. *Elementary Education Online, 11*(2), 292-305.

Rivers, M. L. (2021). Metacognition about practice testing: A review of learners' beliefs, monitoring, and control of test-enhanced learning. *Educational Psychology Review*, *33*(3), 823-862.

Sanium, S., & Buaraphan, K. (2022). Developing a Coding Scheme for Exploring Preservice Science Teachers' Metacognition in a Method Course. *Sustainability*, *14*(9), 5644. https://doi.org/10.3390/su14095644

Scherer, R. F., Luther, D. C., Wiebe, F. A., & Adams, J. S. (1988). Dimensionality of coping: Factor stability using the ways of coping questionnaire. *Psychological reports, 62*(3), 763-770.

Schraw, G. (2001). Promoting general metacognitive awareness. In *Metacognition in learning and instruction: Theory, research and practice* (pp. 3-16). Dordrecht: Springer Netherlands.

Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive awareness. *Contemporary educational psychology*, *19*(4), 460-475.

Schraw, G., Crippen, K. J. & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education*, *36*, 111-139.

Song, J. H., Loyal, S., & Lond, B. (2021). Metacognitive Awareness Scale, Domain Specific (MCAS-DS): Assessing metacognitive awareness during raven's progressive matrices. *Frontiers in Psychology*, *11*, 607577. https://doi.org/10.3389/fpsyg.2020.607577

Sperling, R. A., Howard, B. C., Miller, L. A., & Murphy, C. (2002). Measures of children's knowledge and regulation of cognition. *Contemporary educational psychology*, *27*(1), 51-79.

Tabachnick, B. G. & Fidel, L. S. (2015). Using Multivariate Statistics.,(Baloğlu, M., Çev. Ed.). Ankara: Nobel Yayıncılık.

Tosun, A. & Irak, M. (2008). Adaptation, Validity, and Reliability of the Metacognition Questionnaire-30 for the Turkish Population, and its Relationship to Anxiety and Obsessive-Compulsive Symptoms. *Turkish Journal of Psychiatry*, *19*(1).

Tosun, C., & Senocak, E. (2013). The effects of problem-based learning on metacognitive awareness and attitudes toward chemistry of prospective teachers with different academic backgrounds. *Australian Journal of Teacher Education (Online)*, *38*(3), 61-73. https://doi.org/10.14221/ajte.2013v38n3.2

Tudor, S. L. (2013). The role of multimedia strategies in educational process. *Procedia-Social and Behavioral*

Sciences, *78*, 682-686. https://doi.org/10.1016/j.sbspro.2013.04.375

Uzunboylu, H., Bicen, H., & Cavus, N. (2011). The efficient virtual learning environment: A case study of web 2.0 tools and Windows live spaces. *Computers & Education*, *56*(3), 720-726. https://doi.org/10.1016/j.compedu.2010.10.014

Vandergrift, L., Goh, C. C., Mareschal, C. J., & Tafaghodtari, M. H. (2006). The metacognitive awareness listening questionnaire: Development and validation. *Language learning*, *56*(3), 431-462. https://doi.org/10.1111/j.1467-9922.2006.00373.x

Veenman, M. V., Van Hout-Wolters, B. H., & Afflerbach, P. (2006). Metacognition and learning: Conceptual and methodological considerations. *Metacognition and learning*, *1*, 3-14.

Veneziano, L. (1997). A method for quantifying content validity of health-related questionnaires. *American Journal of Health Behavior*, *21*(1), 67-70.

Yurdakul, M., Kanaatkar, O., Irtegun, E., Calbay, F., & Yildirim, R. (2023). The role of school administrators in teachers' motivation. TURAN: *Strategic Research Center*, *15*(59), 370-376. https://doi.org/10.15189/1308-8041

Zhang, L. J., & Qin, T. L. (2018). Validating a questionnaire on EFL writers' metacognitive awareness of writing strategies in multimedia environments. In *Metacognition in language learning and teaching* (pp. 157-178). Routledge.

Zhang, R., & Zou, D. (2021). A State-of-the-art review of the modes and effectiveness of multimedia input for second and foreign language learning. *Computer Assisted Language Learning*, 1-27.

Author Information

Adem Koç

https://orcid.org/0000-0002-2721-3781

Department of Mathematics and Science Education

Mersin University, Mersin

Turkey

Contact e-mail: *ademkoc@mersin.edu.tr*

Mutlu Nisa Ünaldı Coral

https://orcid.org/0000-0001-6124-4576

Department of Mathematics and Science Education

Mersin University, Mersin

Turkey

Appendix. Turkish and English Expressions of the 41 Items in the Scale

Turkish	English
1. Multimedya araçlarıyla öğrenme sürecinde dikkatimi nelere odaklamam gerektiğini bilirim.	1. I know what to focus on in the learning process with multimedia tools.
2. Konuyla ilgili multimedya araçlarından öğrenme yöntemime uygun olanları seçerim.	2. I choose multimedia tools that are suitable for my learning method.
3. Multimedya kaynaklarıyla ilgili sık karşılaşılan sorunların neler olabileceğine dair fikrim var.	3. I have an idea of common problems related to multimedia sources.
4. Multimedya kaynaklarıyla ilgili karşılaşılan sorunların üstesinden nasıl gelebileceğimi bilirim.	4. I know how to overcome problems encountered with multimedia sources.
5. Konuya göre konuyu öğrenmeme yardımcı olacak farklı multimedya araçlarını belirlerim.	5. I identify different multimedia tools that will help me learn the subject.
6. Multimedya kaynaklarıyla öğrenmede güçlü yönlerimi doğru bir şekilde belirleyebilirim.	6. I can accurately identify my strengths in learning with multimedia sources.
7. Multimedya kaynaklarıyla öğrenmede zayıf yönlerimi doğru bir şekilde belirleyebilirim.	7. I can accurately identify my weaknesses in learning with multimedia sources.
8. Multimedya kaynaklarıyla öğrenmemi geliştirmek için daha fazla bilgi veya desteğe ihtiyacım olduğunda bunun farkına varabilirim.	8. I can recognize when I need more information or support to improve my learning with multimedia sources.
9. Etkili multimedya araçlarının özelliklerini tanımlayabilirim.	9. I can describe the features of effective multimedia tools.
10. Multimedya araçlarıyla öğrenme sürecine hazırlanırken konuya ve kendime en uygun öğretim yöntemini belirlerim.	10. I determine the most suitable teaching method for the subject and myself when preparing for the learning process with multimedia tools.
11. Multimedya kaynaklarıyla daha iyi öğrenmeme yardımcı olacak stratejilerin farkındayım.	11. I am aware of strategies that will help me learn better with multimedia sources.
12. Hangi multimedya materyalinin (yazılı, sesli, görsel vb.) konuya uygun olduğunu bilirim.	12. I know which multimedia material (written, audio, visual, etc.) is suitable for the subject.
13. Multimedya araçlarıyla öğrenmede daha önce benzer konularda kullanılmış yöntemleri tercih ederim.	13. I prefer methods previously used in similar topics when using multimedia sources for learning.
14. Multimedya kaynaklarını kullanırken öğrenmemi desteklemek için not alma, taslak oluşturma ve temel kavramları özetleme gibi çeşitli stratejiler kullanırım.	14. I use various strategies such as note-taking, drafting, and summarizing key concepts to support my learning while using multimedia sources.
15. Karışık kavramları açıklığa kavuşturmak için multimedya kaynaklarını kullanırken akranlarımla veya eğitmenlerle işbirliği yaparım.	15. I collaborate with peers or instructors while using multimedia sources to clarify complex concepts.
16. Multimedya araçlarıyla öğrenme sürecinde	16. I find myself automatically using appropriate

kendimi otomatik olarak konuya uygun stratejileri kullanırken bulurum.	strategies for the subject when learning with multimedia tools.
17. Karmaşık multimedya içeriklerini öğrenmeme yardımcı olması için daha küçük parçalara ayırırım.	17. I break down complex multimedia content into smaller pieces to aid learning.
18. Multimedya kaynaklarını kendi öğrenme stilime adapte ederim.	18. I adapt multimedia sources to my learning style.
19. Hangi konu içeriğine hangi multimedya araç/araçlarının uygun olduğunu bilirim.	19. I know which multimedia tools are suitable for which subject content.
20. Hangi multimedya öğrenme ortamının kendi öğrenme stilime uygun olduğunu bilirim.	20. I know which multimedia learning environment is suitable for my learning style.
21. Hangi konuya hangi multimedya öğrenme ortamının neden uygun olduğunu bilerek seçerim.	21. I make informed choices about which multimedia learning environment is appropriate for which subject and why.
22. Multimedya kaynaklarıyla öğrenirken zorluklarla karşılaştığımda farklı bilişsel stratejileri nasıl kullanacağımı bilirim.	22. When facing challenges while learning with multimedia sources, I know how to use different cognitive strategies.
23. Farklı multimedya içeriği türleri (örneğin videolar, etkileşimli simülasyonlar, grafikler) ile çalışırken öğrenme stratejilerimi ayarlayabilirim.	23. I can adjust my learning strategies when working with different types of multimedia content (e.g., videos, interactive simulations, graphics).
24. Öğrenim hedeflerim ve ihtiyaçlarım ile uyumlu multimedya kaynaklarını nasıl seçeceğimi ve kullanacağımı bilirim.	24. I know how to select and use multimedia sources that align with my learning goals and needs.
26. Farklı öğrenme stilleri ve multimedya kaynaklarıyla öğrenmemi geliştirmek için bu bilgiden nasıl yararlanabileceğim konusunda iyi bir anlayışa sahibim.	26. I have a good understanding of how to utilize this knowledge to enhance different learning styles and multimedia sources.
27. Multimedya araçlarıyla öğrenirken zamanı verimli bir şekilde kullanmaya dikkat ederim.	27. I pay attention to using time efficiently when learning with multimedia tools.
28. Multimedya araçlarıyla öğrenme sürecinden önce sürece yönelik bir plan hazırlarım.	28. I create a plan for the learning process before engaging with multimedia tools.
29. Öğrenme hedeflerime ulaşmak için multimedya kaynaklarını nasıl kullanacağıma dair bir plan oluştururum.	29. I create a plan on how to use multimedia sources to reach my learning goals.
31. Öğrenme hedeflerime öncelik vererek multimedya araçlarıyla etkileşim kurarken zamanımı buna göre ayarlarım.	31. I prioritize my learning goals and adjust my time accordingly while interacting with multimedia tools.
32. Öğrenmek için multimedya araçlarını kullanırken büyük ödevleri veya projeleri daha küçük, yönetilebilir görevlere ayırırım.	32. When using multimedia tools for learning, I break down large assignments or projects into smaller, manageable tasks.

33. Öğrenme durumumu değerlendirmeye vakit ayırabilmek için multimedya içeriğiyle çalışırken öğrenme hızımı ayarlayabilirim.	33. I adjust my learning pace when working with multimedia content to allow time for evaluating my learning.
34. Multimedya kaynaklarını kullanırken öğrenme hedeflerimi anlama ve ilerleme düzeyime göre ayarlarım.	34. I adjust my learning goals and progress levels when using multimedia sources.
36. Multimedya araçlarıyla öğrenme sürecinde konu ile ilgili olan öğeleri ayırt edebilirim.	36. I can distinguish the elements relevant to the subject while learning with multimedia tools.
37. Multimedya araçlarıyla öğrenme sürecinde dikkatimi konu ile ilgili öğeler üzerine yoğunlaştırabilirim.	37. I can focus my attention on elements related to the subject while learning with multimedia sources.
38. Multimedya kaynakları kullanırken önceki bilgi ve deneyimlerimin öğrenmemi nasıl etkilediğinin farkındayım.	38. I am aware of how my previous knowledge and experiences affect my learning with multimedia sources.
39. Multimedya kaynaklarını tamamlamak ve anlayışımı geliştirmek için diyagramlar, kavram haritaları veya akış şemaları gibi görsel yardımcılar oluşturuyorum.	39. To complete multimedia sources and enhance my understanding, I create visual aids such as diagrams, concept maps, or flowcharts.
43. Multimedya araçlarıyla öğrenme sürecimi nasıl daha iyi duruma getirebileceğimi değerlendiririm.	43. I evaluate how to improve my learning process with multimedia tools.
44. Multimedya kaynaklarından yararlanırken öğrenme hedeflerime ulaşmama ne kadar yardımcı olduklarını değerlendirmek için kendi öğrenme süreçlerimi gözden geçiririm.	44. I review my own learning processes to assess how much multimedia tools have contributed to achieving my learning goals.
46. Multimedya araçlarıyla öğrenme süreci sonunda özetleyerek, sentez yaparak veya kritik sorular sorarak öğrendiklerim hakkında derinlemesine düşünürüm.	46. At the end of the learning process with multimedia tools, I reflect deeply on what I have learned by summarizing, synthesizing, or asking critical questions.
47. Multimedya araçlarıyla öğrenme süreci sonunda öğrenme hedeflerime ne kadar ulaştığımı sorgularım.	47. I question how well I have achieved my learning goals at the end of each learning process with multimedia tools.
48. Her multimedya araçlarıyla öğrenme süreci sonunda konuya uygun farklı teknikler kullanabilir miydim diye sorgularım.	48. I evaluate if I could have used different techniques at the end of each learning process with multimedia tools that are appropriate for the subject.