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RESEARCH ARTICLE

Group Metacognition Scale in Turkish: Validity and Reliability Study

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Abstract

The study aims to adapt to Turkish and analyze the validity and reliability of the metacognition of group processes in online learning The original scale consists of 20 items and 4 sub-dimensions. Metacognitive skills are commonly modeled in these sub-dimensions in the literature. The scale adapted to Turkish was applied to 288 students at the Education Faculty of a state University. Participants studied and finalized a project in an online collaborative learning model for a semester. The sub-dimensions of the original scale are knowledge of cognition, planning, monitoring, and evaluating. The construct validity of the adapted scale in the sample was analyzed by confirmatory factor analysis (CFA). Twenty items with four sub-dimensional structure of group metacognition scale was preserved in the results of CFA and the model had an acceptable fit with the data. (χ^2 = 522.4, *df* = 164, $p < .01$, comparative fit index (CFI) = 0.92, root mean square error of approximation (RMSEA) = 0.09, Tucker–Lewis index (TLI)Non-normed Fit Index = 0.91, standardized root mean square residuals (SRMR)= 0.05). The composite reliability coefficient of the scale varied between 0.90 and 0.91 in each sub-dimension, which is sufficiently reliable. Findings showed that the adapted Turkish group metacognition scale was comparable to Turkish culture, and the scale could be utilized in this adapted form.

Keywords: Co-regulation, group metacognition, metacognition, online collaborative learning

Introduction

Online (computer-supported) collaborative learning (OCL) is not a new phenomenon but has been vigorously emphasized in the last decade and promoted at all education levels. Online collaborative learning primarily started with wikis and continues with simply online word processors and integrated collaborative applications in the digital landscape. Various applications that appeal to different characteristics of collaborative learning are increasingly developing (Al-Samarraie & Saeed, 2018; Mohammed et al., 2019). While the functions and usability of applications are improving, their costs are getting inexpensive. Primarily, employees and academics, who inevitably have to work collaboratively in groups, use these enthusiastic collaborative tools (Marion & Fixson, 2021). Unfortunately, in schools, students and teachers use them belatedly and in a limited way. In parallel with these developments in the business world, integrating OCL into educational processes is becoming increasingly essential. People need to be educated within the education system before joining the business world to manage complex processes, process a large amount of information, and perhaps most importantly, work in harmony, and create and manage knowledge (De Wever & Strijbos, 2021). Unfortunately, in the academy, there is relatively little research on exploring the metacognitive processes in OCL, and the relevant group dynamics are still discovering.

Numerous research results have been published in the aftermath of the COVID-19 pandemic, highlighting the significance of collaboration. A recent report on the impact of COVID-19 on world universities was published by the International Association of Universities. One of the most remarkable findings in the report was that 60% of universities reported that COVID-19 has increased virtual mobility and/or collaborative online learning as alternatives to physical student mobility (Marinoni et al., 2020). Collaboration between industry and universities is a driving force for scientific and technological advances, such as AstraZeneca and British universities' collaborative drug discovery studies (Rezaei & Kemali, 2022)

Individual metacognition processes of students in online learning have long been researched for improving various skills (Akben, 2020, Bozorgian, 2014; Cer, 2019) and academic achievement (Bryce et al., 2015; Hidayat et al., 2018, Young & Fry, 2008); however, recently group metacognition processes have gained increasing attention from researchers (Socratous & Ioannou, 2022, Zheng et al., 2019, 2021). Recently, disruptive technologies and practices have enabled teachers and academics to encourage their students to engage in more collaborative learning.

The effective learning development of group members in the OCL process depends on group metacognition as well as the metacognition level of the members. The effects of a group's skill set on metacognition may be similar to the effects of metacognition on individuals but may have an additional effect on group work (Biasutti & Frate, 2018). While various instruments in the literature determine the metacognitive awareness of students at different levels, group metacognition scale (GMS), an instrument that measures the metacognitive awareness of the group, has recently been developed by Biasutti and Frate (2018).

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This study aims to adapt the GMS developed by Biasutti and Frate (2018) into Turkish and investigate its validity and reliability. In this way, it will be used in studies on group metacognition in Türkiye in the near future.

Within the scope of its adaptation to Turkish, the scale was first translated into Turkish and then evaluated by bilingual field experts and language experts, and recommended changes were made in line with their suggestions. In order to determine language equivalence, it was first applied to English language teaching students with an interval of 20 days, then applied to students of computer and instructional technology education. Afterward, the final scale items were applied to 288 students. After the validity and reliability studies, the scale was found to be usable.

Literature

Metacognition

Flavell first introduced metacognition in his leading papers (Flavell, 1976, 1979). The concept of metacognition is the process of deliberately structuring and memorizing inputs, scanning, and extracting information from memory; it is explained as monitoring the information in memory and being aware of this stored information. In its broadest sense, metacognition is defined as being aware of and controlling mental activities in human higher-level thoughts own perception and thinking (Hacker & Dunlosky, 2003).

Flavell (1979) modeled metacognition and cognition control using a quadratic classification. These are metacognitive knowledge, experience, goals/tasks, and operations/strategies. Several authors emphasized that metacognition consists of two components: the knowledge of cognition and the regulation of cognition (Nietfeld et al., 2005; Pintrich, 2002; Schraw & Moshman, 1994). The knowledge of cognition is the information people have about their own cognitive processes, while the regulation of cognition contains metacognitive activities that help regulate and control one's learning or thinking processes. Regulation of cognition comprises the activities of planning, monitoring, and evaluating (Moshman, 2018).

While planning includes selecting appropriate strategies and organizing resources that affect performance, monitoring refers to one's awareness of comprehension and task performance, and evaluation refers to observing the efficiency and products of one's learning (Schraw, 2001). These metacognitive activities are mutually related and influence each other (Biasutti & Frate, 2018).

Schraw (2001) claimed states that metacognition can be improved by increasing general awareness and knowledge of cognition about the importance of metacognition, improving regulation of cognition, and arranging environments that increase metacognitive awareness. When students learn how their cognitive processes work and metacognition strategies, they can learn meaningfully by rearranging these processes (Ülgen, 2004). Some contemporary studies have confirmed that metacognition positively affects the learners' outcomes (Pery et al., 2019), and academic achievement (Abdelrahman, 2020, Veas et al., 2019). Some studies focus on the impact of metacognition in some subjects such as reading (Jacobs & Paris, 1987), math (Kahramanoğlu & Deniz, 2017, Serra & Metcalfe, 2009), science (Jayapraba & Kanmani, 2013; Özkan & Bümen, 2014).

The complex and abstract process, such as metacognition, is very problematic to measure (Tosun & Irak, 2008). Despite the criticism, researchers mainly used scales based on student self-assessment. Example of such scales are metacognitive awaraness inventory Schraw & Dennison, 1994), metacognitive awareness inventory for Children A-B Form (Sperling et al., 2002).

Online Collaborative Learning

Dillenbourg & Schneider (1995) briefly define collaborative learning as situations in which group members simultaneously create a standard solution and interactively for an issue/project/homework. Online collaborative learning is mainly defined as a group of learners that learn together with the support of computer and communication technology (Kirschner & Erkens, 2013; Ludvigsen & Mørch, 2010). Online collaborative learning may occur in campus-based classrooms, online/distance education, or blended learning environments (Resta & Laferrière, 2007). Online collaborative learning is based on three parts; collaboration with each other, using a computer or mobile device, and using different learning environments, applications, or strategies (Chen et al., 2018). Considering current information technologies, it would be more appropriate to define "with computers or mobile devices connected to the Internet" instead of computers connected to the network.

Group members have to plan together, discuss collaboration strategies, monitor group performance, evaluate the work, and change and regulate activities according to obtained results. Metacognitive processes are related to empowering group coordination and developing effective learning in OCL environments (Järvelä et al., 2015). Group members must co-regulate their tasks and group interactions by setting goals, planning, choosing and enacting strategies, monitoring, and evaluating (Zheng, 2017). Studies on regulation in OCL have progressed from self-regulation to peer-assisted co-regulation and group regulation (Järvelä & Panadero, 2015).

Stahl and Hakkarainen (2021) proposed three primary modes of regulation in collaborative learning in early work: self-regulated learning, shared regulation of learning, and co-regulated learning. The dynamic metacognitive mechanisms that support self-regulation and shared regulation of cognition, behavior, motivation, and emotions are referred to as co-regulation (Hadwin et al., 2017). Co-regulated learning requires each group member to be aware of the whole progress and be able to regulate the others (Zheng, 2017). Co-regulation supports students' learning (Bourgeois, 2016) and self-regulated learning (Chan, 2012) and is essential for valuable and effective collaborative learning (Winne et al., 2013). Online collaborative learning encourages learners to co-regulate their learning (Jeong & Hmelo-Silver, 2016).

The ideas that argue OCL would spread rapidly in the classrooms and transform education when the students have a computer and are connected could not predict how difficult and long it would be to implement OCL in the classrooms (Stahl & Hakkarainen, 2021). Students use digital tools and produce their personal media to maintain their interests and relationships with their peers and express themselves. Under these favorable conditions, OCL offers significant opportunities for academic collaborative and creative productions of technology for knowledge construction (Ito et al., 2013).

Recent studies have revealed remarkable new findings about OCL. A meta-analysis study by Chen et al. (2018) reveals two significant results for OCL. First, collaboration and using computers significantly affected knowledge gain, skill acquisition, and student perceptions; second, using computers in an OCL environment positively affected group task performance and social interaction in OCL conditions. In another meta-analysis of STEM education, OCL found an effect firstly on process outcomes, followed by cognitive, and emotional outcomes (Jeong et al., 2019).

Biasutti and Frate (2018) investigated several scales in the developing phase related to metacognition assessment, such as the metacognitive awareness inventory (Schraw & Dennison, 1994), the metacognition questionnaire (Garrison & Akyol, 2013), and the state metacognitive inventory (SMI) (O'Neil & Abedi, 1996). They adapted

some items from these scales and changed the individual to a group dimension of metacognition.

Method

This research is a scale adaptation study. The scale developed in a foreign culture was adapted to apply in Turkish culture, the validity and reliability were analyzed, and analyzed whether the original sub-dimension structure was preserved. The steps for adaptation are presented below.

Participants

This research has four different study groups. The first is five field experts for Turkish and English translations at the beginning of the adaptation process. The second one is 17 third- and fourth-year students in the English language teaching undergraduate program who are proficient in Turkish and English, and the third is 37 students to whom the Turkish version was carried out, and pre-test and post-test were conducted. The fourth one is a group of 288 volunteer students to whom the validity and reliability study for the Turkish version of the scale was conducted. The study group to which the scale was applied consisted of university students studying at the faculty of education of a state university in Istanbul, Türkiye.

The students with theoretical knowledge about collaborative learning were trained on OCL and Google education suite applications. Students were divided into groups of three or four to prepare their term papers. A directive was given by the researcher about the process of preparing and evaluating the term papers. How to use Google education suite while preparing their homework was presented through an example. The researcher prepared the necessary documents to access and control the Google documents of all groups and shared them with the students. In this way, the researcher controlled the collaborative learning processes of the students and guided or reminded the students when necessary. At the end of one semester, the groups submitted their assignments. The scale was then applied to the students.

The information of the students in the study group is given in Table 1.

There are distinctive opinions on the sample size for Factor Analysis. While Bentler (1990) recommends 5–10 observations for each observed variable, the ideal sample size is 200 (Boomsma & Hoogland, 2001, Kline, 2015). In general, it is indicated that a sample between 3 to 20 times the number of observed variables is necessary and sufficient for confirmatory factor analysis (CFA) (Goodwin, 1999; Stevens, 2002). Therefore, in this study, the number of 288 participants for a 20-item test was deemed sufficient for CFA.

Limitations

How to use Google docs, spreadsheets, presentations, and drive on the Google education platform as online collaborative work tools that students will use at the beginning of this research was explained in detail. In addition, for those who had no previous experience with online learning applications, the web addresses of the training they could learn were given. They then formed groups of three or four students. During one academic semester, the groups prepared and completed an online project. The fact that the participants were only education faculty students can be seen as a limitation of the study. The fact that the participants' collaborative online learning process was during the COVID-19 period and that they completed the project without ever meeting face to face may be a limitation, but it may also have had positive effects.

Table 1.
Descriptive Statistics of the Study Group

Study Group	Female *f*/%	Male *f*/%	Total *f*/%
1. Field experts	3/60	2/40	5/100
2. English students	13/76	4/24	17/100
3. Turkish students (pre-test and post-test)	12/32	25/68	37/100
4. Scale applied students	203/70	85/30	288/100

Data Collection Instruments

The GMS developed by Biasutti & Frate (2018) to measure group metacognition in OCL was used as a data collection instrument. The scale consists of four sub-dimensions: knowledge of cognition, planning, monitoring, and evaluating. Confirmatory factor analysis showed that the best-fitting model was the four-factor model ($\chi^2 = 265.40$, $df = 164$, $p < .01$, comparative fit index (CFI) = 0.96, root mean square error of approximation (RMSEA) = 0.077, standardized root mean square residuals (SRMR) = 0.082, GFI = 0.77, AGFI = 0.71, NNFI = 0.96).

In addition, convergent validity and discriminant validity studies were conducted to investigate scale validity; as evidence of convergent validity, standardized factor loadings were statistically significant and greater than .5; as evidence of discriminant validity, the square root of the average variance extraction (AVE) value was greater than the correlation coefficients. Corresponding values are given in Table 4.

Factor loadings of all items on the original scale were higher than 0.40 and ranged between 0.46 and 0.83. It was shown that the structure of the scale consisted of four dimensions: knowledge of cognition, planning, monitoring, and evaluating. The scale consists of 20 items.

Cronbach's alpha, the reliability coefficient, was computed to assess the scale's reliability and internal consistency. The values for each factor ranged from 0.80 to 0.86, while 0.91 was the value for the whole scale.

A form with 20 items was created by translating the original scale, and then the final data collection instruments were obtained by adding a gender question, including demographic information, to the form. The final form applied to the participants is presented in the appendix.

Data Collection Procedure

The implementation process of the scale started after receiving permission from Biasutti and Frate via e-mail on November 11, 2019. Further processes of the study progressed in the sequence presented in the table.

Implementation Process	Translation of the scale from English to Turkish
	Experts control the translation compatibility in both languages
	Implementation of the form in both languages to a group and finalization of the Turkish
	Implementation of a group of students for the reliability and validity of the Turkish
	Testing the original structure of the scale with first-order DFA
	The analysis of the four sub-dimensions in the scale defining a unique scale with the second-order CFA
	Obtaining the findings regarding the reliability of the scale

The scale was approved by University Social and Human Sciences Research Ethics Committee with the numbers 2020-147. After the translation process, findings regarding the validity and reliability of the scale were obtained. The data were obtained from the students of the Faculty of Education in the spring semester of the 2020–2021 academic year; the consent form explaining the research subject and

including ethical permissions was presented in the beginning section of the Google form and data were obtained from the students who approved it.

Data Analysis

In the study, the Spearman–Brown correlation coefficient was used to investigate the relationship between the scores obtained from the original and Turkish scale forms. A high level of correlation between the two forms was expected to indicate translation success.

Confirmatory factor analysis was conducted to test the scale's construct validity to determine whether the original structure was retained. The maximum likelihood method was used for CFA parameter estimations, and the UVI-unit variance identification method was used to scale latent variables.

Confirmatory factor analysis aims to statistically test the significance of the model formed by a known number of factors and to provide evidence for construct validity. In this study, Adjusted Chi-Square Goodness of Fit [χ^2/standard deviation (*SD*)], CFI, Non-normed Fit Index (TLI/NNFI), RMSEA, and SRMR fit indices were investigated for CFA. Internal consistency and composite reliability (CR) coefficients were calculated to determine the reliability of the adapted scale as a whole and its sub-dimensions. In addition, AVE coefficient was calculated for each factor. According to the literature, Cronbach's alpha coefficient gives a lower reliability value in multi-factor congeneric measurements (Guttman, 1945). The data analysis presented the scale's psychometric structure and the measurement results' norms in both languages. These norms that should be compared in both scales are the mean scores, standard deviations, cut-off points, factor structures, factor-item loadings, and measurement error values (Öner, 1997).

In addition, the independent samples *t*-test was used to test whether there was a difference between group means according to gender; one-way analysis of variance (ANOVA) was used to see if there was a difference between the group averages according to the department of students.

In the analyses, Mplus 7.0 (Muthén & Muthén, 1998) package program was used for CFA, and IBM SPSS Statistics 25 and MS Excel were used for other calculations.

Results

In this section, the findings regarding the language validity, construct validity, and reliability analyses of the scale are presented.

Turkish Adaptation and Translation Validity Findings

The original scale was first translated from English to Turkish, and three language experts checked the translation compatibility in both languages in the GMS adaptation process. With judgmental translation, one or a group of experts translate the scale from the source to the target language. Revisions can be made to the target version of the instrument to correct problems identified by the translators (Hambleton & Kanjee, 1993). Necessary changes were realized. Then, it was carried out with five students, and their feedback was taken. In the next step, the original and Turkish forms of the scale were tested at a 20-day interval with a group of third and fourth-year English language teaching students who were proficient in both Turkish and English. The Spearman's rho correlation coefficient between the two forms was .726. Finally, an adapted scale was carried out with 37 students as a pilot application, and Spearman's rho correlation coefficient between the two forms was .856.

In the analyses conducted between the original and localized scales, the inter-group correlation was high both in the bilingual group and in the final pilot study.

Construct Validity Findings

Confirmatory factor analysis was conducted to analyze whether the adapted scale has four sub-dimensions as specified in the original scale and thus construct validity. At first, first-level CFA was applied to test the fit of the scale with the four sub-dimensional structures in the original scale. Many fit indices are used in the interpretation of CFA results. Various discussions exist regarding interpreting the obtained fit indices and the limits of acceptable values (Weston & Gore, 2006). The first-order CFA diagram and the results regarding the obtained fit indices and their acceptable values are as follows (Figure 1).

Confirmatory factor analysis was conducted to determine whether the data collected with the Turkish form of the scale resembled the original structure.

The fit indices obtained as a result of the first-order CFA are as follows. Confirmatory factor analysis fit indices of the original scale, the fit index values of the Turkish scale belonging to first-order CFA, and the acceptable limits for these indices are given in Table 2.

According to the CFA findings, it was observed that the 20-item 4-subdimensionalstructure of the Turkish GMS was preserved and the model provided an acceptable fit with the data ($\chi^2 = 522.46$, $df = 164$, $p < .01$, CFI = 0.92, RMSEA = 0.09, TLI = 0.91, SRMR = 0.05). As a result of the first-order CFA, it was seen that the four-factor structure of the scale as knowledge of cognition, planning, monitoring, and evaluating was preserved; thus, the original factor structure of the scale was validated.

While four relatively independent sub-components were validated with the first-order CFA, the second-order CFA was conducted to see whether the sub-dimensions are a component of the GMS. The extent to which each sub-dimension explains the superstructure can be examined with the second order of CFA. The CFA diagram of model 2 created for the second-order CFA is shown in Figure 2.

When the second-order CFA model 2 was analyzed, it was seen that the minimum χ^2 value ($\chi^2 = 525.95$, $N = 166$, $p = .00$) was significant. The fit indices obtained were $\chi^2/df = 3.16$, RMSEA = .08, SRMR = .05, CFI = .92, and NNFI = .91. It was determined that the fit indices obtained were at an acceptable and excellent fitness level. Accordingly, it can be said that the level of group metacognition in online learning can be measured with the GMS consisting of 20 items and 4 sub-dimensions.

In the structure obtained from the second order CFA, factor loadings for the knowledge of cognition sub-dimension ranged between 0.75 and 0.85; factor loadings for the planning sub-dimension ranged between 0.67 and 0.88, and factor loadings for the monitoring sub-dimension ranged between 0.74 and 0.84, and factor loadings for the evaluating sub-dimensions ranged between 0.76 and 0.89.

It was determined that there was a very slight difference between the fit indices obtained from both first-order and second-order CFA; both fit index values were found to be at an acceptable level.

In addition, convergent and divergent validity were also investigated in the Turkish version of the scale to construct validity. Firstly, the relationship between the AVE values between each sub-dimensionsaccording to first-order CFA was examined (Table 4), and the square roots of the AVE values and correlation values between the sub-dimensionsare indicated in Table 3.

Although high factor values obtained from CFA provide evidence for convergent validity, it can also be determined whether convergent validity is achieved by examining the AVE values. The AVE values above 0.50 are considered evidence for convergent validity (Fornell & Larcker, 1981).

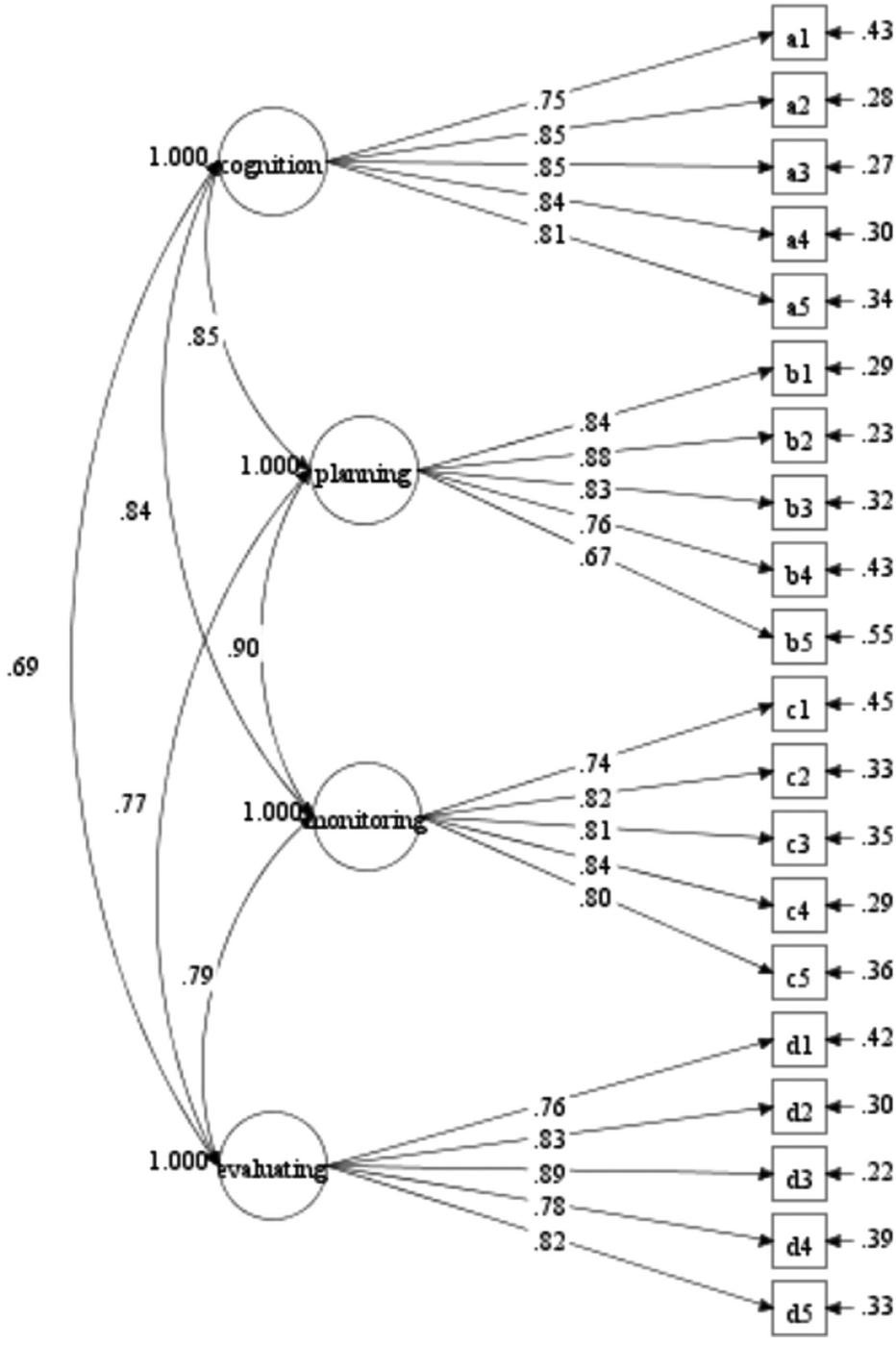

Figure 1.
First-Order Confirmatory Factor Analysis Model for Adapted Turkish Scale.

Table 2.
First-Order CFA Fit Indices for the Original and Adapted Scale

Fit Indices	Original Scale	First order CFA	Second order CFA	Acceptable fit values
χ^2/SD	1.62	3.19	3.16	$2 \leq \chi^2/SD \leq 3$
RMSEA	0.08	0.09	0.08	.06 ≤ RMSEA ≤ .10
CFI	0.96	0.92	0.92	.90 ≤ CFI ≤ .95
TLI	0.96	0.91	0.91	.90 ≤ NNFI (TLI) ≤ .95
SRMR	0.08	0.05	0.05	.05 ≤ SRMR ≤ .10
Akaike (AIC)		10,622.47	10,621.96	The lowest value among the models compared
Bayesian (BIC)		10,864.22	10,856.38	
Sample-Size Adjusted BIC		10,654.93	10,653.43	

The AVE value was calculated by squaring the factor loadings of the items in that sub-factor for each sub-dimensionsin the model obtained from CFA and finding the arithmetic mean of the values obtained (Alarcón & Sánchez, 2015). The average variance/AVE values extracted in the sub-dimensions of the GMS scale are 0.67 for the knowledge of cognition sub-dimension, 0.64 for the planning sub-dimension, 0.64 for the monitoring sub-dimension, and 0.67 for the evaluating sub-dimension, respectively. Table 4 indicates the AVE and standardized loadings values for both the original and the Turkish scale.

Reliability

Cronbach's alpha and CR methods were used to calculate the reliability of the scores obtained from the Turkish version of the scale.

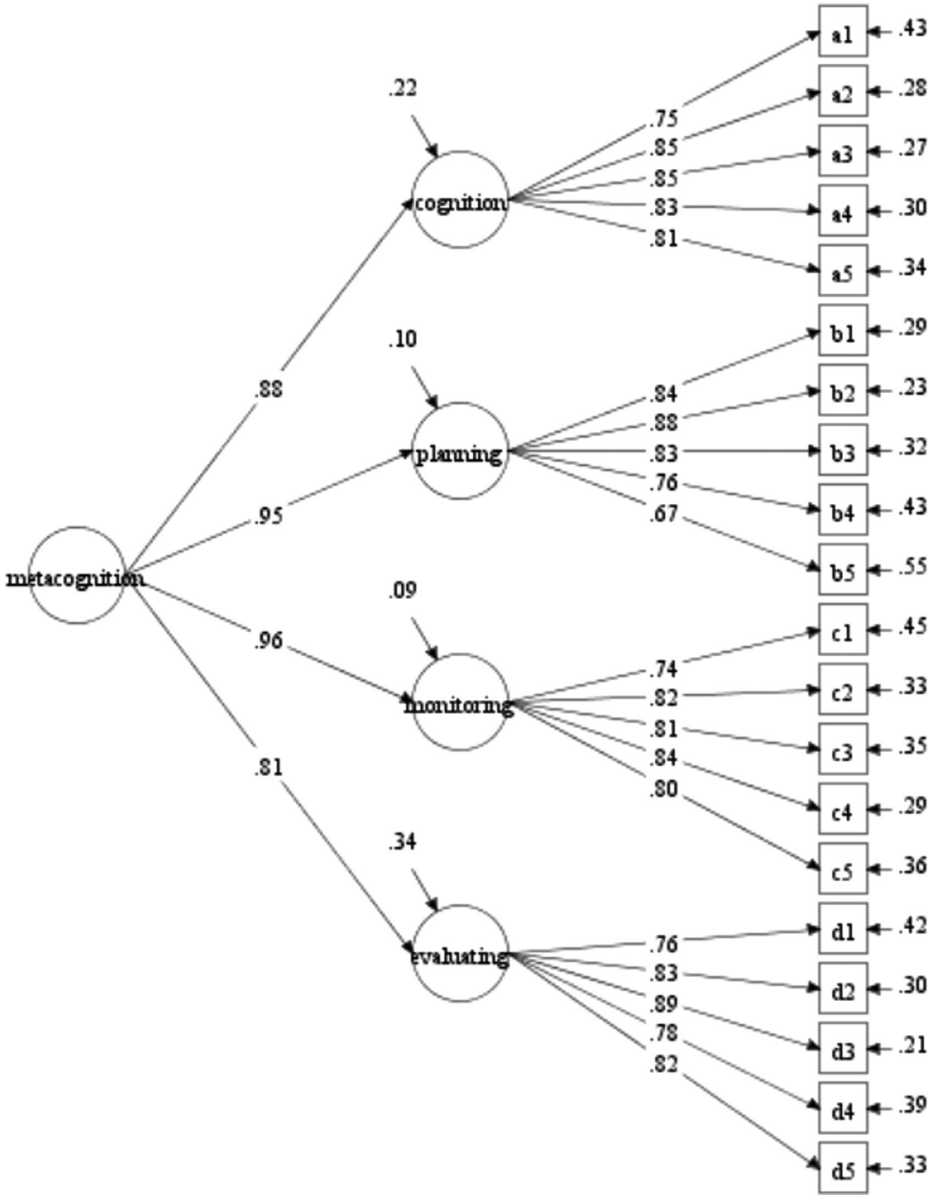

Figure 2.
Second-Order Confirmatory Factor Analysis Model for Adapted Turkish Scale.

The findings obtained are presented in Table 5. The AVE value is calculated by squaring the factor loadings of the items in that dimension for each dimension in the model obtained from CFA and calculating the arithmetic mean of the obtained values (İlhan & Çetin, 2013). Since the AVE values obtained accordingly were greater than .50, as seen in Table 4, the convergent validity of the scale was ensured.

When analyzing divergent validity, the value obtained by taking the square root of the average variance value extracted for each sub-factor must be greater than .50, and the correlation between that factor and the other factors must be greater than .50 (Fornel & Larcker, 1981). Accordingly, the diagonal values in Table 3 should be expected to be greater than 0.50 and greater than the other values under the column. The research findings ensured divergent validity as they ranged between 0.80 and 0.82.

Table 3.
The Square Root of AVE Values of GMS Sub-dimensions and Comparison of Correlations Between These Values

	Knowledge of Cognition	Planning	Monitoring	Evaluating
Knowledge of cognition	0.82			
Planning	0.85	0.80		
Monitoring	0.84	0.90	0.80	
Evaluating	0.69	0.77	0.79	0.82

Note: AVE = average variance extraction; GMS = group metacognition scale.

The scale consists of four subscales: knowledge of cognition factor has a CR coefficient of .91; AVE of .67; planning factor has a CR coefficient of .90; AVE of. 64; the CR coefficient for the monitoring factor is .90; AVE is .64, and the CR coefficient for the evaluating factor is .91; AVE is .67. Malhotra (2010) defines CR values above 0.7 as good and values between 0.6 and 0.7 as acceptable. Accordingly, since the CR value of each factor is above 0.7, the scale reliability is reasonable (Table 5).

Group Mean Comparisons inGroup Metacognition Scale

t-Test results were performed to compare the means of the two groups according to gender. There was no significant difference for gender, $t_{(286)} = 1.29$, $p = .20$, despite female ($M = 83.60$, $SD = 13.03$) attaining higher scores than male ($M = 81.36$, $SD = 14.23$) (Table 6).

Table 4.
Mean, SD, Factor Loadings, and AVE Values of Sub-dimensions of the GMS

		Turkish GMS			Original GMS	
Factor	**Items**	***M* (*SD*)**	**Standardized Factor Loads**	**The Average Variance Extracted**	**Standardized Factor Loads**	**The Average Variance Extracted**
Knowledge of Cognition	Item 1	4.06 (0.89)	0.75	0.67	0.69	AVE not calculated
	Item 2	4.07 (0.86)	0.85		0.83	
	Item 3	4.02 (0.86)	0.85		0.78	
	Item 4	4.02 (0.88)	0.84		0.79	
	Item 5	4.10 (0.87)	0.81		0.72	
Planning	Item 6	4.30 (0.86)	0.85	0.64	0.53	
	Item 7	4.30 (0.81)	0.88		0.79	
	Item 8	4.28 (0.76)	0.83		0.72	
	Item 9	4.09 (0.90)	0.76		0.58	
	Item 10	4.06 (0.95)	0.67		0.66	
Monitoring	Item 11	4.25 (0.81)	0.74	0.64	0.74	
	Item 12	4.27 (0.83)	0.82		0.8	
	Item 13	4.31 (0.80)	0.81		0.72	
	Item 14	4.24 (0.86)	0.84		0.77	
	Item 15	4.33 (0.81)	0.80		0.46	
Evaluating	Item 16	4.03 (0.96)	0.76	0.67	0.78	
	Item 17	4.00 (0.96)	0.83		0.8	
	Item 18	4.05 (0.94)	0.89		0.66	
	Item 19	4.12 (0.91)	0.78		0.65	
	Item 20	3.94 (1.04)	0.82		0.58	

Note: AVE = average variance extraction; GMS = group metacognition scale; SD = standard deviation.

The ANOVA test was performed to control significant differences in the department of students for the GMS. Descriptive findings are given in Table 7. There was no significant difference for the students in education faculty departments $F(6.281) = 1.536$, $p = .166$. (Table 8)

Scoring the Items

The GMSconsists of 20 items in 4 sub-dimensions. The scale is a 5-point Likert scale; the lowest score for each item is 1, and the highest score is 5. Therefore, the lowest possible score for this scale is 20, and the highest score is 100. Since there are five items in each sub-dimension, the highest score obtained from the sub-dimensions is 25, and the lowest score is 5. The fact that the fit indices of the scale in both CFA models are acceptable and reasonable indicates that it is possible to operate on the total scores in the sub-dimensions and the whole scale. An increase in the total score on the scale indicates a higher metacognitive skills.

Table 5.
Cronbach's Alpha and Composite Reliability Values

	Turkish GMS		Original GMS	
	Cronbach's Alpha	**Composite Reliability**	**Cronbach's Alpha**	**Composite Reliability**
knowledge of cognition	0.91	0.91	0.86	not calculated
planning	0.89	0.90	0.80	
monitoring	0.90	0.90	0.82	
evaluating	0.91	0.91	0.81	

Table 6.
t-*Test Findings for the Gender of Students*

Group Statistics and *t*-Test for Equality of Means							
Gender		***N***	**Mean**	**Standard Deviation**	***t***	***df***	***p***
Total	Female	203	83.60	13.03	1.29	286	.20
	Male	85	81.36	14.23			

Conclusion and Recommendations

This study presented the development and validation of the Turkish version of the GMS developed by Biausitti and Frate (2018) which has a 20-item scale based on the following four subdimensions: knowledge of cognition, planning, monitoring, and evaluating. Several instruments consider metacognition an individual process, while the GMS focuses on the group metacognitive skills during OCL. The reliability and stability analyses have shown that the Turkish version of GMS is sufficiently valid and reliable, and it is appropriate for measuring metacognition skills in university students. The CFA sustains the validity of the scale's structure and supports the metacognition model exposed by Schraw & Moshman (1995).

The contributions of group members to group metacognition or the contributions of group members' metacognition awareness levels to group metacognition may be focused on research topics.

Table 7
Descriptive Findings of Students in Education Faculty Departments

Group	**N**	**Mean**	**Standard Deviation**
Germany Language Education	30	78.20	15.453
Science Education	48	83.56	18.042
Pre-school Teaching	29	86.79	10.479
Gifted Students Education	25	86.68	13.025
Psychological Counseling and Guidance	52	82.67	14.050
Social Sciences Education	20	80.15	9.178
Computer Education and Instructional Technology	84	82.67	10.364
Total	288	82.94	13.408

Table 8
ANOVA Findings of Students in Education Faculty Departments

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Between Groups	1638.526	6	273.088	1.536	0.166
Within Groups	49953.470	281	177.770		
Total	51591.997	287			

Students increasingly use technology in their daily life, educational activities, cognition, and learning practices; therefore, research projects should be conducted to find the similarities and diversities between experimental prototypes of classic OCL. In addition, GMS can be used to examine the connections between metacognitive group attitudes and other constructs, such as regulated learning processes and self-efficacy in online learning environments.

The GMS is a full scale with few items and a relatively high degree of measurement. Group metacognition scale is a convenient instrument for exposing different aspects of group metacognition using laboratory experiments, quasi-experimental designs, and mixed methods. Data may be collected from fields such as STEM education, computational thinking, and educational robotics. GMS may also be used to compare students' behaviors and experiences in OCL for specific subjects at the K12 level, such as math, physics, and literature.

There have been numerous organizational management and behavioral science studies on collaborative knowledge creation have been published in recent years (Antunes & Pinheiro, 2020; Chowdhury, 2021, Serino et al., 2020). There is a lack of research in the literature that investigates the cognitive processes involved in collaborative knowledge creation. In the meantime, metacognition is a concept that has been prominent in the field of education for many years and has yielded numerous noteworthy findings. GMS may be a suitable instrument for evaluating collaborative knowledge production processes and revealing the individual and group dynamics influencing knowledge creation in these processes.

This GMS scale can also be used for identifying both individual and collective behaviors that influence the group metacognitive processes of team members in the research and development industries.

Ethics Committee Approval: The scale was approved by Istanbul University-Cerrahpaşa Social and Human Sciences Research Ethics Committee with the numbers 2020-147.

Informed Consent: Written informed consent was obtained from all participants in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – A.A.; Design – A.A.; Supervision – A.A.; MaterialsData Collection and/or Processing – A.A.; Analysis and/or Interpretation – S. A.; Literature Review – Writing – A. A.; Writing Manuscript – A.A.; Critical Review – A.A.

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Appendix

Turkish Group Metacognition Scale

1. I strongly disagree
2. I do not agree
3. Partially Agree
4. I agree
5. Absolutely I agree

Items	1	2	3	4	5
1. We know our strengths as learners					
2. We know how to select relevant information					
3. We know how to use the material					
4. We know how to organize new information					
5. We know how to connect new information with prior knowledge					
6. We plan the activities					
7. We determine what the task requires					
8. We select the appropriate tools					
9. We identify the strategies depending on the task					
10. We organize our time depending on the task					
11. We modify our work according to other group participants' suggestions					
12. We ask questions to check our understanding					
13. We check our approach to improve our outcomes					
14. We improve our work with group processes					
15. We detect and correct errors					
16. We make judgments on the difficulty of the task					
17. We make judgments on the workload					
18. We make judgments on the instruments					
19. We make judgments on our learning outcomes					
20. We make judgments on the teamwork process					

Knowledge of cognition 1–5 items.

Planning 6–10 items.

Monitoring 11–15 items.

Evaluations 16–20 items.

Turkish GMS scale can be used in academic studies without permission by citing the source.