Journal of Educational Technology & Online Learning
Volume 5 | Issue 3 | 2022
http://dergipark.org.tr/jetol

Adaptation of the shared-metacognition questionnaire (SMQ) into Turkish for online collaborative learning environments

Amine Hatun Ataş [a] *, Zahide Yıldırım [b]

[a] Galatasaray University, Türkiye.
[b] Middle East Technical University, Türkiye.

Suggested citation: Ataş, A. H. & Yıldırım, Z. (2022). Adaptation of the shared-metacognition questionnaire (SMQ) into Turkish for online collaborative learning environments. *Journal of Educational Technology & Online Learning, 5*(3), 585-599.

Article Info

Keywords:

Metacognition
Shared-metacognition
Online learning
Online collaborative learning
Community of inquiry

Research Article

Abstract

The aim of this study was to adapt Shared-Metacognition Questionnaire (SMQ) into Turkish. The original version of the SMQ consisting of 26 items and two factors measures metacognition in online collaborative learning environments based on the Community of Inquiry (CoI) framework. The data were collected from 364 university students who had online learning experience. Confirmatory factor analysis was done on two-factor and three-factor model. The three-factor model was confirmed with satisfactory model fit indices. The value of AVE for each dimension verified the convergent validity. For verifying discriminant validity, the AVE estimates of three factors were compared with the square of correlation among the factors, and reported as greater than shared-variance of related row-column values. The factor loading values indicated very good to excellent loadings, as verifying the statistically satisfactory indicator reliability. For internal consistency, composite reliability and alpha reliability were found satisfactory. Thus, the Turkish version of the SMQ indicated a reliable and valid estimate for online collaborative learning environments. Moreover, an Independent Samples t-Test was performed to examine whether there is a significant mean difference between female and male groups, and revealed that females scored higher on total shared metacognition, individual monitoring, individual regulation and group regulation than males.

1. Introduction

With the invasion of ubiquitous technological advances in many areas, there is an increasing need to understand collaborative thinking and learning procedures in the relevant world. Limits between an individual and a group are getting progressively obscured. Online Collaborative Learning (OCL), as one of the models of online education, focuses on discourse and collaboration to enhance learning. OCL points out educational implementations focusing on collaborative communication and knowledge building through the Internet, which leads learners to work together to determine and develop understanding issues, and also transfer them into action to solve problems and conduct plans (Harasim, 2012). The quality of collaboration can affect both to the cognitive discussion content and metacognitive characteristics of interaction (Iiskala et al., 2004). Typically, discourse in OCL is text-based, but web-based tools and conferencing tools are used in OCL as well (Harasim, 2012). With the development of online technology such as synchronous web-based applications, and cloud-based conferencing applications, or shared

* Corresponding author: Galatasaray University, Türkiye.
e-mail address: aminehatunatas@gmail.com

Doi: http://doi.org/10.31681/jetol.1106008
Received 19 Apr 2022; Revised 29 Aug 2022; Accepted 30 Aug 2022
ISSN: 2618-6586 .

documents features; the opportunities for constructing collaborative learning activities continually increased (Robinson et al., 2017). Harasim (2002) proposed three phases of OCL's theory of discourse, namely idea generation, idea organization, and intellectual convergence. In the idea generating phase, idea divergence occurs through verbalization of thoughts and brainstorming. In the second phase, generated ideas are clustered according to the similarities and differences. In the intellectual convergence phase, the shared ideas are synthesized and a consensus is reached.

Metacognition was stressed as a mediating tool between collaborative learning acts and internal learning processes (Akyol & Garrison, 2011). The simplest definition of metacognition was put forward by Flavell in 1979 as thinking about thinking. Martinez (2006) stated metacognition "as the monitoring and control of thought" (p. 696). Akyol and Garrison (2011) explained metacognition by stating that activities within each dimension of metacognition reflect both individual and shared regulation of other people's metacognition. Akyol and Garrison (2011) mentioned three dimensions of metacognition as Knowledge of Cognition (KC), Monitoring of Cognition (MC), and Regulation of Cognition (RC). KC means the awareness of individuals; MC pertains to the awareness of the thinking and learning process, and lastly, RC refers to the on-action dimension of individuals' learning experience. While KC is a more general aspect and can be observed anytime, MC and RC occur during the process of learning. Thus, according to Akyol and Garrison (2011), in an online community of inquiry in which an individual has the opportunity to interact with others; metacognition is the total of "knowledge and skills to monitor and regulate manifest cognitive processes of self and others" (p.184).

There's a move from individualistic formative and cognitive models of metacognition to socially arranged models with the developments in metacognition theories (Larkin, 2009), and therefore, the metacognition construct has been reexamined from a social perspective (Chen et al., 2012; Goos et al., 2002; Hurme et al., 2006; Iiskala et al., 2004; Iiskala et al., 2011; Khosa & Volet, 2014). Through shared-metacognition, group members are able to monitor each other's actions, create shared understanding, and evaluate their actions (Chen et al., 2012; Iiskala et al., 2011). Shared-metacognition has been studied theoretically through the CoI framework by Garrison and Akyol (2015) by the development of SMQ. They argued that parallel with the adoption of collaborative approaches in learning settings, individual and shared roles of learners as they metacognitively regulate their learning become a prominent issue. Ubiquitous communication technologies change the boundaries among learners and groups to a more blurred status. These changes call for needs such as how these collaborative environments might change how we think and how we share our understanding with others. Metacognition is seen as a crucial construct that is not only a self-regulated ability but also has a shared aspect. In more detail, in a community of inquiry, an individual has the opportunity to regulate his/her learning personally and according to group support and feedback. Individuals in a community of inquiry can build up personal interpretation, also they can confirm their constructed meaning through the discourse with members of the group. With the social aspect in mind, Garrison and Akyol (2015) developed the SMQ, which includes two interdependent factors, self-regulation (SR) and co-regulation (CR).

Self-constructed thinking, sentiments, and behaviors that are designed and continually adapted to achieve personal objectives are referred to as SR (Zimmerman, 2005). Because feedback from a previous result is used to adjust the present effort, the SR phase is characterized as cyclical. As individual, behavioral, and natural variables are changing during the learning and execution; contemplations, sentiments, and activities are balanced utilizing three self-oriented criticism circles, which are secrecy/covert, natural, and behavioral self-regulation. Other research has also highlighted the bilateral influences of individual, behavioral, and environmental variables on SR (Meyer & Tuner, 2002; Patrick & Middleton, 2002). CR includes an individual and another person who is more capable of sharing the regulation of an individual's learning process. Through the CR process, the expert and novice roles are assumed by all participants during a shared activity; in other words, as opposed to the socio-cognitive view of self-regulated learning, which focuses on external model and feedback for an individual, CR stresses the emergence and sharing of

regulation through a Zone of Proximal Development (ZPD) (Hadwin & Oshige, 2011; Panadero & Järvelä, 2015; Volet et al., 2009). McCaslin and Hickey (2001), and McCaslin (2009) also stated that CR is grounded directly on Vygotsky's thoughts on ZPD and about the social source of a higher psychological group of acts, and define CR as a manifestation of ongoing interaction through ZPD. Hadwin and Oshige (2011) exemplify CR as follows. Instead of demonstrating how to tie a shoelace to her child, a mother might inquire of her child, "What do you know about connecting those two laces? When you've completed the first stage, how do you know it's time to go on to the next one? ...in order to satisfy her child's need for metacognitive monitoring, evaluation, and regulation of task processes. In other words, CR in ZPD combines SR and social and cultural components.

The abovementioned literature indicates the significance of shared-metacognition construct and online collaborative learning. Due to the lack of validated data collection tools to measure shared metacognition, this study aims to validate the SMQ in the Turkish language to be used in online collaborative learning environments. Additionally, this study seeks to address whether there is a statistically significant difference between gender groups in terms of overall shared-metacognition and its components.

Methodology

1.1. The Original SMQ Instrument

The SMQ was designed to examine the structure and features of metacognition in collaborative learning contexts, with a focus on individual and shared regulation assessments. Garrison and Akyol (2015) developed a shared metacognition questionnaire by collecting data from 192 graduate students, three of whom were undergraduate students. Exploratory Factor Analysis (EFA) was used to investigate self- and co-regulation structures by executing a principal component analysis employing oblimin rotations. To investigate monitoring and managing sub-elements of self and co-regulation, EFA was performed on the four factors using the varimax rotation method, but it was pointed out that the monitoring and management functions of self-regulation and co-regulation were not separated. That is, the results of exploratory study revealed evidence to support hypothesized elements of SR (13 items) and CR (13 items) as parts of shared metacognition construct with a 6 point- Likert scale.

1.2. Translation Process

The SMQ was adapted into Turkish by following the guidelines offered by Hambleton and Patsula (1999) and Hambleton and De Jong (2003). At first, it was ensured that the shared-metacognition construct can be investigated in Turkish culture as if a social learning environment is created. Then, permission was obtained from the authors of the original SMQ. Later, the translation process was followed. Three researchers with the high proficiency in English and knowledge of metacognition, translated the original SMQ from English to Turkish. Then an English language expert checked the three versions of Turkish translations and the original scale and formed the last Turkish version of the scale. Another English language expert translated the version back from Turkish to English. The back-translation version, original scale, and Turkish version of the scale were checked for any errors by two experts studying metacognition and regulation constructs. The final version was checked and confirmed by one of the authors of the SMQ for any errors. After the translation process was completed, cognitive interviews were done with two researchers having online education experience to ensure plausibility, clarity, and fluency of the translated version. Cognitive interview technique is used in many fields including education to check whether items of a scale are open and conceivable enough for the purpose of identifying validity problems (DeWalt et al., 2007; Kutlu & Yavuz, 2019). Cognitive interviews consist of questions focusing on understanding of a participant while doing an activity such as completing a scale or survey (Wolcott & Lobczowski, 2021).

1.3. Sampling and Data Collection

After completing the forward and backward translation process, a data collection process was planned. After getting ethical approval, the translated version of the scale was transferred to Google Forms. Representative online learners who interacted, collaborated and/or engaged with other learners in an online learning environment were included in the study for ensuring validity. The translated scale was administered to 679 online learners. Those who did not remember their experiences in an online learning environment or did not involve in any social interaction/collaborative activity with other learners were excluded; thus, the data from 364 students, 178 women and 170 men, with an age mean of 28.98 (SD = 7.69) and ranged from 17 to 61, were included into the analysis. The majority of the students were undergraduates (63.5%), followed by 26.9% postgraduates, and 9.6% associate degree students. The data were collected before Covid-19 pandemic from the online programs of the universities, where the students were getting mostly fully online and/or hybrid courses. As online platforms, Adobe Connect, Microsoft Teams, and Zoom were used to present the online courses.

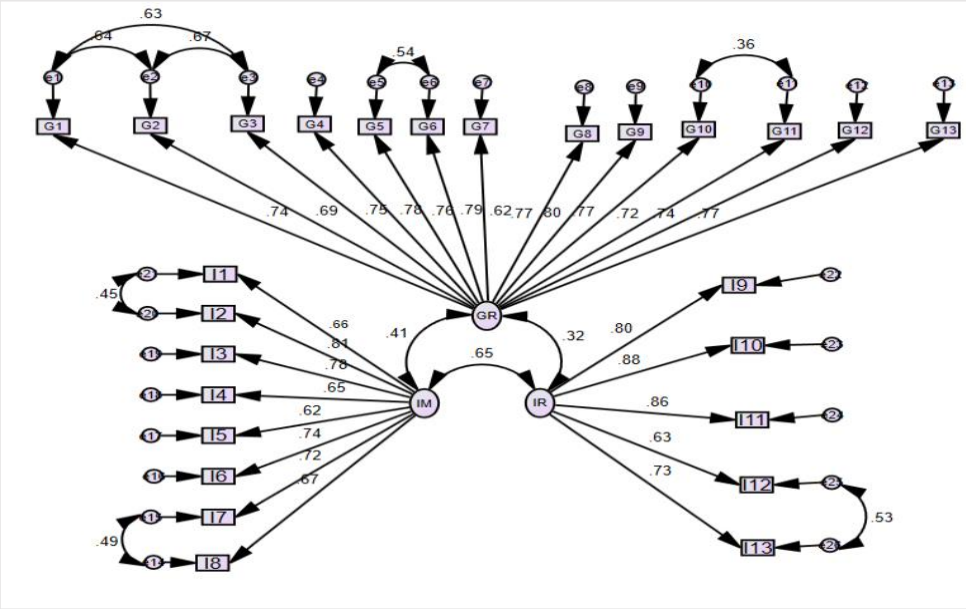
1.4. Assumptions

A Confirmatory Factor Analysis (CFA) was actualized by use of the IBM SPSS AMOS Version 21.0.0 program. The presumptions of CFA were controlled before performing the examination. Sample size (n = 364) meets the requirements indicated as a minimum of 200 by Guilford (1954) and Hair et al. (2010). Univariate normality assumption was checked through Skewness and Kurtosis values. Skewness values ranged between -1.375 and .095, while Kurtosis values were between -1.177 and 1.252. The values are moderately skewed (Bulmer, 1979; Hair et al, 2010), and the kurtosis values ranged between +3 and -3 are acceptable (Hair et al., 2010). Variance Inflation Factor (VIF) values for ensuring that the data meet collinearity assumption showed that multicollinearity was not an issue; that is, for setting GR as dependent variable, the values were obtained as IR, tolerance = .59, VIF = 1.69; IM tolerance = .59, VIF = 1.69. For setting IM as dependent variable, the values were obtained as GR, tolerance = .90, VIF =1.11; IR tolerance = .90, VIF = 1.11, and lastly by rotating IR as dependent variable, the values were obtained as GR, tolerance = .86, VIF =1.17; IR tolerance = .86, VIF = 1.17. Both the tolerance values above the .20 and the VIF values below 5.0 shows that multicollinearity is not a concern for this data (Menard, 2001). Multivariate normality was assessed through MVN Package in R Studio version 1.1.463. The Multivariate Normality assumption is rejected by The Mardia's MVN Test (Skewness = 9391.67, Kurtosis = 67.70). Though multivariate normality is an assumption of Maximum Likelihood (ML) estimation and is based on the relatively large sample size, in practice mostly small samples from non-normal distributions are reached by the researchers (Micceri, 1989). According to concerning research conducted by "Anderson and Gerbing (1984), West and Finch (1996), Finch et al. (1997), Harlow (1985), Hu et al. (1992)", non-normality shows up to have small effect on model parameters evaluated by means of ML (as cited in Nevitt & Hancock, 2001, p.354). Though the ML estimation method is somewhat insensitive to departure from normality of the dimension for large samples (Fuller & Hemmerle, 1966), there are alternative estimation methods with no multivariate normality assumptions. Brown (2006) states that if at least one of the factor indicators is categorical or the data are extremely non-normal, Weighted Least Squares, robust Weighted Least Squares (WLSMV), and Unweighted Least Squares (ULS) are more suitable. ULS is defined as "a factor extraction method minimizing the sum of squared differences between the observed and reproduced correlation matrices" (IBM, Factor Analysis Extraction, para. 3). For that reason, ULS was also conducted in addition to ML.

2. Findings

The data's confirmation on the model was checked by conducting both ULS and ML estimations, which generated acceptable model fit indices and supported construct validity (See Table 1).

Figure 1
Item factor structure of adapted SMQ



CFA was conducted to check the two-factor model as proposed in the original scale and based on a three-factor model based on item structure and theory. Model fit value of Chi- Square/Degree of Freedom ($\chi 2$/sd) with 3.197, smaller than 3.0 (Hair et al., 2010), or at least smaller than 5.0 is acceptable (Byrne, 2011). Since the Chi-Square is a non-parametric measurement and is sensitive to sample size, Goodness of Fit Index (GFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), Incremental Fit Index (IFI), and also Root Mean Square Error of Approximation (RMSEA) and, Standardized Root Mean Square Residual (SRMR) were checked. Threshold values were reported for RMSEA as smaller than .08 (MacCallum et al., 1996), for GFI as greater than .08 (Greenspoon & Saklofske,1998), for CFI as greater than .09 (Awang, 2012b), for NFI as greater than .08 (Forza & Flippini, 1998; Awang, 2012a), for IFI as greater than .08 (Bollen, 1989), and for SMMR as greater than .05 (Hu & Bentler, 1999).

The original scale offers two-factor models consisting of co-regulation and self-regulation. Two-factors model, and three-factors model were checked for construct validity (See Table 1).

Table 1.

Model Fit Indices

Model	$\chi 2$/sd	RMSEA	GFI	CFI	NFI	IFI	SRMR
Two-factors	4.161	.093	.783	.869	.835	.870	.0633
Three-factors (ML)	3.197	.078	.835	.910	.874	.910	.0659
Three-factors (ULS)	3.714	-	.979	-	.973	-	.0616
			AGFI				
			.974				

At first, the offered model was checked for confirmation of the two-factor model. Although the chi-square (4.161) and SMMR (.0633) values are acceptable, model fit indices were below the cut off values with GFI = .783, CFI = .869, NFI = .835, IFI = .870, RMSEA = .093. The findings for three factor model Individual-Monitoring (8 items), Individual-Regulation (5 items) and Group Regulation (13 items) are confirmed, with RMSEA = .078, GFI = .835, CFI = .910, NFI = .874, IFI = .910, SRMR =.0659. According to Kline (2005), at least the model chi-square, RMSEA, SRMR, and CFI should be reported. The acceptable

model fit indices presented in Table 1 above indicate that the data confirms the three-factor model. The model fit indices (three factors model) support the construct validity

Convergent validity is a test to determine the level of agreement between different measurements of the same construct (Ab Hamid et al., 2017). Convergent validity test results were given in Table 2.

Table 2.

Convergent Validity

Factors	Items	AVE
GR	13	.559
IM	8	.502

The value of AVE for each dimension, which are GR = .559, IM = .502 and IR = .618, is greater than 0.5, as verifying the convergent validity (Fornell & Larcker, 1981) (See Table 2). Convergent validity is supported by factor loadings and composite reliability (Ab Hamid et al., 2017).

Table 3.

The Discriminant Validity Index Summary

SMQ	GR	IM	IR
GR	**0.559**		
IR	0.168	**0.502**	
IM	0.102	0.423	**0.618**

Discriminant validity ensures that variance in observed variables is due to the latent variable rather than due to measurement error, other constructs in the model, or any other external effect (Farrell, 2009; Fornell & Larcker, 1981). For verifying discriminant validity, the AVE estimates of three factors (GR, IM, and IR) were compared with the square of correlation (shared variance) among the factors (Hair et al., 2010). As seen in Table 3, the bold AVE values are higher than the row and column values, indicating the shared variance.

For internal consistency, composite (construct) reliability and Cronbach alpha reliability were calculated and found as satisfactory (See Table 4).

Table 4.

Internal Consistency Values

Factors	Items	Cronbach Alpha Reliability	Composite Reliability
GR	13	.944	.943
IM	8	.893	.889
IR	5	.895	.606

The internal consistency for each factor exceeds 0.7 (Cronbach, 1951). For composite reliability, the alpha value and omega value should be greater than at least .60 (Fornell & Larcher, 1981; McDonald, 1985).

(See the appendix for the original and translated item list with factor loadings, alpha reliability, composite reliability, and average variance extracted values).

2.1. Comparison of Individual Regulation, Individual Monitoring, Group Regulation with respect to Gender

To be consistent with the original study, gender difference was investigated. An independents t-test was performed to examine whether there is a noteworthy mean difference between gender groups in relation to total shared-metacognition (SM), Individual Regulation (IR), Individual Monitoring (IR), and Group Regulation (GR) scores. Examination of Q-Q (quantile-quantile) Plots and histograms showed that dependent variables (SM, IR, IM, GR) were normally distributed for the male and female groups. Inspection of boxplots for independent variable's each category (gender) showed that there were no significant outliers. Levene's Test for Equality of Variance shown that there was homogeneity of variance for SM, IM, and GR except for IR (See Table 5).

Table 5.
Comparison of SM, IM, IR, and GR over gender

	Gender	M	SD	SEM
SM	Females	4.68	.75	.06
	Males	4.42	.64	.06
IM	Females	4.98	.06	.06
	Males	4.79	.06	.06
IR	Females	4.91	.07	.07
	Males	4.68	.08	.08
GR	Females	4.42	.08	.08
	Males	4.16	.08	.08

The independent t-test results revealed that females scored significantly higher on total SM, IM, IR and GR than males for SM: t (346) = 3.09, p = .002; for IM: t (362) = 2.21, p = .028; for IR: t (350) = 2.25, p = .025; and for GR: t (362) = 2.30, p = .022.

3. Conclusion and Suggestions

The results of CFA revealed that the shared-metacognition construct consisted of three factors, named Individual Monitoring (IM), Individual Regulation (IR), and Group Regulation (GR) in OCL. In the original study, Garrison and Akyol, (2015) assumed that the shared-metacognition construct had two interdependent factors (SR & CR), and these two factors consisted of monitoring and managing functions. However, the assumed sub-elements, monitoring, and managing function, were not separated based on Exploratory Factor Analysis in the original study. In this study, item structure was examined by subject experts, and the static/monitoring related items were categorized under the IM element and dynamic/managing related items were categorized under the IR element, which were; "I9: I change my strategy when I need to", "I10: I search for new strategies when needed", "I11: I apply strategies", "I12: I assess how I approach the problem.", and "I13: I assess my strategies". Individualized-perspective of metacognition, which was reported as SR, was separated as monitoring and regulation parts based on CFA results. The literature on metacognition constructs also supports this structure. Flavell (1979) categorized metacognition under two dimensions, namely monitoring and control. The metacognitive knowledge and metacognitive experiences belong to monitoring, while metacognitive skills belong to the control dimension. This typical two-

dimensional categorization was conceptualized by Efklides (2006), Garrison (2003), Hacker (1998), and Murphy (2008). Schraw (1998, 2001) stated that knowledge and regulatory abilities required to control cognition are included in metacognition. This typical categorization of metacognition stresses the static and dynamic nature of the construct (Akyol & Garrison, 2011, p.184).

Through the first stage of metacognition questionnaire development, Akyol and Garrison (2011) also hypothesized that metacognition consists of three dimensions; KC, MC, and RC. KC is defined as an introductory metacognitive capacity reflecting knowledge and motivation regarding the set of inquiry actions, and MC is defined as on-the-spot reflection and evaluation of progress in terms of aim and expectations. The RC is the execution and controlling of the learning activities through the use of learning strategies, which are referred to as in-action enactments (Garrison & Akyol, 2015). Although the terminology changes, the individual part of metacognition has mostly been explained as having static and dynamic elements.

In this study, the term "self" was replaced with the term "individual". Models of self-regulation are actualized in developmental and cognitive psychology, and also in the fields of learning and instruction. When the theory of self-regulation is considered in the situation of learning, the name of construct changes to self-regulated learning (SRL), which refers to goal-directed strategic and metacognitive action, ambition, and thought. (Volet et al., 2009). SRL is defined by Zimmerman and Schunk (2011) as the processes by which learners personally engage and sustain cognitions, emotions, and behaviors that are systematically oriented to achieving personal objectives. The role of social situations in SR has changed during the last 20 years. The common idea in research on SRL has concentrated on personal learning situations; however, the approach that social context is prominent in SRL is affirmed in many studies, and research on the social aspects is continuing to increase (Volet et al. 2009; Hadwin et al., 2011; Panadero & Järvelä, 2015). These kinds of studies are "theoretically grounded in the Vygotskian (1930/1978) notions of Zone of Proximal Development and scaffolded guidance from other regulation to self-regulation" (Volet et al., 2009). The contextual variables which can contribute to the development of individuals are based on socio-cognitive theory, situated and distributed cognition studies, and sociocultural and simulative perspectives (Volet et al., 2009, p.216; Meyer & Turner, 2002; Patrick & Middleton, 2002). According to the diverse viewpoints on regulatory constructs, whereas self-regulation concentrates on the cognitive and metacognitive activities that a person utilizes to arrange and get their objectives; social regulation centers how people balance each other's cognitive and metacognitive forms and share the forms of cognitive and metacognitive regulation (Volet et al., 2009). That is, the learning process might be affected by instructors or other social agents in the learning community (Hadwin & Oshige, 2011). The level of social regulation is described with different terminology, and co-regulation is one of these terms. The term co-regulation was changed with "group regulation" to indicate the spectrum of collaboration from peers to groups, and to stress the joint/balanced contribution of groups in a collaborative learning environment. According to the results of a review conducted by Panadero and Järvelä in 2015 with 17 articles, co-regulation refers an uneven kind of regulation that a member of a group regulates the behavior of another member. Hadwin et al. (2011) state while working on shared activities, a learner individually regulates his/her learning, coregulate the process with a peer and/or shares is/her learning regulation within a group bilaterally, which also supports that regulation of groups differs from the level of regulation exchange that might occur within co-regulative processes and activities.

Lastly, this study revealed that females had higher total shared metacognition, individual monitoring, individual regulation, and group regulation levels than males. Garrison and Akyol's (2015) similarly reported that average co-regulation levels of females are higher than males' co-regulation levels. Another study conducted with pre-service teachers revealed that females' co-regulation levels were significantly higher than males' scores, and this difference was attributed to the possible differences in communication ability and learning styles for students (Pan & Tanrıseven, 2016). Sperling et al.'s (2002) study with 3rd - 9th-grade students reported insignificant gender differences in terms of regulation of cognition. The existing

research studies conducted within different contexts with varying age groups are inadequate to picture gender differences within elements of shared-metacognition, and thus stress the need for further examination and qualitative exploration of the possible reasons for gender differences.

Through the original SMQ development, the conceptual clarification of the metacognition construct was noted (Garsion & Akyol, 2013, 2015). In spite of the fact that monitoring and managing capacities were hypothesized as sub-components of SR and CR, the data did not affirm this presumption. This study, on the other hand, revealed that the monitoring and regulation functions of SR were confirmed for online collaborative learning. Further refinements were needed to define the shared-metacognition construct's structure and its sub-elements in both one-to-one and online collaborative learning environments.

The CoI framework was considered as a theoretical structure while developing SMQ. The empirically validated CoI, a collaborative constructive lens, provided a systematic point of view to study cognitive and social presence dynamics with the binding function of teaching presence. The commonalities among the dynamic dimensions of metacognition construct and categories of TP, CP, and SP created the need for conducting further research to examine the shared-metacognition (Garrison & Akyol, 2015). Thus, although the dynamic structure of collaborative learning environments can coherently be studied with CoI (Garrison & Akyol, 2015), there is a paucity of research investigating shared-metacognition within the dynamic components of CoI. It has been estimated that shared-metacognition might be at the overlap of TP and CP components (Garrison, 2017); however, the construct might be correlated with the SP dimension as well. Kilis and Yıldırım (2018) found that self-regulation, metacognition, and motivation significantly predicted CoI and its sub-dimensions, and they offered a new dimension as regulatory presence to the tentative emergent model of CoI. Besides putting forth the correlations between the components of CoI and SMQ, the practical implications of shared-metacognition in online as well as face-to-face collaborative learning environments should be explored.

The CFA revealed reliable and valid estimations for confirming the Turkish version of SMQ to be used in online collaborative learning environments. CFA analysis confirmed that the adapted SMQ had three dimensions, which were Individual Monitoring, Individual Regulation, and Group Regulation. The independent samples t-test results revealed that females scored higher on total shared metacognition, individual monitoring, individual regulation, and group regulation than males. The study contributed to the development of SMQ by considering OCLs. Through this study, monitoring and regulation functions of self (individual) regulation were also defined. Further research is needed to explore how to enhance shared-metacognition in collaborative learning environments and examine possible gender-based differences and the reasons behind these differences.

References

Ab Hamid, M. R., Sami, W., & Mohmad Sidek M, H. (2017). Discriminant Validity Assessment: Use of Fornell & Larcker criterion versus HTMT Criterion. *Journal of Physics: Conference Series, 890*(1). https://iopscience.iop.org/article/10.1088/1742-6596/890/1/012163.

Akyol, Z. & Garrison, D. R. (2011). Assessing metacognition in an online community of inquiry. *The Internet and Higher Education, 14*(3), 183-190. https://doi.org/10.1016/j.iheduc.2011.01.005.

Awang, Z. (2012a). *A Handbook on SEM 2nd Edition.* MPWS Publisher.

Awang, Z. (2012b). *Structural Equation Modeling Using Amos Graphic*.UiTM Press.

Bollen, K. A. (1989). A new incremental fit index for general structural equation models. *Sociological Methods and Research, 17*, 303–316. https://doi.org/10.1177/0049124189017003004.

Brown, T. A. (2006). *Confirmatory factor analysis for applied research*. Guilford Press.

Bulmer, M. G. (1979) *Principles of Statistics.* Dover.

Byrne, B. M. (2011). *Structural equation modeling with AMOS Basic concepts, applications, and programming (Multivariate Applications Series)*, Routledge.

Chen, G. g., Chiu, M. M., & Wang, Z. (2012). Social metacognition and the creation of correct, new ideas: A statistical discourse analysis of online mathematics discussions. *Computers in Human Behavior*, *28*(3), 868-880. https://doi.org/10.1016/j.chb.2011.12.006.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16,* 297–334. https://doi.org/10.1007/BF02310555.

DeWalt, D. A., Rothrock, N., Yount, S., & Stone, A. A. (2007). Evaluation of Item Candidates: The PROMIS Qualitative Item Review. *Medical Care, 45*(5), S12–S21. https://doi.org/10.1097/01.mlr.0000254567.79743.e2.

Efklides, A. (2006). Metacognition and Affect: What Can Metacognitive Experiences Tell Us about the Learning Process? *Educational Research Review, 1*(1), 3–14. From http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip&db=eric&AN=EJ800695&site=eds-live&authtype=ip,uid.

Farrell, A. M. (2009). Insufficient discriminant validity: A comment on Bove, Pervan, Beatty, and Shiu (2009). *Journal of Business Research, 63*(3), 324–327. https://doi.org/10.1016/j.jbusres.2009.05.003.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive developmental inquiry. *American Psychologist, 34*(10), 906-911. https://doi.org/10.1037/0003-066X.34.10.906.

Fornell, C., and Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research,18*(1), 39-50. https://doi.org/10.1177/002224378101800104.

Forza, C., & Filippini, R. (1998). TQM impact on quality conformance and customer satisfaction: A causal model. International *Journal of Production Economics, 55*(1), 1–20. https://doi.org/10.1016/S0925-5273(98)00007-3.

Fuller, E. L., Jr., & Hemmerle, W. J. (1966). Robustness of the maximum-likelihood estimation procedure in factor analysis. Psychometrika. *A Journal Devoted to the Development of Psychology as a Quantitative Rational Science, 31,* 255. https://doi.org/10.1007/BF02289512.

Garrison, D. R. (2003). *Self-Directed Learning and Distance Education.* In M. G. Moore, & W. Anderson (Eds.), Handbook of Distance Education (pp. 161-168). Lawrence Erlbaum.

Garrison, D. R. (2017*). E-Learning in the 21st Century: A Community of Inquiry Framework for Research and Practice* (3rd Edition). London: Routledge/Taylor and Francis.

Garrison, D. R. & Akyol, Z. (2013). Toward the development of a metacognition construct for communities of inquiry. *Internet and Higher Education, 17*(1), 84–89. https://doi.org/10.1016/j.iheduc.2012.11.005.

Garrison, D. R., & Akyol, Z. (2015). Developing a shared metacognition construct and instrument: Conceptualizing and assessing metacognition in a community of inquiry. *Internet and Higher*

Education, 24, 66-71. https://doi.org/10.1016/j.iheduc.2014.10.001. (This study was published under title "Toward the development of a metacognition construct for the community of inquiry framework".)

Goos, M., Galbraith, P., & Renshaw, P. (2002). Socially Mediated Metacognition: Creating Collaborative Zones of Proximal Development in Small Group Problem Solving. *Educational Studies in Mathematics, (2),* 193. https://doi.org/10.1023/A:1016209010120.

Greenspoon, P. J., & Saklofske, D. H. (1998). Confirmatory factor analysis of the multidimensional Students' Life Satisfaction Scale. *Personality and Individual Differences, 25*(5), 965-971. https://doi.org/10.1016/S0191-8869(98)00115-9.

Guilford, J. P. (1954). *Psychometric methods* (2nd Ed.). McGraw-Hill.

Hacker, D. J. (1998). *Definitions and empirical foundations*. In D. J. Hacker, J. Dunlosky, &A. C. Graesser (Eds.), Metacognition in educational theory and practice (pp. 1−23). Lawrence Erlbaum Associates.

Hadwin, A., & Oshige, M., (2011). Self-regulation, coregulation, and socially shared regulation: Exploring perspectives of social in self-regulated learning theory. *Teachers College Record, 113*(2), 240-264. https://eric.ed.gov/?id=EJ927077.

Hadwin, A. F., Järvelä, S., & Miller, M. (2011). *Self-regulated, co-regulated, and socially shared regulation of learning*. In B. J. Zimmerman & D. H. Schunk (Eds.), Educational psychology handbook series. Handbook of self-regulation of learning and performance (pp. 65–84). Routledge/Taylor & Francis Group.

Hair, J.F., Black, W.C., Babin, B.J., & Anderson, R.E. (2010). *Multivariate Data Analysis*. Seventh Edition. Prentice Hall.

Hambleton, R. K. & De Jong, J.H.A.L. (2003). Advances in translating and adapting educational and psychological tests. *Language Testing, 20*(2), 127-134. https://doi.org/10.1191/0265532203lt247xx.

Hambleton, R.K. & Patsula, L. (1999). Increasing the validity of adapted tests: Myths to be avoided and guidelines for improving test adaptation practices. *Journal of Applied Testing Technology, 1*(1), 1-30. From http://jattjournal.net/index.php/atp/article/view/48345/39215.

Harasim, L. M. (2002*). What makes online learning communities successful? The role of collaborative learning in social and intellectual development.* In C. Vrasidas & G. V. Glass (Eds.), Distance education and distributed learning (pp. 181–200). Charlotte, NC: Information Age Publishers.

Harasim, L., M. (2012). *Learning theory and online technology.* Routledge.

Hu, L.-t., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118.

Hurme, T., Järvelä, S., & Palonen, T. (2006). Metacognition in joint discussions: An analysis of the patterns of interaction and the metacognitive content of the networked discussions in mathematics. *Metacognition and Learning, 1*(2), 181-200. https://doi.org/10.1007/s11409-006-9792-5.

Iiskala, T., Vauras, M., & Lehtinen, E. (2004). Socially-shared metacognition in peer learning. *Hellenic Journal of Psychology, 1*, 147–178. From https://www.researchgate.net/profile/Erno-Lehtinen/publication/284553965_Socially-shared_metacognition_in_peer_learning/links/56581f8d08ae1ef9297ca330/Socially-shared-metacognition-in-peer-learning.pdf.

Iiskala, T., Vauras, M., Lehtinen, E., & Salonen, P. (2011). Socially shared metacognition of dyads of pupils in collaborative mathematical problem-solving processes. *Learning and Instruction, 21*(3), 379-393. https://doi.org/10.1016/j.learninstruc.2010.05.002.

Khosa, D. K., & Volet, S. E. (2014). Productive group engagement in cognitive activity and metacognitive regulation during collaborative learning: can it explain differences in students' conceptual understanding? *Metacognition and Learning, 9*(3), 287. https://doi.org/10.1007/s11409-014-9117-z.

Kilis, S., & Yildirim, Z. (2018). Investigation of community of inquiry framework in regard to self-regulation, metacognition and motivation. *Computers & Education, 126*, 53–64. https://doi.org/10.1016/j.compedu.2018.06.032.

Kline, R.B. (2005) *Principles and practice of structural equation modeling* (2nd ed.). Guilford Press, New York.

Kutlu, O., & Yavuz, H. C. (2019). An Effective Way to Provide Item Validity: Examining Student Response Processes. *International Journal of Assessment Tools in Education, 6*(1), 9-24. https://doi.org/10.21449/ijate.447780.

Larkin, S. (2009). Socially mediated metacognition and learning to write. *Thinking Skills and Creativity*, *4*(3), 149−159. https://doi.org/10.1016/j.tsc.2009.09.00.

MacCallum, R., C, Browne, M., W., Sugawara, H., M. (1996) Power Analysis and Determination of Sample Size for Covariance Structure Modeling. *Psychological Methods 1*,130–49. https://doi.org/10.1037/1082-989X.1.2.130.

Menard, S. (2001). Applied Logistic Regression Analysis. 2nd edition. SAGE Publications.

Mccaslin, M. M. (2009). Co-regulation of student motivation and emergent identity. *Educational Psychologist, 44*(2), 137-146. https://doi.org/10.1080/00461520902832384.

McCaslin, M., & Hickey, D. T. (2001*). Self-regulated learning and academic achievement: A Vygotskian view.* In B. J. Zimmerman & D. H. Schunk (Eds.), Self-regulated learning and academic achievement: Theoretical perspectives (pp. 227–252). Lawrence Erlbaum Associates Publishers.

McDonald, R. (1985). *Factor analysis and related methods*. Hillsdale, N J: Erlbaum.

Martinez, M. E. (2006). What is metacognition? *Phi Delta Kappan, 87*(9), 696-699. https://doi.org/10.1177/003172170608700916.

Meyer, D. K., & Turner, J. C. (2002). Using instructional discourse analysis to study the scaffolding of student self-regulation. *Educational Psychologist, 37*(1), 17–25. https://doi.org/10.1207/S15326985EP3701_3.

Micceri, T. (1989). The Unicorn, The Normal Curve, and Other Improbable Creatures. *Psychological Bulletin, 105*(1), 156–166. https://doi.org/10.1037/0033-2909.105.1.156

Murphy, E. (2008). A framework for identifying and promoting metacognitive knowledge and control in online discussants. *Canadian Journal of Learning and Technology, 34(*2), 9−30. https://doi.org/10.21432/T2SW2V.

Nevitt, J., & Hancock, G. R. (2001). Performance of bootstrapping approaches to model test statistics and parameter standard error estimation in structural equation modeling. *Structural Equation Modeling, 8*(3), 353–377. https://doi.org/10.1207/S15328007SEM0803_2.

Pan, V. L., & Tanrıseven, I. (2016). Examination of Pre-Service Teachers' Co-Regulation Situations in Terms of Various Variables. *Mersin University Journal of the Faculty of Education, 12*(1), 377–390. https://dergipark.org.tr/en/pub/mersinefd/issue/17399/182081.

Panadero, E., & Järvelä, S (2015). Socially shared regulation of learning: A review. *European Psychologist, 20*(3), 190-203. https://doi.org/10.1027/1016-9040/a000226.

Patrick, H., & Middleton, M. J. (2002). Turning the kaleidoscope: What we see when self-regulated learning is viewed with a qualitative lens. *Educational Psychologist, 37*(1), 27–39. https://doi.org/10.1207/S15326985EP3701_4.

Robinson, H. A., Kilgore, W., & Warren, S. J. (2017). Care, Communication, Learner Support: Designing Meaningful Online Collaborative Learning. *Online Learning, 21*(4), 29–51. http://dx.doi.org/10.24059/olj.v21i4.1240.

Schraw, G. (1998). Promoting general metacognitive awareness. *Instructional Science. 26,* 113–125. https://doi.org/10.1023/A:1003044231033.

Schraw, G. (2001). Promoting general metacognitive awareness. In H. J. Hartman (Ed.), Metacognition in learning and instruction: Theory, research and practice (pp. 3−16). Boston: Kluwer.

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. https://doi.org/10.1006/ceps.2001.1091.

Wolcott, M. D., & Lobczowski, N. G. (2021). Using cognitive interviews and think-aloud protocols to understand thought processes. *Currents in Pharmacy Teaching and Learning, 13*(2), 181–188. https://doi.org/10.1016/j.cptl.2020.09.005.

Volet, S., Vauras, M., & Salonen, P. (2009). Self- and social regulation in learning contexts: An integrative perspective. *Educational Psychologist, 44*(4), 215-226. https://doi.org/10.1080/00461520903213584.

Zimmerman, B. J. (2005). *Attaining self-regulation: A social cognitive perspective.* In M. Boekaerts, P. R. Pintrich & M. Zeidner (Eds.), Handbook of self-regulation (pp. 13–39). Elsevier.

Zimmerman, B. J., & Schunk, D. H. (2011). *Handbook of self-regulation of learning and performance*. Routledge.

Appendix.
SMQ Item List

	Original Items	*Translated Items*	*FL*	*AR*	*CR*	*AVE*
	"When I am engaged in the learning process as an INDIVIDUAL:"	BİREYSEL gerçekleştirdiğim öğrenme etkinliklerimi düşündüğümde:				
IM	1. "I am aware of my effort."	1. Gösterdiğim çabanın farkında olurum.	.66	.893	.943	.502
	2. "I am aware of my thinking."	2. Öğrenme etkinlikleriyle ilgili düşüncelerimin farkında olurum.	.81			
	3. "I know my level of motivation."	3. Motivasyon düzeyimin farkında olurum.	.78			
	4. "I question my thoughts."	4. Öğrenme etkinlikleriyle ilgili düşüncelerimi sorgularım.	.65			
	5. "I make judgments about the difficulty of a problem."	5. Bir problemin zorluğu hakkında yargıda bulunurum.	.62			
	6. "I am aware of my existing knowledge."	6. Mevcut bilgimin farkında olurum.	.74			
	7. "I am aware of my level of learning."	7. Ne kadar öğrendiğimin farkında olurum.	.72			
	8. "I assess my understanding."	8. Ne kadar anladığımı değerlendiririm.	.67			
	"When I am engaged in the learning process as an INDIVIDUAL:"	BİREYSEL gerçekleştirdiğim öğrenme etkinliklerimi düşündüğümde:				
IR	9. "I change my strategy when I need to."	9. Gerek duyduğumda kullandığım öğrenme stratejisini değiştiririm.	.80	.895	.889	.618
	10. "I search for new strategies when needed."	10. Gerektiğinde yeni öğrenme stratejileri ararım.	.88			
	11. "I apply strategies."	11. Gerektiğinde çeşitli öğrenme stratejileri kullanırım.	.86			
	12. "I assess how I approach the problem."	12. Bir probleme nasıl yaklaştığımı değerlendiririm.	.63			
	13. "I assess my strategies."	13. Kullandığım öğrenme stratejilerini değerlendiririm.	.73			

Note. IM: Individual Monitoring, IR: Individual Regulation, GR: Group Regulation, FL: Factor Loadings, AR: Alpha Reliability, CR: Composite Reliability, AVE: Average Variance Extracted

	Original Items	*Translated Items*	*FL*	*AR*	*CR*	*AVE*
	"When I am engaged in the learning process as a member of a GROUP:"	Öğrenme etkinliklerine bir GRUBUN üyesi olarak katıldığımda:				
GR	1. "I pay attention to the ideas of others."	14. Gruptaki diğer arkadaşlarımın fikirlerini dikkate alırım.	.74	.944	.606	559
	2. "I listen to the comments of others."	15. Gruptaki diğer arkadaşlarımın yorumlarını okurum/dinlerim.	.69			
	3. "I consider the feedback of others."	16. Gruptaki diğer arkadaşlarımın geri-bildirimlerini dikkate alırım.	.75			
	4. "I reflect upon the comments of others."	17. Gruptaki diğer arkadaşlarımın yorumları üzerinde derinlemesine düşünürüm.	.78			
	5. "I observe the strategies of others."	18. Gruptaki diğer arkadaşlarımın kullandıkları öğrenme stratejilerini gözlemlerim.	.76			
	6. "I observe how others are doing."	19. Gruptaki diğer arkadaşlarımın nasıl ilerlediklerini gözlemlerim.	.79			
	7. "I look for confirmation of my understanding from others."	20. Konuyu anladığıma dair gruptaki diğer arkadaşlarımdan onay beklerim.	.62			
	8. "I request information from others."	21. Gruptaki diğer arkadaşlarımdan bilgi talep ederim.	.77			
	9. "I respond to the contributions that others make."	22. Gruptaki diğer arkadaşlarımın yapmış olduğu katkılara karşılık veririm.	.80			
	10. "I challenge the strategies of others."	23. Gruptaki diğer arkadaşlarımın kullandığı öğrenme stratejilerini sorgularım.	.77			
	11. "I challenge the perspectives of others."	24. Gruptaki diğer arkadaşlarımın bakış açılarını sorgularım.	.72			
	12. "I help the learning of others."	25. Gruptaki diğer arkadaşlarımın öğrenmesine yardımcı olurum.	.74			
	13. "I monitor the learning of others."	26. Gruptaki diğer arkadaşlarımın konuyu öğrenmelerini takip ederim.	.77			

Note. IM: Individual Monitoring, IR: Individual Regulation, GR: Group Regulation, FL: Factor Loadings, AR: Alpha Reliability, CR: Composite Reliability, AVE: Average Variance Extracted