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Development and Validation of Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ)

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Abstract

The main objective of the present study was to develop and validate a tool to measure metacognitive abilities among prospective teachers called Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) with three sub-dimensions: Cognitive Strategies Use (CSU), Self-Regulation (SR), and Cognitive Self-Consciousness (CSC). The initial draft, comprising of thirty-five (35) items, was pilot tested on 244 prospective teachers enrolled in B. Ed and M.A. Education of a national university of Pakistan. Exploratory factor analysis (EFA) was ensured through SPSS version-24 with factor loading less than 0.5 unloaded items were deleted from the tool. Moreover, Confirmatory factor analysis (CFA) was also ensured to make the model fit, through AMOS software. The results of the test affirmed that the model is a valid and reliable; reduced to fourteen (14) items with α =0.784, out of which four (4) items retained for the Cognitive Strategies Use (CSU) with α =0.615, five (5) items for the Self-Regulation (SR) with α =0.742, and five (5) items retained for the Cognitive Self-Consciousness (CSC) with α =0.747. The results thus provided evidence to use Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) to identify and measure metacognitive abilities among prospective teachers.

Keywords: *Prospective Teachers; Metacognitive Abilities; Cognitive Strategies Use; Self-Regulation; Cognitive Self-Consciousness*

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INTRODUCTION

Measuring metacognitive abilities have always been challenging (Cano, 2018) and controversial due to the lack of its generalizability (Veenman, 2005). This happens due to its complexity, its unavailability to direct assessment, and its confounded existence in terms of verbal skill and working memory capability. Many researchers measured metacognitive abilities with different tools. However, a questionnaire is a tool in practice to measure the level of metacognitive abilities. Many researchers (Hashmi, Khalid & Shoaib; 2019; Wagaba, Treagust, Chandrasegaran, & Won, 2016; Ajaja, & Agboro-Eravwoke, 2017) used a questionnaire to measure metacognitive abilities.

Current measures tend to be limited in scope and well away from the teaching-learning framework for schools (Marca, 2014). Measurement of metacognitive abilities on the Likert scale is valid (Cano, 2018) but the quality and standard of the questionnaire in terms of validity, reliability, and other characteristics are generally overlooked due to the absence of the consistent and systematic process of the questionnaire development.

The main objective of the study was to construct an instrument for measuring different dimensions of metacognitive abilities. The instrument referred to as the Metacognitive Abilities Questionnaire (MAQ) may be beneficial to use it as a questionnaire for other relevant survey studies. The instrument used in this study has been developed on a 5-point Likert scale developed by the researchers after rigorous literature review. The questionnaire was developed and obtained a valid factor structure. This instrument was named as the Metacognitive Abilities Questionnaire (MAQ) and was used to measure the metacognitive abilities of prospective teachers.

Literature Review

Metacognitive abilities are referred to as a collection of metacognitive activities, procedures, and methods to achieve/complete a metacognitive target (Peña-Ayala & Cárdenas, 2015). Metacognitive abilities appear early and evolve subsequently. These are core abilities that pertain to consciously organize mental abilities. Metacognitive abilities play a major role in various tasks, including conception, reading, writing, memory, problem-solving, inspiration and capacity-building, help overcome challenges (Escolano-Pérez, Herrero-Nivela, & Anguera, 2019). Therefore, learning metacognitive skills needs to be empowered.

Every day, humans learn consciously as well as unconsciously, gain knowledge, and cultivate metacognitive abilities to fulfill different cognitive responsibilities and tasks (Peña-Ayala, 2016). Metacognitive abilities contribute towards reflective education, better understanding, and lifelong learning. Learners with enhanced metacognitive abilities show better academic performance in academic activities, and vice-versa (Baş & Sağırlı, 2017). Therefore, students may learn effectively through metacognitive abilities.

Metacognitive abilities are important for prospective teachers as it is crucial to develop cognitive skills among their lateral students. Learning metacognitive abilities is essential (Azizah & Nasrudin, 2019). Prospective teachers should be well equipped with metacognitive capabilities; and the existence of metacognitive capabilities among prospective teachers would enable them to use techniques and procedures that are suitable for classroom teaching (Cetin, 2015).

The literature illustrates several forms of metacognitive abilities like metacognitive knowledge, metacognitive monitoring, metacognitive regulation, metacognitive awareness, metacognitive experiences; Self-Regulation; Planning, monitoring and evaluating; Cognitive Strategy Use; and Cognitive Self-Consciousness (Sidi et al, 2017). However, Cognitive Strategy Use (CSU), Self-Regulation (SR), and Cognitive Self-Consciousness (CSC) are dominant metacognitive abilities in the classroom (Wagaba et al., 2016).

Cognitive Strategies Use (CSU)

Cognitive strategy Use refers to the degree to which learners use specific and appropriate learning strategies. The use of cognitive strategies helps learners to address problems effectively; monitors learning processes; correlates with conception; promote learning, increases self-efficiency and strengthens student participation in academic activities (Perry & Steck, 2015). Learning Outcomes are best accomplished by the use of appropriate cognitive strategies. The use of cognitive strategies helps to understand and perform, in general. Learners use cognitive strategies to effectively execute cognitive tasks (Lemaire, 2016). The use of cognitive Strategies promotes student academic performance by enhancing student participation in learning. Cognitive Strategies Usage (CSU) increases intellectual efficiency. Its use is beneficial for problem-based learning and is effective for task accomplishment. It controls emotions and boosts student engagement (Moyal, Henik & Anholt, 2014). Cognitive Strategies Use (CSU) for cognition in terms of Knowledge, Understanding, and Application includes rehearsal, elaboration, and organizational strategies (Perry & Steck, 2015).

Rehearsal strategies dedicated to learning retention include copying, note-taking, repeating, and revising. Elaboration strategies dedicated to enhancing memory retrieval include paraphrasing, summarizing, highlighting, underlining and, précising, etc. Similarly, Organizational strategies for learning pertain to the management of resources, material, time, thoughts, or actions (Gonzalez, 2016).

Self-regulation (SR)

Self-regulation applies to the coordinated initiative of learners to attain learning outcomes. Self-regulation is proactive; purposeful learning; helps set goals; supports to reach targets; develops the engagement of learners in learning practices, helps them to set academic targets and track professional success (Crede & Phillips, 2011). Planning, monitoring, and evaluation are sub-components of Self-regulation (Langdon et al.,

2019). Proper planning, followed by monitoring and evaluation enhances efficiency. Planning helps to achieve outcomes while monitoring and evaluation help to improve achievements.

Cognitive Self-Consciousness (CSC)

It refers to as aware and monitors the personal thoughts of students when they are engaged in learning; ability to focus on and to be aware of the cognitive processes. Cognitive self-consciousness (CSC) helps in decision making; highly correlated with examination activities; improve effort convergence, self-esteem, and self-efficacy; expedites the learning process; and, enables the learners to complete the tasks. Cognitive self-consciousness is considered as a significant factor for teachers' professional development (Petanova & Stoyanova, 2016).

1. Cognitive Strategy Use (CSU) refers to the extent to which students use strategies to learn. It has three sub factors i.e. Rehearsal strategies, Elaboration strategies, and Organizational strategies.
2. Self-regulation (SR) is the extent to which students plan, monitor, and evaluate their cognition.
3. Cognitive Self-Consciousness (CSC) is the extent to which students monitor their thoughts during the learning process.

Methodology

A literature review was carried out to align the construct definition with previous related studies and concepts; and to identify factors and the items that might be adapted or used. Interviews/discussions were carried out with the focus groups to get in-depth insight that how they understand, theorize, and define the construct. Then, the literature review and the interviews/discussion were aligned to ensure the conceptual sense of the construct. This exercise helped in finalizing three factors of metacognitive abilities, i.e., Cognitive Strategy Use (CSU), Self-Regulation (SR), and Cognitive Self-Consciousness (CSC). Thus, the initial draft of the questionnaire was developed with three (3) factors and twenty-five (25) items on five points (5) Likert type Scale, i.e., Almost Always, Often, Sometimes, Seldom and Always never; and, named as the Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ). The values of scale were adjusted in 1 for Never, 2 for Seldom, 3 for Sometimes, 4 for Often, and 5 for Always. Cognitive Strategy Use (CSU) consisted of six (6) items, Self-Regulation (SR) consisted of twelve (12) items and Cognitive Self-Consciousness (CSC) consisted of seven (7) items. The items on the questionnaire were stated to make them easy and understandable for the respondents of the study (i.e., Prospective Teachers).

Expert Validation of Metacognitive Abilities Questionnaire (MAQ)

Validity refers to the suitability, meaningfulness, accuracy, and effectiveness of the tool; the use of experts for systematic review improves its overall quality and

representativeness. In order to ensure the content and face validity, items were produced / developed from a variety of sources, including in-depth consultation with experts, respondents, and the rigorous literature review. Hence, the initial draft was discussed with the subject matter experts. They were requested to review each item of the questionnaire, and, provide their opinion/level of agreement for each of the statements/ each item about the appropriateness, clarity, comprehensibility, plausibility, the suitability of the language, linkage, and relevancy of the items with the construct, and the item usability for the survey research.

Moreover, the proposed draft was restructured and improved after detailed discussion/dialogue sessions held by the experts. By adopting the process of expert validation, the initial draft was amended after seeking expert opinion on all the factors and items of the questionnaire. This initial draft was sent to different educationists and psychologists (experts) working at different national and international universities within Pakistan and abroad. They were requested to give their suggestions as well as judgment on the suitability of the language for prospective teachers; the linkage between factors and individual items; appropriateness of the factors and individual items; clarity of the items, and plausibility of the items.

The draft, in a hard form, was distributed among faculty members of two departments (i.e., Department of Education and Department of Psychology) of the University of Gujrat. The soft copy of this Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) was shared by experts in metacognition by using the Google Form through email.

Content Validity of Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ)

The Content Validity Ratio (CVR) for each item and overall Content Validity Index (CVI) of the questionnaire was calculated to improve the quality and to ensure the validity of the questionnaire. Three items CSU6, SR3 and SR10 were excluded/deleted as CVR values of these items were below 0.49. The Content Validity Ratio (CVR) of retained items of the questionnaire ranged from 0.733 to 1.000, whereas the overall Content Validity Index (CVI) of the questionnaire remained at 0.885 for fifteen (15) experts; CVR value more than 0.49 is considered acceptable (Lawshe, 1969).

Table 1

Content Validity Ratios (CVR) of the items and Content Validity Index (CVI) of the initial Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ)

Item No.	Statement	CVR	Mean	Decision
CSU1	I underline/highlight the important content	0.867	1.933	Retained

CSU 2	I discuss with peers for learning during the study	0.867	1.933	Retained
CSU 3	I seek help for unsolved problems from others	0.733	1.867	Retained
CSU 4	I note the weakness of my learning during peer discussion	0.867	1.867	Retained
CSU 5	I discuss with others about the relevancy of selected content for learning	0.867	1.933	Retained
CSU 6	I write important points of the content in my own words.	**0.467**	1.467	**Dropped**
SR1	I identify the resources of content before starting	0.867	1.867	Retained
SR2	I allocate time for completion of each learning task	1.000	2.000	Retained
SR3	I explore content material related to learning	**0.467**	1.600	**Dropped**
SR4	I ensure to follow the schedule for learning set by me	1.000	2.000	Retained
SR5	I monitor my learning on a regular basis	0.733	1.800	Retained
SR6	I compare the consumed time with the allocated time for completion of learning tasks	0.867	1.933	Retained
SR7	I revisit my plan of learning on a weekly basis	1.000	2.000	Retained
SR8	I rearrange my content of learning according to the study plan	0.867	1.933	Retained
SR9	I examine learning progress on a weekly basis	0.867	1.867	Retained
SR10	I try to resolve the problems faced during the study by myself	**0.333**	1.400	**Dropped**
SR11	I evaluate learning outcomes throughout the course	1.000	2.000	Retained
SR12	I judge my learning in terms of learning outcomes	0.867	1.867	Retained
CSC1	I am aware of my thoughts when I am engaged in learning.	0.733	1.867	Retained
CSC2	I continuously examine my thoughts for and during learning	0.867	1.867	Retained

CSC3	I know how to achieve learning outcomes while learning	0.867	1.867	Retained
CSC4	I am aware of the way my mind works during learning.	0.867	1.933	Retained
CSC5	I am constantly aware of my thinking for learning	1.000	2.000	Retained
CSC6	I monitor my thoughts when I am engaged in learning	1.000	2.000	Retained
CSC7	I pay close attention to the way my mind works	0.867	1.933	Retained

Pilot Testing of Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ)

The sample size equivalent to 10-15 participants per item is essential for factor analysis (Hof, 2012). Therefore, the Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) was pilot tested on 244 prospective teachers enrolled in B.Ed. (Hons.) and M.A. Education at a public sector university of Pakistan. Construct and discriminant validity of the scale was ensured through factor analysis. Both exploratory and confirmatory factor analysis was conducted to ensure the validity of the prospective teachers' Metacognitive Abilities Questionnaire (PTMAQ).

Results

Exploratory Factor Analysis (EFA)

Generally, the Exploratory Factor Analysis (EFA) was used to investigate the relative factor structure of the observed variables without placing a pre-existing structure (Ramakrishnan & Arokiasamy, 2019). Exploratory factor analysis (EFA) was ensured through SPSS version-24 for two times using Principal Component Analysis, Extraction Method and Varimax with Kaiser Normalization Rotation Method. Factors loading of the items for PTMAQ are reported in Table 2 Factor loadings of 0.50 or higher are expressed in this table. The criterion for an item to be retained is described by Henson and Roberts (2006). According to this criteria, the only items in an instrument are retained whose factor loading is at least 0.50 on its own scale and less than 0.50 on all other scales. The application of this criterion led to the removal of some items of PTMAQ Questionnaire. One item CSU1 from Cognitive Strategy Use factor, the five items SR1, SR2, SR6, SR11, and SR12 from Self-Regulation factor and one item CSC6 from Cognitive Self-Consciousness were excluded from the questionnaire. The mentioned items had loadings of less than 0.50 on the factors and were omitted from subsequent analyses.

The table shows that the percentage of variance was 26.372% for Cognitive Strategy Use, 11.292 % for Self-Regulation, 10.827% Cognitive Self-Consciousness. Similarly, the Eigenvalues for three factors of PTMAQ ranged from 1.624 to 3.956.

Table 2 *Factors Loading, Eigen Values and Percentage of Variance Explained of PTMAQ*

Item No.	Factor Loadings		
	Cognitive Self-Consciousness	Self-Regulation	Cognitive Strategy Use
CSU2			0.692
CSU3			0.683
CSU4			0.600
CSU5			0.660
SR4		0.559	
SR5		0.643	
SR7		0.733	
SR8		0.673	
SR9		0.762	
CSC1	0.751		
CSC2	0.602		
CSC3	0.563		
CSC4	0.754		
CSC5	0.661		
CSC7	0.517		
Eigen Values	3.956	1.694	1.624
% Variance Explained	26.372	11.292	10.827

Model fit of Confirmatory Factor Analysis (CFA)

A statistical approach used to validate the factor structure of the questionnaire is Confirmatory Factor Analysis (CFA). It helps in determining the probability of the correlation between the variables observed and their Latent constructs (Ramakrishnan & Arokiasamy, 2019). It indicates that many fit indices can be used.

To determine the Model fit, the researcher used the following statistics: Comparative fit index (CFI), CMIN (Chi-Square Goodness of Fit), Adjusted Goodness of Fit Index (AGFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA) and the Standardized Regression Weights. General standards hold that the minimum standards of a good fit for these metrics are: CFI ≥ .90, AGFI ≥ .90, CFI > .90

and closed to 1, TLI ≥ .90, RMSEA ≤ .08 is accepted however less than 0.05 is good, SRMR ≤ .08.

Thus, Confirmatory factor analysis (CFA) was run through AMOS software, and the values were calculated, accordingly.

Table 3

Criterion values for Confirmatory Factor Analysis

Indicators consistency	value	Function value on the quality of conformity
CMIN/df	1.702	Less than 3
GFI	0.928	
AGFI	0.899	Less than 0.9
TLI (rho2)	0.897	Less than 0.9
RMSEA	0.054	Greater than 0.5 but less than 0.8

The table indicates that the value of the CMIN / DF ratio was below 3 i.e., 1.702, and met the criterion of Model Fit. AGFI value was examined at 0.899 which was found below the criterion value i.e. 09. This value did not meet the criterion of Model Fit. Therefore, it was needed to revisit the covariance matrix between variables. TLI value was observed at 0.897 which was found below the criterion value i.e. 09. This value did not meet the criterion of Model Fit. Therefore, it was needed to revisit the covariance matrix between variables. Similarly, the RMSEA value was observed as 0.54, the value of RMSEA ≤ .08 makes the model a "reasonable fit", however, less than 0.05 is a "close fit" (Xia & Yang, 2019). This value is almost equal to 0.5, and approximately meets the criterion of Model Fit. The standardized regression weights against each item were computed.

Table 4

Standardized Regression Weights of items of PTMAQ

Sub-Scales	**Items**	Standardized Regression Weights
CSU	CSU1	.593
	CSU2	.525
	CSU3	.483
	CSU4	.529
SR	SR1	.690
	SR2	.616
	SR3	.665
	SR4	.547
	SR5	.515
CSC	CSC1	.665
	CSC2	.678
	CSC3	.553

CSC4	.493
CSC5	.605
CSC6	.436

Since the values of AGFI and TLI were below the criterion value, i.e. 09, therefore, it was needed to revisit the covariance matrix between variables. The revisit suggested that the item with the lowest Standardized Regression, Weight may be deleted from the questionnaire. Therefore, item CSC6 was excluded/deleted from the scale to make the model fit because of its lowest value i.e., 0.436. Moreover, the covariance matrix between the variables was evaluated and found the largest covariance between CSC1 and CSC2. Hence, covariance was drawn between these two variables to make the model fit. Confirmatory factor analysis (CFA) was once again run through AMOS software, and the below-mentioned tables indicate the Model Fit Summary of Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ).

Table 5 *Index value of Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) before and after modification*

Indicators consistency	index value before modification		index value after modification	Function value on the quality of conformity
CMIN/df	1.702		1.650	Less than 3
GFI	0.928		0.935	Greater than 0.9
AGFI	0.899		0.906	Greater than 0.9
TLI (rho2)	0.897		0.911	Greater than 0.9
RMSEA	0.054	.052	Greater than 0.5 but less than 0.8	

The table indicates the values of the modified model. The value of the CMIN / DF ratio was below 3 i.e., 1.65, and met the criterion of Model Fit. AGFI value was examined at 0.906 which was found greater than the criterion value i.e. 09. This value of the modified model meets the criterion of Model Fit. TLI value was observed at 0.911 which was found greater than the criterion value i.e. 09. Now, this value meets the criterion of Model Fit. Similarly, the RMSEA value was observed at 0.52 which is much closer to 0.5. The value of RMSEA $\leq$ 0.08 indicates that the model "reasonable fit", however, less

than 0.05 is a "close fit" (Xia & Yang, 2019). This value is almost equal to 0.5, and approximately meets the criterion of Model Fit. Similarly, the standardized regression weights against each item were computed and the values were observed as improved. All the mentioned statistics in table 6 affirm that the model has become fit according to the criteria reported in table 5.

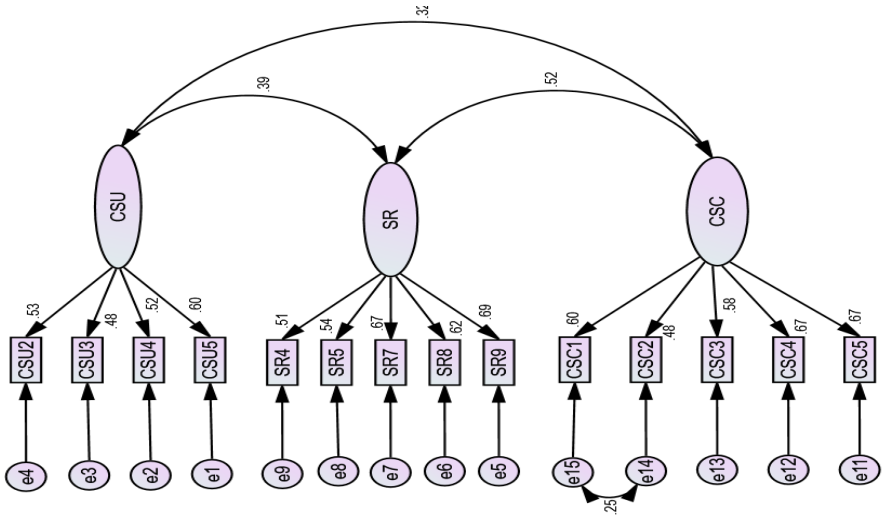

Table 6
Standardized Regression Weights of items of PTMAQ (Final Version)

Sub-Scales	Items	Standardized Regression Weights
CSU	CSU1	.600
	CSU2	.515
	CSU3	.481
	CSU4	.533
SR	SR1	.690
	SR2	.618
	SR3	.666
	SR4	.545
	SR5	.515
CSC	CSC1	.666
	CSC2	.675
	CSC3	.576
	CSC4	.477
	CSC5	.596

Fig. 4: Factor Structure of PTMAQ

Assessing Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) fit with sample Data (the Modified Model)

Preliminary changes/modifications/amendments were incorporated in the Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ). The model became fit. The pictorial illustration of the CFA of Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) was also affirmed which is being represented below.

Pictorial representation describes that item of metacognitive abilities were loaded in three sub-factors called CSU, SR, and CSC. Four (4) items were loaded against CSU and five (5) items against SR. Similarly; five (5) items were loaded against CSC. Moreover, the covariance matrix between the variables was evaluated and found the largest covariance between CSC1 and CSC2. Hence, covariance was drawn between these two variables to make the model fit.

Table 7
Reliability Values of Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ)

Scale	Number of Statements	Mean	SD	Reliability Coefficient
Cognitive Strategy Use (CSU)	4	15.43	3.0	0.615
Self-Regulation (SR)	5	16.87	4.16	0.742
Cognitive Self-Consciousness (CSC)	5	19.8	3.54	0.747
Metacognitive Abilities Questionnaire (PTMAQ)	14	52.14	7.88	0.784

The results of the test affirmed that the model is valid and reliable; reduced to fourteen (14) items with α =0.784, out of which four (4) items retained for the Cognitive Strategies Use (CSU) with α =0.615, five (5) items for the Self-Regulation (SR) with α =0.742, and five (5) items retained for the Cognitive Self-Consciousness (CSC) with α =0.747. The results thus provided evidence to use the Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) to measure the level of metacognitive abilities among prospective teachers.

Discussion

The primary purpose of the study was to develop and validate a questionnaire measuring prospective teachers' metacognitive abilities. The current research study provides the evidence for the reliability and validity of the Prospective Teachers' Metacognitive

Abilities Questionnaire (PTMAQ) for a sample of prospective teachers enrolled in different pre-service teacher education programs.

Literature has been reviewed and initially three sub-factors have been decided for measuring metacognitive abilities of prospective teachers. Later on twenty five items were developed for the questionnaire.

First of all content validity was ensured through subject matter experts through which three items were excluded from the questionnaire. After this exploratory factor analysis was conducted to check the factor structure of items of the questionnaire. Moreover the purpose of factor analysis was to ensure the convergent and discriminant validity of the questionnaire. Consequently a questionnaire comprising of 15 items was obtained.

The present results were also consistent with the conclusions of the authors of the original version in that three-factor structure of Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) found sufficient support in CFA.

Internal consistencies of all the sub-factors and over all of the Questionnaire reflected reasonable results. Internal consistency of the questionnaire was 0.784 which is considered as a reliable measure (Ref). The two factors showed an adequate reliability except of Cognitive Strategy Use factor α=0.615. The Prospective Teachers' Metacognitive Abilities Questionnaire (PTMAQ) has sufficient evidence to be a valid and reliable instrument to measure metacognitive abilities of prospective teachers.

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