

Preliminary validation of the Exam Metacognition Inventory

Calcagno, A.; Muscolino, V.; Caccioppo, N.; Rechici, R., Papalia, T.; Mollaioli, D.

Department of Clinical and Experimental Medicine, University of Messina, Messina, Italy



Introduction

Metacognition, originally defined by Flavell (1979), refers to the ability to reflect on and regulate one's cognitive processes. Flavell emphasized the importance of metacognitive knowledge, including awareness of personal strengths, task demands, and effective strategies. Efklides (2006) further developed this framework by introducing a three-part model: Metacognitive Knowledge (awareness of one's cognitive abilities and strategies), Metacognitive Skills (monitoring, planning, and adjusting strategies), and Metacognitive Experiences (the emotional and motivational responses during cognitive tasks). These components are critical for academic success, as they enable students to evaluate their learning, adjust strategies, and ultimately improve performance.

Despite these insights, there remains a notable gap in the availability of psychometric tools specifically designed to assess metacognition in the context of academic exams.

Aim

The aim of this study was to develop a new psychometric instrument, the **Exam Metacognition Inventory (EMI)**, designed to assess students' awareness and regulation of cognitive processes during exams.

Methods

The initial pool of items was adapted from the Italian version of the **Metacognition Questionnaire (MCQ-30)**. To evaluate the EMI's psychometric properties, including factor structure and criterion validity, data were collected from a convenience sample of 196 university students from southern Italy. A principal-axis Exploratory Factor Analysis (EFA) with oblique (Oblimin) rotation was performed on the preliminary 30-item inventory. Oblique rotation was chosen to allow correlated factors, consistent with Efklides' (2001) framework that different metacognition dimensions are interrelated.

Items to remove were chosen according to the following criteria:

- Low Factor Loadings ($\lambda < 0.30$) or Cross-Loadings;
- Low Community ($\hat{h}^2 < 0.20$)
- Reliability ($\alpha \vee \omega$) increasing if item is removed
- Low Item-total coefficient

Convergent Validity and Construct Validity were assessed through Composite Reliability (CR) and Average Variance Extracted (AVE). Internal consistency was assessed through McDonald's ω Coefficient.

Results

After removing 15 items from the original 30 due to several weakness (low Factor Loading, Communality or Item-Total Correlation) The EFA revealed a three-factor structure, explaining 57.4% of the total variance. Factor 1 (**Metacognitive Knowledge**) accounted for 23.1% of the variance, Factor 2 (**Metacognitive Experiences**) for 17.5%, and Factor 3 (**Metacognitive Skills**) for 16.8%.

The model fit indices indicated an acceptable fit ($\chi^2(63) = 118, p < .001, RMSEA = 0.0799, TLI = 0.905$), and Bartlett's test of sphericity was significant ($\chi^2(105) = 1095, p < .001$), confirming the appropriateness of the analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.846, indicating a good factorability of the correlation matrix.

In terms of reliability and convergent validity, the Composite Reliability (CR) ranged from 0.824 to 0.908, demonstrating acceptable internal consistency.

The Average Variance Extracted (AVE) for MK was 0.644, indicating good convergent validity, while the AVE values for ME (0.460) and MS (0.485) were below the 0.50 threshold, suggesting that the convergent validity for these factors might be less robust.

Factor	Item	λ	\hat{h}^2	CR	AVE	ω
Metacognitive Knowledge (MK)	Item 26	0.937	0.865	0.898	0.644	0.908
	Item 24	0.864	0.787			
	Item 29	0.828	0.691			
	Item 17	0.777	0.55			
	Item 8	0.552	0.494			
Metacognitive Experiences (ME)	Item 15	0.736	0.518	0.908	0.46	0.831
	Item 22	0.723	0.628			
	Item 6	0.673	0.443			
	Item 4	0.647	0.379			
Metacognitive Skills (MS)	Item 21	0.603	0.619	0.824	0.485	0.827
	Item 23	0.771	0.588			
	Item 10	0.715	0.502			
	Item 19	0.704	0.466			
	Item 28	0.667	0.515			
	Item 7	0.615	0.566			

TABLE 1: Factors extracted by 15 items of Exam Metacognition Inventory, with reliability output. λ = Factor Loading; \hat{h}^2 =Communality; CR = Composite Reliability; AVE = Average Variance Extracted; ω =McDonald's Reliability Coefficient

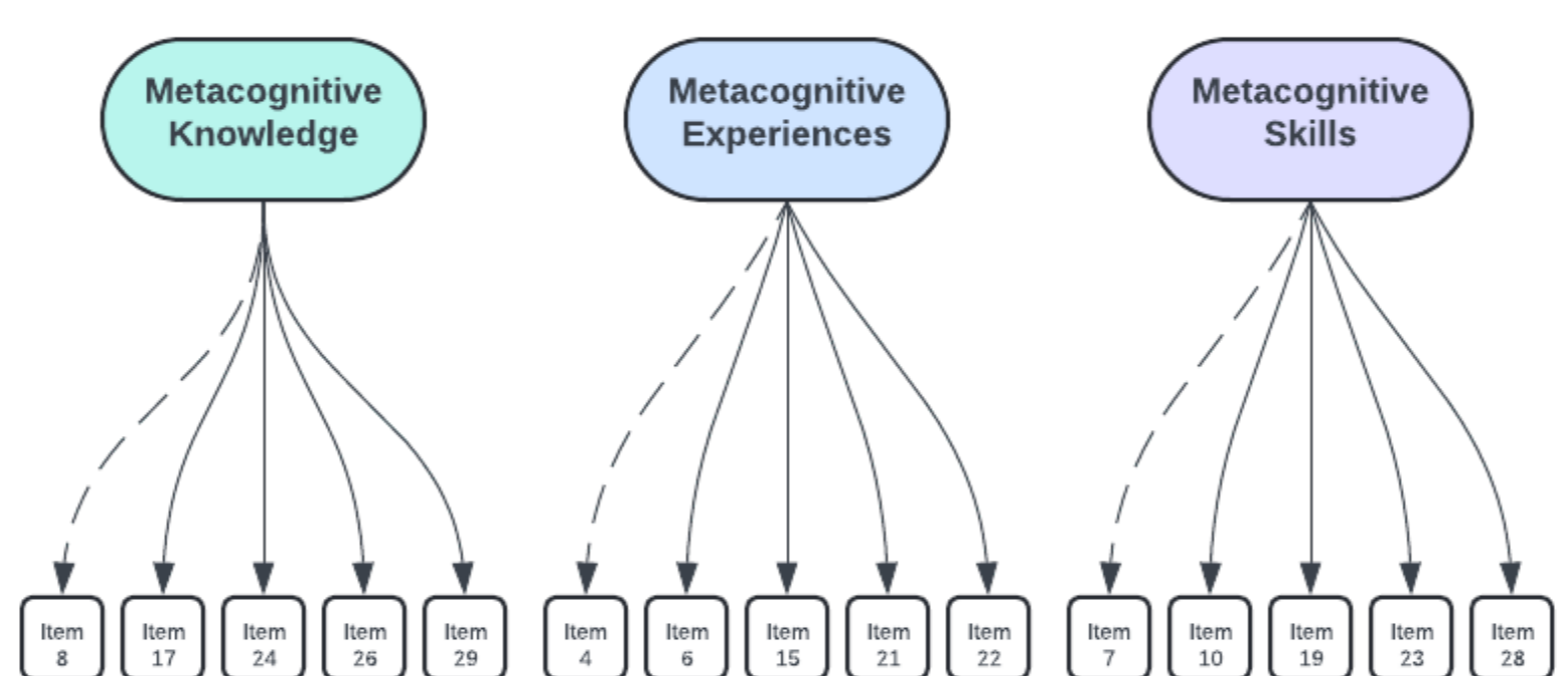


FIGURE 2: Path Diagram of EMI

Discussion

The validation study of the EMI revealed a three-factor structure – Metacognitive Knowledge, Metacognitive Experiences, and Metacognitive Skills – demonstrating an overall satisfactory fit for the data. The high Composite Reliability (CR) across all factors suggests strong internal consistency, particularly for Metacognitive Knowledge (CR = 0.898). However, the lower Average Variance Extracted (AVE) for Metacognitive Experiences and Metacognitive Skills indicates that these dimensions may require further refinement to better capture their constructs. Further research will be needed to confirm the factor structure in a more representative academic population and to assess additional validity indices, such as concurrent and predictive validity.

These findings provide a solid foundation for the EMI's use but highlight areas for future improvement, particularly in enhancing the convergent validity of certain factors.

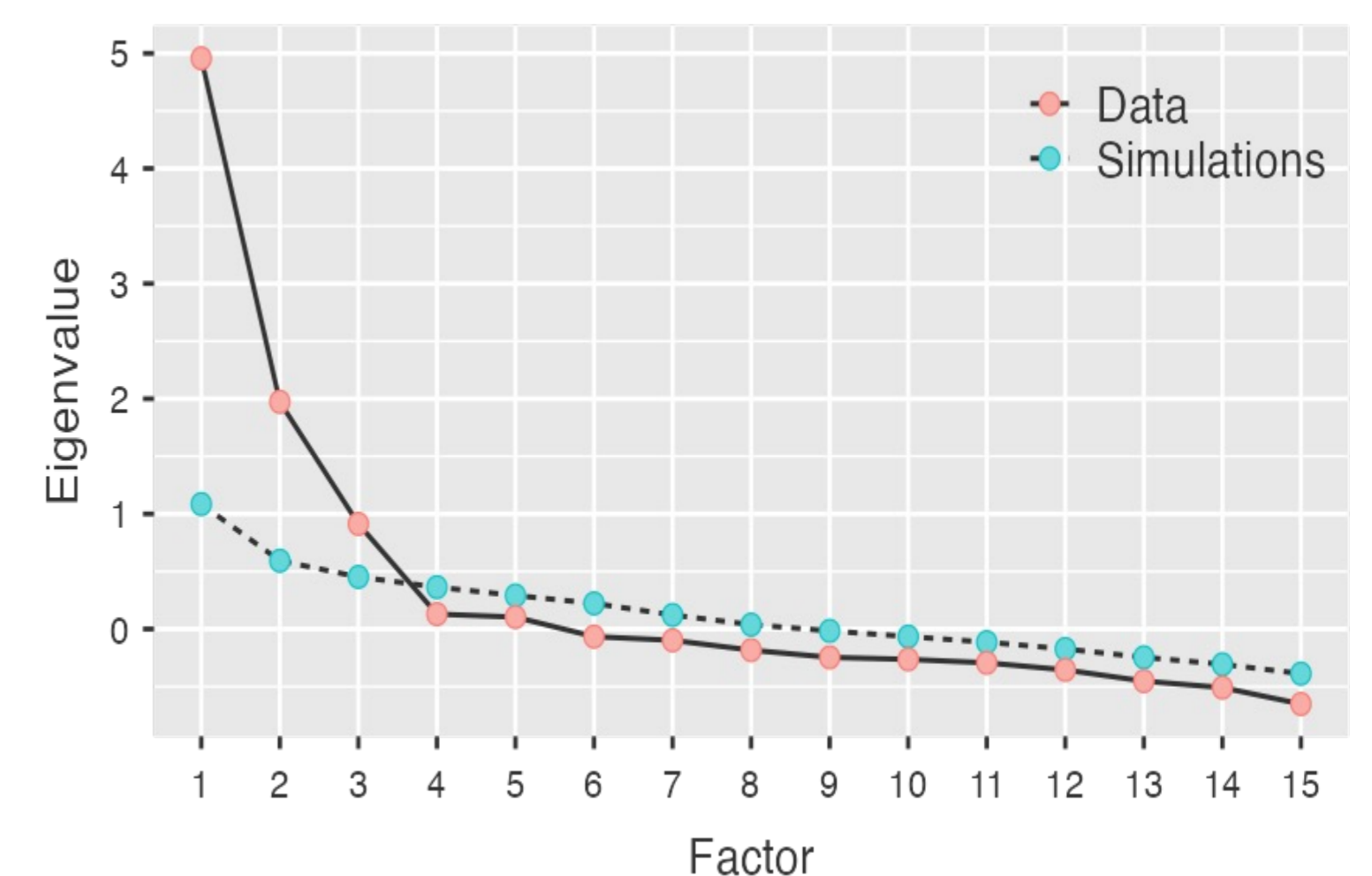


FIGURE 1: Scree Plot with Parallel Analysis of EMI.

Item	Description	Factor
4	Rischio di ammalarmi se mi preoccupo eccessivamente sull'esito possibile di un esame	ME
6	Se non riesco a controllare i miei pensieri negativi sull'esito dell'esame, di fronte ad un fallimento mi autocolpevolizzerei	ME
7	Ho bisogno di preoccuparmi per poter organizzare al meglio lo studio di un esame	MS
8	Ho poca fiducia nel rievocare (o recuperare) i concetti durante l'esame	MK
10	Quando preparo un esame, preoccuparmi mi aiuta a fare ordine nella mia mente	MS
15	Preoccuparmi eccessivamente per un esame potrebbe farmi impazzire	ME
17	Ho una scarsa memoria	MK
19	Preoccuparmi dell'esame mi aiuta a fronteggiarne le difficoltà	MS
21	Quando comincio a preoccuparmi per l'esame non riesco più a smettere	ME
22	Le conseguenze a cui andrò incontro se non controllo certi pensieri saranno devastanti	ME
23	Preoccuparmi mi aiuta ad apprendere meglio i concetti	MS
24	Ho poca fiducia nella mia capacità di memorizzare il materiale di studio	MK
26	Non ho fiducia nella mia memoria	MK
28	Ho bisogno di preoccuparmi per studiare bene	MS
29	Ho poca fiducia nelle mie strategie di apprendimento	MK

TABLE 2: Items of Exam Metacognition Inventory.

