

## **Learner Beliefs, Self-Regulated Learning Strategies and L2 Academic Reading Comprehension: A Structural Equation Modeling Analysis**

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**Abstract:** This study investigated whether and how university students' beliefs about the nature of knowledge i.e., epistemological beliefs affected L2 academic reading ability directly and/or indirectly via self-regulated learning strategies. EFL college students (n =196) answered the reading section of a TOEFL test, two parts of Motivated Strategies for Learning Questionnaire and Epistemological Beliefs Inventory. Structural Equation Modeling was conducted to determine which factors influenced L2 academic reading ability. Data analysis revealed that epistemological beliefs had both a direct and an indirect effect on L2 academic reading ability via self-regulated learning strategies. It was also found that metacognitive and resource management strategies influenced cognitive strategies. Likewise, cognitive strategies influenced L2 academic reading ability.

**Key words:** Epistemological beliefs • Self regulated learning • Cognitive strategies • Metacognitive and resource management strategies • L2 academic reading ability

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### **INTRODUCTION**

Reading ability is thought to evolve as a result of interaction among four areas: (a) text variables such as genre, coherence, text length and information density, (b) reader variables such as general and domain-specific background knowledge, linguistic knowledge, metalinguistic knowledge, metacognition, attitude, interest and beliefs (c) task variables such as complexity of the task and cognitive demand and (d) context variables such as social and physical setting [1]. Each aspect of the four areas mentioned above makes its own contribution to reading comprehension. In other words, there are four potential areas, each with many aspects, to be investigated for possible sources of problem.

An under-examined area within the second group i.e., reader variables is the contribution of learner beliefs to L2 reading comprehension. In cognitive psychology, though, beliefs held by learners about the nature of knowledge and learning i.e., epistemological beliefs, have been investigated as part of learners' metacognition. Links have been found between such beliefs and reading comprehension [2-3]. Nonetheless, to the authors' best knowledge, no study has been carried out to find out whether and how learner beliefs

influence L2 academic reading ability. Thus, this study investigated the interrelationships between learner beliefs, self-regulated learning strategies and L2 academic reading ability.

**Review of Literature:** It is well documented that metacognitive strategies are at the core of all test taking and learning strategies. Purpura [5-6] found that metacognitive strategies directly influenced cognitive strategies. Phakiti [7] reported that monitoring and evaluating strategies had an executive function on subscales of cognitive strategies. However, less strong relationships have been observed between cognitive strategies and test performance. Purpura [5] found the positive effect of retrieval strategies and the negative effect of memory strategies on performance on grammar tests. Likewise, Phakiti [6] recorded positive effects of comprehending strategies on reading comprehension. Likewise, O'Malley and Chamot [7] noted that metacognitive strategies monitored and managed cognition. Yet, it is not quite well known whether metacognitive strategies are, in turn, affected by yet another higher up regulating mechanism. This study entertains the possibility that epistemological beliefs have such a function.

**Epistemological Beliefs:** The notion of epistemological beliefs was first proposed in the 1970s. Thus, the concept has gone through constant revisions and remodeling, a report of which is outside the scope of this paper. In their review of decades of theorizing and experimenting in this field, Hofer and Pintrich [8] claimed that the construct of epistemological beliefs consisted of four relatively independent dimensions, namely, (1) certainty of knowledge, (2) simplicity of knowledge, (3) source of knowledge and (4) justification for knowing.

The first dimension has to do with certainty of knowledge. It has been proposed that the individuals who believe in the certainty and stability of knowledge are less aware of the limitations and boundaries of human knowledge. Thus, their expectations of what science can offer are often unrealistic because they believe all scientific theories to be true and final. It is difficult for such individuals to accept the view that scientific theories often require modifications and revisions let alone abandonment. Consequently, they cannot entertain the possibility of competing theories. It seems that this aspect is at the heart of all epistemological beliefs models.

The second dimension has to do with simplicity of knowledge. Individuals who believe in simplicity of knowledge view knowledge as the agglutination of simple facts just as buildings are built by agglutination of bricks. The consequences of such a belief could be to encourage low-level processing or surfaces approaches to learning at the cost of higher-order processing and deeper approaches to learning. Learners who adopt this view might not use their ability to analyze as much as they use their ability to synthesize. The alternative belief is to view knowledge as highly interrelated, relative, contingent and contextual concepts.

The third dimension, namely, source of knowledge has to do with role of experts and scientists as constructors of knowledge. There are people who see no role for themselves as the constructors of knowledge. Thus, they solely rely on the outside authority as the source of knowledge. However, as the conception of the self as a knower evolves, they see themselves as capable of constructing knowledge or making meaning in interaction with others.

The fourth dimension, namely, Justification for knowing has to do with how individuals evaluate knowledge claims. Individuals with naïve epistemological beliefs usually resort to authority, observation, or what feels right in cases of uncertainty. However, according to

Hofer [9] individuals with sophisticated epistemological beliefs “use rules of inquiry and begin to personally evaluate and integrate the views of experts” (p. 381).

Hofer and Pintrich’s classification [8] has not led to the development of a well tested instrument yet<sup>1</sup>. An earlier classification of epistemological beliefs proposed by Schommer [3] lacked the fourth dimension of Hofer and Pintrich’s classification [8] i.e., justification for knowing. Instead it had two other categories, namely, innateness and speed of learning. The former is the belief that learning is an innate ability fixed at birth and very much outside one’s control. The latter is the belief that learning is a quick or not at all process rather than a gradual one.

**Self-Regulated Learning Strategies:** Self-regulated learning highlights the learner’s role in the management and control of the learning process. According to Pintrich and Zusho [10], self-regulated learning “is an active process whereby learners set goals for their learning and monitor, regulate and control their cognition, motivation and behavior” (p. 64). Thus, self-regulated learners choose learning goals, select and execute suitable cognitive activities to achieve those objectives, monitor their learning process, evaluate learning outcomes and adjust their learning strategies if necessary.

Pintrich, Smith, Garcia and McKeachie [11] provide a classification of self-regulated learning strategies and motivational orientation for any specified academic course. This system, known as motivated strategies for learning includes two subcategories: (1) cognitive strategies and (2) metacognitive and resource management strategies. The cognitive module includes rehearsal, elaboration, organization and critical thinking strategies. The metacognitive and resource management component includes metacognitive self regulation strategies, time management strategies, effort regulation strategies and help seeking strategies.

Although the concept of self regulated learning strategies originated from educational psychology, recent research suggests its applicability to the field of language education. To compare similarities and differences between general education and L2 learning, Huang [12] investigated the reliability of Motivated Strategies for Learning Questionnaire (MSLQ) [11] and its correlation with L2 achievement. He found that “in spite of some inherent uniqueness, L2 learning is similar to other subjects in the school environment and the MSLQ has the potential to be applied to L2- related studies” (p. 259).

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<sup>1</sup>In fact, items of an instrument developed by Hofer (2004) loaded only on three factors rather than four

Stoffa, Kush and Heo [13] reported similar findings. Furthermore, they tested the possible overlap between MSLQ and Strategy Inventory for Language Learning (SILL) [14]. They found “while the two scales do have similar content, the scales do not overlap entirely and appear to measure two discrete indices”.

**Reading Comprehension:** For a long time the literature on reading comprehension has centered on the so called reading processes. The process models of reading start with what we directly know about the experience of reading. Two such processes are often mentioned in the literature, namely, bottom-up and top-down reading processing. Viewed from a bottom-up perspective, reading is mainly a decoding process. Such a process, therefore, refers to the textual decoding of linear written symbols in order to make sense of the printed material [15]. Employing bottom-up processing, “the reader begins with the printed word, recognizes graphic stimuli, decodes them into sounds, recognizes words and decodes meaning” [16] (p.16). Viewed from a top-down perspective, reading is mainly a constructive process. It, therefore, relies on the role of interpretation and prior knowledge in text comprehension. According to Bernhardt [17] current research generally views reading as an interactive, sociocognitive process involving the text, the reader and the social context within which the activity of reading takes place.

However, Wineburg [18] criticized the process view of reading on the ground that it views reading as a relatively automatic process, in which the reader relies on processes from word recognition, the ability to understand sentences and the relations between them. Thus, it attributes comprehension failures to any of these levels, namely, word level, sentence level and coherence at text level. Yet, it fails to mention “the failure to understand the intention of the author, the failure to grasp the polemic of the text, the failure to recognize connotations (not just the denotations) of words, the failure to situate the text in a disciplinary matrix” (p. 502).

Another perspective on reading focuses on reading purposes [16]. As such, L2 academic reading ability- the focus of this study- is a complex and multi-component construct. Sengupta [19] defined academic reading as “purposeful and critical reading of a range of lengthy academic texts for completing the study of specific major subject areas” (p. 3). Grabe [20] asserted that academic reading ability deals with such complex skills as integrating, evaluating, critiquing and using information

as well as some simpler skills such as searching for information and quick understanding across academic texts as follows:

- Reading to search for information (skimming and scanning).
- Reading for quick understanding.
- Reading to learn.
- Reading to integrate information.
- Reading to evaluate, critique and use information.
- Reading for general comprehension (in many cases, reading for interest or reading to entertain).

**Model Building and Research Hypotheses:** It has long been known that reading ability is influenced by such factors as background knowledge and all sorts of schemas [16]. Yet, it seems that there might be a hierarchical relationship between schemas and what Shommer, Crouse and Rhodes [21] called schema of schemas about the very knowledge itself. Schommer-Aikens’ hypothesis [22] about the interrelationship among the constructs of this study is that there are both indirect and direct relationships between epistemological beliefs, self regulated learning and reading ability. She also points to the so called filtering effects of epistemological beliefs on text comprehension. She states:

Epistemological beliefs have both direct and indirect effects. By indirect effects it means that epistemological beliefs mediate learning. For example, a strong belief in isolated knowledge could set the standard for what it means to learn. In this case learning would mean being able to recall a list of words. This standard in turn leads the learner to select only memorizing as a study strategy. This single, limited study strategy would result in impoverished mental representation of the content. Ultimately, this leads to inert knowledge. As an example of a more direct effect, strong belief in certain knowledge may serve as a filter in interpreting a tentative text as if it were definitive (p.106).

Winne [23] hypothesized “epistemological beliefs serve an important role of setting standards for students’ self regulated learning” (p.106). This view is echoed by Muis and Franco [24]. They stated “epistemic beliefs influence the process of self-regulated learning via standards students set for themselves once goals are produced” (p.1). In the case of reading comprehension this means that a student with naïve epistemological beliefs is more likely to set the standard of superficial understanding than a student with more sophisticated

epistemological beliefs. Support for this proposition also comes from other educational psychologists. Wineburg [18] showed how even the most highly- gifted high school students misinterpreted history textbooks due to their implicit theories of reading<sup>2</sup> (epistemology of text).

There are also a number of theoretical models positing a hierarchical relationship between metacognition and cognition. Kitchener [25] proposed a model of cognition with three levels: (a) cognition, (b) metacognition and (c) epistemic cognition. Cognition is considered to be lowest level in this model. It encompasses such lower-order mental processes as perception, reading and computing. Metacognition is the second level in the ladder responsible for such skills as inductive and deductive reasoning and reflective thinking. The highest level i.e., epistemic cognition encompasses knowing about knowing. As the most abstract form of cognition they are not expected to emerge until late adolescence. Kuhn [26] proposed a similar hierarchical model, in which personal epistemology supersedes metacognition. He excluded cognition from his model. Instead, he focused on components of what he called meta-knowing, which encompasses three hierarchically-arranged components as the following: (a) metacognitive knowing, (b) metastrategic knowing and (c) epistemological knowing. Hofer [27] saw learner beliefs as aspects of metacognition, which is a higher level than cognition. He proposed just two levels: (a) cognition and (b) metacognition with three components: a) metacognitive knowledge (beliefs about the nature of the knowledge), b) metacognitive judgment and monitoring (beliefs about knowing process) and c) metacognitive self-regulation and control of cognition (beliefs about values, motivation and volition). Thus, theoretically it is safe to hypothesize that epistemological beliefs have a direct impact on metacognition, which, in turn, influences cognition. Then cognition influences reading ability. Bachman [28] introduced a model of language ability in which metacognitive strategies, alternatively known as strategic competence, have an executive function over other aspects of language use, thus including cognitive strategies.

Informed by above-mentioned theoretical positions, the model proposed in this study consists of four variables: epistemological beliefs (EB), metacognitive and resource management strategies (MR), cognitive strategies (CS) and L2 academic reading ability (RA).

Epistemological beliefs are the exogeneous variables (antecedents) of the model. Metacognitive strategies, cognitive strategies and L2 academic reading ability are endogenous variables (consequents). The relationships can be expressed in four paths in the proposed model. Path one predicts a relationship between epistemological beliefs and L2 academic reading ability (epistemological beliefs → L2 academic reading ability). Path two presumes a relationship between cognitive strategies and L2 academic reading ability (cognitive strategies → L2 academic reading ability). Path three assumes a relationship between epistemological beliefs and metacognitive and resource management strategies (epistemological beliefs → metacognitive and resource management strategies). Path four suggests a relationship between metacognitive strategies and cognitive strategies (metacognitive strategies → cognitive strategies). Thus, this model could be broken down into four hypotheses outlined below.

**H1:** (EB → RA) Epistemological beliefs (EB) have a direct impact on academic reading ability.

**H2:** (CS → RA) Cognitive strategies have a direct impact on academic reading ability.

**H3:** (EB → MR) Epistemological beliefs have an effect on metacognitive and resource management strategies.

**H4:** (MR → CS) Metacognitive and resource management strategies have an impact on cognitive strategies.

## MATERIALS AND METHODS

**Participants:** The participants in this study were 196 (172 males and 24 females) EFL college students. Their mean age was 23.04 for men (SD =3.43) and 21.91 for women (SD= 3.21). The sample size is considered to be sufficient given Bentler and Chou's [29] criterion of 10 to 15 participants per variable for each measurement model. Maximum variation sampling [30] was used to ensure heterogeneity of the sample, which is a concern of structural equation modeling analyses. Thus, the participants were recruited from across four universities from diverse locations in Iran, namely, Jahrom Higher Education Complex (n=60), Shiraz and Sepidan branches of Islamic Azad University (n =50 and 52 respectively) and Gonbad Payam-e-Noor (n=34) University.

<sup>2</sup>The students' implicit theory of reading was thought to be that when one encounters a text in a textbook, one simply reads it to order to be able to reproduce it later rather than to evaluate it critically

University admission system in Iran is organized in such a way that it spreads students to different types of universities on the basis of their ability level. The strongest students are normally admitted to state-run universities, where they study for free, through national screening tests. Other less strong students are admitted to Branches of Islamic Azad University and Payam-e-Noor University in major cities. Such students have to pay tuition for their studies. Other still less strong students are admitted to Branches of Islamic Azad University and Payam-e-Noor University in small towns, where they not only have to pay tuition but also have to bear extra expenses for living in dormitories. The sample in this study consists of all three types of universities to ensure maximum variability.

**Materials:** Two questionnaires and one test were used in the study. The questionnaires were piloted to see whether or not there was a need for any modifications. The pilot study provided the researchers with information about the necessary modifications in the instruments. The final modified versions of the instruments were used in the main study as follows:

- *Epistemological Beliefs Inventory* (EBI), developed by Schraw, Bendixsen and Dunkle [31] is a 32 item Likert-scale questionnaire that assesses Schommer's five epistemic factors of epistemological beliefs [3]: Belief in (a) simple knowledge, (b) certain knowledge, (c) omniscient authority, (d) fixed or innate ability and (e) quick learning.
- The researchers employed *Motivated Strategies for Learning Questionnaire* [11] to assess Iranian college students' reported use of strategies when studying texts usually found in academic settings such as textbooks. It is multi-component Likert-scale questionnaire consisting of two scales i.e. motivation and learning strategies designed to measure motivation and self-regulated learning strategies. The learning strategy component consists of two sub scales i.e. cognitive and metacognitive and resource management strategies. *Motivated Strategies for Learning Questionnaire* (MSLQ) scales "are designed to be modular and can be used to fit the needs of researchers" [11] (p. 3). Therefore, two modules of MSLQ were used to assess participants' self reported use of cognitive strategies. The following are components of this instrument: (a) rehearsal strategies, (b) elaboration strategies, (c) organization strategies and (d) critical thinking strategies and

metacognitive and resource management strategies, which has four components: (a) metacognitive self-regulation, (b) time and resource management, (c) effort regulation and (d) help seeking.

- A paper adaptation of the reading part of a TOEFL iBT was used to measure the participants' academic reading ability. TOEFL is a proxy for academic English in the domain of reading. Sawaki, Stricker and Oranje [32] defined TOEFL as "a battery of academic English language ability measures" (p. 1).

**Procedure:** The TOEFL test, Motivated Learning Strategies Questionnaire (MLSQ) and Epistemological Beliefs Questionnaire were introduced to the participants in the study in different sessions. The participants were informed that (a) there were no right and wrong answers in the questionnaires, (b) the instruments were used only to gather information for the purpose of research and they were not linked to any form of classroom evaluation and (c) the information obtained would be kept confidential.

The process of data collection lasted for two months from March to June 2009. The data were collected in classrooms during class hours. First, the students took the reading test. Later, they filled out the strategy use questionnaire. In the following week the students were given the learner beliefs questionnaire. They were asked to fill them out and return them the following week. Some instructions were given to the students as how to fill out the questionnaire.

**Data Analysis Method:** The current study used LISREL version 8.54 to analyze the data. A two-step approach was adopted for the analysis of the hypothesized model. In this approach all the measurement models were analyzed by confirmatory factor analysis (CFA) prior to the analysis of the structural model. A significance level of ( $p < 0.01$ ) was set. Furthermore, to ensure the robustness of the analysis maximum likelihood estimation procedure was adopted.

## RESULTS

Structural Equation Modeling (SEM) with LISREL software was used to analyze the data. SEM consists of two models, namely, the measurement and the structural model. The measurement model had to do with the relationship between the manifest variables and the first-order latent variables. The structural model had to do with the relationships among latent variables.

**The Measurement Model:** Confirmatory factor analyses (CFA) were run to determine the adequacy of factor loadings of the latent variables and the degree of model fit for the measurement model. Yet, since Root Mean Squared Error of Approximation (RMSEA) in the initial measurement model was 0.142, which higher than the recommended maximum level of 0.05, some co-variances among indicators were freed iteratively. In each step the covariance that had the largest standardized residual was freed on the condition that it did not change the structural model.

The logic behind this operation is that SEM uses goodness of fit between the hypothesized model and the sample data; therefore, eliminating residuals is a useful method for improving the model fit and locating the sources of misspecifications [35]. SEM employs two such residual measures, namely, standardized root mean squared residual (SRMR) and the root mean squared error of approximation (RMSEA). The former is the averaged differences between the population and the sample variance covariance matrix. The latter measures the deviation of parameter values from the variance-covariance matrix of the population. As such, freeing co-variance among indicators should lower both SRMR and RMSEA.

The residuals which were allowed to correlate were critical thinking with metacognitive strategies (CT MS), certain knowledge with omniscient authority (CK OA) and time management with effort regulation strategies (TM ER). All chi square differences were significant after

each operation as follows: ( $\chi^2_{\text{diff}}^{(1)} = 4.73, p < 0.01$ ; ( $\chi^2_{\text{diff}}^{(2)} = 4.40, p < 0.01$ ; ( $\chi^2_{\text{diff}}^{(3)} = 4.46, p < 0.01$ ). Once these residuals were correlated, significant improvements in fit indices emerged in the fourth model: *chi-square*, 156.09, *SPMR*, 0.04; *RMSEA*, 0.056. Table 1 depicts the results of the modification stages of the measurement model. Table 2 gives the fit indices of the modified measurement model.

The CFA analysis for the variables of the measurement model, namely, epistemological beliefs, self-regulated learning strategies and L2 academic reading comprehension show acceptable factor loadings from .42 for beliefs in innate ability to .79 for metacognitive strategies. The only exception is the subscale of rehearsal strategies from the construct of cognitive strategies with a factor loading of just .08 and a t-value of 1.12, suggesting that we need to drop the items belonging to this subscale from the final analysis of the structural model. Similarly, all the subscales had a t-value well above the recommended level of 1.96 with the exception of rehearsal strategies. Furthermore, the standardized error for all variables was below the recommended level .07. Composite Reliability (CR) of all variables was well above the recommended level of .60. Average Variance Extracted (AVE), a measure of error-free variance in subscales, was well above the recommended level of .50 in all subscales. CR and AVE are considered to indicate convergent validity i.e., as aspect of construct validity. Figure 1 shows factor loadings of the measurement model. Table 3 gives detailed information about the modified measurement model.

Table 1: The stages of model modifications

		$\chi^2$	$\Delta\chi^2$	SRMR	p	RMSEA	(%90 CI)	CFI
M1	---	169.98	---	0.12	---	0.142	(.000-.665)	.95
M2	CT, MS	165.25	4.73	0.08	<.01	0.098	(.000-.754)	.96
M3	CK, OA	160.55	4.40	0.06	<.01	0.068	(.000-.683)	.96
M4	TM, ER	156.09	4.46	0.04	<.01	0.056	(.000-.890)	.97

Note: M1 = Model1, M2= model 2, M3= model3, M4 =model4 CI = Confidence Interval CFI= Comparative Fit Index

Table 2: Fit indices of the measurement model

Index	Critical value	Observed value	Comment
Root Mean Squared Residual RMR		0.140	Very good
Standardized RMR	<0.08	0.040	Very good
Goodness of Fit Index (GFI)	>0.90	0.950	Good
Normed Fit Index (NFI)	>0.90	0.960	Very good
Non-Normed Fit Index (NNFI)	>0.90	0.940	Good
Incremental Fit Index (IFI)	>0.90	0.970	Very good
Comparative Fit Index (CFI)	>0.90	0.970	Very good
Root Mean Square Error of Approximation (RMSEA)	<0.05	0.056	Very good

Table 3: Indices of the measurement model

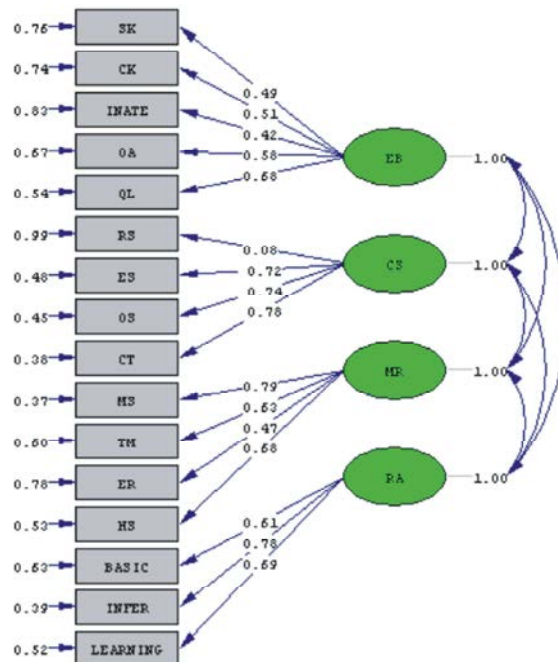
Construct	Indicators	Factor Loading	t-value	Standardized error	Composite Reliability (CR)	Average Variance Extracted (AVE)
EB	SK	0.49	6.58	0.074	0.95	0.79
	CK	0.51	6.79	0.075		
	OA	0.58	7.87	0.073		
	INATE	0.42	5.47	0.076		
	QL	0.68	9.61	0.070		
CS	*RS	0.80	1.12	0.070	0.96	0.89
	ES	0.72	11.07	0.065		
	OS	0.74	12.53	0.059		
	CT	0.78	12.45	0.062		
MR	MS	0.79	12.61	0.062	0.96	0.86
	TM	0.63	9.37	0.067		
	ER	0.47	6.63	0.070		
	HS	0.68	10.32	0.065		
RA	BASIC	0.61	8.72	0.069	0.91	0.87
	INFER	0.78	11.98	0.065		
	READ	0.69	10.33	0.066		

BASIC: basic understanding, CK: certain knowledge, CS: cognitive strategies, CT: critical thinking, EB: epistemological beliefs, ER: effort regulation, ES: elaboration strategies, FA: fixed ability, HS: help seeking, INFER: inferencing, MR: metacognitive and resource management strategies, MS: metacognitive strategies, OA: omniscient authority, OS: organization strategies, QL: quick learning, RA: reading ability, READ: reading to learn, RS: rehearsal strategies, SK: simple knowledge, TM: time management

Table 4: inter-correlation matrix among study variables

	Mean	Standard deviation	1	2	3	4
EB (1)	25.04	3.9	0.88			
CS (2)	23.14	3.5	*0.59 (03.8)	0.94		
MR (3)	22.11	3.1	*0.55 (70.7)	*0.55 (96.7)	0.92	
RA (4)	13.05	2.6	*0.84 (25.12)	*0.79 (40.11)	*0.85 (08.14)	93.0

\*P<.01 EB = Epistemological beliefs, CS = Cognitive Strategies, MR = metacognitive and resource management strategies, RA = L2 Academic Reading Ability



Chi-Square=156.09, df=98, P-value=0.00017, RMSEA=0.056

Fig. 1: Confirmatory factor analysis for the final measurement model

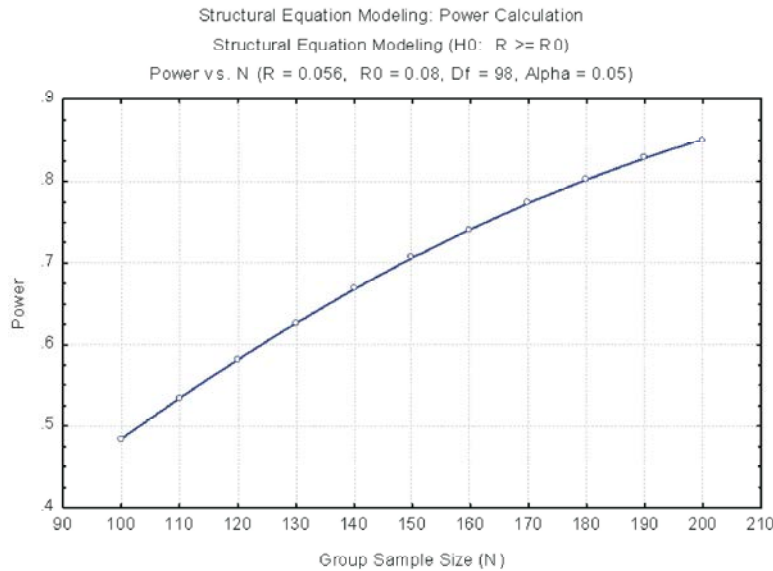


Fig. 2: Power analysis for the measurement model

Although the relationships presented above are all statistically significant, the analysis is not completed yet. The focus of the next stage of analysis is assessing the effect of the size of power- a measure of practical significance. Figure 2 depicts a graph of the power analysis for the measurement model. It shows power in relation to sample sizes from 100 to 200. As it can be seen, the power reaches .82 at the sample size of 196 and RMSEA of .056. Theoretically, such as sample size requires a power ranging from .80 to .90.

**The Structural Model:** Since the initial models usually fit poorly, SEM allows a number of solutions to improve model fit. Imposing constraints and adding new parameters are two solutions for model modification in LISREL. In the former approach certain constraints are imposed on the model. One of the strategies commonly used in human sciences is zero-restriction. It requires the researcher to limit certain structural factors to zero, or to equate certain structural factors with each other, or to fix a certain parameter to one. In the latter approach new parameters are added to the model. Researchers normally look at the inter-correlation matrix among study variables to decide which method to apply. If there are high correlations among study variables, they choose the latter method i.e, adding new parameters to the model. Table 4 presents inter- correlation matrix among study variables.

All t-values given in the parentheses are significant at  $p < .01$ . Therefore, given the high inter-correlation among the variables, it was decided to add new

parameters to the model. This process was carried out in series of steps. The first three steps manifest significant reduction of  $\chi^2$ . That is, All chi square differences were significant at ( $\chi^2_{\text{diff}}^{(1)} = 8.63, p < 0.01$ ; ( $\chi^2_{\text{diff}}^{(2)} = 5.56, p < 0.01$ ; ( $\chi^2_{\text{diff}}^{(3)} = 6.31, p < 0.01$ ), suggesting improvements in the model. However, -chi square differences were not significant in the subsequent steps. As such, the fourth model was chosen as the final model. It is noteworthy that this model is a saturated model in the sense that there is no covariance error unaccounted for. Table 5 depicts this process.

**The Full SEM Model:** In terms of the relationships among latent variables, data analysis showed that cognitive strategies (CS) are strongly associated with L2 academic reading comprehension (RA) (coefficient parameter=1.4,  $t=39.10, P < .01$ ) with the exception of rehearsal strategies. It also showed that all the subscales of metacognitive and resource management strategies (MR) have an effect on cognitive strategies (CS) (coefficient parameter=1.2,  $t=48.31, P < .01$ ). Epistemological beliefs (EB) directly influence L2 academic reading ability (RA), though the association is rather weak (coefficient parameter= .07,  $t=4.84, p < .01$ ). They also have an effect on metacognitive and resource management strategies (MR) (coefficient parameter=.89,  $t=38.34, P < .01$ ). Table 6 shows these effects.

The full SEM model also contains information about the relationships between latent variables and their indicators. With respect to L2 academic reading ability, all

Table 5: Stages of model modifications

Modified Models	$\chi^2$	$\Delta\chi^2$	Df	RMSEA	Significance of deletion chi-square $P < 0.01$
Model one	178.21	---	124	0.101	----
Model two	169.58	8.63	115	0.095	Significant
Model three	164.02	5.56	106	0.067	Significant
Model four	157.71	6.31	100	0.055	Significant
Model five	156.87	0.54	98	0.055	Not significant

Table 6: Relationships among latent variables

Hypothesis	Path	Estimated parameter	Standard error	t- value	p
H1	EB → RA	0.27	0.055	4.84*	<.01
H2	CS → RA	0.75	0.019	39.10*	<.01
H3	EB → MR	0.87	0.022	38.34*	<.01
H4	MR → CS	0.99	0.020	48.31*	<.01

\*Significant at <.01

the subscales showed a strong and statistically significant association with L2 academic reading ability. This means L2 academic reading ability was well measured by the participants' performance on basic reading with a loading of 0.61 ( $R^2=.37$ ) and by inference questions with a loading of 0.78 ( $R^2=.60$ ) and by reading for learning items with a loading of 0.69 ( $R^2=.47$ ).

With regard to the construct of metacognitive and resource management strategies, all the subscales show a strong and statistically significant association with it. That means, this construct is explained by participants' metacognitive self regulation strategies with a loading of 0.70 ( $R^2=.49$ ), by time management strategies with a loading of 0.63 ( $R^2=.39$ ), by effort regulation strategies with a loading 0.47 ( $R^2=.22$ ) and by help seeking strategies with a loading of 0.68 ( $R^2=.46$ ). The results suggest that metacognitive self-regulation is the strongest determinant of metacognitive and resource management strategies.

Regarding strategies, three of the subscales showed a strong and statistically significant association with this construct. That means, this construct is explained by participants' elaboration strategies with a loading of 0.72 ( $R^2=.51$ ), by organization strategies with a loading of 0.75 ( $R^2=.56$ ) and by critical thinking strategies with a loading 0.79 ( $R^2=.62$ ). However, the rehearsal strategies subscale had a non-significant loading of 0.08 ( $R^2=.006$ ). The results suggest that rehearsal strategies might lose their importance for junior and senior EFL college students.

With regard to epistemological beliefs, all the subscales show a strong and statistically significant association with this construct. That means, this construct is explained by participants' belief in simple knowledge with a loading of 0.49 ( $R^2=.24$ ), by belief in certain knowledge with a loading of 0.51 ( $R^2=.26$ ), by belief

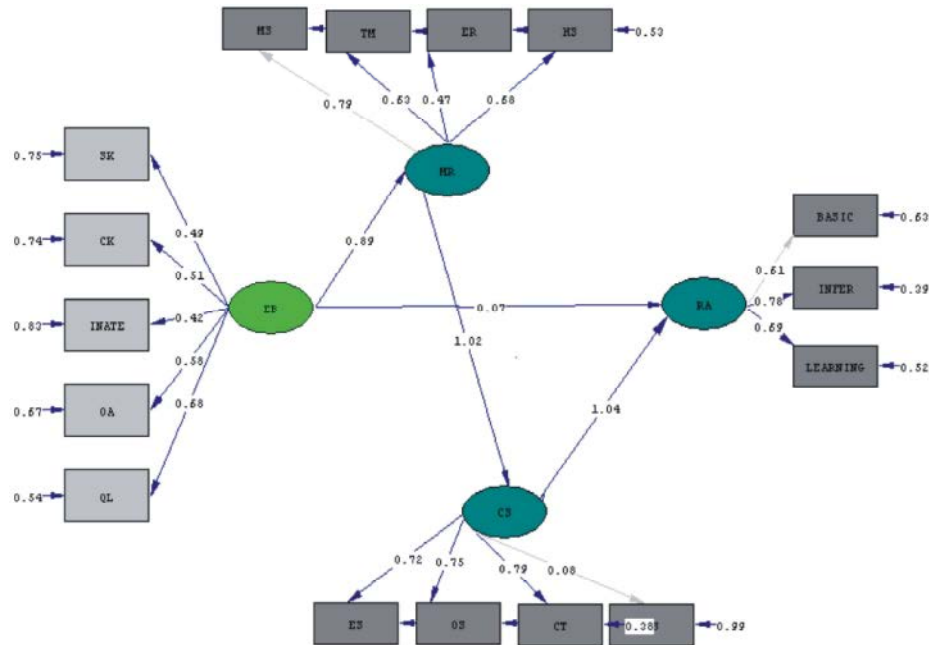
in innate ability with a loading 0.42 ( $R^2=.17$ ), by belief in omniscient authority with a loading of 0.58 ( $R^2=.33$ ) and by belief in quick learning with a loading 0.68 ( $R^2=.46$ ), Figure 3 depicts the full SEM model.

**Model Evaluation:** A number of fit indices were used to see whether the data supported the model proposed. The GFI (Goodness of Fit) value is 0.91. The NNFI (Non Normed Fit Index) value is 0.98. The NFI (Normed Fit Index) is 0.95. The CFI (Comparative Fit Index) value is 0.98. IFI (Bollen's Incremental Fit Index) is 0.98. According to Kunnan (1998) if the above mentioned indices are above .90, the rule of the thumb is that the model has good fit indices, provided that it meets the criteria set for chi square, RMSEA and SPMR and provided that the model is interpretable. The value of  $\chi^2/df$  is 1.57, which is below the recommended cutoff value of 3.0, indicating a good fit. RMSEA is 0.055, which is considered to be an excellent fit. Standardized root mean square residual (SRMR) is 0.049 indicating that there is little unexplained error residual in the model. Table 7 summarizes model fit indices.

Although the proposed model enjoys acceptable model fit indices, two other issues need to be addressed i.e., effect sizes and multivariate normality. Statistical significance does not necessarily mean practical significance [36]. Therefore; it is recommended that researchers calculate effect sizes as well. Effect sizes allow the researcher to understand if the results have any practical significance. As such, the final stage of the data analysis for the SEM model is power analysis. Figure 4 depicts power in relation to sample size. It shows power reaches .96 at the sample size of 196 and RMSEA of .055. This also shows that the sample size required for a close fit has been obtained.

Table 7: Model fit indices of the final SEM model

Index	Critical value	Observed value	Comment
$\chi^2/df$	<3	1.570	Very good
Standardized RMR	<0.08	0.049	Very good
Goodness of Fit Index (GFI)	>0.90	0.910	Marginal
Normed Fit Index (NFI)	>0.90	0.950	Very good
Non-Normed Fit Index (NNFI)	>0.90	0.980	Very good
Incremental Fit Index (IFI)	>0.90	0.980	Very good
Comparative Fit Index (CFI)	>0.90	0.980	Very good
Root Mean Square Error of Approximation (RMSEA)	<0.05	0.055	Very good



Chi-Square=155.87, df=100, P-value=0.00030, RMSEA=0.055

Fig. 3: The full SEM model

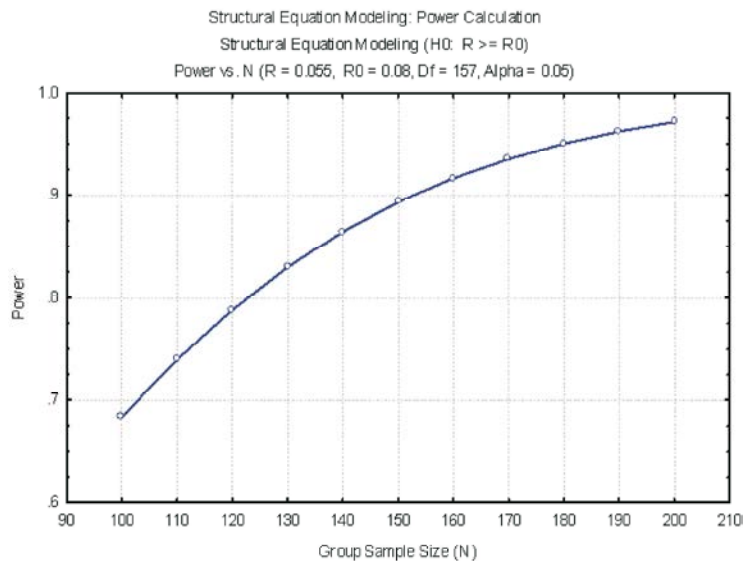


Fig. 4: Power analysis of the SEM model

Another major requirement of structural equation modeling is univariate and multivariate normal distribution of the data. One technique to establish this criterion is to inspect the distribution diagrams and check the descriptive statistics and values of skewness and kurtosis. Epistemological beliefs inventory have a mean of 25.04 and standard deviation of 3.9. Cognitive strategies have a mean of 23.14 and standard deviation of 3.5 (Range= 11.2-27.4). Metacognitive and resource management strategies have a mean of 22.11 and standard deviation of 3.1(Range=11.5-26.9). The reading part of TOEFL test has a mean of 13.05 and standard deviation of 2.6 (Range= 6.9-15.1). Judging from distribution diagrams few the violation of skewness, namely, values outside the range of -3 to 3 were observed. Likewise, there were no violations of kurtosis beyond the threshold level of 10.

## **DISCUSSION**

The findings seem to support the idea that part of the gains in L2 academic reading ability as shown by TOEFL scores can be attributed to self-regulated learning strategies and epistemological beliefs. They also support the assertion that metacognitive and resource management strategies act as a mediating construct between epistemological beliefs and cognitive strategies, suggesting that the relationship between epistemological beliefs and cognitive strategies is a conditional indirect one.

The following relationships were found between the endogenous variables of the study i.e., metacognitive and resource management strategies, cognitive strategies and L2 academic reading comprehension. The effect of cognitive strategies on L2 academic reading ability is strong (path coefficient= 1.4) and significant ( $p < .01$ ). The influence of metacognitive and resource management strategies on cognitive strategies is almost equally strong (path coefficient = 1.2) and significant ( $p < .01$ ). According to Kline [37] standardized path coefficients with absolute values greater than .5 may indicate a large effect.

Indeed, these findings form a mini model within the main model. There is both theoretical as well as empirical support for such relationships in the literature. Theoretically the findings are in line with Bachman's model of language ability [28], in which strategic competence has an executive function in language use. Similar findings have been reported in the literature. Purpura [4] and Phakiti [6-7] found a significant and direct influence of metacognitive strategies on cognitive ones. This means that metacognitive and resource management

strategies regulate and control learning process. Therefore, they regulate the use of other kinds of learning strategies. For example, a learner who uses a metacognitive and resource management strategy such as "effort regulation" probably has a realistic idea of what it takes to learn a new and challenging subject. Therefore, s/he is likely to choose the actual study techniques more intelligently. Accordingly, s/he may decide that it is less helpful to resort to such techniques as memorizing facts than to check multiple sources for a better understanding of the subject.

However, the question remains as to whether or not metacognitive strategies, in turn, are affected by yet another regulating mechanism. Assuming a relationship between epistemological beliefs and metacognitive and resource management strategies, path two in the proposed model deals with this question. There is indeed a strong (path coefficient=.89) and significant ( $p < .01$ ) relationship between the two constructs.

In practice, this means unless an EFL college student has a fair understanding of what scientific knowledge is and how it is acquired, s/he will not be in a position to manage and control his/her own learning process e.g., use metacognitive and resource management strategies well. This impediment, in turn, will affect the rest of the learning / test taking process. That is, she will not be able to use effective study techniques. Instead, she will rely on techniques that help him/her to accumulate pieces of knowledge (rehearsal strategies) rather than techniques that help him/her examine implications and making mental connections between materials being studied and existing knowledge.

The above findings are only partially supported by experimental research in cognitive psychology. On the one hand, Köller, Baumert and Neubrand [38] found that the students who believed in simple knowledge tended to rely on rehearsal strategies more often. Also, Dahl, Bals and Turi [39] found that the more naïve epistemological beliefs the students had, the fewer metacognitive strategies they used. On the other hand, Strømsø, Bråten and Samuelstuen [40] found little relationship between epistemological beliefs and type of cognitive strategies employed by college students.

The weakest relationship is the direct influence of epistemological beliefs on L2 academic reading ability (path coefficient = .07). Although weak, this influence is significant at ( $t = 4.84, p < .01$ ). According to Kline [37] standardized path coefficients with absolute values less than .10 indicate a small effect. This suggests that beliefs may have a direct effect on reading ability, but given the

Table 8: The hypotheses and their significance

Paths	paths	t value	Significant
P1: Epistemological beliefs have a statistically significant effect on L2 academic reading ability.	EB → RA	4.84 P<0.01	Yes P1 Supported
P 2: cognitive strategies have a statically significant effect on L2 academic reading ability.	CS → RA	39.10 P<0.01	Yes P2 Supported
P 3: Epistemological beliefs have a statistically significant effect on metacognitive and resource management strategies.	EB → MR	38.34 P<0.01	Yes P3 Supported
P 4: Metacognitive and resource management strategies have an effect on cognitive strategies.	MR → CS	48.31 P<0.01	Yes P4 Supported

small size of the effect it is doubtful whether or not they are powerful enough to exert a filtering effect on reading ability. There are suggestions both in cognitive psychology and in philosophy that beliefs are powerful enough to exert such an effect. For example, Pajares [41] asserts “the potent, affective, evaluative and episodic nature of beliefs makes them a filter through which new phenomena are interpreted” (p. 324). Elsewhere he maintains “the filtering effect of belief structures ultimately screens, redefines, distorts, or reshapes subsequent thinking and information processing” (p. 325). Shommer [3] found that the students who believed in certain knowledge often interpreted text with a tentative character as absolute. Table 8 summarizes the findings.

**Implications:** At the theoretical level, the main implication of such findings is that disposition to use strategies may have to do with language learners’ deep grained beliefs and myths. Looking at strategies from this perspective entails shifting the focus from implementation level to the more abstract domains of beliefs and conceptions. It also entails not only deepening but also broadening our view of strategies. As such, we may need to look at the interfaces or common roots of learning and test taking strategies.

There are also insights to gain at the practical level, too. The fact is that a lot of resources are spent annually to prepare students for high-stake tests such as TOEFL and SAT. Nonetheless, intervention courses offered for this purpose are often too short-sighted in the sense that they focus on short term goals and testing gimmicks. Indeed, many such courses view strategies as a form of instinctual knowledge to get round a problem. We hope to have shown that strategy instruction needs to be put in the broader context of intellectual development.

The current study has a number of limitations. First, although a number of influences have been predicted in the model, the model is almost certainly incomplete. There is a host of variables that can be added to the model. For example, it has been suggested that epistemological beliefs are influenced by such factors as personality and cognitive styles [42]. Second, the notion of

epistemological beliefs is under constant revisions [43]. Therefore, further research is needed to take care of such rethinking. Third, generalizations from this study might be limited as the sample comes from a single ethnic group. Therefore, it remains for future researchers to further extend or revise the proposed model.

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