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Effects of Strategies, Motivation, Cognitive Load and Anxiety on Chinese Undergraduates' English Reading Performance

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Abstract: *This study investigates the relationships among learning strategies, motivation, cognitive load, and anxiety, as well as their effects on the performance of English reading in higher education in China. An English reading examination and a questionnaire were administered to 272 undergraduates (184 males, 88 females) with a mean age of 19.64. Data analysis was conducted using SPSS 26 and AMOS 24. The study revealed that English reading strategy, motivation, cognitive load, and anxiety predict 75% of the variation in reading performance. The reading strategy partially mediated the relationship between reading motivation and performance. The relationship between reading anxiety and performance was fully mediated by cognitive load. Educators need to recognize the interconnected nature of learner-related variables, as well as the critical role that both cognitive load and reading strategies play in this mediation. To enhance Chinese undergraduates' English reading performance, instructors should boost students' reading motivation, teach students effective reading strategies, alleviate the reading-related anxiety, and provide students with reading materials of appropriate difficulties.*

Keywords: *Strategy; Motivation; Cognitive Load; Anxiety; Reading Comprehension Performance*

1. Introduction

Proficiency in reading a second language (L2) is crucial for academic achievement. The application of language learning strategies, along with learning motivation, cognitive load, and learning anxiety, is important factor that may influence learning English as a foreign language (EFL). Research indicates that effective language learning strategies enhance language acquisition [1]. Hong-Nam and Leavell [2] also identified a curvilinear correlation between English competence and strategy usage among 55 university students who learn English as a second language (ESL). Yu et al. [3] investigated both university students and middle school students and claimed that learning strategies and motivation were positively correlated with learning outcomes. Research by Steensel et al. [4] discovered that perceived difficulty obviously led to the variance in students' reading comprehension outcomes. Liu [5] explored the quasi-causal link between English performance and foreign language anxiety, revealing a significant negative correlation between these two variables. Nonetheless, research exploring the simultaneous relationships among all these variables is limited. Therefore, it is valuable to quantitatively analyze the relationships among these learner variables to understand their impact on English reading comprehension performance, potentially offering pedagogical insights for English teachers. The study of the interaction among the above personal differences is based on the Component Model of Reading that highlights the significance of both cognitive and affective factors in reading ability [6]. Theoretically, this study aims to uncover complex relationships among reading motivation, strategies, cognitive load, reading anxiety, and performance.

2. Theoretical background

2.1 EFL reading strategies

Language learning strategies are methods employed by individuals to enhance their acquisition and performance in a second language [7]. Strategies of language learning vary among learners and tasks, and interplay with other factors like anxiety, motivation, and outcomes [8]. Investigating language learning strategies and other individual factors enhances our understanding of their role in language acquisition

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[9]. Reading a second language text involves problem-solving activity. Skilled readers modify reading behaviors based on the text's complexity, task requirements, and contextual factors, therefore, the application of reading strategies is the strongest predictor of successful reading comprehension [10]. Mokhtari and Sheorey [11] classify reading strategies into three categories: global strategies for managing reading, such as setting a purpose; problem-solving strategies, including adjusting reading speed, inferring meanings of unknown words, and rereading; and support strategies, like underlining or highlighting information.

2.2 EFL reading motivation

Motivation is crucial in facilitating the learning of a foreign language [12]. Reading motivation encompasses an individual's goals, beliefs, and values about reading, reflecting their purposes, values, and perspectives on the themes, procedures, and outcomes of reading [13]. According to Eccles and Wigfield' s renowned expectancy-value theory [14], value is composed of four key elements: intrinsic value, extrinsic utility value, attainment value, and cost. Intrinsic value pertains to the satisfaction or enjoyment experienced when engaging in a task. In contrast, extrinsic utility value highlights the task's relevance or usefulness in achieving future goals. Attainment value is the subjective significance of excelling in a task in relation to an individual's fundamental personal needs and values. Cost denotes the negative valence and emotional burden associated with a task.

Motivation is crucial for a successful reading experience and serves as a predictor of reading performance [15]. Reading motivation is significantly linked to multiple indicators of reading comprehension [16]. For instance, research indicates that learners with higher motivation levels utilize a wider range of strategies than their less motivated counterparts [17].

2.3 Cognitive load

Researchers of Cognitive Load Theory (CLT) have categorized cognitive load into three types: intrinsic, extraneous, and germane [18]. Intrinsic cognitive load refers to the inherent characteristics of the information being processed. Instructional procedures determine extraneous cognitive load. Germane cognitive load involves the working memory demands during schema development and automation [19]. Bahari et al. [20] suggest that CLT indicates that overly complex information or inadequately designed instructional materials can elevate cognitive load. Excessive cognitive load can hinder information processing, negatively affecting reading comprehension performance [21].

2.4 EFL reading anxiety

Following the introduction of foreign language anxiety (FLA), research has transitioned from examining general language-related anxiety to focusing on skill-specific FLA, as noted by Saito et al. [22], the conception of foreign language reading anxiety (FLRA) was initially introduced in 1999. Research on FLRA is still emerging, having only recently gained attention compared to general FLA. Studies have shown that FLRA negatively predicts reading performance in foreign language learners. [23],[24] There are two sources of anxiety in FL reading, one being unfamiliar scripts and writing systems, and the other being unfamiliar cultural material [22]. Saito et al. assessed foreign language reading anxiety by developing the Foreign Language Reading Anxiety Scale, which has been applied in many follow-up studies. Research indicates a negative relationship between language anxiety and foreign language proficiency [25],[26].

3. Research aims and hypotheses

Oxford and Burry-Stock [27] discovered a correlation between strategy use and successful learning outcomes. Oxford and Nyikos [25] examined over 1200 undergraduates, concluding that motivation significantly impacts the selection of language learning strategies. Gardner et al. [7] conducted a survey among 102 university students and observed that foreign language learning motivation predicts learning achievement through learning strategies. Khamkhien [28] investigated 1405 Thai undergraduate students and found that motivation is an effective variable influencing the application of English learning strategies. Yau surveyed 396 Taiwanese high-school students and concluded that reading motivations directly influence strategy use and that strategy use affects L2 performance [29]. Hence FL reading motivation is likely to affects FL reading performance via reading strategies.

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Anxiety impacts readers' cognitive resource allocation, thereby influencing reading comprehension [30]. Reading anxiety makes readers' attention more likely on irrelevant text information, which will decrease their processing resources during reading. Anxiety elevates cognitive load, restricting information processing and negatively affecting reading performance [31]. In other words, anxiety may affect reading comprehension by mediating cognitive load.

In FL learning, reading strategies and motivation are generally beneficial, whereas reading anxiety and cognitive load tend to be detrimental. These factors interact with various other factors throughout the learning process. Whereas few studies have explored the correlation between all these variables concerning reading tasks. This research aimed to investigate the relationships among FFL reading strategy use, motivation, cognitive load, and anxiety, and their impact on EFL reading comprehension performance in higher education. To accomplish this purpose, we formulated the following hypotheses:

Hypothesis 1. EFL reading strategies are positively associated with motivation and reading performance.

Hypothesis 2. EFL reading motivation is positively associated with reading performance.

Hypothesis 3. EFL reading anxiety is positively related to Cognitive load but negatively related to reading performance.

Hypothesis 4. Cognitive load is negatively related to EFL reading performance.

4. Material and methods

4.1 Participants

Two hundred seventy-four undergraduate students (184 males and 88 females) in a comprehensive university in East China took part in the study. The participants were EFL learners with a mean age of 19.64 (SD = 0.77). They have been learning EFL for about 8 or 9 years. Only 15.3% of these students have passed the College English Test Band 6 (CET-6), a standard examination for assessing Chinese non-English majors' English proficiency. Data from two participants were excluded due to uniform responses across all survey questions. The survey was conducted while all students were enrolled in the course of English Reading and Writing.

4.2 Instruments

This research conducted one reading comprehension test and one survey which examined students' EFL reading strategies, motivation, cognitive load, anxiety, and reading performance. The questionnaire included three parts. The initial section gathered students' background details, including student number, age, gender, and CET-6 pass rate. The second section of the questionnaire includes a survey assessing students' reading strategies, motivation, cognitive load, and anxiety. This section consists of 29 items across four subscales, using a 7-point Likert scale ranging from 1 'strongly disagree' to 7 'strongly agree'. The third section required students to assess their English reading proficiency. The questionnaire items were developed in Chinese, as all participants were EFL learners with Chinese as their mother language.

4.2.1 EFL reading strategies subscale

A shortened version of Mokhari and Sheorey's Survey of Reading Strategies (SORS) [11] was utilized to measure students' reading strategies because of its demonstrated high reliability and validity in the pilot study. The SORS instrument was selected for measuring reading strategies due to its extensive field-testing across diverse student populations, comprising both native and non-native English speakers, as well as adolescent and adult learners. It demonstrated strong psychometric properties, including validity and reliability. With the help of two experienced colleagues in English reading comprehension instruction, 11 strategy statements were selected to create a condensed version of the instrument. The condensed version includes items most frequently used by the participants in a prior interview. The scale comprises three components: Global Reading Strategies (6 items), Support Reading Strategies (3 items), and Problem-Solving Strategies (2 items). Higher overall reading strategy scores suggest greater perceived utilization of these strategies. A sample question from the Global Reading Strategies subscale is: "Before reading, I have an overall view of the text to understand its general content." An illustrative item from the Problem-Solving Strategies is: "I adapt my reading speed based on the content." An example item of the Support Reading Strategies is "I go back and forth in the text to find relationships among ideas in the text". The scale's Cronbach's was 0.76.

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4.2.2 EFL reading motivation subscale

The researchers developed the English Reading Motivation Scale, grounded in the existing literature on foreign language reading motivation [32] to evaluate students' motivation for FL reading. The scale had 7 items, which contained two factors: intrinsic value motivation (2 items) and attainment value motivation (5 items). An example item of intrinsic motivation is "I take the initiative to do fragmented English reading online after class" and an example of attainment value motivation is "I want to expand my knowledge through English reading." A high grade would reflect high motivation in EFL reading. The Cronbach's alpha of the scale was 0.83.

4.2.3 Cognitive load subscale

This study employs the cognitive load scale to assess students' overall cognitive load during a reading comprehension task. The scale is an adapted version of the NASA-TLX evaluation scale [33], focusing on four categories: time demand, mental demand, frustration and effort. One of the example items is: "When I was doing the reading comprehension test, I felt very flustered". The scale had a Cronbach's α of .88.

4.2.4 EFL reading anxiety subscale

The Reading Anxiety Scale is an adaptation of the Foreign Language Reading Anxiety Scale [22]. It consists of six items in Saito's FLRAS and one self-designed item according to a prior survey conducted by the author. The scale's Cronbach's α was .85, closely aligning with the .86 reported in Saito's original study.

4.2.5 EFL reading performance

Students' EFL reading performance was assessed using a reading comprehension test and their self-rated reading proficiency. The reading test was based on the reading sections from four previous CET-6 exams. Research shows that the CET-6 examinations possess a high degree of reliability and validity [34]. The reading examination comprised four passages, each paired with five questions that required participants to choose the most appropriate answer. Each question was allocated a score of 5 points. The test had a maximum score of 100 points. The duration was limited to 45 minutes. The self-assessment used a 10-point Likert scale in the questionnaire's last section, where "1" represented the lowest reading comprehension and "10" was the highest.

4.3 Data Collection Procedure

Researchers informed participants about the study's purpose and secured their verbal consent before data collection. The questionnaire was first uploaded by the author to an online survey platform (http://www.wjx.cn/), where a corresponding QR code was generated. Secondly, participants took the reading comprehension test during an English class. Following the reading comprehension test, assisting teachers provided students with a QR code linking to the online survey. The students subsequently used their smartphones to scan the QR code and complete the questionnaire online.

4.4 Statistical processing

The data analysis was conducted using SPSS 26.0, encompassing common method bias testing, reliability analysis, independent sample testing, and Pearson correlation analysis. Additionally, AMOS 24.0 was employed for structural equation modeling to evaluate the reliability and validity of the questionnaire items and to estimate the path coefficients.

5. Results and discussion

5.1 Exploratory factor analyses (EFA) of questionnaires

Since the FL reading motivation scale was self-designed and the other 3 subscales were adapted and different from the original scales, an EFA was initially carried out to identify the factor structure of the questionnaire.

The questionnaire retained four factors comprising a total of 24 items (KMO=0.85). The measurement demonstrated acceptable reliability across four factors: 'reading strategies' (8 items, Cronbach's α=.85), 'reading motivation' (6 items, Cronbach's α=.78), 'cognitive load' (3 items, Cronbach's α=.84), and 'reading anxiety' (7 items, Cronbach's α=.82).

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5.2 Common method bias test

The Harman single-factor test identified five factors with eigenvalues greater than one among all measured items in this study. The first factor explained 23.07% of the total variance, which is below the 40% threshold, suggesting the absence of significant common method bias in this study (Podsakoff and Organ, 1986).

5.3 Correlation analysis

Bivariate correlations, means, and standard deviations for reading strategy, reading motivation, cognitive load, reading anxiety, reading examination score, and self-evaluation of reading performance are listed in Table 1. Table 1 shows the skewness and kurtosis coefficients for all variables. All absolute values are less than 1, suggesting the data closely follows a normal distribution. Consequently, a Pearson Correlation analysis was conducted.

Table 1: Descriptive statistics and correlation of variables.

	MEAN	SD	1	2	3	4	5	6
1.Strategy (8 items)	5.51	.87	1					
2.Motivation (6 items)	4.20	.79	.47**	1				
3.Cognitive load (3 items)	4.68	1.36	.01	-.11	1			
4.Anxiety (7 items)	4.63	1.20	.05	-.05	.57**	1		
5.Test [a]	56.84	16.11	.07	.22**	-.37**	-.17**	1	
6.Self-rating [b]	5.56	1.86	.24**	.33**	-.44**	-.29**	.32**	1
7.Skewness			-.31	.15	-.30	-.35	-.09	-.67
8.Kurtosis			.25	.00	-.23	-.04	-.52	.38

Note. ** $p<0.01$; a possible range of reading test score = 1-100; b possible range of self-rating score = 1-10. Mean of strategy, motivation, cognitive load and anxiety is the mean score of the items in each category.

Table 1 indicates that the average reading comprehension test score is 56.84, which may contribute to the low pass rate of 15.3% for the CET-6 examination, as previously discussed. The findings indicated that all independent variables, except for reading strategy, were significantly correlated with participants' reading comprehension and self-rating scores. The coefficients between learner factor variables and self-rating scores were larger than those between learner factor variables and objective reading test scores. The findings suggest that reading strategy correlates positively with both motivation for reading and self-assessed reading proficiency. Motivation for reading is positively related to reading test scores as well as self-assessment scores. Cognitive load shows a positive relationship with reading anxiety and a negative relationship with both reading test and self-assessment scores. Reading anxiety negatively impacts both reading test and self-assessment scores. Additionally, students' reading test scores are positively linked to their self-evaluated reading ability scores. Thus, all the four previous hypotheses are confirmed here. Pearson correlation analysis showed a positive relationship between students' reading anxiety and cognitive load, and a negative relationship with reading performance, supporting Saito et al.'s findings. According to Saito et al.'s study (1999), students with higher reading anxiety tended to receive lower grades, and their anxiety levels rose with perceived difficulty in foreign language reading, leading to further grade declines.

According to the result of the correlation analysis, we intended to test the further hypotheses:

Hypothesis 5. Reading motivation influences reading performance through reading strategy.

Hypothesis 6. Reading anxiety influences reading performance through cognitive load.

5.4 Confirmatory factor analysis (CFA) of questionnaires

We subsequently used CFA to provide additional validation for the questionnaires on reading strategy, motivation, cognitive load, and anxiety. Following the CFA, the finalized instrument comprised 15 items: four items each for reading motivation, reading strategy, and reading anxiety scales, and three items for the cognitive load scale (refer to Table 2).

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Table 2: Coefficient of the measurement model.

		UNSTD.	S.E.	T-VALUE	STD.	SMC	CR	AVE
Motivation	Motivation3	1.00			.64	.41		
	Motivation4	1.14	.11	10.01	.85	.72	.81	.51
	Motivation5	.91	.10	9.14	.71	.50		
	Motivation7	.92	.11	8.66	.65	.43		
Strategy	Strategy10	1.00			.81	.66		
	Strategy8	1.00	.07	15.03	.88	.78	.88	.64
	Strategy7	1.01	.08	12.52	.74	.55		
	Strategy11	.90	.07	13.73	.76	.58		
CL	CL3	1.00			.74	.55		
	CL2	1.09	.09	12.11	.84	.70	.84	.64
	CL1	1.23	.10	12.09	.83	.68		
Anxiety	Anxiety7	1.00			.67	.45		
	Anxiety6	1.20	.11	10.59	.79	.62	.82	.54
	Anxiety5	1.18	.11	10.32	.81	.65		
	Anxiety2	.93	.10	9.03	.66	.44		

Note. CL=Cognitive Load

We conducted a CFA analysis to evaluate the convergent validity, internal consistency reliability, and discriminant validity of the constructs of the model, specifically focusing on reading strategy, motivation, cognitive load, and anxiety. The findings showed the composite reliability of every construct was between 0.81 and 0.88, surpassing the 0.7 recommended value, thereby demonstrating reliability of internal consistency. All items' factor loadings were statistically significant ($p<0.001$). All constructs had average variance extraction (AVE) between 0.51 and 0.64, above the 0.5 recommended value and demonstrated good convergent validity. According to Table 3, discriminant validity was supported because the estimated intercorrelations between the components were not higher than the square roots of their individual AVE.

Table 3: Discriminant validity of the constructs.

	AVE	ANXIETY	CL	MOTIVATION	STRATEGY
Anxiety	.54	(0.73)			
Cognitive Load	.64	0.64	(0.80)		
Motivation	.51	-0.06	-0.02	(0.72)	
Strategy	.60	0.02	0.06	0.41	(0.80)

Note. The square roots of AVE are on the diagonal.

Additionally, the structural modeling results (x2/df=1.904, TLI=0.938, CFI=0.948, IFI=0.949, RMSEA=0.058, SRMR=0.055, AGFI=0.892, GFI=0.920) also proved the proposed model fit the data

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properly.

A path analysis was performed to identify causal links between individual variables and reading performance. Figure 1 illustrates that participants' reading performance was positively influenced by reading motivation (β=.25, p<0.01) and reading strategy (β=.40, p<0.001), while negatively affected by cognitive load (β=-.71, p<0.001). Reading anxiety did not have a direct predictive effect (β=.06, p=0.55). Reading motivation significantly predicted reading strategy (β = .41, p < 0.001). Reading anxiety significantly predicted cognitive load positively (β=.63, p<0.001).

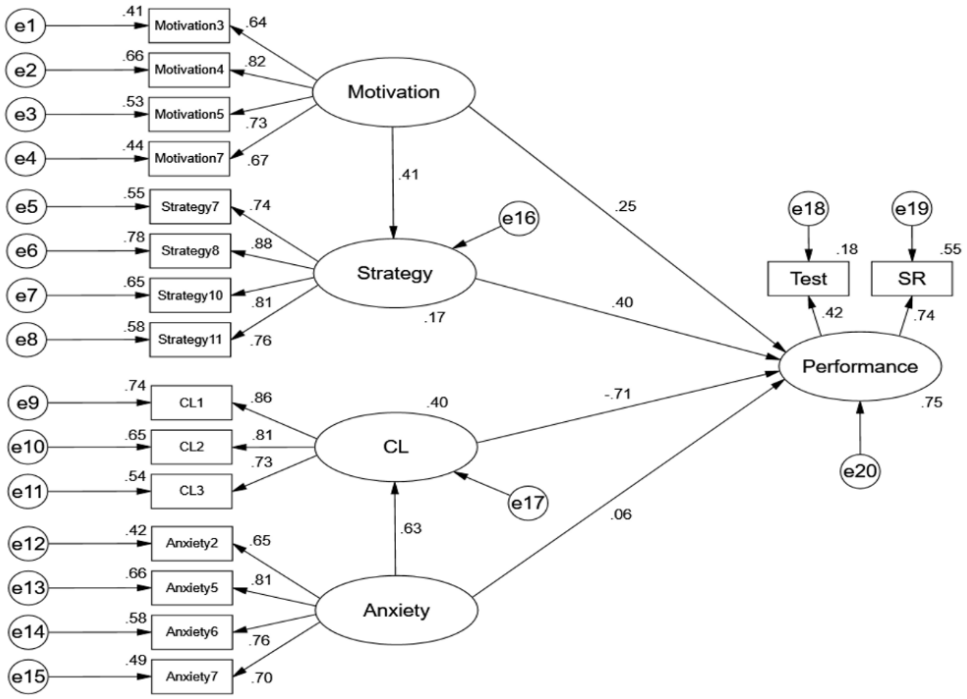

Figure 1: Results of 4 variables and reading performance path analysis.

We utilized the bootstrapping method in AMOS 24 to find out the potential indirect effects of reading strategy and anxiety on reading performance. Following Hayes (2009), we computed the confidence interval for the lower and upper bounds to assess the significance of the indirect effects (refer to Table 4). An analysis with 5000 bootstrapped samples identified a significant partial mediation of reading strategy between reading motivation and performance (unstandardized indirect effect = 1.158), and a significant full mediation of cognitive load between reading anxiety and performance (unstandardized indirect effect = -2.665). Therefore both hypotheses 5 and 6 are confirmed

Table 4: Unstandardized direct, indirect, and total effects of the hypothesized model.

	POINT ESTIMATED	Product of Coef		Bias-corrected		Percentile		Two-tailed significance
		SE	Z	Lower	Upper	Lower	Upper	
			Indirect effect					
Mot→Perf	1.158	0.351	3.299	0.637	2.140	0.513	1.891	.000(***)
			Direct effect					
Mot→Perf	1.756	0.735	2.389	0.567	3.576	0.447	3.321	0.003(**)
			Total effect					
Mot→Perf	2.914	0.781	3.731	1.650	4.870	1.427	4.474	000(***)
Indirect effect								

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RA→Perf	-2.665	0.860	-3.099	-4.648	-1.199	-4.471	-1.098	.000(***)
Direct effect								
RA→Perf	0.367	0.761	0.482	-0.931	2.047	-0.966	2.011	0.647
Total effect								
RA→Perf	-2.299	0.656	-3.505	-3.928	-1.268	-3.684	-1.112	.000(***)

Note. N=272. Mot=motivation, Perf =performance, RA=reading anxiety, ** p<0.01 *** p<0.001

It is unavoidable that students are expected to read materials with difficult content. One possible way to reduce students' reading anxiety is to offer reading strategy instruction[35]. Systematically organized instruction or training is necessary. English teachers should seek practices that will help learners improve their English reading strategies to help students acquire effective reading approaches and boost reading proficiency in the English reading process. Teachers should strive to foster a supportive and encouraging reading environment to alleviate students' anxiety and enhance their confidence and enjoyment in EFL reading.

Although the research result showed that cognitive load is negatively correlated with reading performance, not all methods to lessen cognitive load in foreign language reading are beneficial to learners. In the process of EFL teaching, the cognitive load should be optimized. Because if the cognitive load in the reading process is too low, it will cause a waste of resources and time; while if the cognitive load is too high, it will hinder the learner's processing of information. English teachers should select reading materials that are suitably challenging without causing cognitive overload to facilitate knowledge acquisition with minimal psychological strain.

6. Conclusions and implications

This study examined the relationships among EFL reading strategy use, motivation, cognitive load, anxiety, and their impact on EFL reading performance. This research leads to the following conclusions:

Firstly, structural equation modeling revealed that EFL reading strategy, motivation, cognitive load, and anxiety explained 75% of the variation in reading performance. Reading motivation accounted for 17% of the variation in reading strategies and reading anxiety accounted for 40% of the variation in cognitive load.

Secondly, reading motivation is a positive predictor of both reading performance and reading strategies. Reading strategies partially mediate the relationship between reading motivation and performance.

Thirdly, reading anxiety positively predicts cognitive load but negatively predicts reading performance. Cognitive load completely mediates the relationship between anxiety and reading performance.

A high level of English reading proficiency is a basic quality that all university students should have, and it is also a requirement for cultivating international talents. University students' English reading proficiency will make a great difference in their future study, work, and life. Therefore, English teachers should try every means to enhance students' EFL reading motivation and at the same time help them acquire more reading strategies so as to improve their EFL reading ability. In the meantime, choosing reading texts with appropriate difficulty for students is beneficial to lower their anxiety as well as intrinsic cognitive load during the reading process. EFL reading instruction should also be designed based on CLT which may result in better reading performance rather than using a randomized and conventional design which unnecessarily increase students' extraneous cognitive load.

The findings indicate that the model provides a framework for understanding the interrelationships among individual variables such as reading motivation, strategies, anxiety, and cognitive load. However, this does not prove to be the only correct model. Alternative models could potentially fit the data with equal effectiveness. Future research should continue to explore how learner difference variables affect EFL reading performance.

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7. Limitations and future studies

The research findings present implications for both pedagogy and further study. However, there are certain limitations to the research that need to be taken into account. The study, involving 272 non-English major undergraduates, was conducted at a single university in eastern China. Surveys at different universities in China or in other countries might produce varied outcomes. Therefore, the study's participants might not encompass the entire range of undergraduates learning EFL reading. Future research should include a larger sample size encompassing a wider context. Secondly, cross-sectional data analysis was the only method used in the study. To properly examine the temporal and dynamic relationships, other researchers can consider carrying out longitudinal studies to gain a deeper understanding of the temporal and dynamic relationships between reading strategies, reading motivation, cognitive load, reading anxiety, and EFL reading comprehension performance.

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